TECHNICAL BACKGROUND DOCUMENT

Environmental Evaluation of Existing and Proposed Mining Operations VOLUME II

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3.0 AFFECTED ENVIRONMENT

3.1 Physiographic Characteristics

3.1.1 Physiography

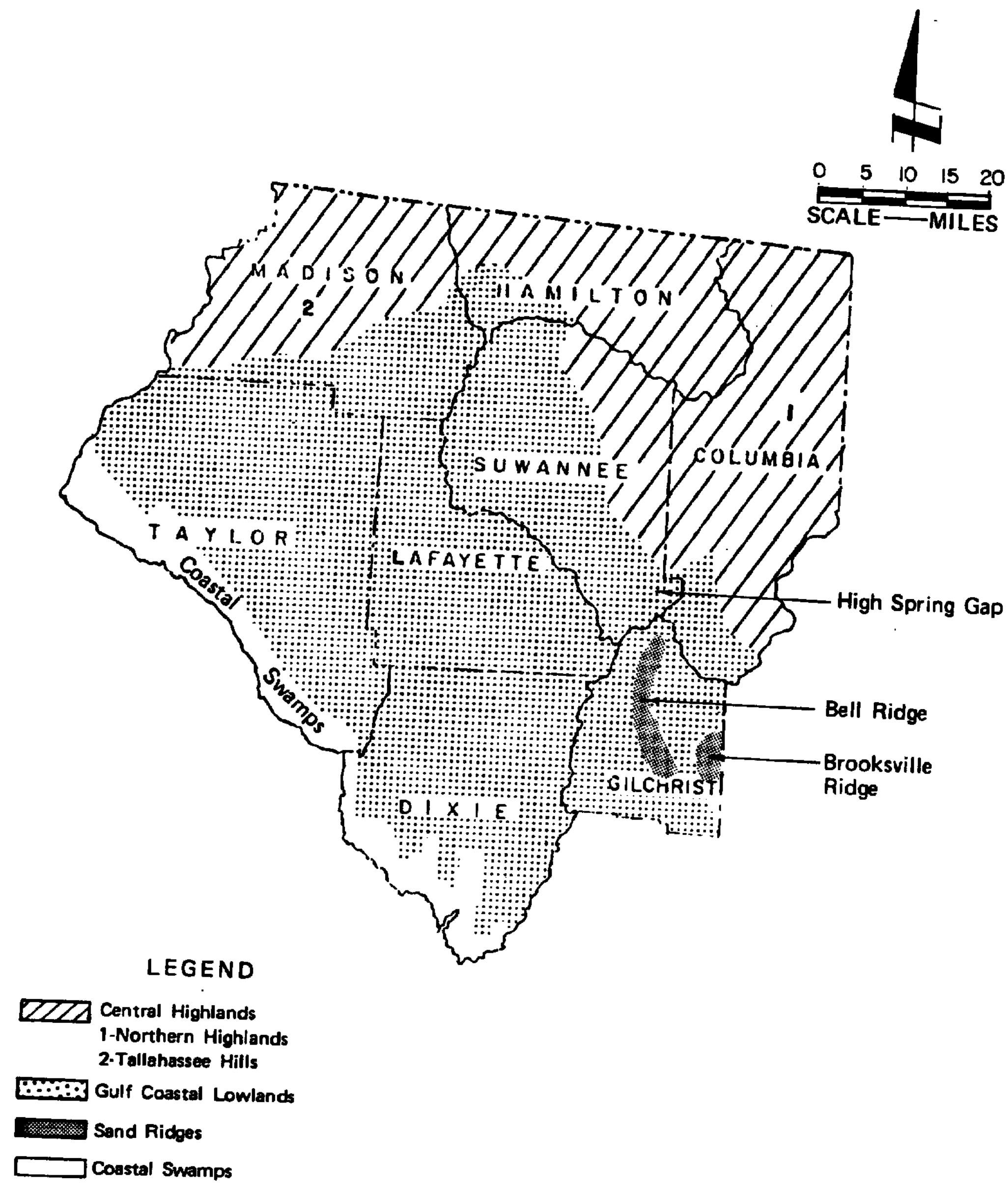
Northern peninsular Florida consists of wide belts of flatlands which extend inland from each coast (Coastal Lowlands) and merge with a high central region (Central Highlands) (Cooke 1939). Puri and Vernon (1964) subdivide these two physiographic regions into the Gulf Coastal Lowlands and the Northern Highlands/Tallahassee Hills, respectively (Figure 3.1-1). The boundary between the Gulf Coastal Lowlands and the Northern Highlands/Tallahassee Hills is an "outward facing scarp" locally called the Cody Scarp (Puri and Vernon 1964). The continuity of the Cody Scarp, which is approximately coincident with the 100-ft elevation contour line, is unbroken except where the deep stream and river valleys have dissected it.

The locations and elevations of glacial-age Pleistocene terraces in Florida have been the subject of considerable research (Table 3.1-1; Cooke 1945; MacNeil 1950; Meyer 1962; Cathcart 1963a,b,c; White 1970). MacNeil (1950) and Cathcart (1963a,b,c) consider terraces above 150 ft to be riverine deposits and those below 150 ft to be of marine origin.

The Highlands area consists of lands with terraces as high as the Coharie and Sunderland terraces (Figure 3.1-2). The remnants of the Coharie and Sunderland terraces form a high ridge which crosses central Columbia County from west to east. The Okefenokee terrace was formed when sea level was about 150 ft above the present level and includes the basin of the present Okefenokee Swamp. The Okefenokee Swamp ranges in altitude from about 90 to 130 ft NGVD and was once occupied by a shallow intracoastal bay or sound (MacNeil 1950).

Meyer (1962) reports that the Lake City Ridge existed as a chain of islands or keys which formed the southern boundary of the ancestral Okefenokee Sound. The surface of the ridge is a sandy, almost level, poorly to well-drained area. Solution depressions and sinkhole lakes are common, the largest of which are Ocean Pond in Baker County and Alligator Lake in Columbia County.

The Lake City Ridge forms a surface water divide between water flowing to the north and to the south. The ridge is drained to the north by tributary streams of the Suwannee River which lie to the north and west, and by tributaries to the St. Mary's River to the east of the Suwannee River. The ridge forms the drainage divide for the Santa Fe River basin to the south.



From White 1970 and Puri and Vernon 1964

Figure 3.1-1. Regional Physiography.

Table 3.1-1. Terraces Formed by Fluctuating Seas.

Pleistocene Age	Terrace and Shoreline Elevation (ft NGVD*)
Nebraskan (glacial) Aftonian (interglacial)	Coharie (220)
Kansan (glacial) Yarmouth (interglacial)	Okefenokee (150) and/or Sunderland (170)
Illinoian (glacial) Sangamon (interglacial)	Wicomico (100)
Early Wisconsin (glacial) Peorian (interglacial)	Pamlico (25-30)
Late Wisconsin (glacial) Two Creeks (interglacial)	Silver Bluff (8)

* National Geodetic Vertical Datum.

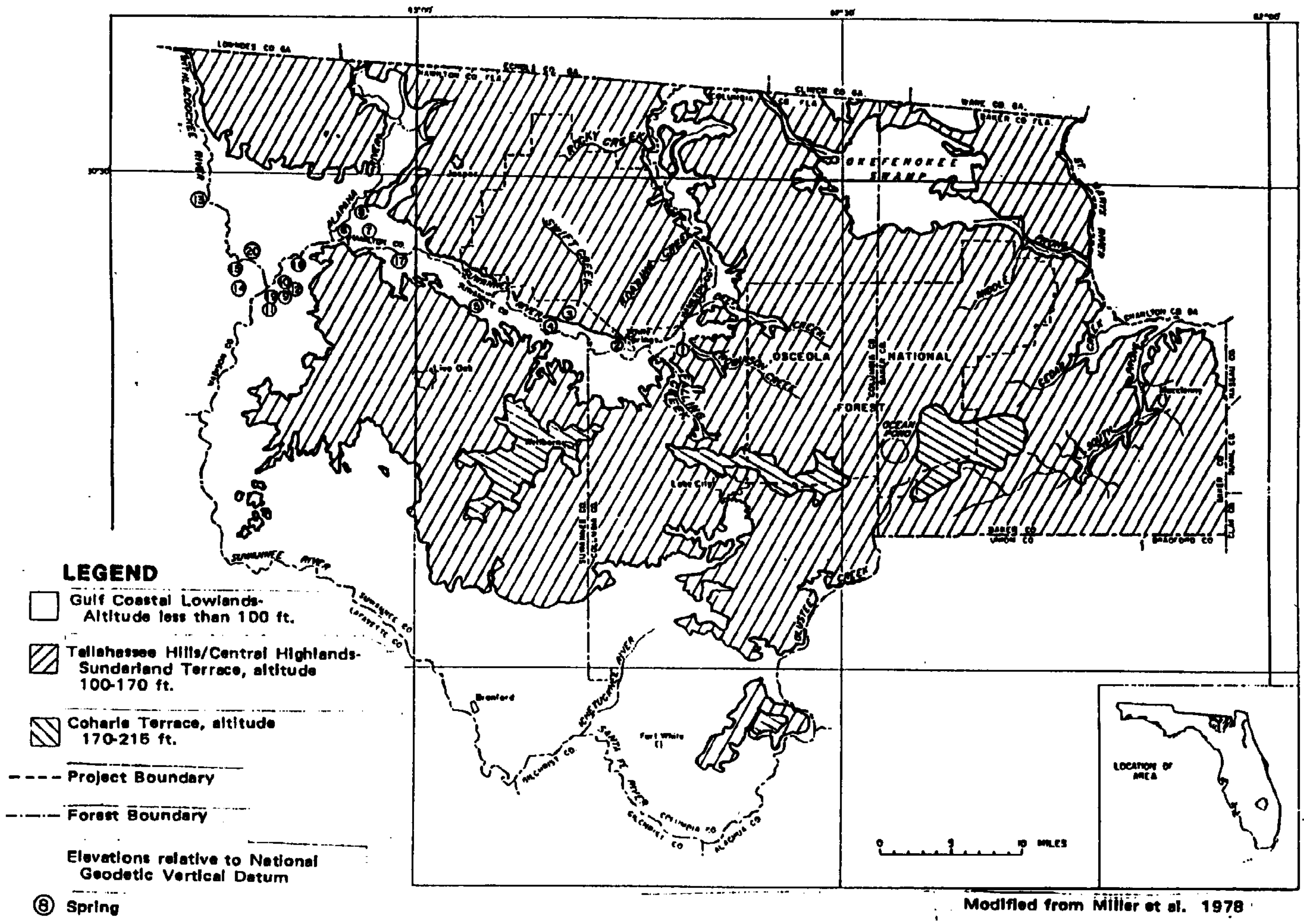


Figure 3.1-2. Physiographic Divisions of Baker, Columbia, Hamilton, and Suwannee Counties, Florida.

The Suwannee River changes direction from south to west at a point approximately 6 mi east-northeast of White Springs where its valley crosses and intersects a hard calcareous bed of clay; the river crosses and intersects limestone between this point and White Springs (Meyer 1962). Above the point of limestone intersection, the flow in the river depends mostly on runoff from local rainfall. Below the point of intersection, the increased baseflow of the river is attributed to large springs in the exposed limestone. Colton (1978) reports that 92% of the total length of the rivers cutting the Suwannee Limestone in Hamilton County (i.e., Alapaha, Suwannee, and Withlacoochee) can be attributed to either a primary or secondary joint pattern. The primary joint pattern has a dominant fracture direction of N65W±15° and a subordinate direction of N37E±15°. The secondary joint pattern has a dominant fracture direction of N6W±15° and a secondary fracture direction of N75W±10°.

Miller et al. (1978) report that the Highlands area is underlain by a thin sequence of clastic sediments of post-Miocene age which are separated from limestone bedrock by a thick sequence of consolidated or semi-consolidated Miocene clastic and carbonate strata. Therefore, few karst features are surficially evident on the Highlands in the region except at lower altitudes in the Gulf Coastal Lowlands and in the area of the scarp. Most surficially recognizable sinkholes and other karst features in Baker, Columbia, Hamilton, and Suwannee counties occur in southern and western Suwannee and Columbia counties and central and western Hamilton County.

The Coastal Lowlands (25-100 ft NGVD) is a region of karst topography terraced by several Pleistocene interglacial periods (Meyer 1962). The surfaces of the terraces have been modified greatly by erosion and surface collapse of the underlying limestones. Aerial photographs show many circular sinkholes which are aligned principally parallel or normal to the major drainage features and which are connected at the surface by gulleys or valleys of intermittent streams of an ancestral drainage system. The few perennial streams crossing the Coastal Lowlands are fed predominantly by springs rather than by surface runoff.

Brooks et al. (1966) state that the major concentrations of pebble phosphate in north peninsular Florida are of riverine origin associated with the ancient eroded straits of the Suwannee River, Olustee Creek, the New River, the Santa Fe River, and several creeks. They suggest that all of the rivers of the Suwannee River system, which now flow to the Gulf of Mexico, once flowed northeast off the Ocala Arch to the Atlantic Ocean. The time at which the headwaters of the ancestral Suwannee River were captured by the present Suwannee River, eroding from the Gulf of Mexico eastward, is not known. Once the Miocene clastics were eroded, karst development probably occurred rapidly on the Ocala Arch, probably early in the Pleistocene Age.

The present Suwannee River exhibits several changes in form as it passes through the project area. North of Rocky Creek, the Suwannee River has a low, broad floodplain; from that point downstream to White Springs, the river is deeply incised and flows in a direction that is generally up-dip to the underlying formations. Westward from White Springs, the river is deeply incised and flows parallel to the strike of the formations. The alignment of the river is undoubtedly controlled in part by faults or jointing.

The OXY project area is located within the Northern Highlands and is characterized by a relatively high flat land surface (elevation 125-150 ft NGVD) drained by a number of tributaries to the Suwannee River, including Rocky Creek, Hunter Creek, Roaring Creek, Long Branch, Four Mile Branch, Sal Marie Branch, Swift Creek, Camp Branch, Jerry Branch, Sugar Creek, Ratliff Creek, and several small unnamed creeks. The Suwannee River streambed ranges from approximately 50 ft NGVD in the vicinity of the mouth of Camp Branch (approximately 4 mi downstream from the mouth of Swift Creek) to approximately 85 ft NGVD at the Florida-Georgia border. Because of the presence of low permeability clastic surficial sediments, sinkholes are not common in the area, and shallow, low velocity streams have developed to carry the surface water runoff. As the streams approach the Cody Scarp (i.e., elevation approximately 100 ft NGVD), the channels become incised until reaching the Suwannee River.

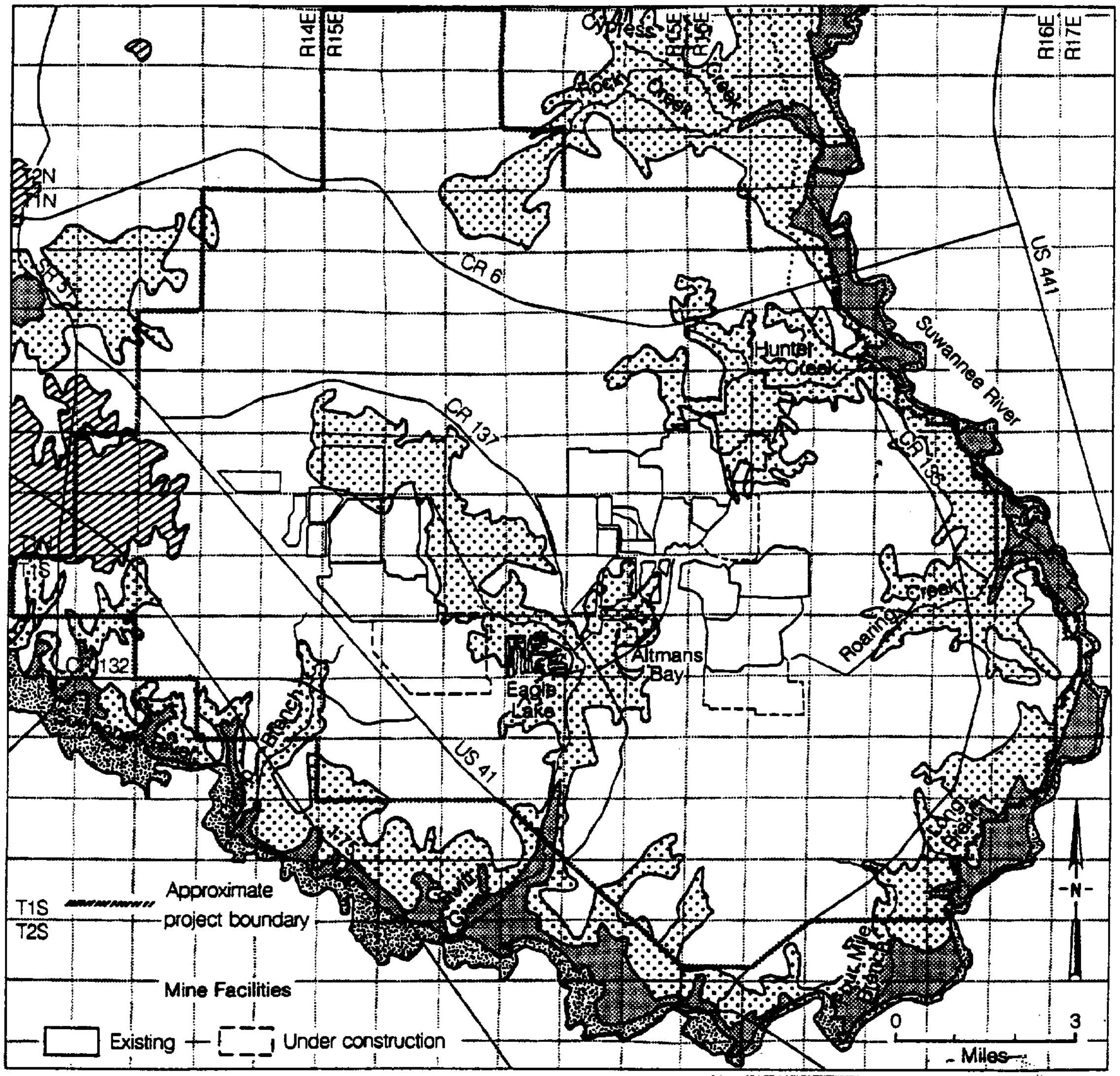
3.1.2 Topography

The Lake City Ridge (maximum elevation 215 ft NGVD) separates the upper and lower Suwannee River (Miller et al. 1978). Most of the Northern Highlands region has land surface elevations between 100 and 170 ft NGVD. The major river valleys (i.e., Suwannee, Alapaha, and Withlacoochee) in the Gulf Coastal Lowlands have land surface elevations <100 ft NGVD.

The land surface elevations of the site range from >150 ft NGVD in the vicinity of Jasper to <50 ft NGVD in the Suwannee River in the vicinity of the mouth of Swift Creek (Figure 3.1-3). A large portion of the project area is at 125-150 ft NGVD, with slight depressions along the major tributaries (100-125 ft NGVD). The Suwannee River and its floodplain are typically between 50 and 100 ft NGVD.

Between the Florida-Georgia state line and Ellaville, Florida, a 75-mi reach, the Suwannee River streambed ranges from 74 ft NGVD to 17 ft NGVD (Figure 3.1-4). Upstream from Big Shoals, in the vicinity of the mouth of Deep Creek (elevation approximately 65 ft NGVD, River Mile 180), the streambed slope is uniform and drops at a rate of 0.3-0.4 ft/mi. Between the mouth of Deep Creek and the vicinity of White Sulphur Springs (River Mile 167), the river drops 37 ft in 13 mi, producing a slope of 2.8 ft/mi. At the mouth of Swift Creek (River Mile 164), the streambed is 32-33 ft NGVD. In the vicinity of the U.S. Geological Survey (USGS) gaging station at Suwannee Springs, the streambed elevation is 29 ft NGVD with a slope of approximately 1.2 ft/mi. Approximately 16 mi upstream of Ellaville, the streambed drops to its lowest elevation (17 ft NGVD). At Ellaville the streambed is 20 ft NGVD.

A review of streambed profiles of Rocky Creek, Roaring Creek, Swift Creek, Hunter Creek, and several creeks along the east side of the



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

- Elevation >150 ft NGVD
- Elevation 125-150 ft NGVD
- Elevation 100-125 ft NGVD
- Elevation 75-100 ft NGVD
- Elevation 50-75 ft NGVD

Figure 3.1-3. General Topography of Site.

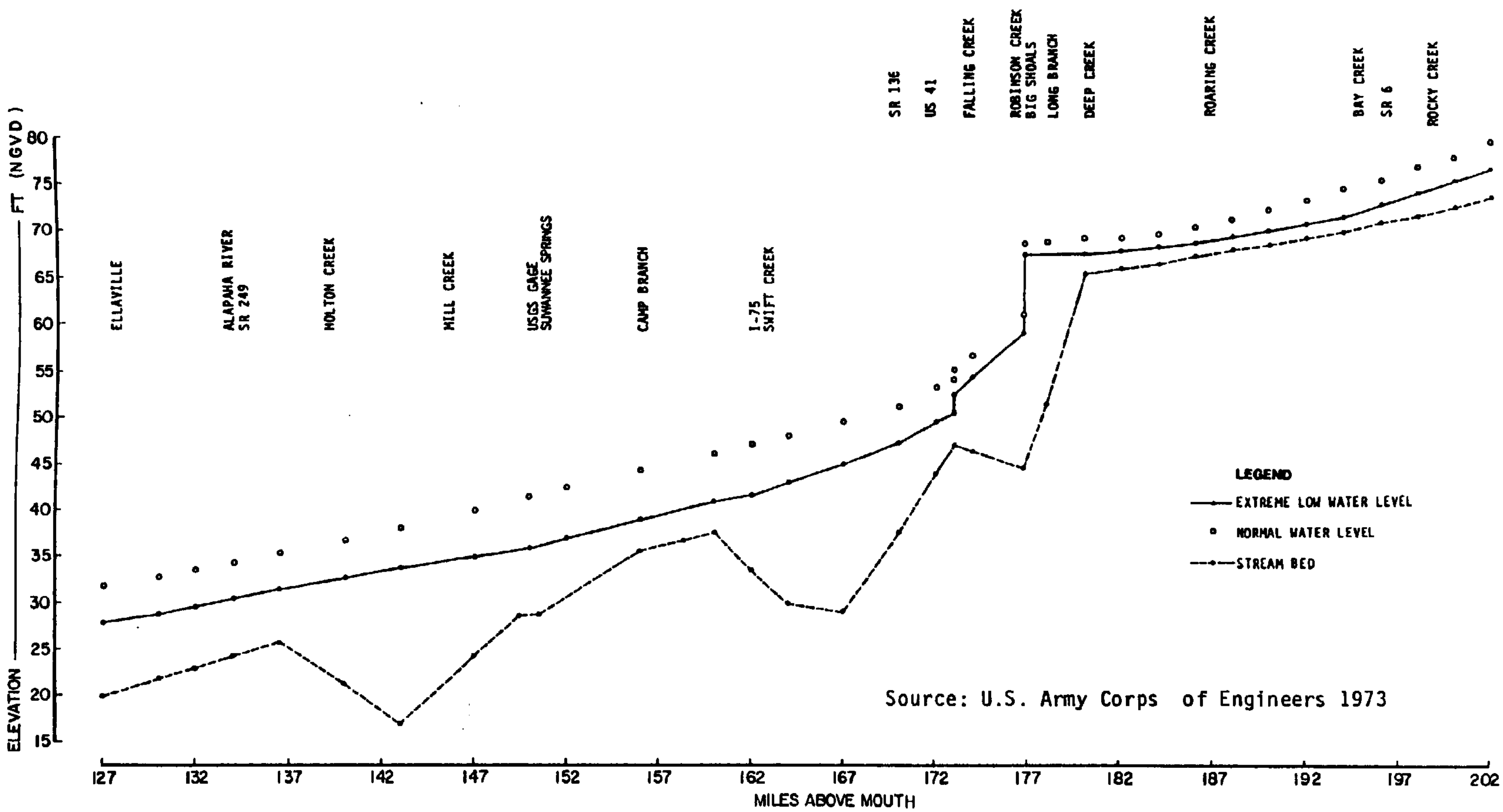


Figure 3.1-4. Streambed Profile of Suwannee River.

Suwannee River (Figures 3.1-5 and 3.1-6, PELA 1977) reveals the following characteristics:

1) Approximately 8-9 mi upstream from the Suwannee River, the streambeds of the tributaries flatten out to a slope of ≤1 ft/mi.

2) The large swamps (i.e., Swift Creek Swamp and Bee Haven Bay) occur in this relatively flat part of the streambed profile.

3) The flat slope of 1 ft/mi on these tributaries approximates the slope of the Suwannee River above the Big Shoals (River Mile 180).

4) The slope of the tributary streams is concave as opposed to convex. In geomorphology, the concave slope typically represents a young stream system as opposed to an old stream system (Thornbury 1969).

3.1.3 Geology

3.1.3.1 Depositional Environment

Florida is part of the eastern Gulf of Mexico sedimentary basin. Pressler (1947) divided the basin into two sedimentary provinces based on sediment origin: the Panhandle Florida and Peninsular Florida provinces. The boundary between these two provinces is a line generally running from Levy County northeast to Nassau County, Florida. North of this line are found predominantly clastic sediments (sands and clays) of terrigenous origin, and toward the south are found non-clastic (carbonate and evaporite) sediments of marine origin. Although the project area is located north of the boundary drawn by Pressler, the encountered sediments of the Hawthorn and deeper units are primarily carbonates. This can be explained by the shifting of the boundary through time (Chen 1965). Therefore, the project area is considered to be a transitional zone between the two sedimentary provinces.

3.1.3.2 Structural Features

The Peninsular Arch, Ocala Uplift, Southeast Georgia Embayment, and Suwannee Straits are the four major structural features in the vicinity of the project area (Figure 3.1-7). The Peninsular Arch, which was formed during the Mesozoic era, is a deep subsurface feature which extends south-southeastward down the Florida peninsula from southern Georgia to southeastern Florida. During the Cretaceous, the arch was topographically high, and sediments were deposited on the flanks of the structure but did not completely cover it. Upper Cretaceous and younger sediments were deposited over the crest of the arch.

The Ocala Uplift, which formed during the Tertiary, is the major near-surface structural feature in Florida and lies on the southwestern flank of the Peninsular Arch. The Ocala Uplift affected the thickness and depositional patterns of Middle Eocene and younger sediments. The Southeast Georgia Embayment is a downwarped area lying to the north and

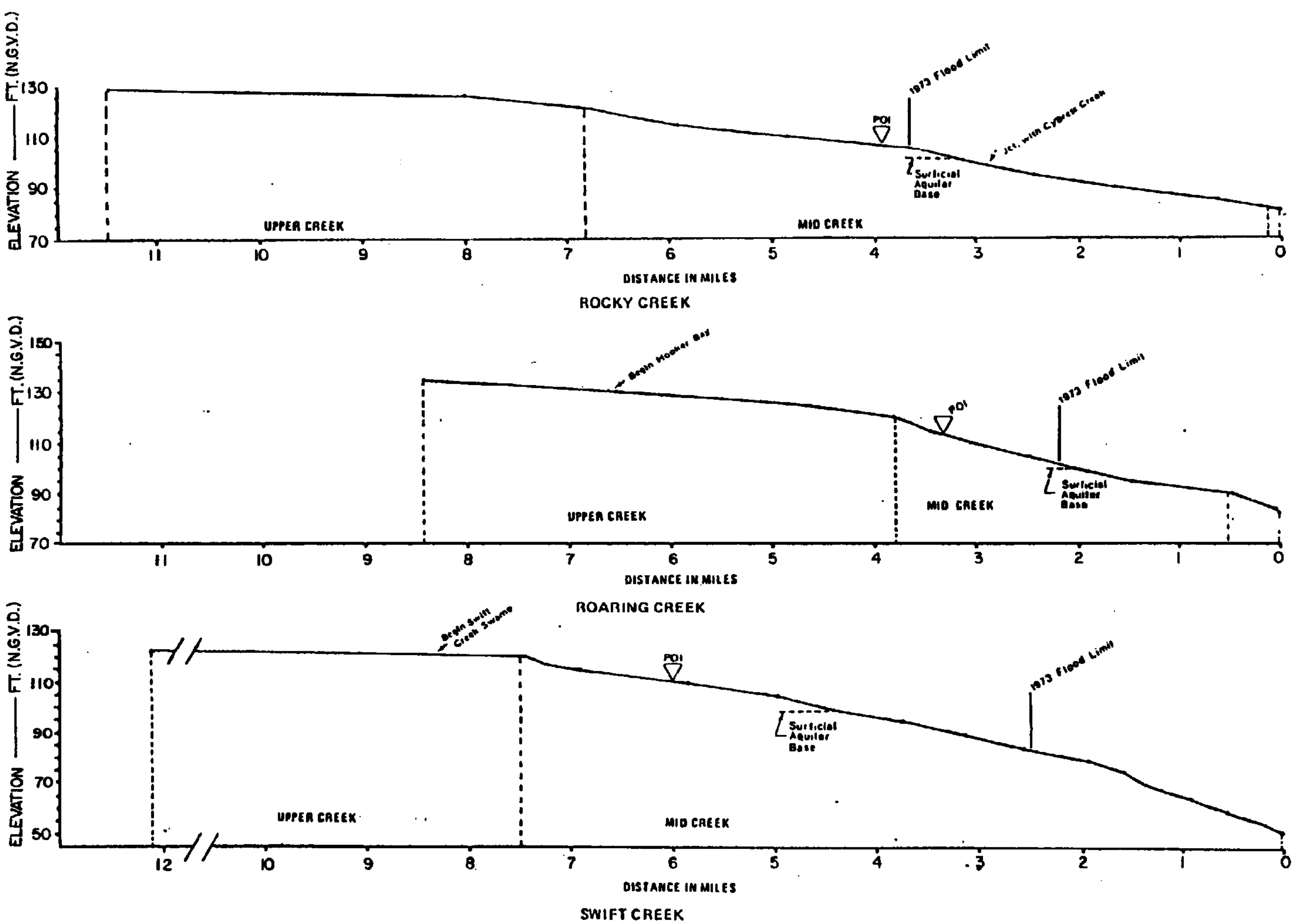
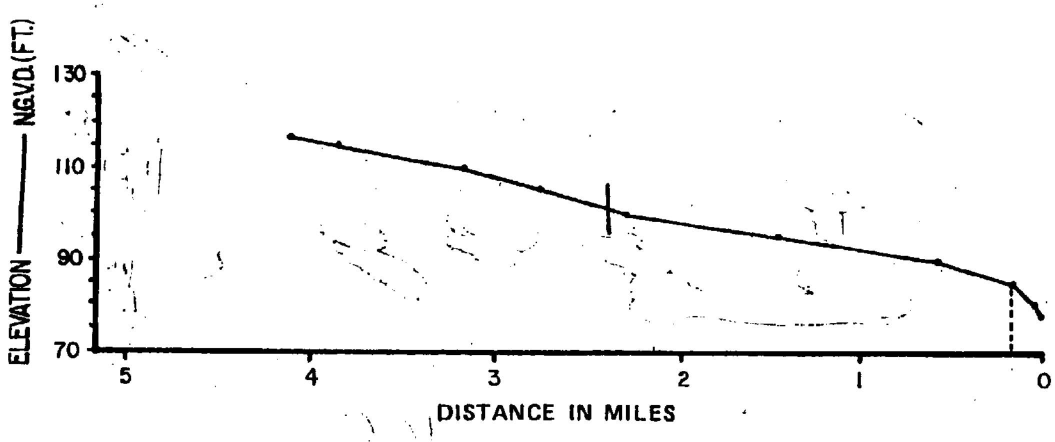


Figure 3.1-5. Streambed Profiles of Selected Tributary Streams of the Suwannee River in the Study Area.



HUNTER CREEK

Figure 3.1-5 (Continued).

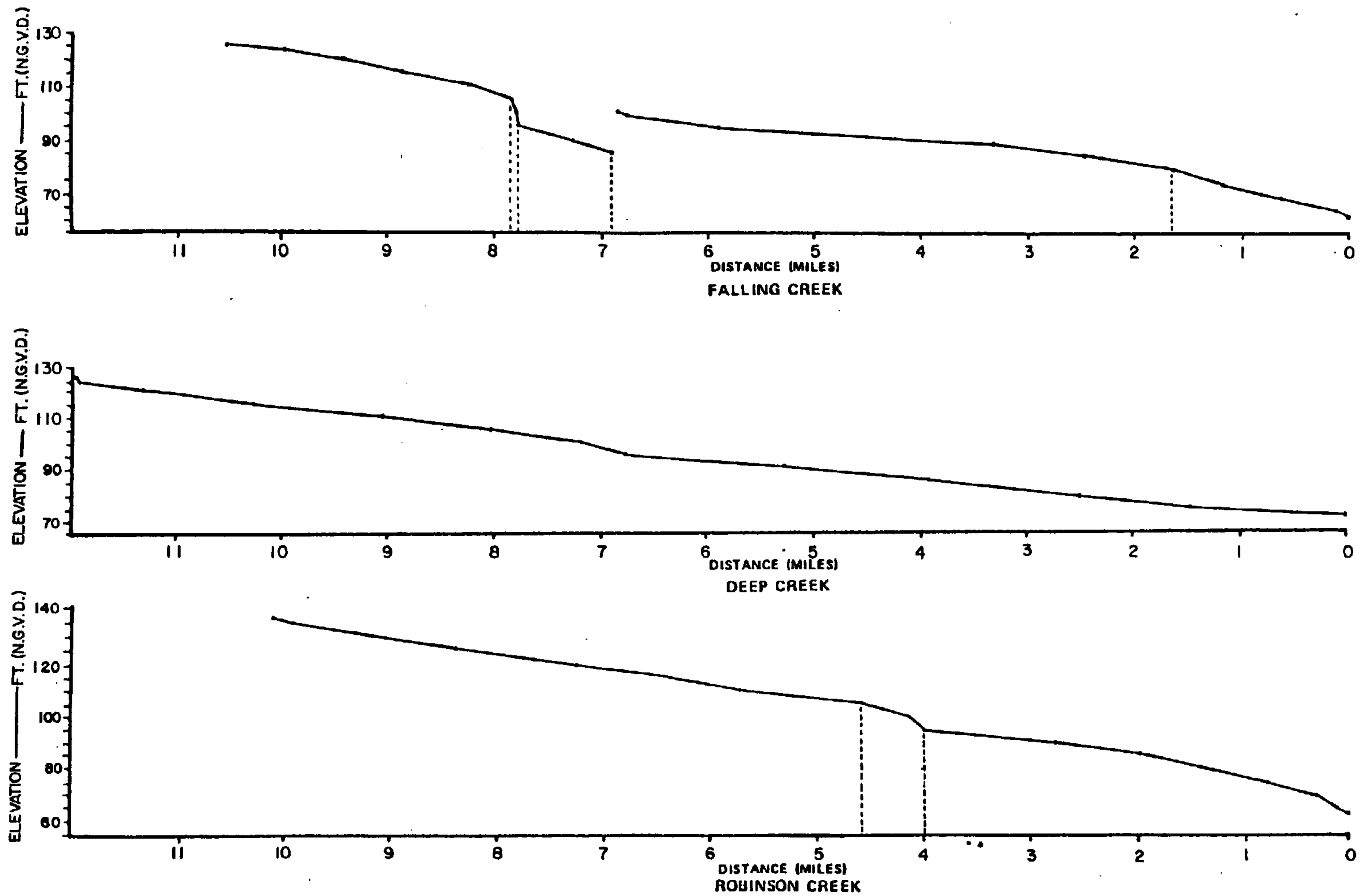


Figure 3.1-6. Streambed Profiles of Selected Tributary Streams of the Suwannee River near the Study Area.

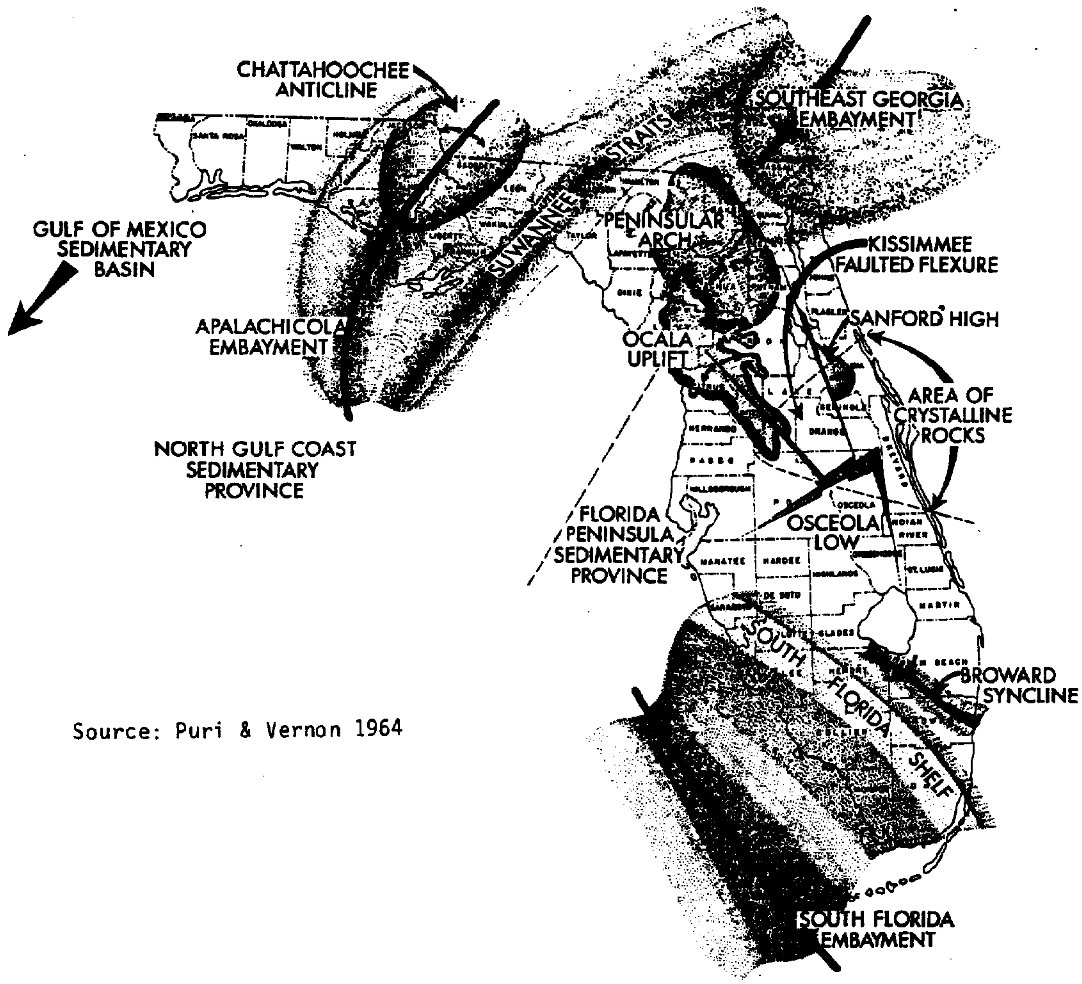


Figure 3.1-7. Major Structural Features.

east of the Peninsular Arch containing a thick sequence of Mesozoic and Cenozoic-age deposits.

The Suwannee Straits is a northeast-southwest trough lying north of the Peninsular Arch. The Straits formed a natural barrier to the southward transport of clastic sediments and, therefore, accumulated fine sands, clays, and limestones during the Upper Cretaceous to Lower Eocene. By the middle of the Eocene, the Straits probably were no longer an effective barrier, and the clastic facies moved south and southeast.

Since Eocene time, the Ocala Uplift and the Southeast Georgia Embayment are the two structural features which have most directly affected sedimentation in the project area. Lineaments discerned from aerial photographs could represent joint, fracture, and/or faulting patterns of the younger deposits (Figure 3.1-8, Table 3.1-2).

3.1.3.3 Stratigraphy

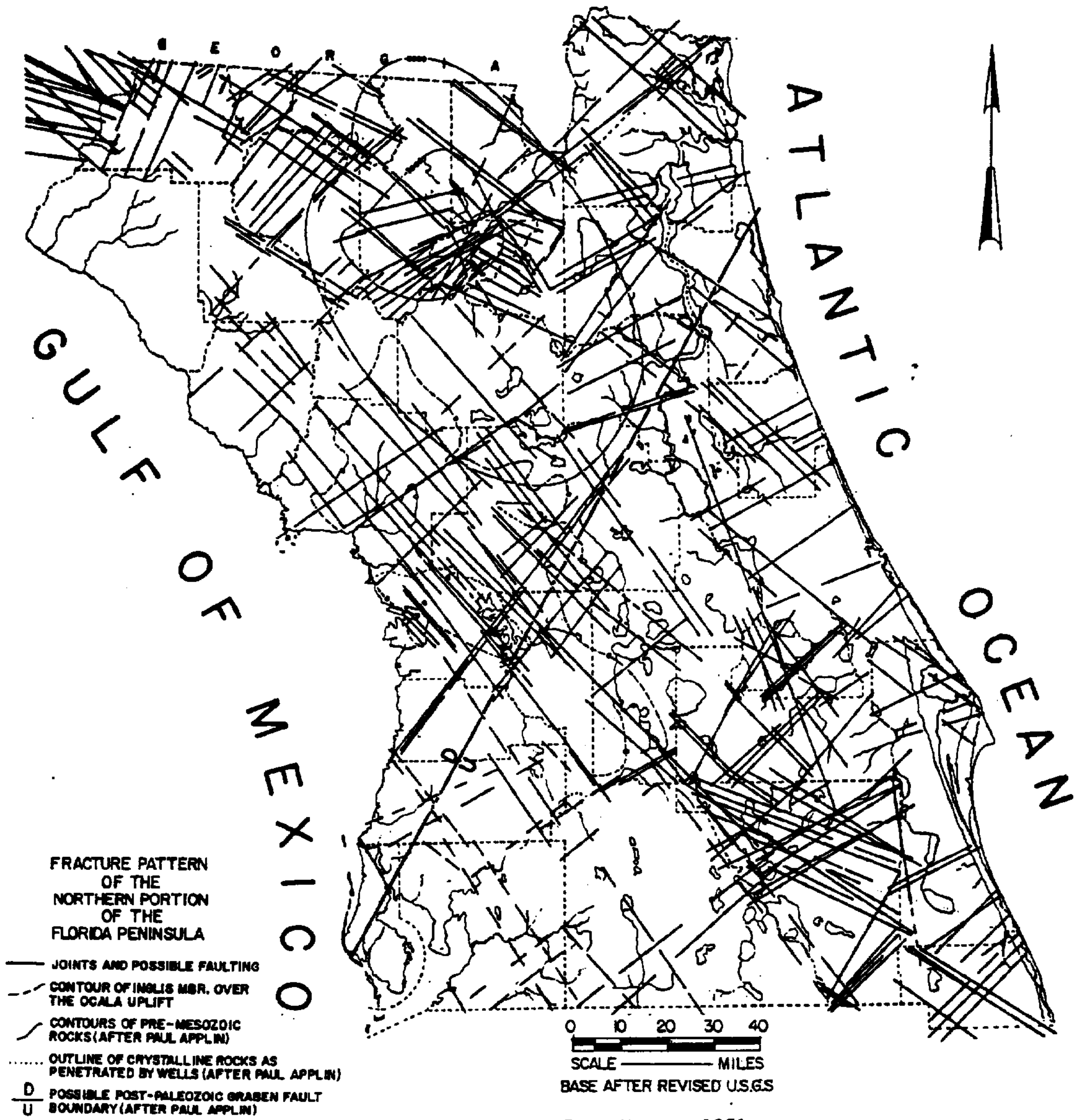
Regional System. The area is underlain by a sequence of Coastal Plain sediments whose minimum thickness is 3500 ft, as determined by deep oil test wells (Applin and Applin 1967). These sediments are predominantly of shallow water origin and are composed of marine limestones, evaporites, and clays, ranging in age from Early Cretaceous to Recent, which were deposited on Lower and Middle Paleozoic rocks. Table 3.1-3 shows the general stratigraphic column and approximate thickness of the geologic units underlying the area. The entire section slopes and thickens gently to the northeast and southwest from the crest of the Peninsular Arch.

The deepest (oldest) formation in the area containing potable water is the Lake City Limestone (Ceryak et al. 1982), which is approximately 500 ft thick in Hamilton County. The Lake City Limestone is predominantly a gray-brown, dense, microcrystalline dolomite with occasional thin beds of limestone, chert, and carbonaceous material. Commonly, this unit is impregnated with gypsum and anhydrite near the top.

The Avon Park Limestone overlies the Lake City Limestone throughout the project area. It is approximately 200-250 ft thick and is described as a cream to brown marine fossiliferous limestone and dolomite.

The Ocala Group consists of three limestone formations of similar characteristics: the Inglis, Williston, and Crystal River formations (in ascending order). The Ocala Group ranges from a cream to white, porous limestone at the top to a brown to dark brown limestone at the base and is approximately 300 ft thick in Hamilton County.

The Suwannee Limestone unconformably overlies the Ocala Group and is unconformably overlain by sediments of Miocene age. The Suwannee Limestone is a cream-colored, porous, soft limestone and can appear as a brown to gray dolomitic or cherty limestone. It contains seams of dark olive clay along bedding planes and within vertical solution pipes. The Suwannee Limestone is considered the uppermost member of the Floridan Aquifer (Figure 3.1-9).



From Vernon 1951

Figure 3.1-8. Major Fracture Patterns.

Table 3.1-2. Joint Fracture Directions for Hamilton County.

Joint Pattern	Fracture Direction
Primary	
Dominant	N65W±15°
Subordinate	N39E±15°
Secondary	
Dominant	N6W±15°
Subordinate	N75W±10°

Source: Colton 1978.

Table 3.1-3. Geologic Units in Hamilton County, Florida.

Era	System	Series	Years Before Present (in thousands)	Geologic Unit	Approximate Thickness (ft)
Cenozoic	Quaternary	Recent		Pleistocene and Recent deposits (undifferentiated)	0-40
			11		
		Pleistocene		Unconformity	
			500-2000		
		Miocene or Pliocene		Alachua Formation Hawthorn Formation	0-150
			13,000		
		Miocene		Miocene sandstone and limestone Unconformity	0-65
			25,000		
		Oligocene		Suwannee Limestone Unconformity	0-50
			36,000		
	Tertiary			Ocala Group of Jackson Age Unconformity	250-350
		Eocene		Avon Park Limestone of Clairborne Age Unconformity	200-250
				Lake City Limestone of Clairborne Age	450-550
				Oldsmar Limestone of Wilcox Age	250-350
			58,000		
		Paleocene		Cedar Keys Formation of Midway Age Unconformity	400-450
			63,000		
Mesozoic				Lawson Limestone of Navarro Age	350-500
				Beds of Taylor Age	400-500
				Beds of Austin Age	200-350
	Cretaceous	Gulf		Atkinson Formation Beds of Eagle Ford Age Beds of Woodbin Age Unconformity	0-200
		Comanche		Red beds of shale and sand Unconformity	0-40
			135,000		
		Triassic		Igneous intrusion Unconformity	
			230,000		
Paleozoic	Silurian or Devonian	Upper Silurian or Lower Devonian		Black shale and quartzite sandstone	
			280,000		

Source: Meyer 1962.

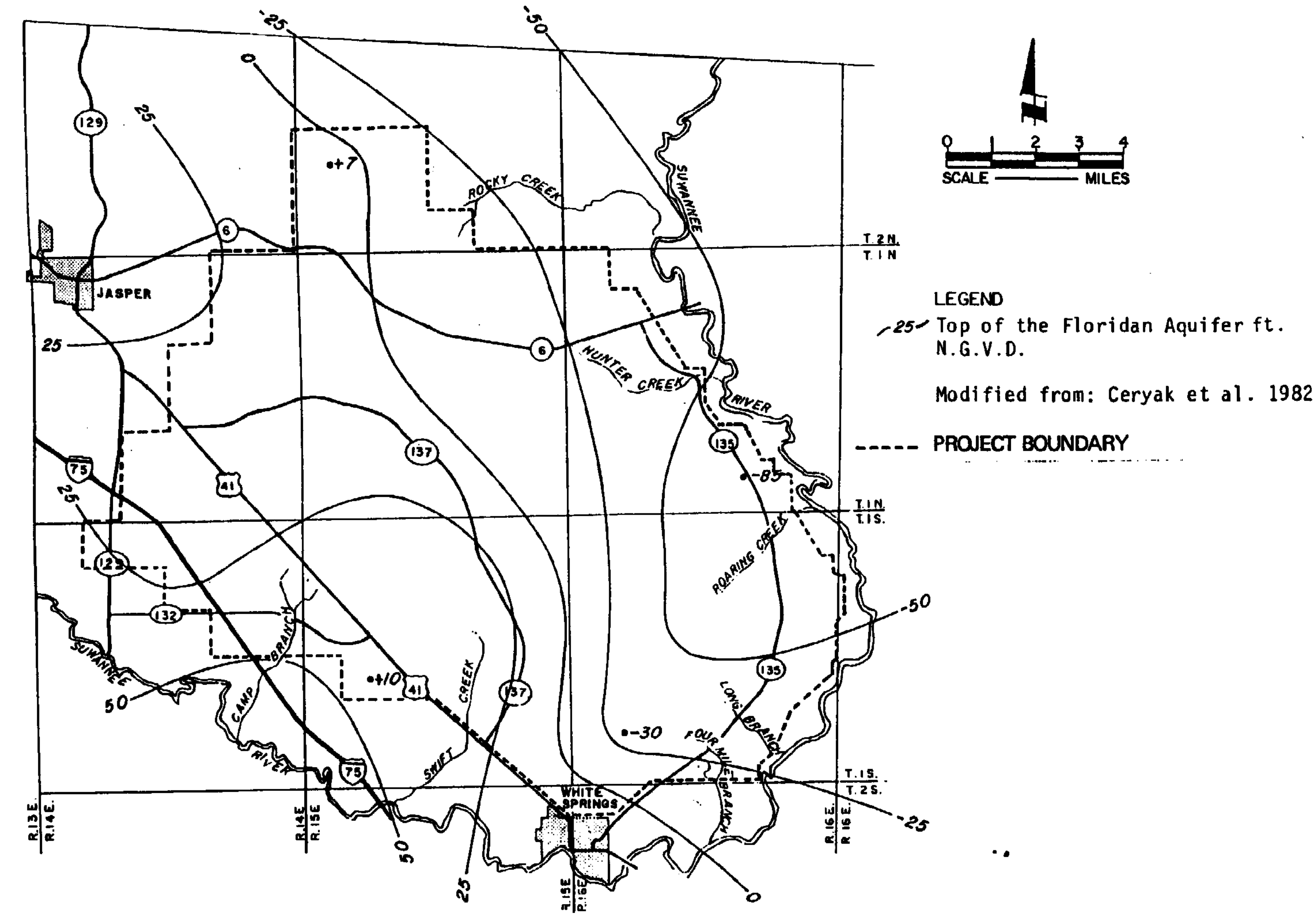


Figure 3.1-9. Altitude of the Top of the Floridan Aquifer.

Three time-rock divisions make up the Miocene Series; however, only sediments of Lower (Tampa Stage) and Middle Miocene (Alum Bluff Stage) appear in the project area. The Lower Miocene St. Marks Formation is a thin, discontinuous bed and only occurs as erosional remnants east of the Alapaha River (Ceryak et al. 1982). Two formations from the Middle Miocene have been identified within Hamilton County: the Alachua and Hawthorn formations.

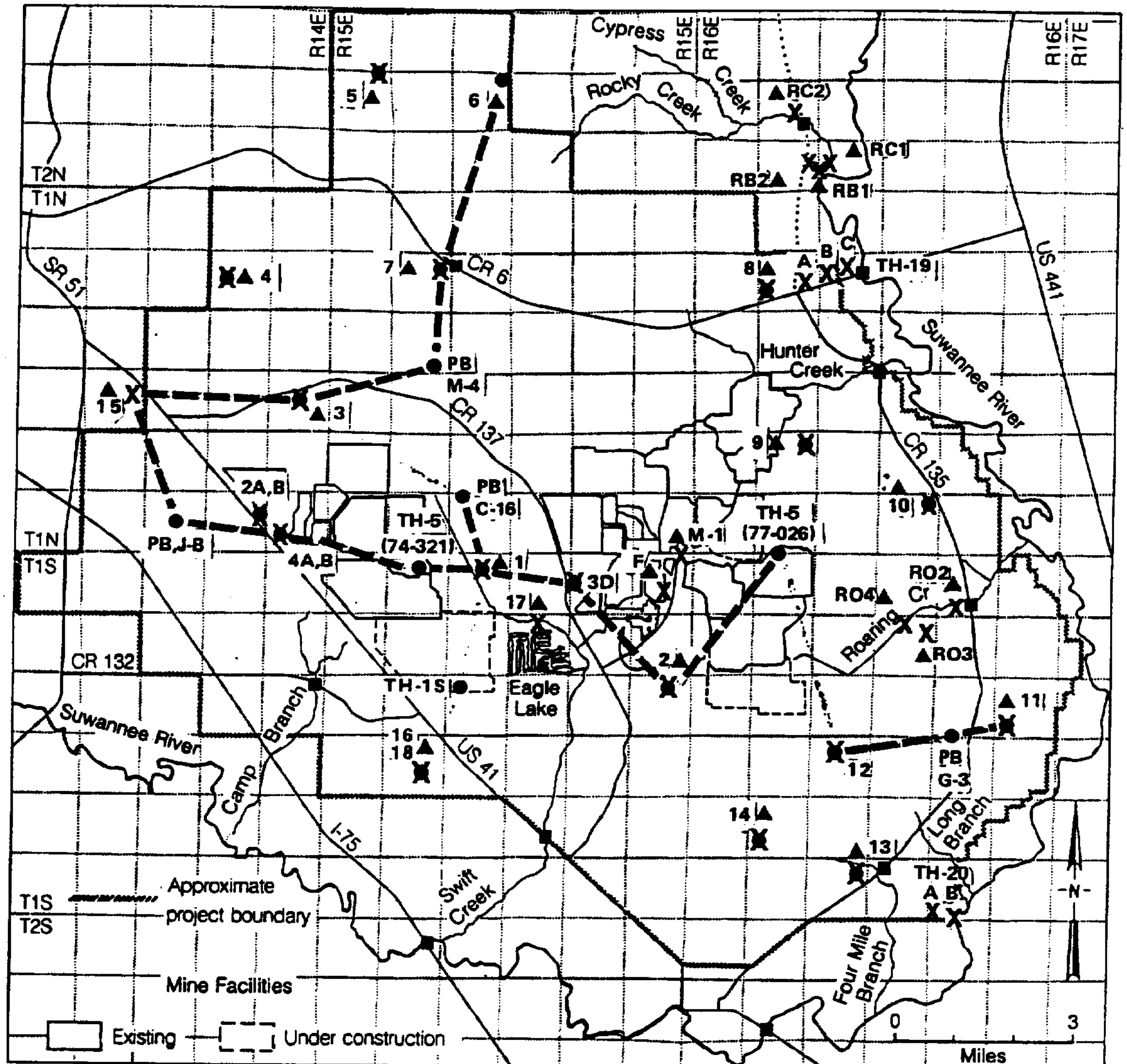
The Alachua Formation was deposited during and somewhat later than the Hawthorn Formation. These deposits were terrestrial and, in part, possibly lacustrine and riverine in origin. Lithologically, the formation is quite diverse, being a mixture of interbedded sand, clayey sand, and sandy clay. Within the project area, it is not possible to lithologically differentiate the Alachua Formation from the Hawthorn or the undifferentiated marine terrace deposits. Therefore, the Alachua Formation is not recognized as a separate geologic formation in this report.

The most important Miocene unit in the project area is the Hawthorn Formation. This formation was deposited in a shallow marine and/or riverine environment and is composed mostly of phosphatic clayey sands and gray to green phosphatic clays in its upper portions with sandy phosphatic dolomite and limestone below. The upper portion can contain deposits of commercially valuable phosphate. The clayey and dense limestone portions of the Hawthorn Formation act as confining beds separating the Surficial Aquifer from the Floridan Aquifer.

The term "undifferentiated marine terrace deposits" is used here for the clastic sediments which lie above the Hawthorn Formation. These deposits are primarily fine to medium-grained quartz sand with varying amounts of organic material and clay and were deposited in terraces during Plio-Pleistocene sea level fluctuations.

Site System. Standard Penetration Test (SPT) borings were made to determine the nature and extent of the deposits underlying the project area (Figures 3.1-10, 3.1-11, and 3.1-12). Portions of four test holes (TH) were cored through and/or into the indurated materials of the Hawthorn, Suwannee, and Ocala units to better define characteristics of the confining layer and to determine the depth at which producing zones within the Floridan Aquifer are found (Figure 3.1-12).

The stratigraphy of the area is relatively uniform and divided into three units: 1) undifferentiated marine terrace deposits, 2) phosphate matrix (uppermost Hawthorn unit) and confining beds of the Hawthorn Formation, and 3) the limestone of the Floridan Aquifer (Figure 3.1-13). The undifferentiated marine terrace deposits are composed of a heterogeneous mixture of slightly silty and slightly clayey fine to medium-grain quartz sand grading downward to silty and clayey sand. Total thickness of these deposits based on the test drillings is 10-30 ft. Beneath these deposits is the Hawthorn Formation which thickens gradually toward the north and east. This formation is a sequence of stratified clay, sand, sandy clay, and limestone beds that contain phosphate throughout. Below the Hawthorn, the limestone formations of the Floridan Aquifer occur at depths of 125-210 ft.



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

● SPT drilling sites

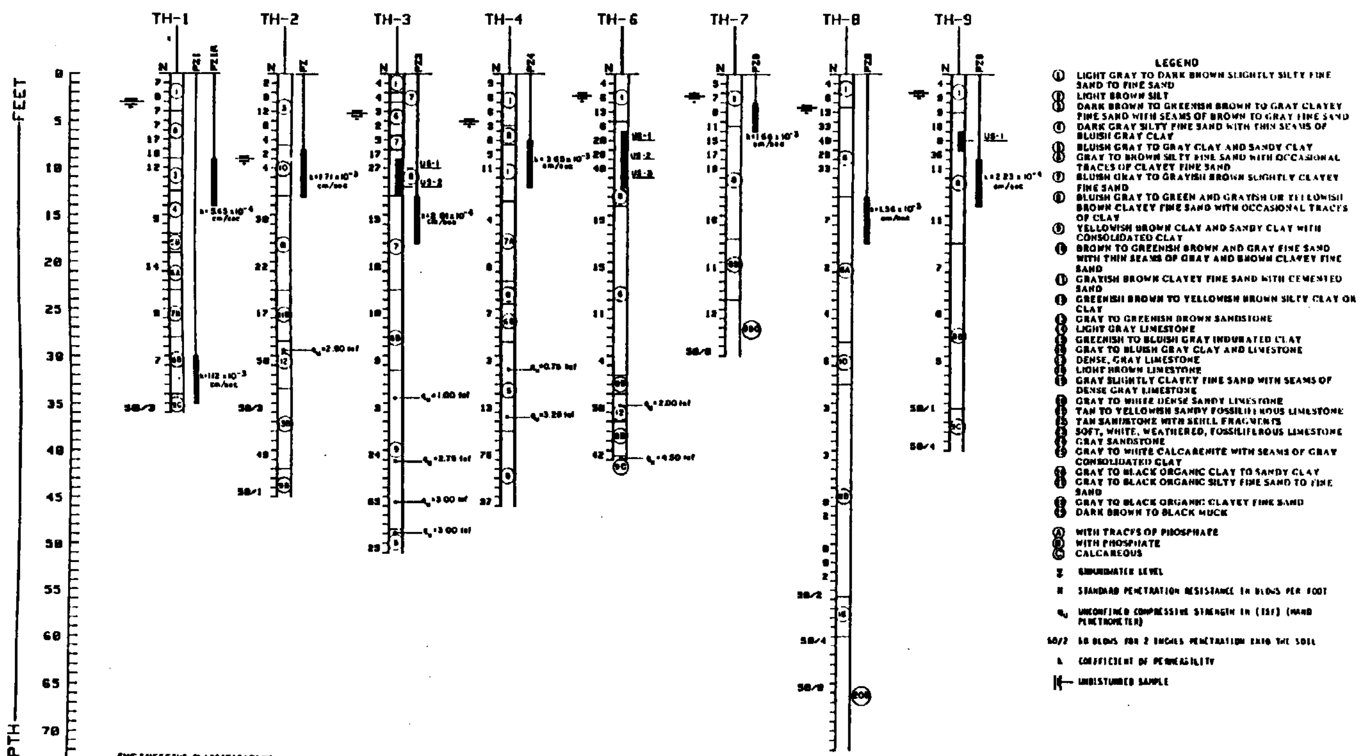
Observation well sites

■ Base flow sites

▲ USGS No. 025-246-1 well

▬▬▬ Location of west-east and north-south soil profiles (see Figures 3.1-15 and 3.1-16)

Figure 3.1-10. Location of SPT Borings.



ENGINEERING CLASSIFICATION

COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N"
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

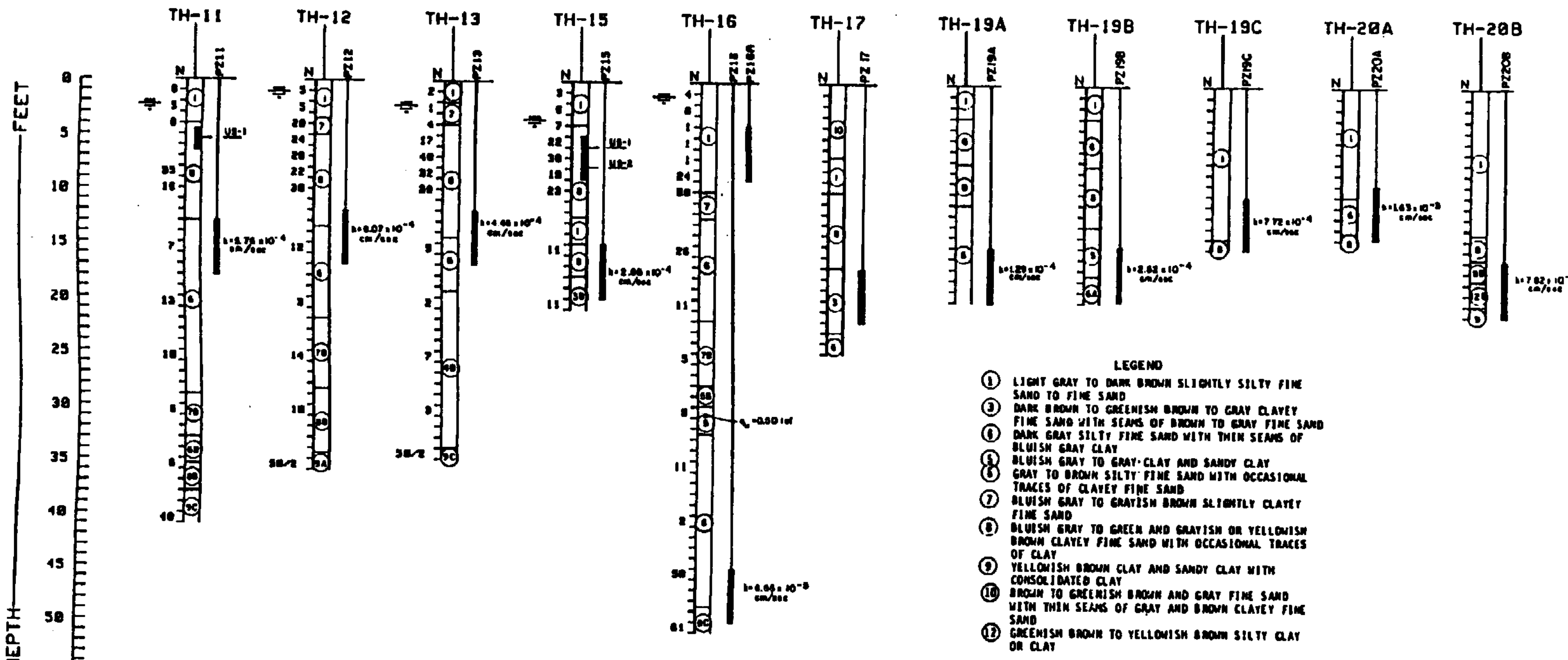
COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, TSF	BLOW COUNT "N"
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

"WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATION AND ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR. ABSENCE OF WATER SURFACE DATA ON CERTAIN BORINGS IMPLIES THAT NO GROUNDWATER DATA IS AVAILABLE, BUT DOES NOT NECESSARILY MEAN THAT GROUNDWATER WILL NOT BE ENCOUNTERED AT THESE LOCATIONS OR WITHIN THE VERTICAL REACHES OF THESE BORINGS."

Figure 3.1-11. Shallow SPT Borings.



LEGEND

(1)	LIGHT GRAY TO DARK BROWN SLIGHTLY SILTY FINE SAND TO FINE SAND
(3)	DARK BROWN TO GREENISH BROWN TO GRAY CLAYEY FINE SAND WITH SEAMS OF BROWN TO GRAY FINE SAND
(4)	DARK GRAY SILTY FINE SAND WITH THIN SEAMS OF BLUISH GRAY CLAY
(5)	BLUISH GRAY TO GRAY CLAY AND SANDY CLAY
(6)	GRAY TO BROWN SILTY FINE SAND WITH OCCASIONAL TRACES OF CLAYEY FINE SAND
(7)	BLUISH GRAY TO GRAYISH BROWN SLIGHTLY CLAYEY FINE SAND
(8)	BLUISH GRAY TO GREEN AND GRAYISH OR YELLOWISH BROWN CLAYEY FINE SAND WITH OCCASIONAL TRACES OF CLAY
(9)	YELLOWISH BROWN CLAY AND SANDY CLAY WITH CONSOLIDATED CLAY
(10)	BROWN TO GREENISH BROWN AND GRAY FINE SAND WITH THIN SEAMS OF GRAY AND BROWN CLAYEY FINE SAND
(12)	GREENISH BROWN TO YELLOWISH BROWN SILTY CLAY OR CLAY
(A)	WITH TRACES OF PHOSPHATE
(B)	WITH PHOSPHATE
(C)	CALCAREOUS
▽	GROUNDWATER LEVEL
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
q_u	UNCONFINED COMPRESSIVE STRENGTH IN (TSF) (HAND PENETROMETER)
50/2	50 BLOWS FOR 2 INCHES PENETRATION INTO THE SOIL
k	COEFFICIENT OF PERMEABILITY
⊢	UNDISTURBED SAMPLE

ENGINEERING CLASSIFICATION

COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT 'N'
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

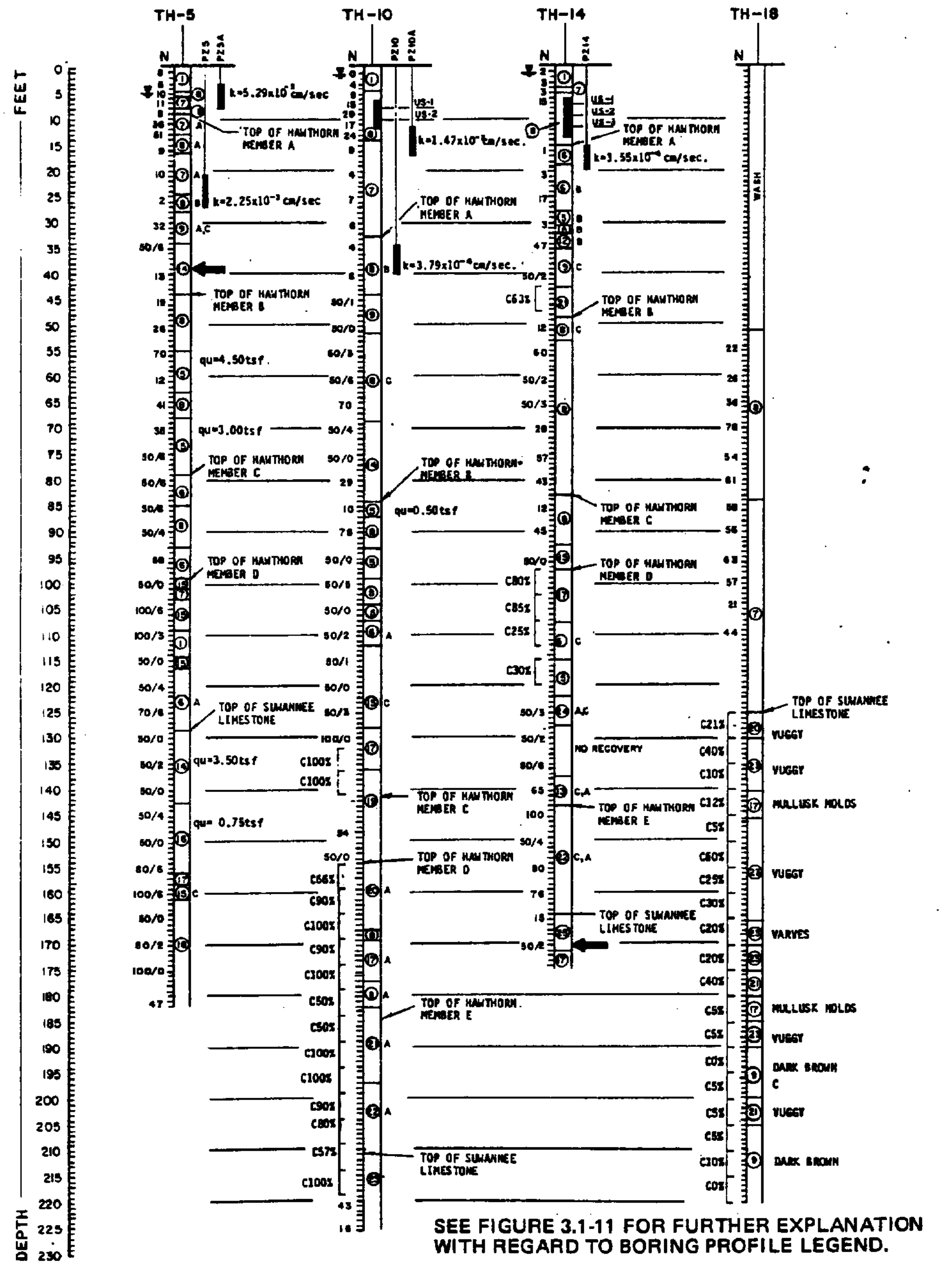
COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, TSF	BLOW COUNT 'N'
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

"WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATION AND ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR. ABSENCE OF WATER SURFACE DATA ON CERTAIN BORINGS IMPLIES THAT NO GROUNDWATER DATA IS AVAILABLE, BUT DOES NOT NECESSARILY MEAN THAT GROUNDWATER WILL NOT BE ENCOUNTERED AT THESE LOCATIONS OR WITHIN THE VERTICAL REACHES OF THESE BORINGS."

Figure 3.1-11 (Continued).



LEGEND

1	LIGHT GRAY TO DARK BROWN SLIGHTLY SILTY FINE SAND TO FINE SAND
5	BLUISH GRAY TO GRAY CLAY AND SANDY CLAY
6	GRAY TO BROWN SILTY FINE SAND WITH OCCASIONAL TRACES OF CLAYEY FINE SAND
7	BLUISH GRAY TO GRAYISH BROWN SLIGHTLY CLAYEY FINE SAND
8	BLUISH GRAY TO GREEN AND GRAYISH OR YELLOWISH BROWN CLAYEY FINE SAND WITH OCCASIONAL TRACES OF CLAY
9	YELLOWISH BROWN CLAY AND SANDY CLAY WITH CONSOLIDATED CLAY
12	GREENISH BROWN TO YELLOWISH BROWN SILTY CLAY OR CLAY
13	GRAY TO GREENISH BROWN SANDSTONE
14	LIGHT GRAY LIMESTONE
15	GREENISH TO BLUISH GRAY INDURATED CLAY
16	GRAY TO BLUISH GRAY CLAY AND LIMESTONE
17	DENSE, GRAY LIMESTONE
18	LIGHT BROWN LIMESTONE
19	GRAY SLIGHTLY CLAYEY FINE SAND WITH SEAMS OF DENSE GRAY LIMESTONE
20	GRAY TO WHITE DENSE SANDY LIMESTONE
21	TAN TO YELLOWISH SANDY FOSSILIFEROUS LIMESTONE
22	TAN SANDSTONE WITH SHELL FRAGMENTS
23	SOFT, WHITE, WEATHERED, FOSSILIFEROUS LIMESTONE
24	GRAY SANDSTONE
25	GRAY TO WHITE CALCARENITE WITH SEAMS OF GRAY CONSOLIDATED CLAY
A	WITH TRACES OF PHOSPHATE
B	WITH PHOSPHATE
C	CALCAREOUS
▼	GROUNDWATER LEVEL
N -	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
q_u	UNCONFINED COMPRESSIVE STRENGTH IN TSF (HAND PENETROMETER)
50/5	50 BLOWS FOR 5 INCHES PENETRATION INTO THE SOIL
←	LOSS OF DRILLING FLUID CIRCULATION
K	COEFFICIENT OF PERMEABILITY
US-1	UNDISTURBED SAMPLE
C50%	PERCENT CORE RECOVERY

Figure 3.1-12. Deep SPT Borings.

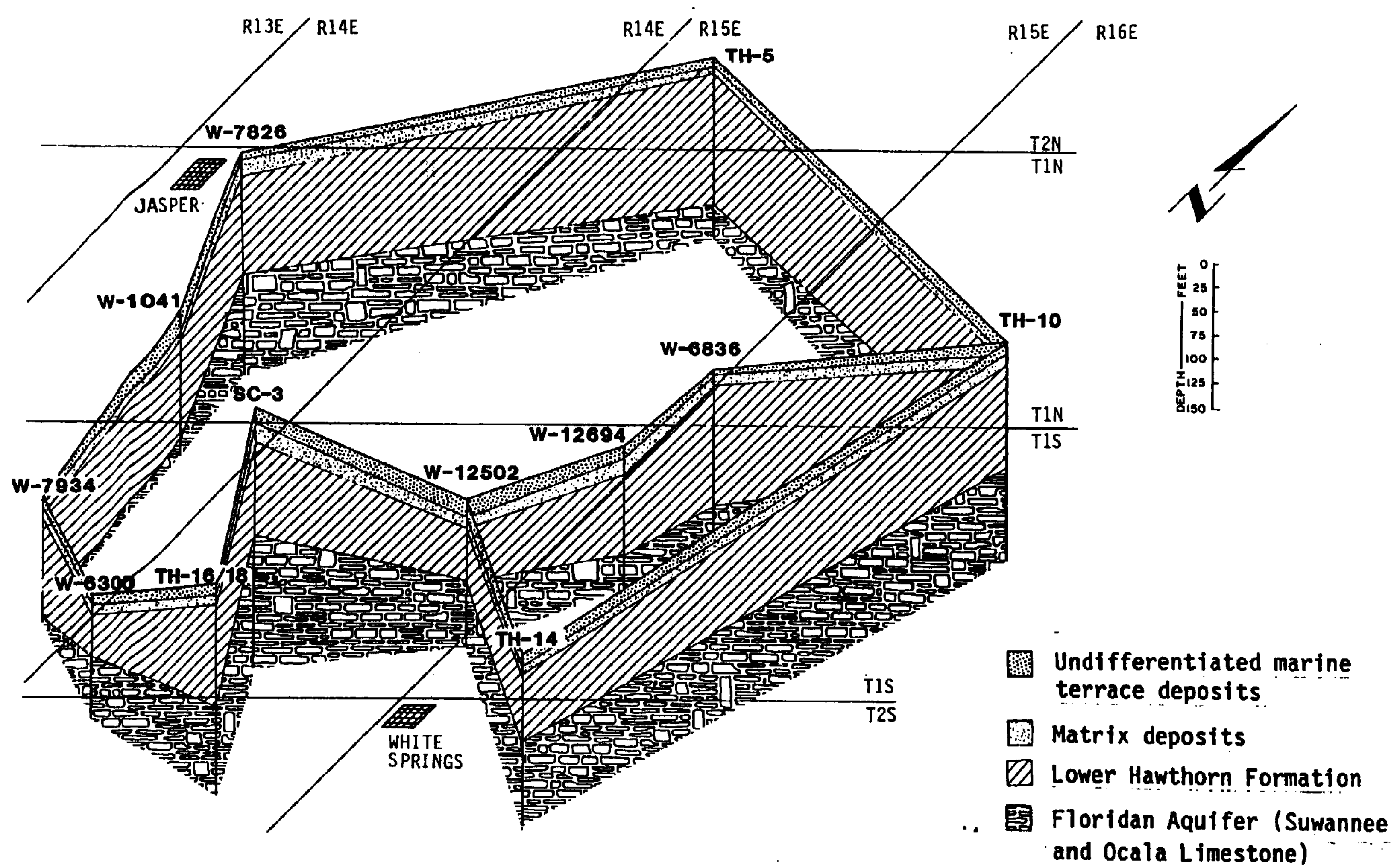


Figure 3.1-13. Fence Diagram of General Geology.

The Hawthorn Formation has been subdivided into distinct lithologic units, designated by lettered members (Miller et al. 1978, Figure 3.1-12):

Member A, the uppermost Hawthorn unit, is the unit currently being mined in Hamilton County. The upper portion consists of highly phosphatic sands and clayey sands while the lower portion consists of a gray to yellow phosphatic limestone which is the lower boundary of mining activity due to its indurated nature. The top of this member typically ranges from approximately 9-32 ft below ground and is 35-52 ft thick.

Member B is primarily bluish-gray and green clay with layers of sandy clay and clayey sand. In TH-10, the lower portion of this member contains thin layers of dense, blue-gray limestone and light brown limestone. Thickness ranges from approximately 33-50 ft.

Member C is the most easily recognized of the four Hawthorn subdivisions in terms of lithology. It is predominantly well-sorted, fine to medium-grained sand containing minor beds of greenish to bluish-gray indurated clay. Thickness of this unit ranges from approximately 10-21 ft.

Member D is the most lithologically variable member of the four Hawthorn units and, therefore, was the most difficult to correlate vertically among the deep test holes. In TH-5, this member extends 20 ft and consists of hard, gray clay layers interbedded with light gray sandstone beds. In TH-10, this unit is 25 ft thick and consists of hard blue-gray limestone and gray to white sandy limestone, with thin beds of brownish clayey fine sand. The entire sequence contains fine sand-sized phosphate grains. In TH-14, the unit is 45 ft thick and consists of hard, blue-gray limestone, gray clay and sandy clay, and hard, calcareous silty, fine sand and sandy silt. Most of the sequence contains trace amounts of fine sand-size phosphate grains.

Member E occurs in the two deep, easternmost borings and is phosphatic throughout. In TH-10, the unit consists of 15 ft of tan, fossiliferous limestone and 10 ft of indurated, brown sandy clay with shell fragments. In TH-14, the unit consists of 22 ft of indurated, brown sandy clay and shell fragments.

The Suwannee Limestone, underlying the Hawthorn Formation at the site, is composed of a relatively soft, white to gray, sandy limestone with pockets of stiff, green clay overlying a hard, gray fossiliferous limestone. This formation is the uppermost member of the Floridan Aquifer.

3.1.4 Soils

3.1.4.1 General Description

The surficial soils of Hamilton County range from sloping, well-drained sands west of the Alapaha River and southwest of Jasper to nearly level, poorly-drained sandy soils in eastern Hamilton County.

The soil association map printed by the Florida Department of Administration (1975) indicates that the soils in the project area belong to seven general associations (Figure 3.1-14):

- Alpin-Blanton-Eustis
- Arredondo, var. - Alaga-Kenney
- Chipley-Albany-Plummer
- Leon-Mascotte-Rutledge
- Surrency-Portsmouth
- Brighton-Dorovan
- Freshwater Swamp

A soil association represents a group of several soils, including at least one major soil series, that form a distinctive pattern and exhibit similar drainage characteristics. Each soil association delineation represents the prevalent soil condition but also may contain individual localized soils which have ratings different from the general rating of the association. Detailed soil surveys, including mapping unit descriptions, are not available for Hamilton County.

General descriptions of each association follow:

Alpin-Blanton-Eustis: nearly level to sloping, excessively drained soils with very thick sandy layers over thin loamy sand or sandy loam lamella, and moderately well-drained soils with very thick sandy layers over loamy subsoil and somewhat excessively drained soils sandy throughout.

Arredondo, var. - Alaga-Kenney: nearly level to sloping, well-drained soils with very thick sandy layers over loamy subsoil and somewhat excessively drained soils sandy throughout.

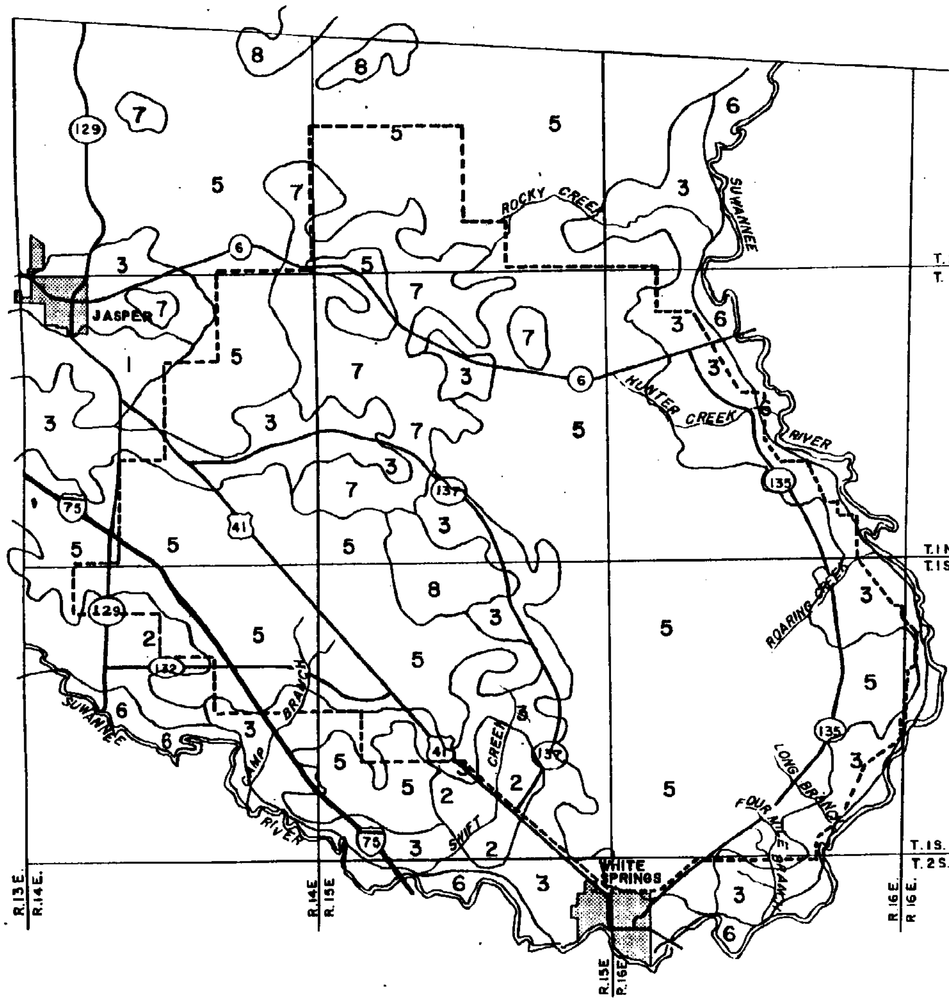
Chipley-Albany-Plummer: nearly level to gently sloping, moderately well-drained soils, sandy throughout, and poorly drained soils with very thick sandy layers over loamy subsoil.

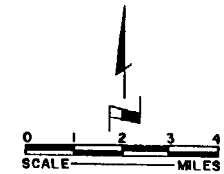
Leon-Mascotte-Rutledge: nearly level, poorly drained, sandy soils with a weakly cemented sandy subsoil layer underlain by loamy subsoil and very poorly-drained soils, sandy throughout.

Surrency-Portsmouth: nearly level, very poorly drained sandy soils with loamy subsoil and very poorly drained loamy soils with loamy subsoil underlain by sand.

Brighton-Dorovan: nearly level, very poorly drained organic soils underlain by sand.

Freshwater Swamp: nearly level, very poorly drained soils subject to prolonged flooding.





LEGEND

1 ALPIN-BLANTON-EUSTIS ASSOC.

2 ARREDONDO, VAR-ALAGA-KENNEY ASSOC.

3 CHIPLEY-ALBANY-PLUMMER ASSOC.

5 LEON-MASCOTTE-RUTLEDGE ASSOC.

6 SURRENCY-PORTSMOUTH ASSOC.

7 BRIGHTON-DOROVAN ASSOC.

8 FRESH WATER SWAMP ASSOC.

----- PROJECT BOUNDARY

SOURCE: BUREAU OF COMPREHENSIVE PLANNING
DIVISION OF STATE PLANNING OF THE
FLORIDA DEPARTMENT OF ADMINISTRATION
(1975)

Figure 3.1-14. Soil Associations in the Study Area.

In terms of suitability as a source of topsoil, most soils were rated as poor because they are too sandy (Fla. Dept. of Admin. 1975). The Brighton-Dorovan association was rated poor because of excess humus. The Freshwater Swamp association was not rated.

3.1.4.2 Soil Profiles

The soil stratification is based on an examination of recovered soil samples and interpretation of field boring logs by a geotechnical engineer (Figures 3.1-10 and 3.1-11). The stratification lines represent the approximate boundaries between soil types of significantly differing engineering properties, although the actual transition may be gradual:

Depth (ft)	Description
0-5	Light gray to dark brown fine sand and slightly silty or slightly clayey fine sand
5-15	Gray to grayish-brown to yellowish-brown clayey fine sand
15-37	Bluish-gray to grayish-brown and greenish slightly clayey to clayey phosphatic fine sand
37-60	Light gray to yellow phosphatic limestone

Generalized soil profiles, west-east and north-south through the project area, illustrate the horizontal continuity of the various soil horizons throughout the project area (Figures 3.1-15 and 3.1-16). Three data sources were used to generate these cross-sections: 1) 1982 data collected by Ardaman and Associates, Inc. (AAI), 2) pre-1982 AAI data, and 3) OXY prospect boring (PB) data. The 1982 AAI data are coded with the Test Hole (TH) number and the AAI project number (i.e., 81-067). The pre-1982 AAI data are coded the same way, with the pertinent AAI project number inserted. The OXY data are coded with the PB boring number (i.e., G-3) and section number (i.e., 14).

The zone above the matrix includes fine sands, muck, slightly silty fine sands, slightly clayey fine sands, sandy clays, clays, clayey sands, and silty sands. The muck soils, fine sands, and slightly silty fine sands predominate in the near surface layer. Therefore, the fine sands and slightly silty fine sands have been lumped together into a separate category, and muck is a separate category. The layer immediately resting on top of the matrix zone consists of sandy clays, clays, clayey sands, and silty sands. Clayey sands and silty sands predominate in visual classification of samples by AAI. A preponderance of the OXY PB log descriptions indicate that sandy clays predominate.

Generalized soil profiles for selected wetland areas where vegetation had been mapped show the surface layer of organic deposits, or muck, to normally range between 1-5 ft (Figures 3.1-17 through 3.1-20). Below the muck layer, the sequence of soils encountered is essentially the same as that found elsewhere in the area.

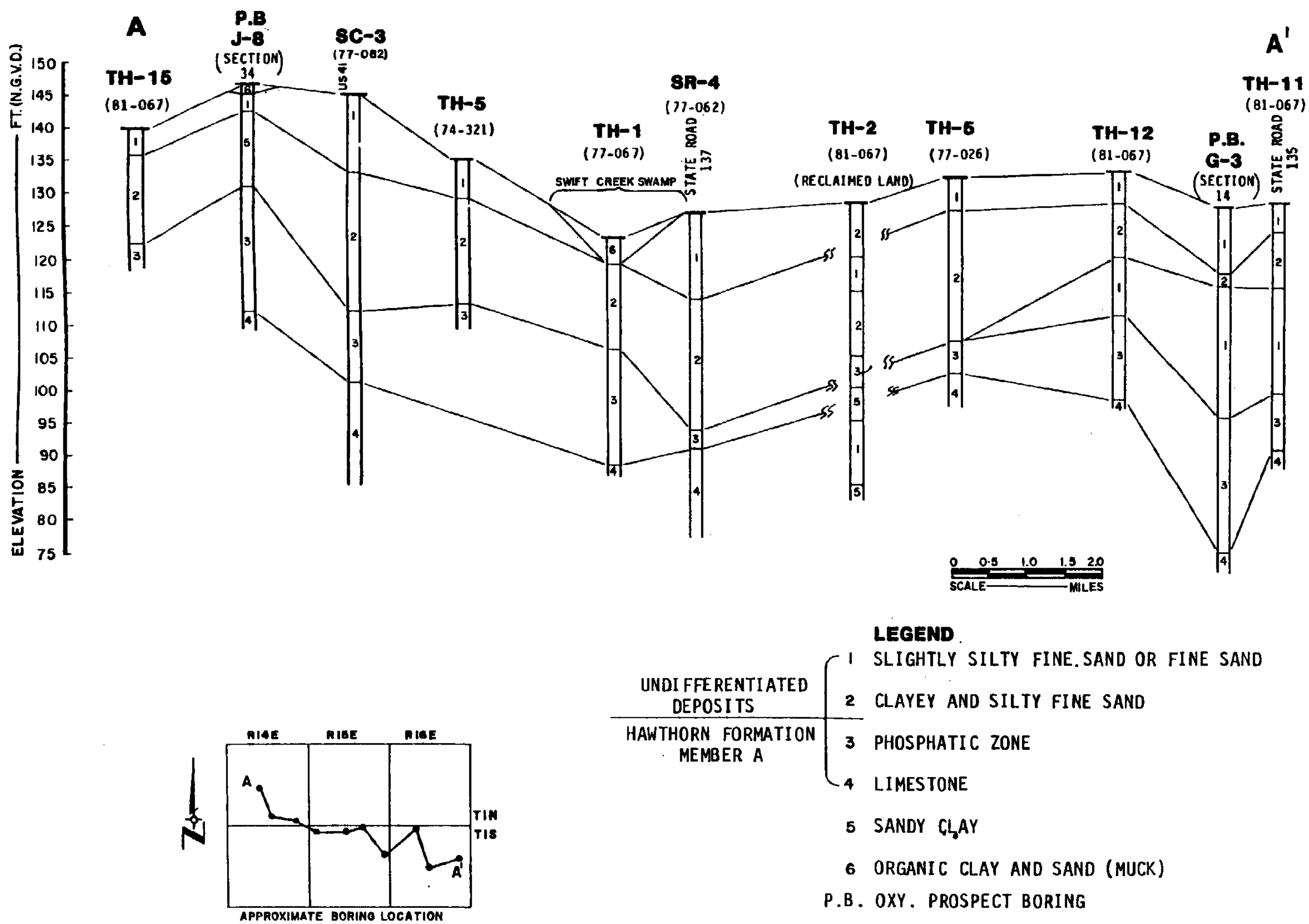


Figure 3.1-15. Generalized West-East Soil Profile.

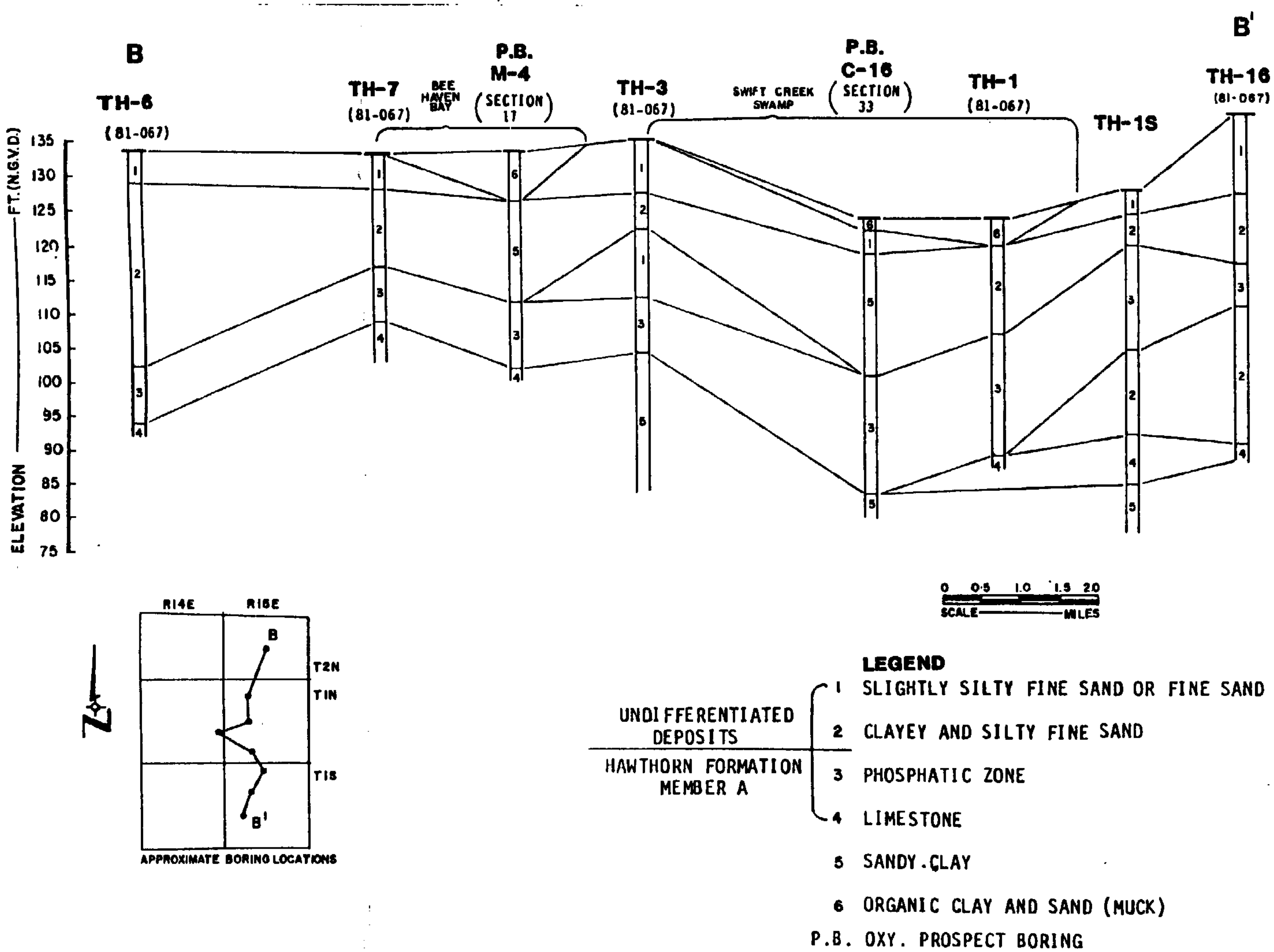


Figure 3.1-16. Generalized North-South Soil Profile.

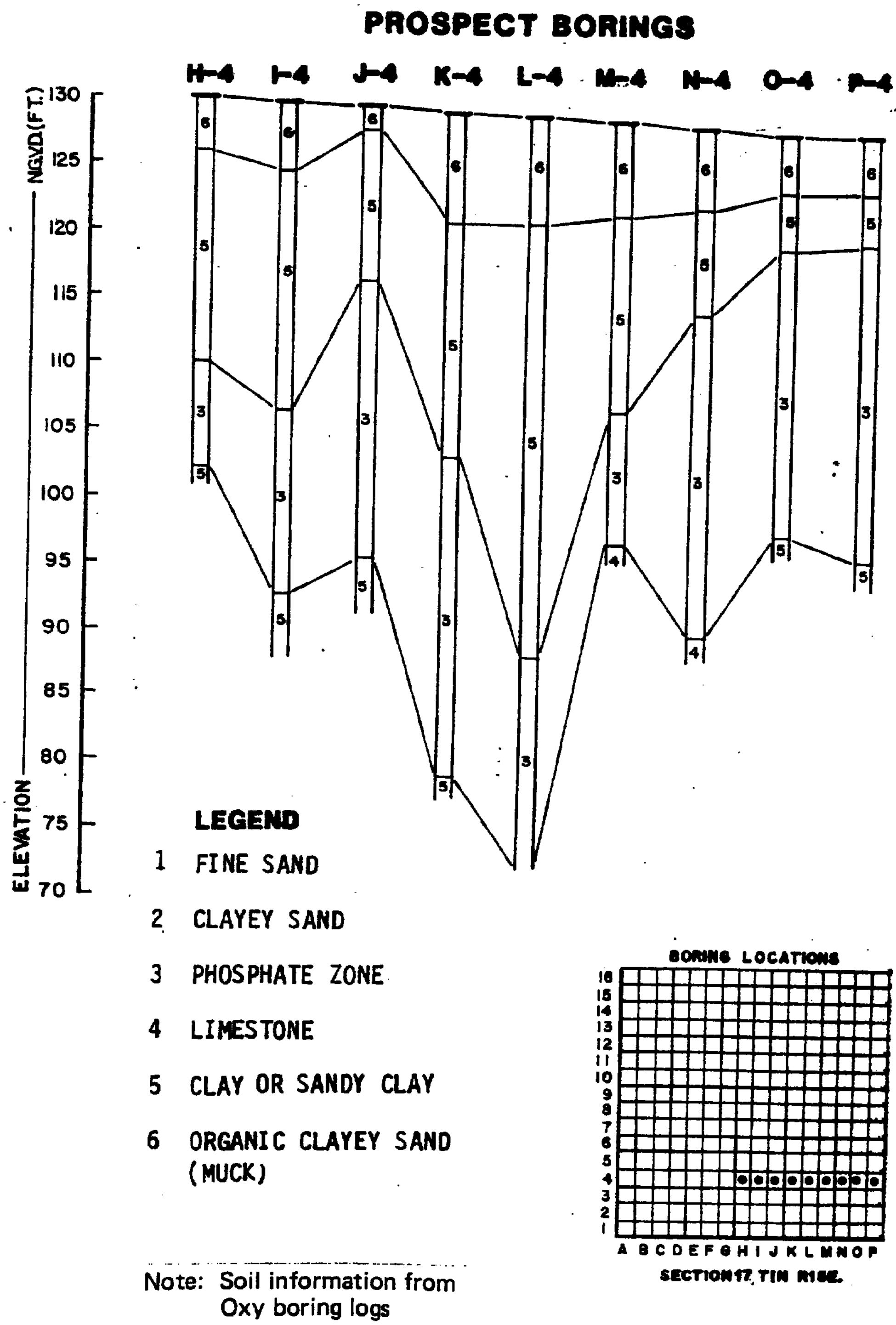


Figure 3.1-17. Wetland Soils Detail for Bee Haven Bay.

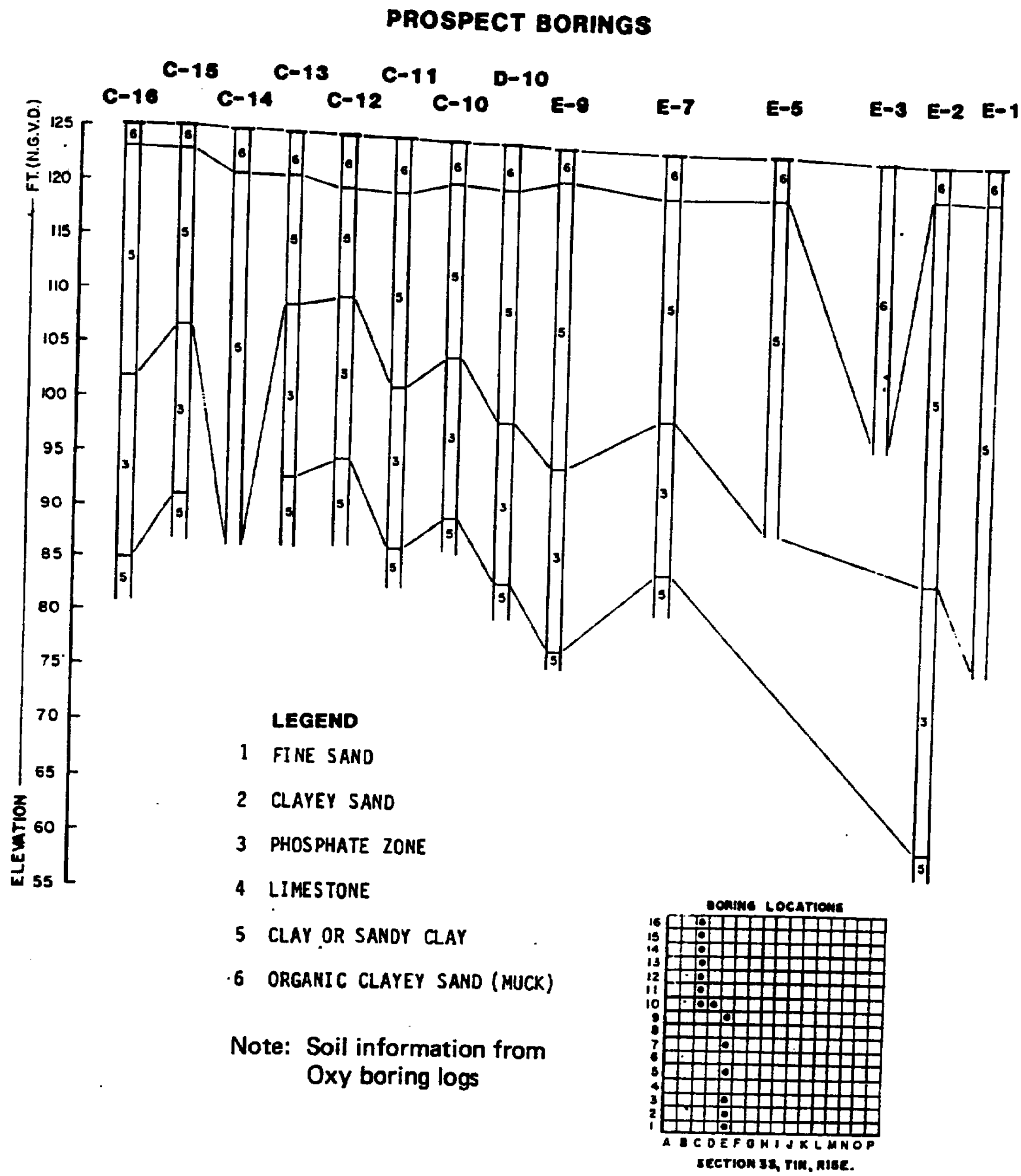
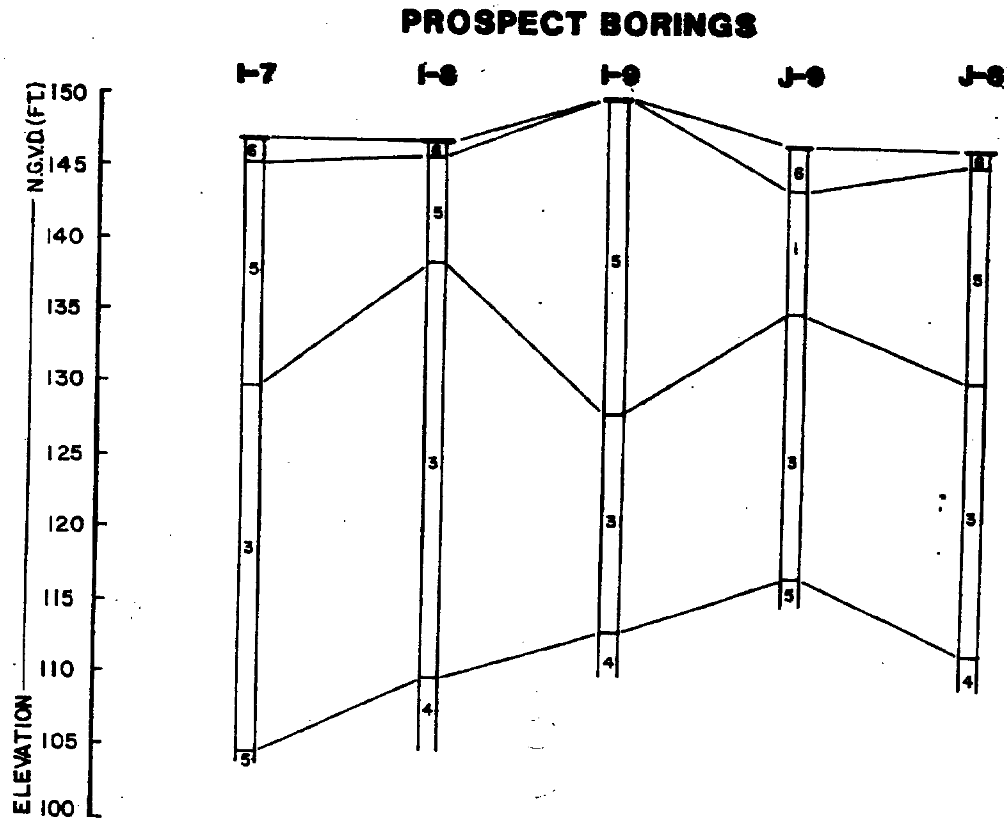


Figure 3.1-18. Wetland Soils Detail for Swift Creek Swamp.



LEGEND

1 FINE SAND

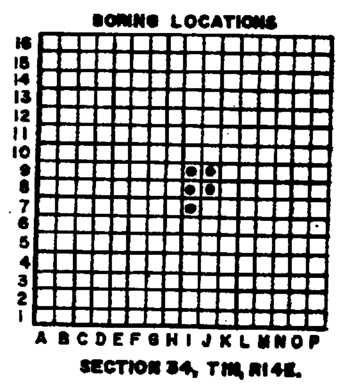
2 CLAYEY SAND

3 PHOSPHATE ZONE

4 LIMESTONE

5 CLAY OR SANDY CLAY

6 ORGANIC CLAYEY SAND (MUCK)



Note: Soils information from Oxy boring logs

Figure 3.1-19. Wetland Soils Detail for Section 34 T1N R14E.

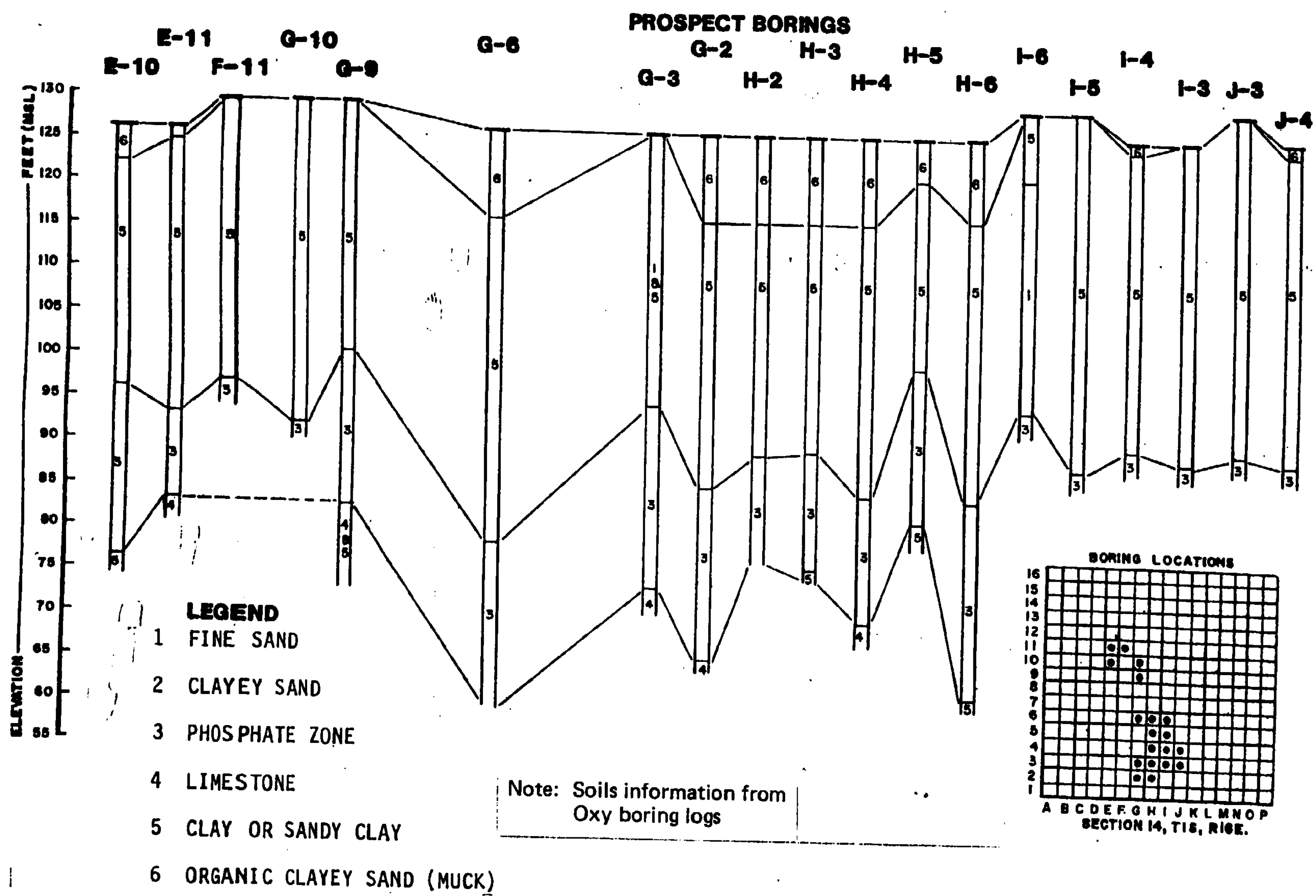


Figure 3.1-20. Wetland Soils Detail for Section 14 T1S R16E.

The presence of ancient sinkholes in the wetland areas is suggested by prospect borings C-14 and E-3. Boring C-14 did not encounter a phosphatic zone at a depth suggested by borings 330 ft either side of it. Based on an OXY geologist's opinion, this lack of an ore-bearing zone is indicative of a sinkhole feature. Boring E-3 encountered a much deeper muck layer than nearby holes, also indicating disturbance of the natural sequence of soils.

Two typical, plugged ancient sinkholes recently uncovered by OXY are filled with rather thick sequences of clay, sandy clay, and clayey sand down into the Hawthorn Formation (Figure 3.1-21). The material plugging the sinkholes has effectively sealed them, and consequently the sinkholes do not provide a direct connection to the Floridan Aquifer. TH-1S was drilled outside the sinkholes and shows the usual soil sequence encountered elsewhere in the study area.

3.1.4.3 Agricultural Uses

The Soil Conservation Service (SCS) divides soils into eight classifications of suitability for cropland and pastureland (Table 3.1-4). Soil capability classes are divided into subclasses based on their dominant limitation: erosion (e), wetness or poor drainage (w), and root zone limiting factors such as shallow, droughty, or stony soils (s). Additionally, soils are rated as low, moderate, or high in their potential for use as pine woodland, cropland, and improved pasture (Table 3.1-5). The overall rating for the association is based on the rating for the dominant soil (Florida Department of Administration 1975).

3.1.4.4 Engineering Uses

Some of the characteristics that limit a soil's use for agricultural purposes also affect its capability for foundation support, its capacity to absorb septic tank effluent, and/or its potential to serve other engineering uses. Some of these more important characteristics are wetness, flood hazard, texture and consistency, depth to rock, permeability, load-bearing capacity, shrink-swell potential, slope, and erodibility. The SCS groups soils into three broad classifications based on their degrees of hazard for non-agricultural uses: slight, moderate, and severe (Table 3.1-6).

3.1.4.5 Runoff Potential

The SCS classifies soils into four hydrologic soil groups, A through D, according to the runoff potential of the soil (Table 3.1-7). This classification is based on the minimum rate of infiltration obtained from a base soil after prolonged wetting. Some soils are placed in two groups: the first represents runoff after drainage improvements have been made, and the second represents runoff under natural conditions. The least runoff will occur in areas in which the soils percolate rapidly and do not require drainage improvements, i.e., Alpin-Blanton-Eustis, Arredondo var. - Alaga-Kenney, and Chipley-Albany-Plummer.

The remaining soil associations tend to saturate during periods of heavy rainfall. (Low topographic relief contributes to slow surface water

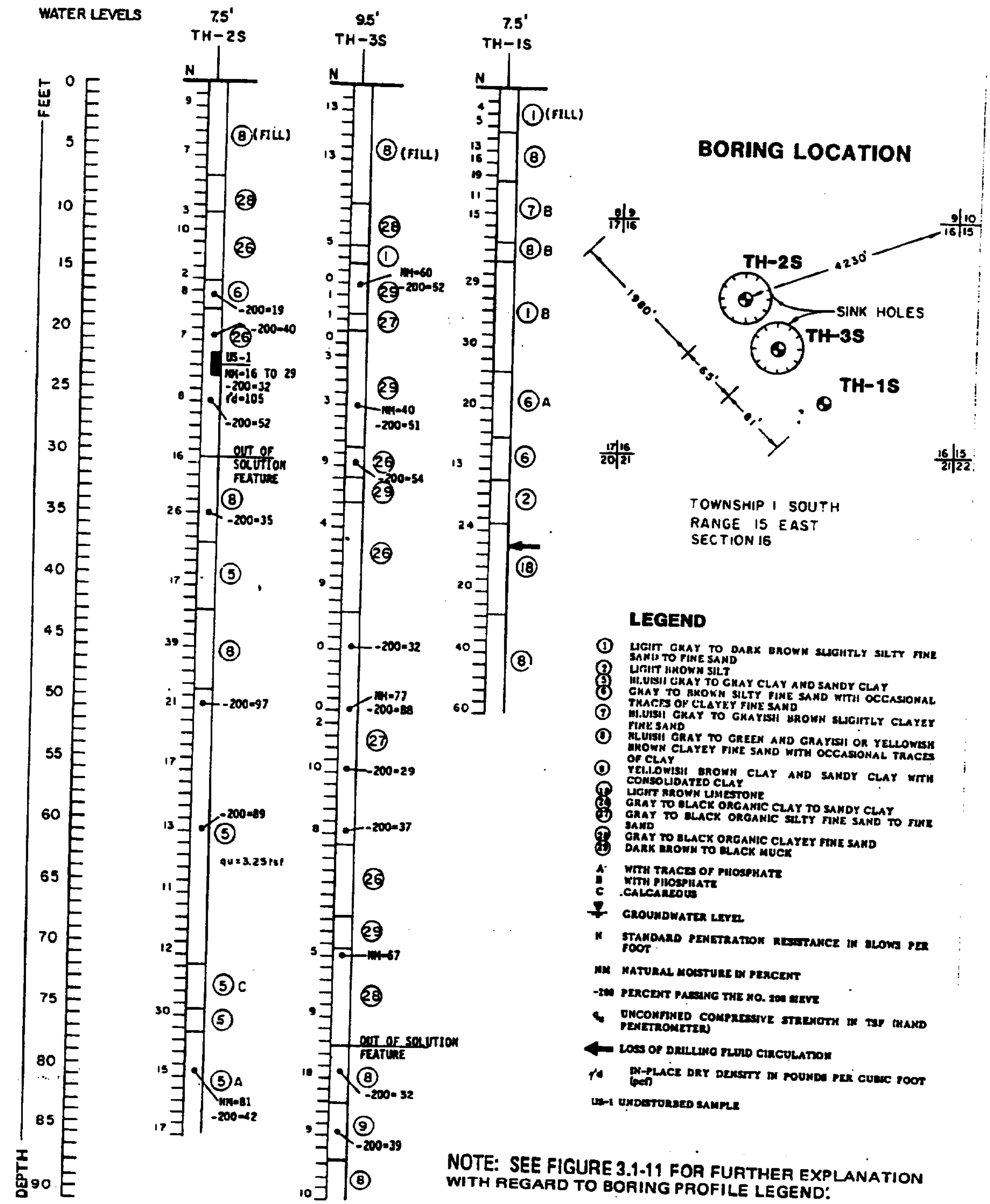


Figure 3.1-21. Ancient Sinkhole Detail within Section 16 T1S R15E.

Table 3.1-4. Agricultural Soil Capability Classes.

Class	Soil Limitations
I	Few limitations that restrict use.
II	Moderate limitations that reduce the choice of plants or require moderate conservation practices.
III	Severe limitations that reduce the choice of plants, require special conservation practices, or both.
IV	Very severe limitations that reduce the choice of plants, require very careful management, or both.
V	Not likely to erode, but have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture, woodland, or wildlife.
VI	Severe limitations that make them generally unsuited for cultivation and that limit uses largely to pasture, woodland, or wildlife.
VII	Very severe limitations that make them unsuited for cultivation and that restrict uses largely to pasture, range, woodland, or wildlife habitat.
VIII	Limitations that preclude use for commercial plants and that restrict use to recreation, wildlife, water supply, or aesthetic purposes.

Table 3.1-5. Agricultural Use Potential.

Map Symbol	Association and Soils	% of Association[1]	Soil Potential for Agriculture[2,3] Capability Unit	Pine Woodland	Cropland	Improved Pasture
1	ALPIN-BLANTON-EUSTIS			MODERATE	LOW	LOW
	Alpin	45	IVe	Moderate	Low DTY, PR	Low DTY, PR
	Blanton	30	IIIe	High	Moderate DTY, PR	Moderate DTY, PR
	Eustis	15	IIIe	Moderate	Moderate DTY, PR	Moderate DTY, PR
	Others	10				
2	ARREDONDO, VAR.-ALAGA-KENNEY			MODERATE	MODERATE	HIGH
	Arredondo, Var.	30	IIIs	Moderate	Moderate DTY, PR	Low
	Alaga	30	IIIs	Moderate	Moderate DTY, PR	Low
	Kenney	20	IIIs	Moderate	Moderate PR	Low
	Others	20				
3	CHIPLEY-ALBANY-PLUMMER			HIGH	MODERATE	MODERATE
	Chipley	50	IIIs	High	Moderate PR, DTY	Moderate PR, DTY
	Albany	20	IIIw	Moderate	Moderate PR, DTY	High
	Plummer	15	IVw	High	Low PDY	Moderate PDY
	Others	15				
5	LEON-MASCOTTE-RUTLEDGE			LOW	LOW	HIGH
	Leon	30	IVw	Low	Low PR, PDY	High
	Mascotte	30	IIIw	Moderate	Moderate PR, PDY	High
	Rutledge	20	IIIw	Moderate	Moderate FL, PO PDY	Low
	Others	20				

Table 3.1-5 (Continued).

Map Symbol	Association and Soils	% of Association[1]	Soil Potential for Agriculture[2,3] Capability Unit	Pine Woodland	Crop-land	Improved Pasture
6	SURRENCY-PORTSMOUTH			HIGH	V.LOW	V.LOW
	Surrency	40	Vw	High	V.Low FL,PO,PDY	V.Low FL,PO,PDY
	Portsmouth	30	IIIw	Low	Moderate PO,WT	High
	Others	30				
7	BRIGHTON-DOROVAN			V.LOW	MODERATE	HIGH
	Brighton	40	IIIw	V.Low	Moderate FL,WT,PO	High
	Dorovan	35	VIIw	V.Low	V.Low FL,WT,PO	V.Low FL,WT,PO
	Others	25				
8	FRESHWATER SWAMP			HIGH	V.LOW	V.LOW
	Freshwater Swamp	75	VIIw	High[4]	V.Low FL,DTC PO	V.Low FL,DTC PO
	Others	25				

[1]Percentages are estimates and are not based on measured acreage.
[2]High level management is assumed which includes water management.
[3]Abbreviations:

DTC - difficult to clear; DTY - droughty; FL - floods; PDY - productivity; PO - poor outlets; PR - percolates rapidly; WT - wet

[4]Rating is for hardwood trees.

Table 3.1-6. Non-Agricultural Use Potential.

Map Symbol[1]	Association and Soils	Degree and Kind of Limitation[2]: Sanitary Facilities: Septic Tank Absorption Fields	Sanitary Facilities: Sewage Lagoons	Sanitary Facilities: Sanitary Landfill[3]	Community Development: Shallow Excavations	Community Development: Dwellings	Community Development: Light Industry	Community Development: Local Roads and Streets
1	ALPIN-BLANTON-EUSTIS	SLIGHT	SEVERE	SEVERE	SEVERE	SLIGHT	SLIGHT	SLIGHT
	Alpin	Slight	Severe PR	Severe PR,TS	Severe CC	Slight	Slight	Slight
	Blanton	Slight	Severe PR	Moderate TS	Severe CC,WT	Slight	Slight	Slight
	Eustis	Slight	Severe PR	Severe PR,TS	Severe CC	Slight	Slight	Slight
2	ARREDONDO, VAR.- ALAGA-KENNEY	SLIGHT	SEVERE	MODERATE	SEVERE	SLIGHT	SLIGHT	SLIGHT
	Arredondo, Var.	Slight	Severe PR	Moderate TS	Severe CC	Slight	Slight	Slight
	Alaga	Slight	Severe PR	Severe PR,TS	Severe CC	Slight	Slight	Slight
	Kenney	Slight	Severe PR	Moderate TS	Severe CC	Slight	Slight	Slight
3	CHIPLEY-ALBANY-PLUMMER	MODERATE	SEVERE	SEVERE	SEVERE	MODERATE	MODERATE	MODERATE
	Chipley	Moderate WT	Severe PR	Severe TS,PR,WT	Severe CC,WT	Moderate WT	Moderate WT	Moderate WT
	Albany	Severe WP	Severe PR	Severe PR,WT	Severe CC,WT	Moderate WT	Moderate WT	Moderate WT
	Plummer	Severe WT	Severe PR,WT	Severe TS,PR,WT	Severe CC,PR,WT	Severe WT	Severe WT	Severe WT
5	LEON-MASCOTTE-RUTLEDGE	SEVERE	SEVERE	SEVERE	SEVERE	SEVERE	SEVERE	SEVERE
	Leon	Severe WT	Severe PR	Severe TS,PR,WT	Severe CC,WT	Severe WT	Severe WT	Severe WT
	Mascotte	Severe WT	Moderate PR	Severe PR,WT	Severe WT	Severe WT	Severe WT	Severe WT
	Rutledge	Severe WT,FL	Severe WT,FL	Severe WT,FL	Severe WT,FL	Severe WT,FL	Severe WT,FL	Severe WT,FL
6	SURRENCY-PORTSMOUTH	SEVERE	SEVERE	SEVERE	SEVERE	SEVERE	SEVERE	SEVERE
	Surrency	Severe WT	Severe PR	Severe WT	Severe CC,WT	Severe WT,FL	Severe WT,FL	Severe WT,FL
	Portsmouth	Severe WT	Severe WT	Severe WT	Severe WT	WT	WT	WT

Table 3.1-6 (Continued).

Map Symbol[1]	Association and Soils	Degree and Kind of Limitation[2]: Sanitary Facilities: Septic Tank Absorption Fields	Sanitary Facilities: Sewage Lagoons	Sanitary Facilities: Sanitary Landfill[3]	Community Development: Shallow Excavations	Community Development: Dwellings	Community Development: Light Industry	Local Roads and Streets
7	BRIGHTON-DOROVAN	V.SEVERE	V.SEVERE	V.SEVERE.	V.SEVERE	V.SEVERE	V.SEVERE	V.SEVERE
	Brighton	V.Severe WT,FL	V.Severe WT,EH,PR	V.Severe WT,EH,PR	V.Severe WT,FL,EH	V.Severe WT,FL,LS	V.Severe WT,FL,LS	V.Severe WT,FL,LS
	Dorovan	V.Severe WT,FL	V.Severe WT,EH,PR	V.Severe WT,EH,PR	V.Severe WT,FL,EH	V.Severe WT,FL,LS	V.Severe WT,FL,LS	V.Severe WT,FL,LS
8	FRESHWATER SWAMP	V.SEVERE	V.SEVERE	V.SEVERE.	V.SEVERE	V.SEVERE	V.SEVERE	V.SEVERE
	Freshwater Swamp	V.Severe WT,FL	V.Severe WT,FL	V.Severe WT,FL	V.Severe WT,FL	V.Severe WT,FL	V.Severe WT,FL	V.Severe WT,FL

[1] See Figure 3.1-14.
[2] Abbreviations:
PR - percolates rapidly
WT - wet
FL - floods
EH - excess humus
[3] Trench type.

TS - too sandy
CC - cutbanks cave
LS - low strength

Table 3.1-7. Hydrologic Soil Groups.

Soil Series	Hydrologic Group*
Alpin	(A)
Blanton	A
Eustis	A
Arredondo	(A)
Chipley	C
Albany	C
Plummer	B/D
Leon	A/D
Mascotte	D
Rutledge	D
Surrency	B/D
Portsmouth	D
Brighton	A/D
Dorovan	D
Alaga	A
Kenney	A

* (A) Inferred grouping.
A Low runoff potential - soils having high filtration rates even when thoroughly wetted; high rate of water transmission.
B Soils having moderate infiltration rates when thoroughly wetted; moderate rate of water transmission.
C Soils having slow infiltration rates when thoroughly wetted; slow rate of water transmission.
D High runoff potential - soils having very slow infiltration rates when thoroughly wetted; slow rate of water transmission.

drainage.) A high water table, therefore, can occur at or near the surface throughout most of the wet season.

3.1.4.6 Reservoir Embankment Suitability

Use of the various horizons of surficial soils at the site for pond embankment construction is restricted by the engineering properties of certain sections of the embankment cross-section (Table 3.1-8). An SCS rating of "slight, moderate, or severe" is inappropriate without further clarification. Although a soil's suitability for use in a homogeneous embankment may be considered severe, its use in a zoned embankment would be completely acceptable. Construction control and embankment design, with particular attention to seepage control through the embankment, are required for acceptable pond embankment performance. A rating of "severe" can be automatically assigned to organic surface soils, where present, due to the excess humus, high compressibility, and low shear strength. However, the substrata at these locations are suitable for construction of a zoned embankment once the organic soils have been excavated.

A more useful method of classifying soils for engineering purposes is the Unified Soil Classification System. The strata encountered in the top 30 ft of the SPT soil borings (Figures 3.1-11 and 3.1-12) were classified in accordance with the Unified Soil Classification System (Table 3.1-9). All of these sandy, silty, and clayey soils, except for strata Nos. 9 and 12, could be used for dikes or other construction activities. The SC soil type could be used for clay core material in earthen dams. Typical engineering properties of compacted materials of these types are presented in Table 3.1-10.

3.1.4.7 Erosion Potential

The erosion potential of a soil depends on its ability to resist the erosive forces of rainfall and runoff. Once natural vegetation is removed, the quantity of erosion depends only on the quantity and intensity of the rainfall, the length and steepness of the slope of the unprotected ground surface, the runoff flow velocities, and the erodibility of the soil.

With all other factors being equal, it is possible to rank the erodibility of different soils based solely on soil properties. The soil properties having the largest effect on erodibility are the percentage of silt and very fine sand particles (0.002-0.10 mm) that are easily eroded, the percentage of sand particles (0.1-2.0 mm) that are less susceptible to erosion, the percentage of organic matter and cohesive soils which restrict erosion, the soil structure, and the permeability of the soil. These properties have been combined by Wischmeier and Meyer (1973) into a single parameter termed the Soil Erodibility Factor (k) which normally is expressed in tons per acre per rainfall unit for a 9% slope, 72.6 ft long, on which there is no vegetation. Values of k for most of the surficial soils on the OXY site range from 0.07-0.20 ($\overline{x}$ = 0.15).

When these standard values are modified to reflect the actual slope of the particular soil type, the modified average values are ≤0.03. It

Table 3.1-8. Embankment Suitability.

Map Symbol[1]	Association and Soils	Kind and Degree of Limitation for Embankments[2]
1	ALPIN-BLANTON-EUSTIS	SEVERE
	Alpin	Severe (PR,PG)
	Blanton	Severe (PR,PG)
	Eustis	Severe (PR,PG)
2	ARREDONDO, VAR.-ALAGA-KENNEY	SEVERE
	Arredondo, Var.	Severe (PR,PG)
	Alaga	Severe (PR,PG)
	Kenney	Severe (PR,PG)
3	CHIPLEY-ALBANY-PLUMMER	MODERATE
	Chipley	Moderate (PR,PG)
	Albany	Moderate (PG,EE)
	Plummer	Severe (PR,PG,EE)
5	LEON-MASCOTTE-RUTLEDGE	SEVERE
	Leon	Severe (PR)
	Mascotte	Moderate (EE)
	Rutledge	Severe (PR,PG)
6	SURRENCY-PORTSMOUTH	MODERATE
	Surrency	Moderate (PR)
	Portsmouth	Moderate (LS)
7	BRIGHTON-DOROVAN	V.SEVERE
	Brighton	V.Severe (PR,CP,UF)
	Dorovan	V.Severe (PR,CP,UF)
8	FRESHWATER SWAMP	NR
	Freshwater Swamp	NR

[1]See Figure 3.1-14.
[2]Abbreviations:

PR - percolates rapidly
PG - piping
EE - erodes easily
CP - compressible
UF - unstable fill
NR - not rated
LS - low strength

Table 3.1-9. Unified Soil Classifications for the Project Area.

SPT Soil Boring Classification	Strata No.	Unified Soil Classification
Light gray to dark brown slightly silty fine sand to fine sand	1	SM
Light brown silt	2	ML
Dark brown to greenish brown to gray clayey fine sand with seams of brown to gray fine sand	3	SC
Dark gray silty fine sand with thin seams of bluish gray clay	4	SM-SC
Bluish gray to gray clay and sandy clay	5	CL
Gray to brown silty fine sand with occasional traces of clayey fine sand	6	SM-SC
Bluish gray to grayish brown slightly clayey fine sand	7	SC
Bluish gray to green and grayish or yellowish brown clayey fine sand with occasional traces of clay	8	SC
Yellowish brown clay and sandy clay with consolidated clay	9	CL-CH
Brown to greenish brown and gray fine sand with thin seams of gray and brown clayey fine sand	10	SM-SC
Grayish brown clayey fine sand with cemented sand	11	SC
Greenish brown to yellowish brown silty clay or clay	12	CL

Table 3.1-10. Typical Properties of Compacted Materials.[1]

Unified Soil Type		Maximum Dry Unit Weight (pcf)	Optimum Moisture (%)	Compression[2] 1.4 tsf (20 psi)	Compression[2] 3.6 tsf (50 psi)	Cohesion, compacted (psf)	Cohesion, saturated (psf)	Effective Stress Envelope (degrees)	Tan	Coefficient of Permeability (ft/min)	CBR	Subgrade Modulus k (lb/cu in)
SM	Silty sands, poorly graded sand-silt mix	110-125	16-11	0.8	1.6	1050	420	34	0.67	$5x10^{-5}$	10-40	100-300
SM-SC	Sand-silt clay mix with slightly plastic fines	110-130	15-11	0.8	1.4	1050	300	33	0.66	$2x10^{-6}$	-	-
SC	Clayey sands, poorly graded sand-clay mix	105-125	19-11	1.1	2.2	1550	230	31	0.60	$5x10^{-7}$	5-20	100-300
ML	Inorganic silts and clayey silts	95-120	24-12	0.9	1.7	1400	190	32	0.62	$1x10^{-5}$	≤15	100-200
ML-CL	Mixture of inorganic silt and clay	100-120	22-12	1.0	2.2	1350	460	32	0.62	$5x10^{-7}$	-	-
CL	Inorganic clays of low to medium plasticity	95-120	24-12	1.3	2.5	1800	270	28	0.54	$1x10^{-7}$	≤15	50-200
OL	Organic silts and silt-clays, low plasticity	80-100	33-21	-	-	-	-	-	-	-	≤5	50-100
MH	Inorganic clayey silts, elastic silts	70-95	40-24	2.0	3.8	1500	420	25	0.47	$5x10^{-7}$	≤10	50-100
CH	Inorganic clays of high plasticity	75-105	36-19	2.6	3.9	2150	230	19	0.35	$1x10^{-7}$	≤15	50-150
OH	Organic clays and silty clays	65-100	45-21	-	-	-	-	-	-	-	≤5	25-100

Source: NAVFAC 1971.

Note: All properties are for condition of "standard Proctor" maximum density, except values of k and CBR (California Bearing Ratio) which are for "modified Proctor" maximum density.

[1]Typical strength characteristics are for effective strength envelopes and are obtained from U.S. Bureau of Reclamation data.

[2]Percent of original height (numbers in parentheses indicate that typical property is greater than the value shown). Compression values are for vertical loading with complete lateral confinement.

- indicates insufficient data available for an estimate.

pcf - pounds per cubic foot
psi - pounds per square inch
psf - pounds per square foot
Tan - tangent

should be noted that, for the majority of soils on which the studies by Wischmeier and Meyer were made, the values of k ranged from 0.03-0.69. All of the values calculated for the soils in the project area are at the low end of this range, indicating that these soils have a low erosion potential, even when stripped of vegetation, because of the soil properties and the flatness of the existing slopes, the latter resulting in low flow velocities.

3.1.4.8 Susceptibility to Sinkholes

Local structural features contribute to the solution of the underlying limestone. The presence of points of intersection of fractures on the underlying limerock is one factor conducive to sinkhole development. Where two such fractures intersect, the possibility of localized solutioning is increased. Data on apparent joints discerned from aerial photographs (Vernon 1951, PELA 1977) suggest that the project area has comparatively light to medium fault and fracture patterns and, therefore, the potential for solution cavities is expected to be low (Figure 3.1-22). Any solutioning associated with the noted fractures may be controlled by the limestone beds within the Hawthorn Formation rather than the Suwannee and Ocala limestones. Cavity systems have not been found in the Hawthorn Limestone beds and, therefore, active formation of sinkholes due to collapse or erosion is unlikely. Vernon (1952) considers other parameters which can contribute to sinkhole activity and divides the state into various zones of sinkhole potential (Figure 3.1-23). The project area falls mainly within the least probable region for sinkhole development for two main reasons:

1) Thickness of the sediments overlying the limestone formations of the Floridan Aquifer is quite large over the project area (60-210 ft, Figure 3.1-13). The thinner sequences are located within a narrow zone along the Suwannee River. For example, at TH-16, only 2.5 mi from the river, the overlying strata have increased to 125 ft in thickness. Breaches in sediments of 125-150 ft in thickness would be extremely unlikely.

2) "Impermeable" beds of clays and silts occur within these overlying sediments. These beds retard downward movement of water which could dissolve the limestone and form cavities.

Although the present potential for sinkhole formation is low, sinkholes have formed in the area during the geologic past but have been masked by subsequent sediment deposition. OXY uncovers numerous small, ancient plugged sinkholes during mining operations (a typical section is presented in Figure 3.1-24). Surface depressions inferred by changes in vegetation, as viewed on aerial photography of the same area prior to mining, show little or no correlation with surface expression of these sinkholes. However, most indicated ancient sinkholes have been found in wetlands areas.

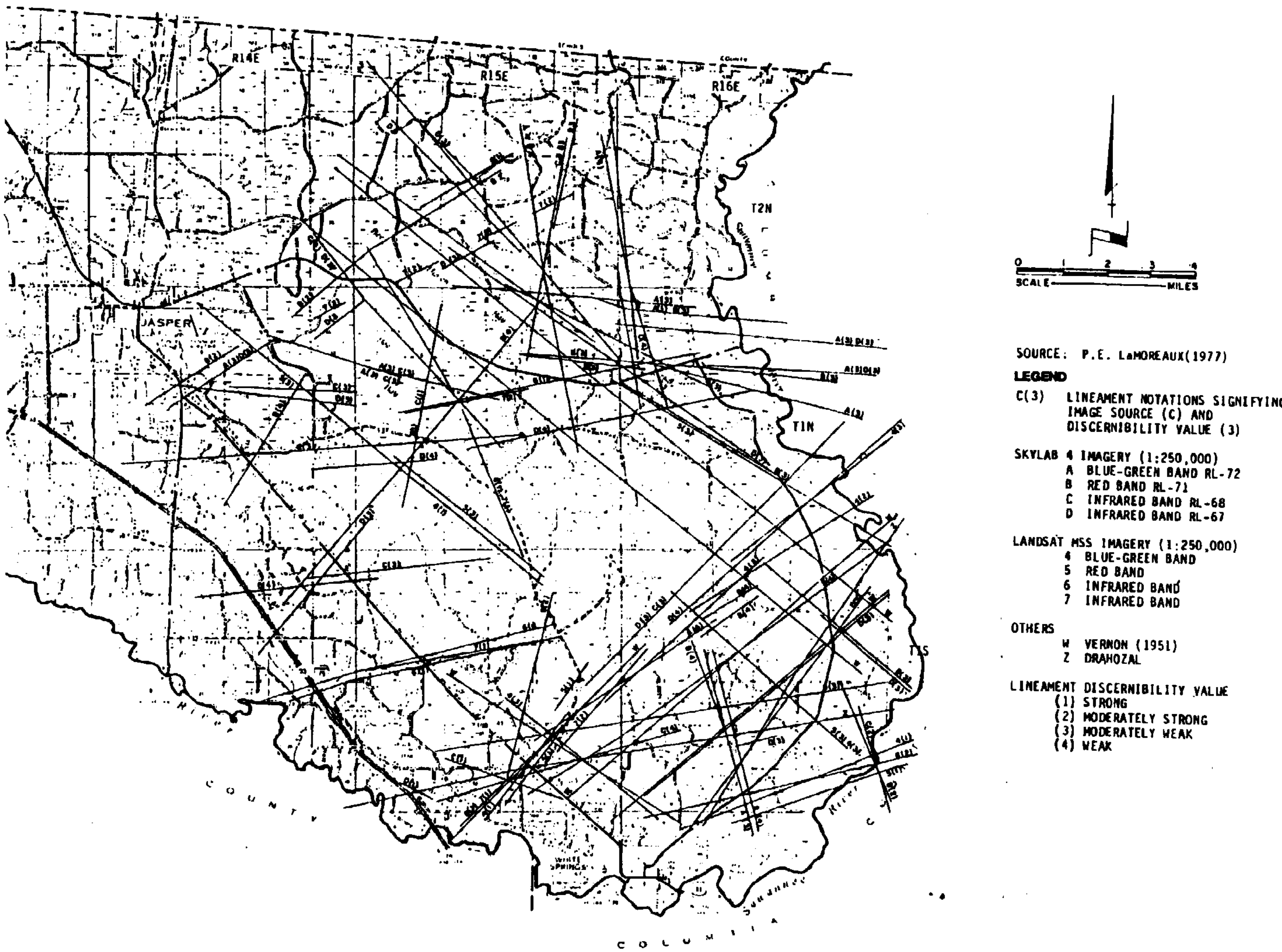


Figure 3.1-22. Site Lineament Map.

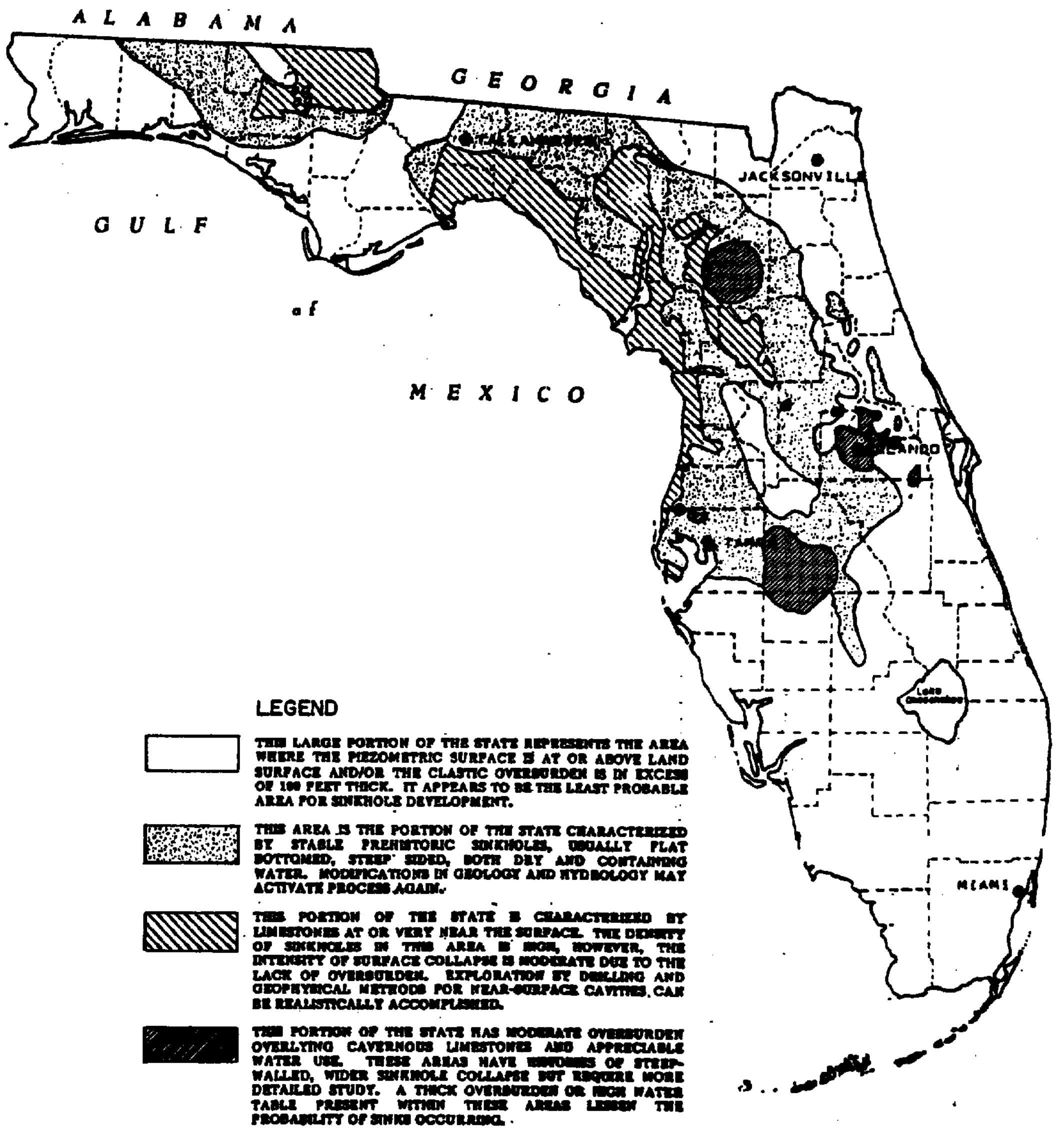
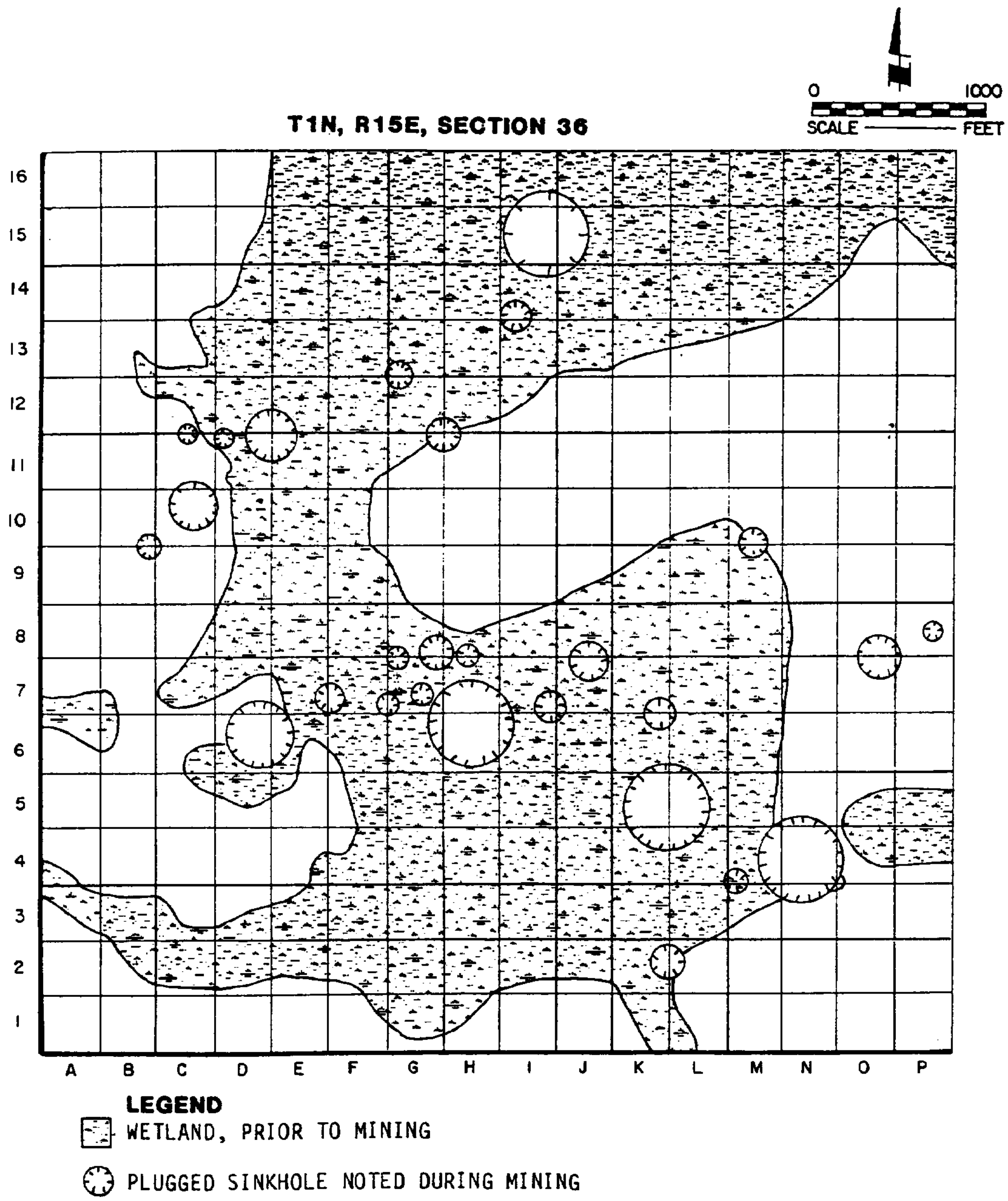


Figure 3.1-23. Most Probable Sinkhole Regions in Florida.



Source: Oxy Mining Records

Figure 3.1-24. Plugged Sinkholes Documented in Section 36 T1N R15E.

The practical implication of this information is that although sinkholes have occurred in the geologic past in the project area, current hydrogeologic conditions are such that the site is in an area with low probability of present sinkhole occurrence.

3.1.4.9 Earthquake Susceptibility

Florida has experienced no damaging earthquakes. The recorded earthquake pattern in the southeastern United States appears to follow a southeast-northwest band from Alabama to Maryland and includes an extension perpendicular to that bank which covers South Carolina. Several ground movements of Intensity V and VI (minor damage) on the Modified Mercalli Intensity Scale apparently have been experienced in north Florida. The Modified Mercalli Intensity Scale covers a full range from I (motions undetected by people) to XII (total damage).

Howell (1975) separated the United States into geologically similar provinces and, using the recorded earthquakes in each area, calculated an Average Regional Seismic Hazard Index which predicts the Modified Mercalli intensity of the hundred-year earthquake for the region. The Atlantic Seaboard Province and Gulf Coast Province boundary occurs near Hamilton County. The predicted hundred-year Modified Mercalli Intensity of these two provinces is approximately 6.5 (standard deviation = 0.8-0.9); i.e., in any 1/2° by 1/2° quadrilateral, an earthquake of Modified Mercalli Intensity of 6.5 can be expected once per century. An epicentral intensity of 6.5 can be crudely correlated to an earthquake of magnitude 5.2 and a ground acceleration of approximately 0.06 g. Magnitude is a direct measure of the overall strength of an earthquake (e.g., an increase of 1 in magnitude corresponds to a 30-fold increase in energy release). An earthquake of magnitude 5.2 is not expected to cause very severe damage. An earthquake zone map (Figure 3.1-25) indicates Hamilton County lies within Zone 1, where only minor damage from earthquakes is expected to occur and where the ground acceleration is expected to be <0.1 g.

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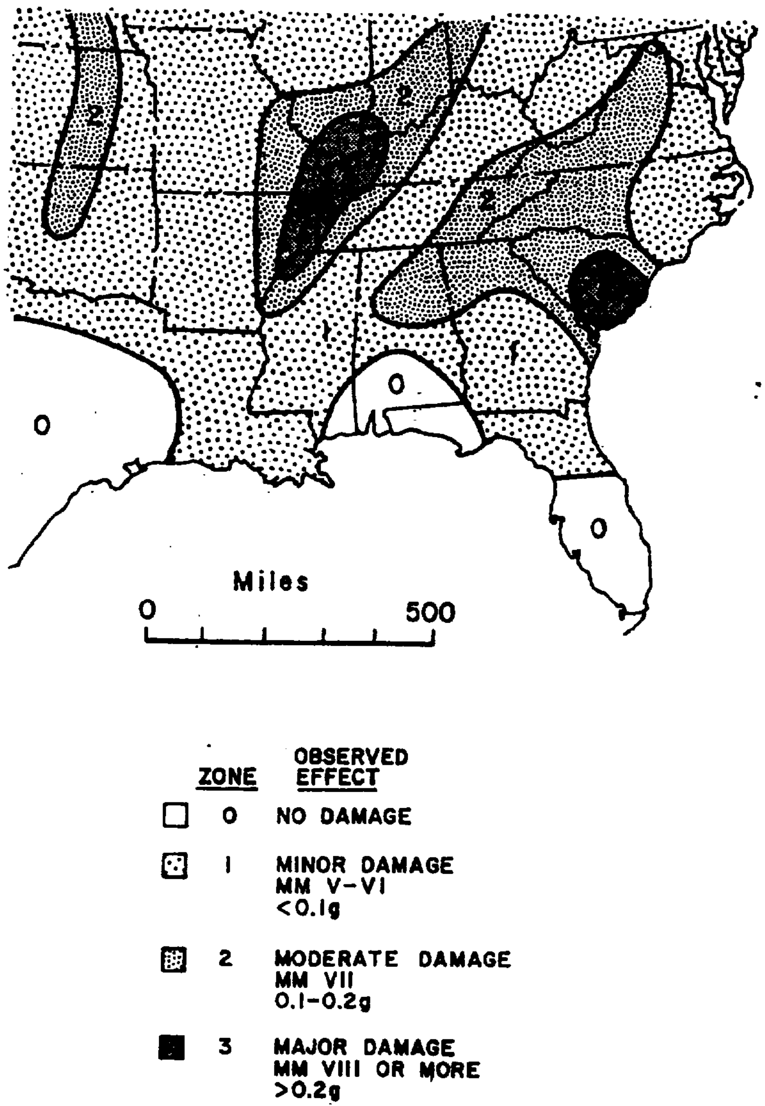

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Figure 3.1-25. Earthquake Zones in the Southern U.S.

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3.2 Meteorology and Climatology

The OXY site, near the northern boundary of the tradewinds, is characterized by relatively dry winters and rainy summers, a high annual percentage of sunshine, and high humidities. The terrain in the area is level and produces no significant effects on local climatology or meteorology.

3.2.1 Temperature and Humidity

The annual mean temperature for the OXY area is 69°F (20°C) (Table 3.2-1). Temperature extremes range from a minimum monthly mean of 45°F (7°C) during December-January-February to a maximum monthly mean of 91°F (33°C) during June-July-August. The area seldom experiences severe cold weather, with freezing temperatures occurring an average of 12 times per year. The first winter freeze normally occurs in early December and the last freeze in mid-February. The mean number of non-freeze days between these dates is 295.

Annual relative humidity averages 76%. Humidity data for the area are summarized in the Swift Creek EIS (EPA 1978).

3.2.2 Precipitation and Evaporation

The greatest rainfall (50% of annual rainfall) is usually in the form of local thunderstorms, occurring primarily during the summer. Widespread rainfall of low intensity occurs during the fall and winter, usually generated by the passage of frontal systems. Mean monthly rainfall ranges from 2-3 in. during the fall and winter to 6-8 in. during the summer. The long-term average for the OXY site is approximately 54 in. per year.

Average annual open water evaporation in Hamilton County is approximately 46 in. per year (Visher and Hughes 1969), while the evapotranspiration rate from soil and vegetation averages 40 in. per year (Fisk 1977). Both rainfall intensity data and monthly evaporation data are presented in the Swift Creek EIS (EPA 1978).

3.2.3 Wind

The OXY site seldom experiences strong winds; annual average wind speed is 3.1 meters per second (7 mph). Winds normally blow from the northeast in the fall, northwest during the winter and early spring, and southwest during the late spring and summer. Joint wind speed/wind direction/stability frequencies for the area are reported by EPA (1978).

3.2.4 Vertical Mixing and Ventilation

The vertical mixing depth is the thickness of the atmospheric layer through which turbulent mixing occurs; it defines the vertical dimension of the volume of air into which pollutants are dispersed. The transverse dimension is defined by the fluctuation in wind direction and by horizontal dispersion. The longitudinal dimension of the air volume is

Table 3.2-1. Summary of Long-Term Ambient Temperature Data, Lake City, Florida.

Parameter[1]	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Absolute Maximum	85	89	96	95	101	106	102	103	101	96	90	85	106
Mean Maximum	67	70	76	81	87	91	91	91	88	81	73	67	80
Mean Monthly[2]	55	57	62	69	75	80	81	81	78	70	61	56	69
Mean Minimum	44	46	51	51	63	69	71	71	69	60	50	45	58
Absolute Minimum	16	6	23	33	42	52	59	59	49	32	20	12	6
Mean No. Days >90°F	0.0	0.0	0.8	9.8	15.1	21.5	20.2	10.6	0.7	0.0	0.0	0.0	78.7
Mean No. Days <32°F	4.8	1.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	4.7	12.3

[1]Period of record is 65 years (1913-1977) unless otherwise noted.
[2]Period of record is 93 years.

defined by wind speed and time. The combination of these factors defines atmospheric ventilation. Valdosta, Georgia surface observations and Waycross, Georgia upper air data for the period 1972-1976 were used as the source of these data.

The annual morning mixing depth averages 500 m, ranging from 400 m in fall and winter to 600 m in spring and summer. The annual afternoon mixing depth averages 1450 m, ranging from 1100 m during the winter to 1700 m in the summer (Holzworth 1972). During a one-year period the number of forecast days of high meteorological potential for air pollution at the OXY site is one (Holzworth 1972).

3.2.5 Severe Weather

The probability of severe weather occurring at the OXY site is quite low. The chance of a hurricane-force wind in the area in a given year is less than 1 in 50. Of the >40 hurricanes reported in Florida since 1900, 10 have passed through or near Hamilton County. The storms typically approach from the south-southwest and, due to overland travel, usually are reduced to tropical storms before reaching Hamilton County. A total of 590 tornadoes has been reported in Florida during the period 1916-1969. However, the probability of a tornado hitting any given spot in Hamilton County is once in 2260 years (Thom 1963). No hailstorms of an intensity that caused significant damage have ever been reported in Hamilton County. Thunderstorms can be expected 68 days per year, based on Lake City meteorological data covering the period 1952-1976.

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3.3 Ecology

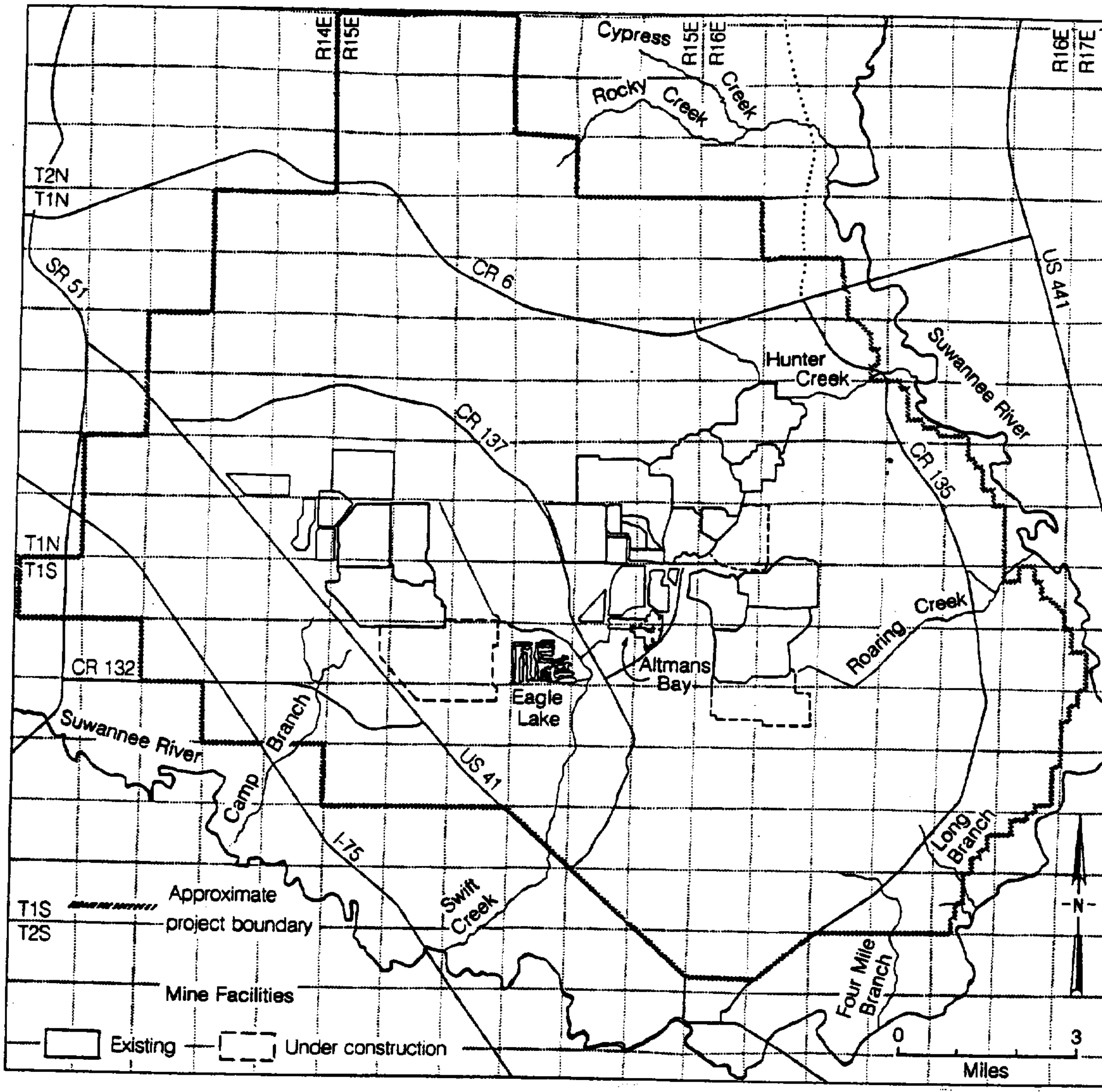
3.3.1 Regional Setting

The geological history of north Florida and the geographical position of the area, in relation to the remainder of peninsular Florida and the main continental land mass of North America, have affected the habitats and distribution of fauna in the north Florida area. The proposed mine site is a part of the Suwannee Straits biogeographical region, one of seven major biogeographical regions of Florida (Neill 1957). This region has been referred to by other biogeographers as the North Florida Suture Zone (Remington 1968) and Suwannee River Pattern (Christman 1975) and has been identified as a faunal break line where species have their northern or southern range terminus or demonstrate abrupt differences in morphological characteristics (National Fish and Wildlife Laboratory [NFWL] 1978). This phenomenon, occurring here more than in any other region of Florida, can be found in all animal groups as well as many plant groups.

Faunal movements and patterns of habitat use generally correlate with the cyclic wet-dry season (Section 3.2). For example, flow characteristics of streams are related to rainfall patterns, though relative flow rate response is additionally a function of basin size, topography, and land use. Volume and intensity of flow is a major factor in determining extent of aquatic habitat and its attendant fauna. Perennial streams usually have more stable environments than do small or intermittent streams, and they normally support a more stable aquatic community. Therefore, temporal variation in rainfall plays a significant role in aquatic community stability.

Southern mixed forest is the dominant vegetation type of the southeastern United States. Dominant vegetation includes sweetgum, southern magnolia, pine, and laurel oak. The most widely recognized vegetation map of Florida (Davis 1967) displays 17 different vegetation types, five of which occur in the region: pine flatwoods, longleaf pine and xerophytic oak forest, hardwood swamp forest, upland hardwood forest, and freshwater marsh. The most extensive vegetation type in the project area is pine flatwoods; however, it has been altered through intense management directed toward increasing pine growth and volume at the expense of overall plant community diversity. Low vegetative diversity generally results in low wildlife diversity (White et al. 1975).

Several small streams drain the project site, e.g., Rocky Creek, Hunter Creek, Roaring Creek, Four Mile Branch, Long Branch, Swift Creek, and Camp Branch. These streams flow into the Suwannee River which approximates the eastern and southern boundary of the project area (Figure 3.3-1). The Suwannee River has two distinct subsystems, with separation between the two at a point near Branford, Florida downstream from the project site. Above the Florida state line, waters from the Okefenokee Swamp flow between low banks over white sands. Once into Florida, the streambed cuts into underlying limestone, forming steep banks and shoal areas. The lower portion of the river (below Branford) exhibits a broad, flat channel characteristic of coastal regions. Environmental fluctuations in the lower subsystem are not as intense as in the upper subsystem where the environment is characteristically unstable due to abrupt seasonal changes in flow regimes.



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

Figure 3.3-1. Detailed Map of Project Area.

Ongoing mining activities (Swift Creek Mine and Suwannee River Mine) have altered the vegetation communities of the area and influenced two of the small streams: Hunter Creek and Swift Creek. The former receives mine water discharge, and the latter receives discharge from the Swift Creek and Suwannee River chemical complexes and both mines.

The project area consists of approximately 100,000 acres of upland, wetland, aquatic, and various developed and mining land use and cover classes. Land use and cover categories of all areas, with the exception of wetlands, were based on the Florida Land Use and Cover Classification System (Fla. Dept. of Administration 1976). Classification of wetlands was based on the National Wetlands Inventory classification nomenclature (Cowardin et al. 1979). Based on these two classification systems, 77 land use and cover types and wetlands categories were identified for the project area (Tables 3.3-1 and 3.3-2 and Figure 3.3-2 in map pocket).

They may be grouped as follows:

- ° Developed areas (10 land use types)
- ° Upland communities (15 land use types)
- ° Wetland communities (48 wetland categories or 7 land use types)
- ° Aquatic communities (4 land use types)

Developed areas (e.g., residential, roads, industrial areas), accounting for 0.7% (688 acres) of the total acreage, have been excluded from the discussions of ecological communities.

Flora and fauna observed or potentially occurring in the project area were recorded in the course of fieldwork for this study as well as from other field reconnaissance and literature sources. Species lists for the area by habitat type are available in EPA (1978a) and NFWL (1978).

As a result of cultural influences, biological characteristics of the upland, wetland, and aquatic communities on site have been altered. These cultural influences in the project area include large-scale forest management, agriculture, logging, drainage, stream channel modifications, phosphate chemical plants, and ongoing mining and reclamation. Upland communities are influenced primarily by ongoing mining and reclamation activities. Some upland community areas have been altered primarily by large-scale forestry management practices which reduce habitat quality value as compared to naturally occurring vegetation associations (Sections 3.3.2 and 3.3.8). Wetland communities also have been affected by ongoing mining, drainage, and logging activities. This results in a reduction of the overall value of wetlands on the project site, with the possible exception of some of the larger wetland areas. Stream channel modifications are the main cultural influence in the tributaries to the Suwannee River. Factors influencing the Suwannee River via the on-site tributaries include ongoing mining and reclamation, logging, and phosphate operation water discharges.

The methods used in classifying and mapping vegetation communities, collecting biological data, and characterizing and evaluating ecological communities in the OXY project area are outlined in Section 3.3.11.

Table 3.3-1. Land Use and Cover Types, Acreage, and Percent of Total Acreage in the OXY Project Area.

Code[1]	Description	Approx. Acreage[2]	Percent of Total Area[2]
DEVELOPED AREA			
111	Residential, single unit, low density	53	<0.1
112	Residential, single unit, medium density	5	<0.1
114	Mobile homes, medium density	18	<0.1
123	Offices and professional services	20	<0.1
131	Light industrial	13	<0.1
144	Major roads, highways, and railroads	524	0.5
152	Major long distance transmission lines	27	<0.1
162	Religious facilities, excluding schools	3	<0.1
167	Cemeteries	4	<0.1
193	Land undergoing active development without indication of intended use	21	<0.1
	SUBTOTAL	688	0.7
UPLAND COMMUNITIES			
211	Row crops	3,976	4.0
212	Field crops	2,509	2.5
213	Improved pasture	1,302	1.3
222	Deciduous fruit orchard	1	<0.1
231	Pecan orchard	1	<0.1
242	Confined feeding operations (poultry)	51	<0.1
323	Scrub/brush rangeland	105	0.1
411	Pine flatwoods	3,935	3.9
422	Other hardwoods	87	<0.1
431	Mixed forest	12,399	12.4
441	Planted forest, coniferous	24,861	24.8
451	Clearcut areas	9,195	9.2
741	Scraped areas	8	<0.1
742	Dredge and fill areas	382	0.4
760	Mining and processing	15,379	15.4
	SUBTOTAL	74,191	74.0

Table 3.3-1 (Continued).

Code[1]	Description	Approx. Acreage[2]	Percent of Total Area[2]
WETLAND COMMUNITIES[3]			
6110	Cypress	1,970	2.0
6211	Swamp tupelo	775	0.8
6212	Bayhead	1,322	1.3
6213	Scrub/shrub	1,314	1.3
6311	Cypress/swamp tupelo/bay	12,633	12.6
6312	Swamp tupelo/bay/pine	6,291	6.3
6410	Emergent	430	0.4
	SUBTOTAL	24,735	24.7
AQUATIC COMMUNITIES			
513	Canals	66	<0.1
521	Mine pits reclaimed to lakes	17	<0.1
531	Reservoirs	434	0.4
561	Ponds	73	<0.1
	SUBTOTAL	590	0.6
	TOTAL	100,204	100

[1]Based on Florida Land Use and Cover Classification System (Fla. Dept. of Administration 1976).

[2]All acreages and calculations have been rounded.

[3]See Table 3.3-2 for detailed wetlands classification as based on the National Wetlands Inventory Classification (Cowardin et al. 1979).

Table 3.3-2. Detailed Classification, Acreages, and Percent of Total Acreage of Wetland Communities in the OXY Project Area.

Map Code[1]	Florida Land Use Code (FLUC[2]) and Wetlands Classification[3]		Approx. Acreage[4]	Percent of Total Wetlands[4]
	FLUC 6110 - Cypress			
B	PF02 Cag		3	<0.1
Y	PF02/EM3 Cag		233	0.9
T'	PF02/EM5 Cag		3	<0.1
M	PF02/SS3 Cag		223	0.9
I	PF02/4 Aag, Cag		1,493	6.0
I	PF02/4 Cadg		15	<0.1
		SUBTOTAL	1,970	8.0
	FLUC 6211 - Swamp Tupelo			
A	PF01 Cag		8	<0.1
X	PF01/EM3 Cag		5	<0.1
L	PF01/SS3 Cag		149	0.6
F	PF01/3 Aag, Cag, Eag		483	2.0
F	PF01/3 Cadg		130	0.5
		SUBTOTAL	775	3.1
	FLUC 6212 - Bayhead			
C	PF03 Cag		1,142	4.6
O	PF03/SS3 Cag		170	0.7
F	PF03/1 Cag		10	<0.1
		SUBTOTAL	1,322	5.3
	FLUC 6213 - Scrub/Shrub			
K	PSS3 Cag		231	0.9
M	PSS3/F02 Cag		40	0.2
O	PSS3/F03 Cag		60	0.2
P	PSS3/F04 Cag		983	4.0
		SUBTOTAL	1,314	5.3
	FLUC 6311 - Cypress/Swamp Tupelo/Bay			
H	PF02/3 Cag, Eag		1,131	4.6
H	PF02/3 Cadg		198	0.8
E	PF02/1 Cag		10,916	44.1
E	PF02/1 Cadg		50	0.2
H	PF03/2 Cag		338	1.4
		SUBTOTAL	12,633	51.1
	FLUC 6312 - Swamp Tupelo/Bay/Pine			
Z	PF04/EM3 Cag		20	<0.1
P	PF04/SS3 Cag		979	4.0
G	PF04/1 Cag		170	0.7
J	PF04/3 Cag		160	0.6
J	PF03/4 Cag		449	1.8
J	PF03/4 Cadg		60	0.2
G	PF01/4 Aag, Cag, Eag		2,676	10.8
G	PF01/4 Cadg		1,777	7.2
		SUBTOTAL	6,291	25.4

Table 3.3-2 (Continued).

Map Code[1]	Florida Land Use Code (FLUC[2]) and Wetlands Classification[3]	Approx. Acreage[4]	Percent of Total Wetlands[4]
	FLUC 6410 - Emergent		
Q'	PEM1 Cag	2	<0.1
Q	PEM3 Cag, Eag	69	0.3
S	PEM3/4 Cag	10	<0.1
R	PEM4 Cag	1	<0.1
V	PEM4/5 Cag	251	1.0
T	PEM5 Cag	4	<0.1
U	PEM6 Cag, Eag	44	0.2
U	PEM6 Eadg	10	<0.1
Y'	PEM3/PFO3 Cag	39	0.2
	SUBTOTAL	430	1.8
	TOTAL	24,735	100

KEY

Class	Systems and System Subclasses	
P = Palustrine	FO = Forested	EM = Emergent
	1 = Broad-leaved deciduous (swamp tupelo - *Nyssa biflora*)	1 = Persistent (see EM 5 and 6 species)[5]
	2 = Needle-leaved deciduous (cypress - *Taxodium* spp.)	2 = Nonpersistent (see EM 3 and 4 species)[5]
	3 = Broad-leaved evergreen (bay - *Magnolia virginiana*, *Persea palustris*, *Gordonia lasianthus*)	3 = Narrow-leaved nonpersistent (broomsedge - *Andropogon virginicus*; plumegrass - *Erianthus* spp.; maidencane - *Panicum hemitomon*)
	4 = Needle-leaved evergreen (pine - *Pinus* spp.)	4 = Broad-leaved nonpersistent (pickerelweed - *Pontederia cordata*, *Saururus cernuus*)
	SS = Scrub/shrub	5 = Narrow-leaved persistent (cattail - *Typha* spp., softrush - *Juncus effusus*, Eriocaulon - *Eriocaulon* spp.)
	3 = Broad-leaved evergreen (fetterbush - (*Lyonia lucida*)	6 = Broad-leaved persistent (water loosestrife - *Decodon verticillatus*)

Modifiers:

- Water regime: C = Seasonally flooded; A = Temporarily flooded; E = Seasonal/saturated
- Water chemistry: a = Acid pH, freshwater
- Special: d = Partially drained, ditched
- Soils: g = Organic

[1] Map code for Figure 3.3-2.
[2] Florida Land Use and Cover Classification System (Fla. Dept. of Administration 1976).
[3] National Wetlands Inventory Classification (Cowardin et al. 1979) (See KEY).
[4] All acreages, totals, and percentages have been rounded.
[5] The Emergent Subclasses 1 and 2 comprise only 2 acres out of a total 24,735 acres. These subclasses represent areas where it was impossible to determine from aerial photography which species are dominant.

3.3.2 Upland Communities

Fifteen types of upland communities occupy approximately 74,191 acres (74%) of the project area. These communities are categorized into five major land use groups: pineland systems, mixed forests, other hardwoods, croplands/pasture, and mining and processing lands.

Pineland systems account for 51% (37,991 acres) of the upland community (Table 3.3-1). Planted pine is the predominant cover type of the pineland systems, accounting for approximately 24,861 acres or 65% of the pineland systems. Xeric oak and mixed forest account for 0.1% (87 acres) and 17% (12,399 acres), respectively, of the upland communities. Croplands and pasture occupy only 7,945 acres (11% of the upland community), whereas scraped areas, dredge and fill areas, and other mining and processing lands comprise approximately 15,769 acres (21% of the upland communities).

Large-scale forest management activities, on-going mining and reclamation, past logging, and fires have altered the natural vegetation communities in the project area. Alteration of vegetation characteristics and other ecological characteristics has reduced the functional values of the natural systems and diminished their value for wildlife use.

3.3.2.1 Pineland Systems

Pine flatwoods systems are the most widespread vegetation type in Florida. Prior to 1900, over half the state was vegetated in this community type (FDNR 1975). On the project site three types of pineland systems occupy 38% of the total area:

Pine flatwoods (Type 411)
Planted forest, coniferous (Type 441)
Clearcut areas (Type 451)

Each of these is a distinct plant community, depending to a large extent on the degree of timber management, past land use, and successional trends.

Typically, pineland systems occur in areas of low, flat topography with a relatively high water table (Edmiston 1963). Soils are usually poorly drained and commonly contain an organic hardpan 2-6 ft beneath the land surface which reduces downward percolation of water and impedes root penetration. The pH of these soils varies from extremely acidic, pH 4.5 and below, to strongly acidic, up to a pH of 5.5.

These community types are maintained by periodic fires which aid in recycling nutrients tied up in dead plant material and reducing competition from hardwood tree species. In the absence of fire, succession may result in xerophytic hardwoods, mesic hammocks, or bayheads, depending on local conditions (Monk 1968). In the project area, controlled burning is used in timber management and by hunting clubs which lease portions of the pineland systems. Pineland systems typically exhibit low tree species diversity, with diversity of understory and ground cover species varying from low to moderate depending on silviculture practices.

The pine flatwoods community (Type 411), which occupies approximately 3935 acres (4%) of the project site, occurs on nearly every land level. Water movement is very gradual to the natural drainageways, swamps, and marshes associated with this community. Natural stands of pine, primarily slash pine (Pinus elliottii), characterize this community. Longleaf pine (Pinus palustris) also occurs with occasional water oak (Quercus nigra) and laurel oak (Q. hemisphaerica). Understory shrubs are primarily saw palmetto (Serenoa repens), gallberry (Ilex glabra), fetterbush (Lyonia lucida), staggerbush (Lyonia ferruginea), blueberry (Vaccinium spp.), and waxmyrtle (Myrica cerifera) with scattered tarflower (Befaria racemosa).

Forbs in the understory are grass-leaved golden aster (Heterotheca graminifolia), deer tongue (Trilisa odoratissima), blackberry (Rubus spp.), bracken fern (Pteridium aquilinum), gay feather (Liatris gracilis), yellow jessamine (Gelsemium sempervirens), greenbrier (Smilax spp.), grape (Vitis rotundifolia), runner oak (Quercus pumila), elephant's foot (Elephantopus tomentosus), partridge pea (Cassia spp.), sundew (Drosera spp.), yellow-eyed grass (Xyris spp.), candyweeds (Polygala spp.), goldenrod (Solidago spp.), and blazing star (Carpephorus spp.).

Grasses include creeping bluestem (Schizachrium stoloniferum), broomsedge (Andropogon virginicus), chalky bluestem (Andropogon capillipes), Curtiss dropseed (Sporobolus curtissii), little blue maidencane (Amphicarpum muhlenbergianum), pineland threeawn (Aristida stricta), low panicums (Panicum spp.), Indiangrass (Sorghastrum secundum), and lovegrasses (Eragrostis spectabilis and E. elliottii). Grass-like vegetation includes Scleria spp. and Rhynchospora spp.

Planted pine (Type 441) occupies approximately 24,861 acres (25% of the total site). The dominant tree species in this community is slash pine. Five distinct understory communities are apparent within this community type:

1) Planted pine established on former cropland. Pine plantations, in the 20-25+ year age class, occur on nearly level, somewhat poorly drained soil on narrow to broad ridges slightly higher than the adjacent flatwoods. The forest floor is nearly void of vegetation but has a thick layer of pine needles. Where the area has been clearcut and replanted in pine, the invading vegetation is a homogeneous mixture of low panicums (Dicanthelium spp.) and broomsedge.

2) Site preparation including bedding. A unique understory community is the result of moving topsoil into beds on which pine is planted. The resulting interval between beds is devoid of topsoil. Forbs, mostly annuals, occur as pioneer species in the furrows, while grasses are the major species in the beds. These are the major producers of biomass for the first 5-10 years. Shrubs are very slow to establish following bedding but are the major producers of biomass after 10 years (Ball et al. 1981).

3) Minimum site preparation. Site preparation on large acreages to be established to slash pine consists of roller chopping following harvesting of the natural stand. Thus, the understory of these pine plantations remains very much the same as it was originally. Saw palmetto, gallberry, staggerbush, and broomsedge characterize the understory. Depending on the size of the roller chopper employed, the extent of saw palmetto, pineland threeawn, and Curtiss dropseed may be reduced. Gallberry, with its extensive rhizomatous root system, may increase. The extent of grass, forb, and sedge biomass decreases rapidly after 15 years with a closed crown canopy (Schultz 1976).

4) Clearcut with slash piled in windrows. Areas that have been clearcut, followed by severe soil disturbance by either a roller chopper or piling of slash with a bulldozer, support a dense stand of herbaceous species. Pioneer species, primarily low panicum and either broomsedge or chalky bluestem, remain in the understory for at least 8-10 years. Following site preparation, sprouts of palmetto, gallberry, staggerbush, and blueberries arise from old roots and eventually dominate the understory. In some instances, waxmyrtle forms a dense but localized stand.

5) Planted pine on former mine spoil. These areas have an understory of mostly annual grasses and bahia grass. The pine is not old enough to have a crown canopy which affects the density of the understory.

The soils of clearcut areas (Type 451) are much the same as those previously described. At the time of the survey, clearcut areas occupied approximately 9195 acres (9%) of the project area. The vegetation following clearcutting varies depending on the severity of soil disturbance associated with site preparation. Generally, these areas are dominated initially by annual grasses, primarily panicums including *Panicum chamaelonche* and warty panicum (*P. verrucosum*). In addition, low panicums, bottlebrush (*Aristida speciformis*), chalky bluestem, broomsedge, and blue maidencane are common. Pineland threeawn and Curtiss dropseed may or may not be present depending on the severity of site disturbance. Shrubs include staggerbush, fetterbush, palmetto, runner oak, blueberry, and waxmyrtle.

Habitat quality of pineland systems in the project area varies from low to moderate based on the findings of the habitat evaluation using the Habitat Evaluation System (ACOE 1980) (Section 3.3.8). The lower values are the results of silviculture operations which have significantly altered the vegetative structure of large areas of the project site. The occurrence of fauna within a particular vegetation association or community is usually a function of the physical characteristics of the habitat community as well as availability of food resources, nesting sites, and other ecological requirements unique to a particular species. Disruption of the physical characteristics (e.g., reduction in percent midstory or ground cover vegetation) of a particular habitat usually results in reduction in number of species and overall habitat quality.

The characteristic mammal species of the pineland systems is the hispid cotton rat (*Sigmodon hispidus*). The presence of other mammal species in pinelands is generally dictated by the physical characteristics of the site. Results of small mammal trapping studies in pineland systems in the project area and adjacent areas are summarized in Table 3.3-3.

Trap success rates and number of species of small mammals apparently are dependent on the intensity and types of alterations to the physical structure of the habitat type. Small mammal species encountered in these trapping efforts include the hispid cotton rat, cotton mouse, short-tailed shrew, eastern woodrat, least shrew, southeastern shrew, and golden mouse. Small mammal trap success of pineland communities is moderate compared to other upland and wetland communities (Table 3.3-4).

Intermediate and larger sized mammals encountered in the project area include the raccoon, nine-banded armadillo, feral pig, white-tailed deer, gray squirrel, southern flying squirrel, bobcat, gray fox, and Virginia opossum. Chiropteran species encountered include the evening bat and yellow bat.

Approximately 82 species (35%) of the 235 species of birds expected to occur in the project area utilize pineland systems. As with mammals, avifauna use of a pineland habitat varies with the physical characteristics of the habitat, particularly vegetation density and complexity. The most common species observed in field surveys in the area was the rufous-sided towhee; other species observed include the Carolina wren, fish crow, American crow, American robin, and northern cardinal (Table 3.3-5).

Similarly conducted bird surveys in the north-central Florida area (FGFWFC 1976b) have resulted in more diverse species composition and relative abundance (birds/hour). This may be a result of the more altered conditions of the project area as opposed to the other north-central Florida site, geographic location, and/or intensity of surveys. In prime subclimax condition, pine flatwoods support such species as the red-cockaded woodpecker, Bachman's sparrow, and eastern wood-pewee. However, silviculture operations have eliminated this prime habitat, greatly reducing populations of open pineland species.

Surveys of reptiles and amphibians within the project area are limited to qualitative encounter observations (EPA 1978a). Species typically encountered in pineland systems on the project site include the ornate chorus frog, flatwoods salamander, southern toad, oak toad, eastern narrow-mouthed toad, canebrake rattlesnake, and dusky pygmy rattlesnake. Quantitative surveys of herpetological fauna in north Florida (FWS 1979) and in north-central Florida (FGFWFC 1976b) have been conducted in various pineland system habitats (Tables 3.3-6 and 3.3-7).

3.3.2.2 Mixed Forest

The mixed forest habitat on the OXY project site comprises approximately 12,399 acres (12% of the total area). Mixed forests (Type 431) are those areas in which neither coniferous nor hardwood species dominate. They are generally found on limestone or phosphatic deposit outcrops or in less fertile areas where fire has been suppressed (Monk 1965). These systems are the climax of upland community development initiated in

Table 3.3-3. Results of Small Mammal Trapping Studies on the OXY Site and Adjacent Areas.

Pineland System	No. of Species	No. of Individuals	Adjusted Trap Success*	Source
High intensity site preparation	3	12	0.002	Harris et al. 1974
Low intensity site preparation	3	17	0.003	Harris et al. 1974
Mature, unburned slash pine stand	1	7	0.007	Harris et al. 1974
Mature, burned longleaf pine stand	4	164	0.148	Harris et al. 1974
Pine-palmetto flatwoods	3	5	0.028	EPA 1978a
Pine flatwoods	6	43	0.039	Frohlich 1981

$$\text{*Adjusted trap success} = \frac{\text{no. individuals}}{\text{(no. trap nights)} - \text{(no. sprung traps} \div 2)}$$

Table 3.3-4. Small Mammal Trapping Results in North-Central Florida.

Habitat Type	No. of Species	No. of Individuals	Trap Success*
Upland Communities			
Longleaf pine sandhill	7	28	1.96
Longleaf pine flatwoods	6	163	6.33
Slash pine flatwoods	4	45	3.13
Xeric hammock	7	96	4.21
Mesic hammock	7	93	8.35
Hydric hammock	4	37	2.69
Pine plantation	3	20	2.22
Deciduous oak	5	30	1.47
Pasture	4	24	1.79
Developed land	5	24	3.90
Wetland Communities			
Cypress	3	28	15.56
Bayhead	4	11	2.04
Mixed swamp	3	147	6.46
Freshwater marsh	7	147	13.66

$$\text{*Trap success} = \frac{\text{no. individuals}}{\text{total trap nights}} \times 100.$$

Source: FGFWFC 1976b.

Table 3.3-5. Birds of the Pine-Palmetto Flatwoods in the Project Area.

Species	Birds/Hour
Rufous-sided towhee	12
Carolina wren	9
Fish crow	5
American crow	3
American robin	3
Northern cardinal	3
Red-shouldered hawk	1
Pileated woodpecker	1
House wren	1
Also Observed in the Habitat but not During Counts	
Yellow-rumped warbler	
White-throated sparrow	
Tufted titmouse	
Pine warbler	
Carolina chickadee	
Blue-gray gnatcatcher	
Ruby-crowned kinglet	
Solitary vireo	
Yellow-throated warbler	
White-eyed vireo	
Turkey vulture	

Source: EPA 1978a.

Table 3.3-6. Ecological Characteristics of the Herpetofauna of Various Pineland Habitats in the St. Marks National Wildlife Refuge, Florida.

Habitat Designation	No. of Species	No. of Individuals	d[1]	e[2]
Longleaf pine - turkey oak sandhill natural area	24	200	3.73	0.81
Site-prepared clearcut[3]	24	227	3.21	0.70
8-year-old longleaf pine sandhill	25	206	3.61	0.78
60-70 year-old longleaf pine[3]	21	220	3.46	0.79
100-year-old longleaf pine flatwoods	35	260	4.04	0.79
60-70 year-old longleaf pine (summer burn)	16	115	3.35	0.84
70-year-old longleaf pine flatwoods	21	230	3.72	0.85
Coastal loblolly pine hammock	23	368	3.04	0.67
Loblolly pine hammock	26	559	2.84	0.60
Pine regeneration[3]	24	337	2.78	0.61
Slash pine flatwoods (burned)[3]	30	239	3.60	0.73
Slash pine flatwoods (unburned)[3]	32	344	4.11	0.82

[1]Shannon-Weaver Diversity Index.
[2]Equitability = diversity index/maximal diversity.
[3]Habitat types of similar nature occurring on OXY project site.

Source: FWS 1979.

Table 3.3-7. Ecological Characteristics of the Herpetofauna of Various Habitats in North-Central Florida.

Habitat Types	No. of Species	No. of Individuals	Diversity*
Upland Communities			
Longleaf pine flatwoods	15	117	2.10
Slash pine flatwoods	6	21	1.04
Pine sandhill	13	162	1.97
Xeric hammock	10	59	2.04
Mesic hammock	11	99	1.98
Hydric hammock	17	120	2.01
Deciduous oak sandhill	15	118	2.21
Wetland Communities			
Mixed swamp	3	7	1.00

*Shannon-Weaver Diversity Index.

Source: FGFWFC 1976b.

pine-dominated communities protected from periodic burning or swamp communities that have been drained or filled. Soils are nearly level to strongly sloping, deep to moderately deep; they are well to poorly drained, with loamy or sandy surfaces, and underlain with fine-textured materials. Mixed forest, as mapped under the Florida Land Use and Cover Classification System, includes a broad range of soils under which other land uses are also mapped. Areas of planted pine (Type 441) or clearcut areas (Type 451) adjacent to mixed forests (Type 431) were very likely mixed forest prior to planting or harvesting.

As mapped for the OXY project area, the category includes mixed hardwood and coniferous stands, hammocks, and hardwood forests with relatively high occurrences of pine species. This category also includes the southern mixed hardwood community identified previously in the project area (EPA 1978a). These areas are in various stages of succession on the OXY site, ranging from pineland communities to true climax hardwood ecosystems.

The mixed forest category embraces a wide variety of species. Tree species include slash pine, longleaf pine, loblolly pine (*Pinus taeda*), laurel oak, pignut hickory (*Carya glabra*), water oak, and live oak (*Quercus virginiana*). Shrubs include American beautyberry (*Callicarpa americana*), gallberry, saw palmetto, sumac (*Rhus copallina*), and wax-myrtle. Major forbs include grass-leaved golden aster, gay feather, dog fennel (*Eupatorium capillifolium*), partridge pea, goldenrod, blackberry, greenbrier, and deer tongue. Representative grass species include creeping bluestem, chalky bluestem, broomsedge, pineland threeawn, Curtiss dropseed, lovegrasses, little blue maidencane, and Indiangrass and the grass-like genera *Rhynchospora* and *Scleria*. Habitat quality of this vegetation type is moderate (Section 3.3.8).

Mammals typically encountered in this habitat type include the gray squirrel, southern flying squirrel, cotton mouse, golden mouse, raccoon, and opossum. Characteristic chiropteran species include the red bat and Seminole bat. No quantitative data (trapping studies) are available for this habitat type within the project area. However, trapping studies in similar habitats (mesic hammocks) in north-central Florida indicate that the small mammal community is generally more diverse and has a higher relative abundance than in most pineland habitats (Table 3.3-4). Small mammals encountered in the FGFWFC trapping study (1976b) included the cotton mouse, Florida mouse, hispid cotton rat, eastern woodrat, golden mouse, oldfield mouse, marsh rice rat, short-tailed shrew, and southern flying squirrel. All of these species, with the exception of the Florida mouse, are also expected to occur in Type 431 on the OXY project area. Results of intermediate-sized mammal captures in north-central Florida also revealed higher trap success in mesic hammocks than in pineland systems (Table 3.3-8). Intermediate-sized mammals included the raccoon, opossum, gray fox, spotted skunk, armadillo, and eastern cottontail, all of which potentially occur in the OXY project area.

Quantitative data on avian species were collected in the OXY project area during past studies (EPA 1978a) in habitats designated as southern mixed

Table 3.3-8. Intermediate-Sized Mammal Trap Success and Capture Data for Pineland Systems and Mesic Hammock Habitats of the North-Central Florida Area.

Habitat Designation	Captures		
	No. of Species	No. of Individuals	Trap Success*
Longleaf pine - sandhill	0	0	0.00
Sand pine scrub	3	27	9.12
Longleaf pine flatwoods	2	10	7.41
Slash pine flatwoods	2	12	7.36
Loblolly pine	3	4	9.30
Pond pine flatwoods	1	7	15.56
Pine plantation	2	2	11.76
Mesic hammock	2	8	19.05

*Captures/no. of trap nights.

Source: FGFWFC 1976b.

hardwoods but classified in this study as mixed forest (Type 431). In the previous study, the Carolina wren, cardinal, and pileated woodpecker were the most abundant birds encountered. Other species observed included the American robin, red-bellied woodpecker, blue jay, and hermit thrush (Table 3.3-9). Results of a mesic hammock survey in north-central Florida indicated that the Carolina wren was the most abundant species in the summer survey, and the ruby-crowned kinglet was the most abundant species in the winter survey (FGFWFC 1976b).

No quantitative data are available for the herpetological component of this habitat in the project area. Typical species encountered in this habitat type during qualitative surveys include the green treefrog, Florida box turtle, broad-headed skink, southern black racer, rat snake, and eastern coral snake. Other herpetofauna surveys in the north-central Florida area (FGFWFC 1976b) indicate moderate to high diversity values for mesic hammocks as compared to pineland systems and mixed swamps (Table 3.3-7).

3.3.2.3 Other Hardwoods

The other hardwoods cover type (xeric oak, Type 422) exhibits topographic features ranging from nearly level to steep slopes. It is easily identified by the dominant vegetation, turkey oak (*Quercus laevis*), with scattered longleaf pine. Soils are acid, moderately well to excessively drained, deep, and mostly coarse-textured throughout the profile.

This vegetation category occupies only 87 acres or <0.1% of the total acreage of the project site. It was identified as sandhill habitat in previous studies in the project area (EPA 1978a).

There are several variations of the xeric oak community. Mature natural strands which have not been logged have scattered longleaf pine as an overstory. Logged areas have turkey oak as the predominant overstory. Density of herbaceous plants is low, and numerous bare areas occur. Tree species occurring in this habitat type include turkey oak, bluejack oak (*Quercus incana*, infrequent), southern red oak (*Quercus falcata*, infrequent), and longleaf pine. Characteristic shrubs include gopher apple (*Chrysobalanus oblongifolius*), pawpaw (*Asimina reticulata*), and runner oak. Herbaceous plants are grass-leaved golden aster, partridge pea (*Cassia fasciculata*), tick trefoil (*Desmodium strictum*), and milk pea (*Galactia* spp.). Typical grasses include broomsedge bluestem, creeping bluestem, pineland threeawn, lopsided Indiangrass, pinewoods dropseed (*Sporobolus junceus*), and low panicums.

Due to its extremely small size, no habitat evaluation was conducted in this cover type. Small mammal trapping studies in the project area are not available; however, other studies in north-central Florida (FGFWFC 1976b) indicate relatively low trap success for similar communities (deciduous oak) as compared to other community types (Table 3.3-4). Species typically occurring in this habitat type include the hispid cotton rat, cotton mouse, and oldfield mouse. Intermediate-sized mammals are usually limited in this habitat type in Florida (FGFWFC 1976b).

Table 3.3-9. Birds of Southern Mixed Hardwoods on the OXY Project Site.

Species	Birds/Hour
Carolina wren	11
Northern cardinal	7
Pileated woodpecker	5
American robin	4
Red-bellied woodpecker	3
Blue jay	2
Hermit thrush	2
Eastern phoebe	1
American crow	1
Brown thrasher	1
Ovenbird	1
<u>Observed in Habitat but not During Counts</u>	
Solitary vireo	
Blue-gray gnatcatcher	
Ruby-crowned kinglet	
Tufted titmouse	
Carolina wren	
Red-tailed hawk (edge)	
American kestrel (edge)	

Source: EPA 1978a.

Results of bird counts conducted previously in this habitat type in the OXY project area (EPA 1978a) indicate that the yellow-rumped warbler, pine warbler, and northern cardinal are the most abundant birds in the sandhill or xeric oak habitat (Table 3.3-10). Also observed were the Carolina chickadee, American robin, ruby-crowned kinglet, and yellow-shafted flicker.

No quantitative herpetological data have been collected in the OXY project area. Typically occurring species encountered during field visits include the gopher tortoise, eastern glass lizard, and southern fence lizard. Studies conducted on herpetological populations elsewhere in Florida indicate that this habitat type contains a relatively diverse faunal association as compared with other habitat types (Table 3.3-7).

3.3.2.4 Croplands/Pasture

Seven land use and cover categories comprise this group:

Code	Land Use	Acres	% of Total Site
211	Row crops	3976	4.0
212	Field crops	2509	2.5
213	Improved pasture	1302	1.3
222	Deciduous fruit orchard	1	<0.1
231	Pecan orchard	1	<0.1
242	Confined feeding operations (poultry)	51	<0.1
323	Scrub/brush rangeland	105	0.1
	Total	approx. 7945	7.9

Major row crops (211) occur along and within a short distance of CR 137, CR 135, and CR 6. The major row crop is corn with some field peas and soybeans. Old, unused tobacco sheds are indicative that tobacco was once a major row crop. Field crops (212) are distributed in the project area in a fashion similar to row crops. Field crops consist of oats or rye planted in the fall and utilized for temporary grazing during winter and spring. Improved pasture (213) has been established on fairly well-drained soils of the flatwoods type. These pastures are typically planted in either bahia grass (*Paspalum notatum*) or coastal bermuda (*Cynodon dactylon*).

The deciduous fruit orchards (222) and pecan orchards (231) are small isolated acreages occurring primarily near major roads. Poultry feeding operations (242) occur mainly along CR 137, CR 135, and CR 6. Scrub/brush rangeland (323) occurs primarily along major road areas.

A relatively diverse and abundant fauna is associated with farming areas, largely as a result of the "edge" component where farm fields and croplands abut wooded areas. Results of the habitat evaluation indicate moderate habitat quality for these open lands (Section 3.3.8). Mammal species which could be expected in these areas include the white-tailed deer, gray fox, hispid cotton rat, cotton mouse, evening bat, and armadillo. Results of small mammal trapping in north-central Florida (FGFWFC) 1976b) indicate a relatively low trap success for pasture and moderate success for developed lands (Table 3.3-4).

Table 3.3-10. Birds of the Sandhill Habitat in the OXY Project Area.

Species	Birds/Hour
Yellow-rumped warbler	22
Pine warbler	17
Northern cardinal	7
Carolina chickadee	5
American robin	4
Ruby-crowned kinglet	2
Yellow-shafted flicker	2
Fish crow	2
House wren	2
Hermit thrush	2
Red-bellied woodpecker	1
Eastern phoebe	1
Carolina wren	1
White-eyed vireo	1
Rufous-sided towhee	1

Source: EPA 1978a.

Quantitative bird surveys on agricultural land in the project area indicate that the field sparrow, American goldfinch, and chipping sparrow are the most abundant avian species on this cover type (Table 3.3-11).

No quantitative herpetofaunal surveys have been conducted on the OXY project site; however, the black racer, ground skink, eastern garter snake, southern toad, and green treefrog have been observed in these habitats on site.

3.3.2.5 Mining and Processing Lands

Three major categories of mining and processing lands occur on the OXY project site:

Code	Description	Acres	% of Total Site
741	Scraped areas	8	<0.1
742	Dredge and fill areas	382	0.4
760	Mining and processing	15,379	15.4
	Total	approx. 15,769	15.8

Scraped areas (Type 741) include areas of recent disturbance characterized by complete absence of cover or forage.

Dredge and fill areas (Type 742) consist of canals and spoil banks associated with mining operations. These areas usually have no vegetation, though older canal banks often have extensive aquatic vegetation and/or a grass-shrub covering.

The major land use category of this group, mining and processing (Type 760), can be subdivided into six groups: active settling areas, inactive settling areas, sand tailing disposal areas, unreclaimed mine areas, reclaimed areas (upland and aquatic), and industrial areas (physical mine plants, mine offices, chemical plants, gypsum stacks, etc.).

Active settling areas are characterized by large expanses of open water, sometimes vegetated by dense stands of water hyacinth (*Eichhornia crassipes*), and where shallow enough, *Ludwigia* sp., cattail (*Typha* spp.), and willow (*Salix* spp.). Faces of impoundment dikes on the water side typically are covered with early successional terrestrial species such as blackberry, groundsel tree (*Baccharis* spp.), broomsedge (*Andropogon* spp.), forbs, and grasses.

Vegetative characteristics of inactive settling areas vary according to length of inactivity and rainfall season. Water levels typically decline over time as clays settle and dewater. Succession usually follows from cattail, to *Ludwigia*, to a final dense stand of willow. Water hyacinths are ubiquitous and may dominate the water surface when enough water is present, either during dewatering or during seasonal rainfall periods when water collects in these areas. Stands of snags have formed in flooded areas enclosed by dikes.

Table 3.3-11. Birds of the Agricultural Lands on the OXY Project Area.

Species	Birds/Hour
Field sparrow	100
American goldfinch	42
Chipping sparrow	40
Black vulture	16
Mourning dove	13
American crow	8
Eastern meadowlark	5
American kestrel	3
Turkey vulture	2
Palm warbler	2
Northern bobwhite	2
Northern mockingbird	1
Swamp sparrow	1
<u>Also Observed in Habitat but not During Counts</u>	
Sharp-shinned hawk	
Red-tailed hawk	
Red-shouldered hawk	
Marsh hawk	
Common snipe	
Loggerhead shrike	
Eastern bluebird	
American robin	
Rusty blackbird	
Red-winged blackbird	
Brown-headed cowbird	
Common grackle	
Vesper sparrow	
Song sparrow	
Yellow-rumped warbler	
Eastern phoebe	
Cattle egret	
Ground dove	
European starling	

Source: EPA 1978a.

Sand tailings sites are characteristically slow to revegetate because of the xeric conditions of the habitat. During early succession (1-5 years), vegetation consists primarily of clumped grasses and isolated broad-leaved herbaceous plants such as sedge (Cyperus sp.), sandwort (Arenaria sp.), and Eupatorium sp. Later (6-11 years) vegetation consists mostly of aster (Heterotheca subaxillaris), buttonweed (Diodia teres), horseweed (Conyza parvas), and lower numbers of Eupatorium capillifolium, Andropogon sp., and live oak seedlings. By 11 years of age, cover may reach 30% (EPA 1978a), and seedling vegetation shows a trend toward a xeric oak hammock or scrub habitat community.

Unreclaimed mine sites consist of overburden spoil piles interspersed among water-filled mine cuts. These areas are invaded by vegetation species typical of abandoned agricultural fields. Revegetation rate and density of cover are highly variable, depending on slope, soil conditions, and availability of seed sources for dispersal on these areas. Older sites are dominated by broomsedge, partridge pea, Panicum sp., and dog fennel. Other species present include rattlebox (Crotalaria sp.), daisy fleabane (Erigeron sp.), foxglove (Agalinis sp.), pokeweed (Phytolacca americana), Baccharis halimifolia, and blackberry. More recently mined areas are vegetated primarily by crabgrass (Digitaria sp.) and secondarily by smartweed (Polygonum sp.), Phytolacca, bermuda grass (Cynodon dactylon), thistle (Sonchus asper), and Eupatorium spp. Succession follows oldfield sequence, with pioneer species occurring sporadically in the early years, followed by perennial grasses and herbaceous broad-leaved plants, and finally woody species. Although none of the areas is old enough, the unreclaimed mine sites eventually would be expected to succeed to oak hammocks similar to older mined areas in the central Florida phosphate district (EPA 1978b). Reclaimed areas are discussed in Section 3.3.10.

In the project area, small mammal populations on mining and processing lands were found to be more abundant than small mammal populations in adjacent mature flatwoods (Frohlich 1981, Table 3.3-12). This may be a result of food availability, extent of ground cover, and/or habitat heterogeneity. As vegetational succession occurs on unreclaimed mines, the small mammal community will change and population levels generally will decline. Species composition of mammal populations on mined lands differs from that in adjacent natural systems. The most notable difference is the lack of the arboreal component on mined lands, such as the gray squirrel and southern flying squirrel. Additionally, certain aquatic, semi-aquatic, and fossorial-burrowing species are either absent or limited in occurrence on mined land systems. The mammalian faunal differences between mined lands and natural systems are a result of the physical differences in the vegetation communities and substrates.

Approximately 70 additional avifauna species (30% of the expected total) occur on the OXY site as a result of the various types of mining and processing lands (EPA 1978a), primarily open water habitats, a limited habitat type in the general geographical area. Bird surveys have been conducted in the project area on unreclaimed mine sites and on active and inactive settling areas (EPA 1978a, Tables 3.3-13 through 3.3-17).

Table 3.3-12. Small Mammal Trapping Results on the OXY Site.

Habitat	No. of Individuals	No. of Species	Diversity*	Adjusted Trap Success
Unreclaimed area	263	5	1.01	0.149
Reclaimed area	77	5	0.88	0.031
Sand tailings	74	4	0.83	0.032
Pine flatwoods	43	6	0.56	0.017

*Shannon-Weaver Index.

Source: Frohlich 1981.

The most commonly occurring species on unreclaimed mined lands include the red-winged blackbird, yellow-rumped warbler, turkey vulture, ring-billed gull, American robin, mourning dove, pied-billed grebe, and hooded merganser (Tables 3.3-13 and 3.3-16). The most commonly occurring bird species on active settling areas include the American coot, red-winged blackbird, great egret, great blue heron, double-crested cormorant, pied-billed grebe, northern shoveler, blue-winged teal, ring-billed gull, anhinga, and turkey vulture (Table 3.3-14). The green-winged teal, red-winged blackbird, lesser yellowlegs, blue-winged teal, northern pintail, greater yellowlegs, least sandpiper, American coot, American wigeon, northern shoveler, brown-headed cowbird, killdeer, and swamp sparrow were the most abundant bird species on the inactive settling areas studied (Tables 3.3-15 and 3.3-17).

Active and inactive settling areas with standing trees and snags provide rookery areas for wading birds. In 1977 the Florida Game and Fresh Water Fish Commission estimated the following numbers of birds in a rookery in an active settling area on the OXY project site (EPA 1978a):

Species	No. of Pairs
Double-crested cormorant	250
Anhinga	150
Great egret	150
Cattle egret	4500-5000
Snowy egret	50
Little blue heron	200
Black-crowned night-heron	75
White ibis	2500
Green-backed heron	12

No quantitative studies on the herpetological fauna component have been conducted on the mining and processing lands of the OXY project site. Species observed in the various categories of mined lands during qualitative surveys include the American alligator, brown water snake, Florida softshell, yellow-bellied turtle, bronze frog, southern spring peeper, ground skink, and green treefrog.

Table 3.3-13. Birds of Mined Lands of the Suwannee River Mine.

Species	Birds/Hour
Red-winged blackbird	57
Yellow-rumped warbler	18
Eastern phoebe	3
Common yellowthroat	3
Swamp sparrow	3
Red-tailed hawk	2
Killdeer	2
American crow	2
House wren	2
Northern mockingbird	2
Savannah sparrow	2
Song sparrow	2
Great blue heron	1
Great egret	1
Turkey vulture	1
Red-shouldered hawk	1
Common snipe	1
Eastern meadowlark	1
Boat-tailed grackle	1
<u>Birds Observed in Habitat but not During Counts</u>	
Pied-billed grebe	
Anhinga	
Marsh hawk	
American coot	
Fish crow	
Yellow-rumped warbler	
White-throated sparrow	

Source: EPA 1978a.

Table 3.3-14. Birds of the Suwannee River Mine's Active Settling Areas.

Species	Birds/Hour
American coot	758
Red-winged blackbird	321
Great egret	179
Great blue heron	92
Double-crested cormorant	61
Pied-billed grebe	39
Northern shoveler	33
Blue-winged teal	26
Ring-billed gull	26
Anhinga	19
Turkey vulture	17
Tree swallow	10
Common gallinule	7
Bald eagle	3
Ring-necked duck	3
Killdeer	3
Red-tailed hawk	2
Belted kingfisher	2
American crow	2
Boat-tailed grackle	2
Little blue heron	1
Black-crowned night-heron	1
White ibis	1
Marsh hawk	1

Birds Observed in Habitat but not During Counts

Horned grebe
White pelican
Cattle egret
Snowy egret
Tricolored heron
Mallard
Black duck
Green-winged teal
American wigeon
Redhead
Canvasback
Common goldeneye
Bufflehead
Ruddy duck
Hooded merganser
Red-breasted merganser
Sharp-shinned hawk
Cooper's hawk
Red-shouldered hawk
Peregrine falcon
American kestrel
Common snipe
Mourning dove
Eastern phoebe
Yellow-rumped warbler

Source: EPA 1978a.

Table 3.3-15. Birds of the Suwannee River Mine's Inactive Settling Areas.

Species	Birds/Hour
American coot	31
American wigeon	30
Swamp sparrow	15
Blue-winged teal	9
Green-winged teal	7
Song sparrow	7
Gadwall	6
Red-winged blackbird	6
Pied-billed grebe	4
Wood duck	4
Yellow-rumped warbler	4
White ibis	3
Savannah sparrow	3
Great blue heron	2
Red-tailed hawk	2
Marsh hawk	2
Ring-billed gull	2
Anhinga	1
Great egret	1
Snowy egret	1
American bittern	1
Mallard	1
Ring-necked duck	1
Red-shouldered hawk	1
Belted kingfisher	1
Eastern phoebe	1
Gray catbird	1

Birds Observed in Habitat but not During Counts

Double-crested cormorant	Killdeer
Little blue heron	Greater yellowlegs
Tricolored heron	Lesser yellowlegs
Black-crowned night-heron	Least sandpiper
Northern shoveler	Dunlin
Turkey vulture	Dowitcher
Sharp-shinned hawk	Common flicker
Cooper's hawk	Boat-tailed grackle
American kestrel	

Source: EPA 1978a.

Table 3.3-16. Birds of Mined Lands of OXY's Swift Creek Mine.

Species	Birds/Hour
Turkey vulture	82
Ring-billed gull	36
American robin	20
Mourning dove	19
Pied-billed grebe	14
Hooded merganser	13
Greater yellowlegs	5
Little blue heron	4
Great blue heron	2
Great egret	2
Marsh hawk	2
Belted kingfisher	2
Horned grebe	1
Snowy egret	1
Tricolored heron	1
Green-winged teal	1
Common goldeneye	1
American kestrel	1
Killdeer	1
Forster's tern	1
Birds Observed in Habitat but not During Counts	
Fish crow	
Anhinga	
American coot	
Swamp sparrow	

Source: EPA 1978a.

Table 3.3-17. Birds of the Inactive Settling Areas on OXY's Swift Creek Mine.

Species	Birds/Hour
Green-winged teal	275
Red-winged blackbird	221
Lesser yellowlegs	56
Blue-winged teal	50
Northern pintail	35
Greater yellowlegs	32
Least sandpiper	32
Northern shoveler	28
Brown-headed cowbird	25
Killdeer	16
Little blue heron	9
Mallard	5
Great blue heron	4
Common snipe	3
Ring-billed gull	3
Yellow-rumped warbler	3
Wood duck	1
Hooded merganser	1
Turkey vulture	1
Sharp-shinned hawk	1
Marsh hawk	1
Belted kingfisher	1
American robin	1
Birds Observed in Habitat but not During Counts	
Snow goose	
Cooper's hawk	
Red-tailed hawk	
American kestrel	
Loggerhead shrike	
Common grackle	
Boat-tailed grackle	
Black vulture	
Swamp sparrow	
Savannah sparrow	
Great egret	
Little blue heron	
Common yellowthroat	
House wren	
Common gallinule	
Gadwall	
Dowitcher	

Source: EPA 1978a.

3.3.3 Wetland Communities

3.3.3.1 Classification

Wetland communities, which comprise approximately 24,735 acres (25%) of the project area, were classified according to Cowardin et al. (1979) (Section 3.3.11.1). All of the wetland communities in the project area would be classified in the Palustrine System which is defined as:

> ... all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 $^{o}/oo$. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha (20 acres); (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 2 m at low water; and (4) salinity due to ocean-derived salts less than 0.5 $^{o}/oo$.

Classes within the Palustrine System are defined in terms of the dominant vegetation or the physiography and composition of the substrate. Based on vegetative composition, forested, scrub/shrub, and emergent classes are recognized within the project area. These classes can be further divided into subclasses and described according to dominance type. The forested and scrub/shrub classes within the project area include the following subclasses: broad-leaved deciduous, needle-leaved deciduous, broad-leaved evergreen, and needle-leaved evergreen. The emergent class includes the following subclasses: persistent, nonpersistent, narrow-leaved nonpersistent, broad-leaved nonpersistent, narrow-leaved persistent, and broad-leaved persistent.

Each of the subclasses can be described by dominance type. Traditionally, dominance has been based on the plant species which exerts control over the community (Weaver and Clements 1938). This is usually the predominant species (Cain and de Oliveira Castro 1959). In some situations it was necessary to designate two or more codominant species as a dominance type.

The wetlands within the project area were also classified according to the Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976), a hierarchical system based on cover dominance of vegetation type. Table 3.3-2 lists the Level IV wetland types in the project area and the Cowardin et al. (1979) system classes and subclasses included in each.

3.3.3.2 Vegetation Studies

Forested wetlands of north-central Florida have been studied by numerous investigators. Monk (1965, 1966) described the species composition, edaphic conditions, and inundation regimes in freshwater swamps of the region which he categorized as cypress swamps, deciduous hardwood swamps or mixed swamps, and evergreen hardwood swamps or bayheads. Mitsch and Ewel (1979) compared biomass and growth of cypress in Florida wetlands. Most recently Brown (1981) compared the structure, primary productivity, and transpiration of cypress ecosystems in Florida. Other descriptive works on wetlands of the immediate region include the Osceola EIS, (NFWL 1978), Swift Creek Chemical Complex EIS (EPA 1978a), and a dredge and fill jurisdictional report (PELA 1977).

In addition to previous studies, quantitative data were collected in selected wetlands which constitute a representative sample of the variety of types and sizes of wetlands in the project area (Section 4.0).

3.3.3.3 Wetland Types

Following are descriptions of the major wetland types in the project area, based on the Florida Land Use and Cover Classification System (Level IV codes in parentheses). (Refer to Table 3.3-2 for the Cowardin et al. [1979] system; these classifications are treated herein as subsets of the Florida Classification System.)

Cypress (6110). This forested wetland type comprises 8% (approx. 1970 acres) of the total wetlands on site. It is dominated by essentially pure stands of pond cypress (*Taxodium ascendens*) or bald cypress (*Taxodium distichum*). Associated species include slash pine (*Pinus elliottii*), fetterbush (*Lyonia lucida*), and waxmyrtle (*Myrica cerifera*), and various herbaceous species such as three-way sedge (*Dulichium arundinaceum*), sawgrass (*Cladium jamaicense*), and Virginia chain fern (*Woodwardia virginica*). They occur in isolated depressions in the planted pine or pine flatwoods community or as riparian borders along small streams.

Swamp Tupelo (6211). Wetlands dominated by swamp tupelo (*Nyssa biflora*) comprise approximately 775 acres of the project site (3% of total wetlands). Associated species include pond cypress, bays, and slash pine. Understory species include fetterbush, waxmyrtle, greenbrier (*Smilax laurifolia*), three-way sedge, sawgrass, and Virginia chain fern. These pure stands of swamp tupelo may result from logging of the once associated cypress, or they may be natural.

Bayhead (6212). Bayheads occur along creeks or sloughs but are most common in the project area as isolated depressions in pine flatwoods communities. Bayheads usually occupy sites subject to shorter duration and shallower depth of flooding than cypress domes. They are acidic systems in which there is usually a surface layer of peat 1 ft to >6 ft deep; they are vegetatively characterized by a predominance of evergreen species (76% reported by Monk 1966).

The dominant canopy species are sweetbay (*Magnolia virginiana*), loblolly bay (*Gordonia lasianthus*), and red bay (*Persea borbonia*). Other species represented in the canopy include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), swamp tupelo, slash pine, laurel oak (*Quercus laurifolia*), and pond cypress. Important subcanopy species include saplings of the canopy species, dahoon (Ilex cassine), Leucothoe racemosa, fetterbush, waxmyrtle, sweet pepperbush (Clethra alnifolia), and Virginia willow (Itea virginica). Ground cover is usually sparse, consisting of seedlings of canopy and subcanopy species, grapevine (Vitis rotundifolia), the chain ferns (Woodwardia virginica and W. areolata), and sphagnum (Sphagnum spp.).

There are approximately 1322 acres of bayhead in the project area (5% of total wetlands), primarily occurring in the Rocky Creek drainage area in several large bay systems.

Scrub/Shrub (6213). Scrub/shrub wetlands occur in the project area within some of the larger bay depressions (especially in the Rocky Creek drainage area). They are acidic systems with highly organic to peaty substrates subject to a slight degree of inundation.

A canopy layer is sparse or absent. If present, it usually is represented by an occasional slash pine, pond cypress, swamp tupelo, or bay. The subcanopy is a thick, nearly impenetrable thicket of fetterbush, Virginia willow, sweet pepperbush, laurel greenbrier, titi (Cyrilla racemiflora), and various other primarily ericaceous species. The sparse ground cover is composed primarily of sphagnum and Virginia chain fern.

This wetland type is referred to as shrub bogs by Wharton et al. (1977). There are approximately 1314 acres of scrub/shrub wetlands (5% of total wetlands) within the project area.

Cypress/Swamp Tupelo/Bay (6311). Approximately 51% of the wetland acreage (12,633 acres) within the project area is vegetated by a co-dominant mixture of cypress, swamp tupelo, and sweetbay and/or loblolly bay. Other canopy species may include red maple, green ash (Fraxinus pennsylvanica), sweetgum, and dahoon. Subcanopy species include saplings of the canopy species and shrubs such as waxmyrtle, fetterbush, buttonbush (Cephalanthus occidentalis), sweet pepperbush, Virginia willow, laurel greenbrier, and poison ivy (Rhus radicans). The usually sparse ground cover consists of seedlings of the canopy and subcanopy species, and herbaceous species including the chain ferns, lizard tail (Saururus cernuus), Xyris spp., Hypericum fasciculatum, sawgrass, sphagnum, cinnamon fern (Osmunda cinnamomea), and redroot (Lachnanthes tinctoria).

Wetlands of this type occur in shallow depressions in the pine flatwoods or form riparian borders along small tributary streams. As throughout most of Florida, they have experienced various types of perturbations including logging, drainage, fire, grazing, and changes in surrounding land use. These perturbations have caused changes in the species composition and structure. The most common change in the project area has resulted from repeated cutting of the merchantable cypress and alteration of surrounding land use from pine flatwoods communities to planted pine plantations. As a result of these disturbances, natural drainage patterns and species composition have changed. There has been a shift from cypress-dominated domes to those now dominated by a mixture of cypress and swamp tupelo or even dominated by swamp tupelo with few cypress remaining. Alteration of drainage patterns has also caused a shift to dominance by less water-tolerant upland species.

The cypress dome community is maintained by direct rainfall and runoff which are held by an "impermeable" clay hardpan which shallowly underlies the bottom of the land depressions. Water collects in these depressions and is held in a perched condition by the underlying hardpan until it is dissipated by evaporation and transpiration.

Swamp Tupelo/Bay/Pine (6312). This mixed wetland class comprises 25% (approx. 6291 acres) of the wetlands on site. It is composed of a co-dominant mixture of hardwoods, such as swamp tupelo and sweetbay or loblolly bay and slash pine. Subcanopy species include fetterbush, sweet pepperbush, and titi. Herbaceous species include *Carex* spp., *Eriocaulon* spp., *Panicum* spp., lizard tail, and Virginia chain fern.

Emergent (6410). There are open glade areas, primarily in the southern portion of Bee Haven Bay south of CR 6, which lack canopy or subcanopy layers. These glades are dominated by Virginia chain fern, redroot, broomsedge (*Andropogon virginicus*), and swamp loosestrife (*Decodon verticillata*). Also present are scattered clumps of yellow pitcher plant (*Sarracenia flava*), *Xyris*, green arum (*Peltandra virginica*), and white arum (*Peltandra saggitaefolia*). The soils underlying these glades are peaty to depths of >5 ft. The soils are usually moist, but experience only shallow, infrequent periods of inundation.

Also included in this emergent category, which comprises <2% (430 acres) of the total wetlands, are a few local depressions, bordered by a ring of swamp tupelo, which are dominated by maidencane (*Panicum hemitomon*). These are subject to periods of inundation with depth increasing toward the center of the depressions where there is typically an assemblage of more aquatic species such as water lily (*Nymphaea odorata*), cow lily (*Nuphar lutea*), and frogbit (*Limnobium spongia*).

3.3.3.4 Wetland Fauna

Studies of the wetlands fauna on the OXY project site were limited primarily to qualitative evaluations of faunal occurrence based on encounter techniques utilized during the conduct of other fieldwork and previous studies conducted in the project area and general region.

Previous studies have assessed the avifauna utilizing wetlands in the vicinity of the project site (EPA 1978a, FGFWFC 1976b). In the EPA study of the project area, the most common birds in the bayhead category (Type 6212) were the yellow-rumped warbler, white-throated sparrow, blue jay, red-bellied woodpecker, and Carolina wren (Table 3.3-18). The most common birds observed in studies conducted in other north-central Florida bayheads were the Carolina wren, white-eyed vireo, rufous-sided towhee, American crow, blue jay, and red-bellied woodpecker (FGFWFC 1976b).

In cypress heads (Types 6110 and 6311) on the project site, the swamp sparrow, red-bellied woodpecker, pileated woodpecker, and common grackle

Table 3.3-18. Birds in Bayheads of the OXY Project Site.

Species	Birds/Hour
Yellow-rumped warbler	11
White-throated sparrow	5
Blue jay	4
Red-bellied woodpecker	3
Carolina wren	3
Pileated woodpecker	2
Carolina chickadee	2
Northern cardinal	2
Swamp sparrow	2
Downy woodpecker	1
Yellow-bellied sapsucker	1
Brown thrasher	1
American robin	1
White-eyed vireo	1
Pine warbler	1
Rufous-sided towhee	1

Source: EPA 1978a.

were the most commonly encountered birds (EPA 1978a, Table 3.3-19). The FGFWFC north-central Florida study indicated that the fish crow, northern cardinal, red-bellied woodpecker, American crow, and Carolina wren were the most commonly encountered avifauna in this habitat type (FGFWFC 1976b).

The most common year-round residents of mixed hardwood swamps (Type 6312) in the project area were the Carolina wren, northern cardinal, wood duck, and American robin (Table 3.3-20), whereas in the north-central Florida study the northern cardinal, Carolina wren, tufted titmouse, red-bellied woodpecker, pileated woodpecker, and downy woodpecker were most common (FGFWFC 1976b).

No avifauna studies were conducted on the project site in swamp tupelo (Type 6211), scrub/shrub (Type 6213), or emergent freshwater marsh (Type 6410). These habitat types account for only 0.8%, 1%, and 0.4%, respectively, of the entire project area and 3%, 5%, and 2%, respectively, of the total wetland communities on the project site.

Avifauna studies in the emergent habitat type (freshwater marsh) in north-central Florida (FGFWFC 1976b) indicated that the red-winged blackbird, eastern meadowlark, and American crow were common during the breeding season. The American robin and killdeer were frequently encountered wintering species.

For this study, mammals were surveyed only qualitatively using encounter techniques. Previous studies have been conducted on small mammal populations in cypress and mixed swamp communities in the area (EPA 1978a). Trap success was low in all habitats sampled (Table 3.3-21). Trapping studies on small mammal populations in north-central Florida indicated that wetland communities had, on the average, equal or greater trap success, number of species, and total individuals collected than did similarly studied upland communities (Table 3.3-4, Section 3.3.2.1). These differences in trapping results may be due to the degraded nature of wetland habitat in the project area as compared to wetland areas in the north-central Florida study.

Only qualitative herpetofauna studies have been conducted in the project area. Results of quantitative studies in north-central Florida indicated relatively fewer species and number of individuals and lower diversity in mixed swamp systems than in similarly studied upland communities (FGFWFC 1976b) (Table 3.3-7, Section 3.3.2.2).

Table 3.3-19. Birds in Cypress Heads of the OXY Project Site.

Species	Birds/Hour
Swamp sparrow	5
Red-bellied woodpecker	3
Pileated woodpecker	2
Common grackle	2
Red-shouldered hawk	1
House wren	1
American robin	1
Red-winged blackbird	1
White-throated sparrow	1
<u>Birds Observed in Habitat but not During Counts</u>	
Hooded merganser	

Source: EPA 1978a.

Table 3.3-20. Birds in Mixed Hardwood Swamps of the OXY Project Site.

Species	Birds/Hour
Carolina wren	14
Northern cardinal	13
Wood duck	11
American robin	6
Red-shouldered hawk	4
Carolina chickadee	4
Brown thrasher	4
Hermit thrush	4
Red-winged blackbird	4
Rufous-sided towhee	4
Pileated woodpecker	3
House wren	3
Catbird	3
Yellow-rumped warbler	3
Belted kingfisher	2
Eastern phoebe	2
Blue jay	2
Anhinga	1
Great blue heron	1
Red-tailed hawk	1
Red-bellied woodpecker	1
Birds Observed in Habitat but not During Counts	
American woodcock	
Yellow-billed cuckoo	
Blue-gray gnatcatcher	
Tufted titmouse	
White-eyed vireo	
Yellow-throated warbler	
White-throated sparrow	
American goldfinch	
Common flicker	

Source: EPA 1978a.

Table 3.3-21. Small Mammals of Natural Communities in the OXY Project Area as Assessed by Traplines.*

Species	High Pinelands		Pine-Palmetto Flatwoods		Mixed Hardwoods		Swamps	
	Number Collected	Trap Success	Number Collected	Trap Success	Number Collected	Trap Success	Number Collected	Trap Success
Hispid cotton rat	-	-	1	0.6	-	-	-	-
Cotton mouse	2	1.1	2	1.1	2	1.1	1	0.6
Golden mouse	-	-	-	-	-	-	2	1.1
Least shrew	1	0.6	-	-	-	-	-	-
Short-tailed shrew	-	-	2	1.1	-	-	-	-
Summary	3	1.7	5	2.8	2	1.1	3	1.7
No. of Species	2		3		1		2	

*Based on a total of 720 trap nights, 180 trap nights per habitat. Trap success = number collected ÷ 100 trap nights.

Source: EPA 1978a.

3.3.4 Aquatic Communities

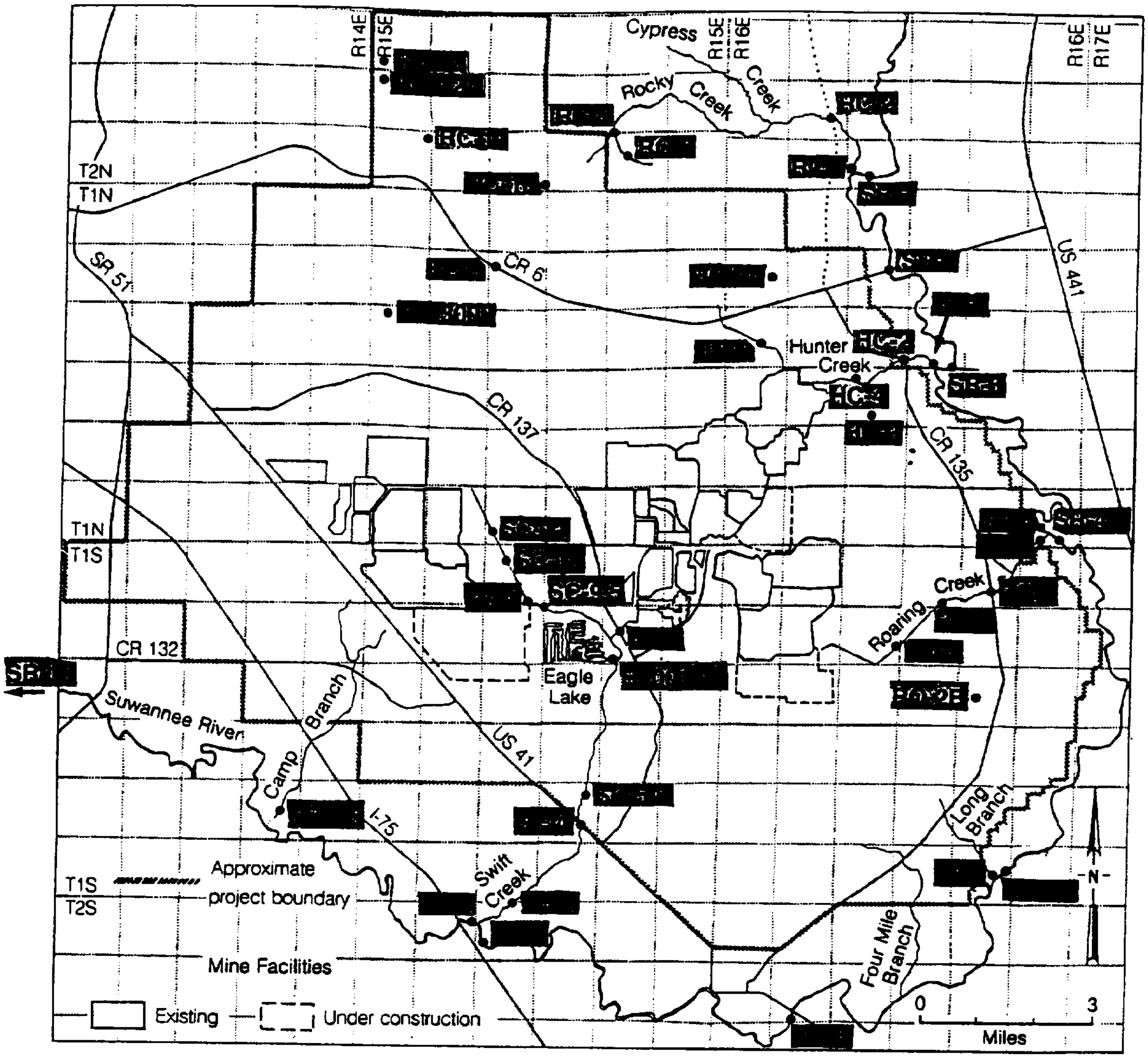
Various levels of the biological community (primary producers, primary and secondary consumers) respond to environmental stress in different ways and in varying degrees. To insure that environmental impacts are adequately evaluated, a number of food chain components should be sampled. Baseline biological conditions for the study area were assessed by sampling an aquatic food chain consisting of phytoplankton, periphyton, macrophytes, macroinvertebrates, and fish. Seasonal variations were examined by sampling three times during a one-year period. Stations were established so that representatives of all significant aquatic habitats within the study area would be sampled (Figure 3.3-3). Both affected and unaffected sites were sampled. Affected sites are those that receive discharge from OXY mining activities and/or chemical plant operations; unaffected sites are those that receive no discharge from any OXY mining or chemical plant activity. In situ water quality/quantity measurements and other water analysis data are included in Section 3.4.2. Station location descriptions, collection methods, and analytical procedures are included in Section 3.3.11.

Variability of the Data. Because of the wide-ranging environmental conditions of the aquatic systems in the OXY study area, the biological data were extremely variable. Table 3.3-22 provides an example of the variation of the macroinvertebrate data for selected sampling periods. The coefficient of variation (CV) was calculated for representative data to indicate the variation in the data. Biological data, which by nature are variable, often have CV values of 25%. CV values are directly comparable from one sample to another because they are independent of the unit of the measurement. For Hester-Dendy and drift samples, the CV values for number of taxa and density were generally lowest for Suwannee River stations and highest for Eagle Lake and Altmans Bay canals. CV values for density in Swift Creek varied among sample types; values were high for petite Ponar and Hester-Dendy samples and low for drift. CV values for Hunter Creek and tributaries not receiving OXY discharge were in the mid-range of values, though Hester-Dendy samples did produce several fairly high CV values.

Coefficients of variation for diversity and equitability were extremely high for Eagle Lake and Altmans Bay Canal, ranging from 70 to 123% (Table 3.3-22). CV values for systems receiving no OXY discharge ranged from 13 to 49%, and values for Hunter and Swift creeks ranged from 7 to 52%.

The high degree of variation in the data makes it difficult to compare data at various stations, because apparent differences or similarities may be an artifact of the variation rather than a result of environmental conditions. Therefore, this variability should be considered in the following analyses.

Environmental Indices. The Shannon-Weaver diversity index (EPA 1973) and equitability (Lloyd and Ghelardi 1964) were used to analyze the data and evaluate the environmental condition of each aquatic system. EPA (1973) states that diversity values >3.0 and equitability values >0.5 generally indicate unstressed systems. However, EPA biologists have shown that where degradation is at slight to moderate levels, diversity



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

• Aquatic sampling station

Figure 3.3-3. Aquatic Sampling Sites for Wetlands Mining EIS, 1981-1982.

Table 3.3-22. Mean, Standard Deviation (SD), and Coefficient of Variation (CV) of Macroinvertebrate Data for Selected Sampling Periods for the OXY Study Area.

	No. of Taxa			Density			Diversity			Equitability		
	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Petite Ponar Samples (August 1981)												
Suwannee River Stations	18	1.3	7	699	578	83	2.79	0.35	13	0.55	0.16	29
Tributaries Not Receiving OXY Discharge	33	10.5	32	704	628	89	3.55	0.65	18	0.55	0.17	31
All Stations Not Receiving OXY Discharge Combined	27	10.9	40	702	575	82	3.24	0.65	20	0.55	0.16	29
Hunter Creek	28	15.6	56	1622	1903	117	3.38	0.54	16	0.58	0.11	19
Swift Creek	16	2.5	16	1907	2099	110	2.41	0.16	7	0.46	0.12	26
Eagle Lake and Altmans Bay Canal	18	11.3	63	3800	4383	115	1.60	1.97	123	0.28	0.22	79
All Stations Receiving Mine and Chemical Plant Discharge Combined	17	6.0	35	2664	2843	107	2.09	1.09	52	0.39	0.17	44
Hester-Dendy Samples (September 1981)												
Suwannee River Stations	23	4.7	20	1004	187	19	3.18	0.29	9	0.57	0.10	18
Tributaries Not Receiving OXY Discharge	21	4.8	23	961	682	71	2.77	0.67	24	0.49	0.24	49
All Stations Not Receiving OXY Discharge Combined	22	4.6	21	978	520	53	2.93	0.57	19	0.52	0.19	37
Hunter Creek	21	7.8	37	2271	1526	67	2.72	1.27	47	0.50	0.26	52
Swift Creek	9	1.2	13	3425	361	11	1.12	0.19	17	0.31	0.08	26
Eagle Lake and Altmans Bay Canal	14	8.5	61	4187	3116	91	2.01	1.81	90	0.47	0.33	70
All Stations Receiving Mine and Chemical Plant Discharge Combined	11	5.2	47	3730	1633	44	1.48	1.04	70	0.38	0.19	50
Drift (February 1982)												
Suwannee River Stations	19	5.5	29	20.3	12.9	64	-	-	-	-	-	-
Tributaries Not Receiving OXY Discharge	16	5.4	34	102.8	99.9	97	-	-	-	-	-	-
All Stations Not Receiving OXY Discharge Combined	18	5.4	30	64.3	82.9	129	-	-	-	-	-	-
Hunter Creek	23	6.8	30	102.3	84.2	82	-	-	-	-	-	-
Swift Creek	11	7.1	65	28.7	36.8	128	-	-	-	-	-	-
Eagle Lake and Altmans Bay Canal	7	1.4	20	151.5	43.0	28	-	-	-	-	-	-
All Stations Receiving Mine and Chemical Plant Discharge Combined	9	4.8	53	90.1	78.1	87	-	-	-	-	-	-

indices lack the sensitivity to demonstrate differences. Equitability, on the contrary, has been found to be very sensitive to even slight levels of degradation (EPA 1973); however, the calculated values indicate no distinction between human-induced stress and "natural" stress resulting from extreme environmental conditions.

Many aquatic systems in the OXY study area are naturally exposed to extremely wide ranging environmental conditions. The streams have high discharge rates during the wet season and may not flow at all during portions of the dry season. During part of the year most aquatic systems have high temperatures, low dissolved oxygen, and are moderately acidic. These conditions create a naturally stressed system that tolerant organisms can best withstand and sensitive organisms must deal with either through dormancy, adaptive life cycles, emergence, or migration.

As a result of such natural stress conditions, many of the aquatic systems may have low diversity and equitability values unrelated to human activity. Although reference is often made to stress levels indicated by low index values, it should be noted that values below the criteria levels indicated for each index do not automatically indicate stress induced by man. The FDER recognizes that index values below the published criteria do not necessarily indicate poor or altered water quality. For example, FDER (1980) states that the Suwannee River had good water quality and yet some macroinvertebrate samples produced diversity values of <2.5. In a Florida lake, a diversity value of 2.55 was considered good by FDER (1979).

Thus, the fact that index values throughout Florida or for the study area do not adhere to the criteria established for each index does not mean that the tests are invalid. Therefore, in order to properly interpret diversity and equitability data, natural variation should be considered by comparing values from affected areas to values from control sites.

3.3.4.1 Flora

3.3.4.1.1 Macrophytes

Macrophytes are defined as all aquatic plants with cells that are differentiated into specialized tissue. They include aquatic flowering plants, aquatic mosses, liverworts, and ferns. They can be divided into floating, submerged, and emersed forms (EPA 1973).

Aquatic macrophyte communities are limited within the water courses of the project area by naturally occurring conditions including low pH, fluctuating flow rates, and low light intensities due to shading by bordering canopy species. Previous studies describe in detail the species composition of the tributary streams and water courses in the study area (EPA 1978a, PELA 1977, NFWL 1978). Typical species found in tributaries in the study area are listed in Table 3.3-23.

3.3.4.1.2 Periphyton

The term periphyton originally was used to describe organisms attached to artificially submerged objects but has been broadened to include the

Table 3.3-23. Principal Macrophyte Species Occurring in Major Tributaries of the Suwannee River in the OXY Study Area, Including Swift Creek, Roaring Creek, Rocky Creek, Long Branch, and Four Mile Branch.

Scientific Name	Common Name
Trees	
Acer rubrum	Red maple
Carya glabra	Water hickory
Gordonia lasianthus	Loblolly bay
Ilex cassine	Dahoon
Liquidambar styraciflua	Sweetgum
Magnolia virginiana	Sweetbay
Nyssa biflora	Swamp tupelo
Persea borbonia	Redbay
Quercus hemisphaerica	Diamond leaf oak
Quercus laurifolia	Laurel oak
Quercus nigra	Water oak
Quercus virginiana	Live oak
Salix caroliniana	Willow
Taxodium ascendens	Pond cypress
Taxodium distichum	Bald cypress
Shrubs	
Callicarpa americana	American beautyberry
Cephalanthus occidentalis	Buttonbush
Clethra alnifolia	Sweet pepperbush
Cyrilla racemiflora	Ti-ti
Ilex glabra	Gallberry
Ludwigia peruviana	Primrose willow
Lyonia lucida	Fetterbush
Myrica cerifera	Waxmyrtle
Quercus minima	Runner oak
Rhus copallina	Sumac
Rubus cuneifolius	Blackberry
Serenoa repens	Saw palmetto
Vaccinium myrsinites	Shiny blueberry
Vaccinium stamineum	Deerberry
Vines	
Parthenocissus quinquefolia	Virginia creeper
Rhus radicans	Common poison ivy
Smilax bona-nox	Saw greenbrier
Smilax rotundifolia	Common greenbrier
Smilax smallii	Lanceleaf greenbrier
Vitis rotundifolia	Muscadine grape

Table 3.3-23 (Continued).

Scientific Name	Common Name
Terrestrial Herbs (Forbs, Grasses, and Grass-like Species)	
Andropogon capillipes	Chalky bluestem
Andropogon virginicus	Broomsedge
Aristida stricta	Pineland threeawn
Carpephorus paniculatus	Deer tongue
Cassia fasciculatus	Partridge pea
Cyperus spp.	Sedges
Elephantopus tomentosus	Elephant's foot
Galactia pinetorum	Milk pea
Heterotheca graminifolia	Grassyleaf goldenaster
Liatris tenuifolia	Blazing star
Pterocaulon pycnostachyum	Black root
Rhynchospora spp.	Beakrushes
Solidago spp.	Goldenrod
Sorghastrum secundum	Indiangrass
Sporobolus curtissii	Curtiss dropseed
Aquatic Herbs (Forbs, Grasses, and Grass-like Species)	
Azolla caroliniana	Mosquito fern
Carex walterina	Giant carex
Centella asiatica	Centella
Cladium jamaicense	Sawgrass
Dulichium arundinaceum	Three-square sedge
Eichhornia crassipes	Water hyacinth
Hydrocotyle umbellata	Hydrocotyle
Juncus effusus	Softrush
Lemna spp.	Duckweed
Micranthemum umbrosum	Baby-tears
Nymphaea odorata	Water lily
Osmunda regalis	Royal fern
Panicum hemitomon	Maidencane
Polygonum hydropiperoides	Smartweed
Pontederia lanceolata	Pickerelweed
Sagittaria falcata	Duck potato
Salvinia rotundifolia	Common salvinia
Saururus cernuus	Lizard tail
Scirpus cyperinus	Woolgrass bulrush
Typha latifolia	Cattail
Woodwardia areolata	Netted chain fern
Woodwardia virginica	Chain fern
Xyris spp.	Yellow-eyed grass

entire community of sessile organisms. A complete review of the terminology is given by Sladeckova (1962). Periphyton communities include predominantly autotrophic to predominantly heterotrophic organisms and are important to the functioning of aquatic ecosystems because they form the basis of the aquatic food chain.

As a result of the sampling, 183 taxa were identified, including 18 Cyanophyta, 73 Chlorophyta, 80 Chrysophyta, 1 Cryptophyta, 10 Euglenophyta, and 1 genus of uncertain affiliation. The Chrysophyta were represented by 10 genera of Centrales and 70 genera of Pennales of the class Bacillariophyceae.

Generally, all stations were dominated by Chrysophyta, particularly the pennate diatoms (Tables 3.3-24, 3.3-25, and 3.3-26). Seasonally, there was a decrease in chlorophycean taxa in February and May from the levels in September. The majority of all taxa at each station were Cyanophyta, Chlorophyta, and Chrysophyta; Cryptophyta and Euglenophyta were rare or absent at all sampling stations. The greatest number of taxa (44) was recorded for SR-4 during September 1981, and the least number of taxa (2) was recorded for RO-2B during May 1982. Densities for September 1981 ranged from 1.2×10^7 algal units/m^2 at RO-2 to 3.5×10^5 algal units/m^2 at SC-5.5 (Table 3.3-27). February 1982 densities ranged from 1.1×10^8 units/m^2 at SC-10 to 1.4×10^4 units/m^2 at RC-2. Samples for May 1982 ranged from 1.4×10^8 units/m^2 at SC-4 to 8.3×10^3 algal units/m^2 at RC-12.

Stations Not Receiving OXY Discharge. The Suwannee River was dominated by diatoms (Eunotia pectinalis, Melosira italica, Achnanthes spp., and Cyclotella sp.). Generally, diatoms comprised 29-83% of all taxa, with E. pectinalis being collected at all stations. Seasonally, pennate diatom taxa decreased during winter. There was an increase during spring and summer in the frequency of occurrence of the centric diatoms, particularly M. italica.

Diversity indices for the Suwannee River ranged between 2.06 and 3.52, with higher values generally occurring during September (Figures 3.3-4, 3.3-5, and 3.3-6). This was a result of the large number of pennate diatom taxa present at this time. Equitability values generally indicated unstressed levels during September and May, but values were depressed during February 1982. There does not appear to be a correlation between diversity/equitability values and station proximity to streams entering the Suwannee River which receive discharge from OXY.

Long Branch was dominated by pennate diatoms which comprised 27-69% of the taxa identified for all sampling periods. Dominant taxa at LB-1 were Oscillatoria geminata, E. pectinalis, Navicula spp., M. italica, and an unidentifiable species of diatom designated Sp. A. These taxa comprised 55-71% of all periphyton samples from LB-1. Seasonally, there was a decrease in total taxa observed at LB-1, from 32 in September to 12 in May. This decrease was the result of fewer centric and pennate diatom species recorded between late winter and spring. The blue-green alga O. geminata was prevalent during September, comprising 31% of the samples.

Table 3.3-24. Number of Taxa for Major Algal Groups Collected September 1981.

Station	Cyanophyta	Chlorophyta	Chrysophyta Centrales	Chrysophyta Pennales	Chrysophyta Other	Cryptophyta	Euglenophyta	Total
SUWANNEE RIVER STATIONS								
SR-1	1	8	3	19	1	0	1	33
SR-4	2	10	5	23	2	0	2	44
SR-5	1	3	1	11	1	0	1	18
SR-10	1	2	1	10	1	0	0	15
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE								
RC-2	0	8	3	15	1	0	0	27
RC-5	2	1	1	12	1	0	0	17
RC-6	1	1	0	11	1	0	0	14
RC-9	3	10	0	6	3	0	0	22
RO-2	1	5	5	22	1	0	0	34
LB-1	1	4	4	17	5	0	1	32
STATIONS RECEIVING MINE DISCHARGE								
HC-2	4	22	4	11	2	0	0	43
HC-3	1	5	2	16	1	1	1	27
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE								
SC-4	1	7	2	14	1	0	4	29
SC-5.5	1	2	1	7	1	0	1	13
SC-9.5	5	4	1	7	1	1	1	20
EL001-18	2	9	2	10	1	0	1	25
ABC	1	3	2	6	1	0	0	13

Table 3.3-25. Number of Taxa for Major Algal Groups Collected February 1982.

Station	Cyanophyta	Chlorophyta	Chrysophyta			Cryptophyta	Euglenophyta	Total
			Centrales	Pennales	Other			
SUWANNEE RIVER STATIONS								
SR-1	1	2	2	13	1	0	0	19
SR-5	2	2	4	11	1	0	0	20
SR-10	1	0	5	15	2	0	1	24
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE								
RC-2	0	0	1	5	1	0	0	7
RC-5	0	2	0	6	1	0	0	9
RC-6	0	0	0	9	1	0	0	10
RO-2	0	1	2	10	2	0	0	15
LB-1	0	2	12	0	1	0	0	15
STATIONS RECEIVING MINE DISCHARGE								
HC-2	2	1	1	7	1	0	0	12
HC-3	1	1	2	7	1	0	0	12
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE								
SC-4	0	2	2	14	1	0	0	19
SC-5.5	0	0	0	4	1	0	0	5
SC-10	1	1	0	7	1	0	0	10
SC-11	1	0	0	7	1	0	0	9
SS-3	2	1	0	5	1	0	0	9
EL001-18	0	2	2	11	2	0	0	17
ABC	0	10	2	5	1	0	0	18

Table 3.3-26. Number of Taxa for Major Algal Groups Collected May 1982.

Station	Cyanophyta	Chlorophyta	Chrysophyta Centrales	Chrysophyta Pennales	Chrysophyta Other	Cryptophyta	Euglenophyta	Total
SUWANNEE RIVER STATIONS								
SR-1	0	0	2	6	1	0	0	9
SR-5	0	2	2	13	2	0	0	19
SR-10	0	2	3	12	2	0	0	19
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE								
RC-2	0	0	1	5	1	0	0	7
RC-5	0	0	0	8	1	0	0	9
RC-10	1	1	1	12	1	0	0	16
RC-12	0	1	1	5	1	0	0	8
RC-12A	0	0	0	9	2	0	0	11
RO-2	0	0	2	8	1	0	0	11
LB-1	0	1	1	9	1	0	0	12
SWAMP AND MARSH STATIONS								
RC-3000	0	4	0	3	1	0	0	8
RO-2B	1	0	0	0	1	0	0	2
HC-2A	0	1	1	6	1	0	0	9
STATIONS RECEIVING MINE DISCHARGE								
HC-2	1	2	1	5	1	0	0	10
HC-3	0	1	0	7	2	0	0	10
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE								
SC-4	1	7	2	8	1	0	1	20
EL001-18	0	2	2	8	1	0	1	14
ABC	1	5	3	4	1	0	0	14

Table 3.3-27. Summary Density (algal units/m^2) for Periphyton Collected in the Study Area.

Station	September 1981	February 1982	May 1982
SUWANNEE RIVER STATIONS			
SR-1	5,520,321	266,850	80,800
SR-4	5,001,991	-	775,000
SR-5	935,500	1,179,700	-
SR-10	1,380,000	134,930	863,600
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE			
RC-2	1,788,000	13,730	62,300
RC-5	1,340,993	14,190	56,430
RC-6	1,281,996	122,090	-
RC-9	4,531,660	-	-
RC-10	-	-	40,420,000
RC-12	-	-	8,330
RC-12A	-	-	76,550
RO-2	12,321,985	172,410	896,700
LB-1	1,460,325	33,110	141,800
SWAMP AND MARSH STATIONS			
RO-2B	-	-	29,400
RC-3000	-	-	645,200
HC-2A	-	-	26,340
STATIONS RECEIVING MINE DISCHARGE			
HC-2	5,698,653	111,650	284,300
HC-3	1,632,994	35,790	15,930,000
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE			
SS-3	-	49,280,000	-
SC-4	2,552,321	26,920,000	142,780,000
SC-5.5	345,663	65,640	-
SC-9.5	3,172,661	-	-
SC-10	-	106,760,000	-
SC-11	-	27,450,000	-
EL001-18	2,598,500	38,200,000	1,310,300
ABC	1,093,329	1,236,400	2,364,000

- No data collected.

Note: Table reflects all stream stations sampled.

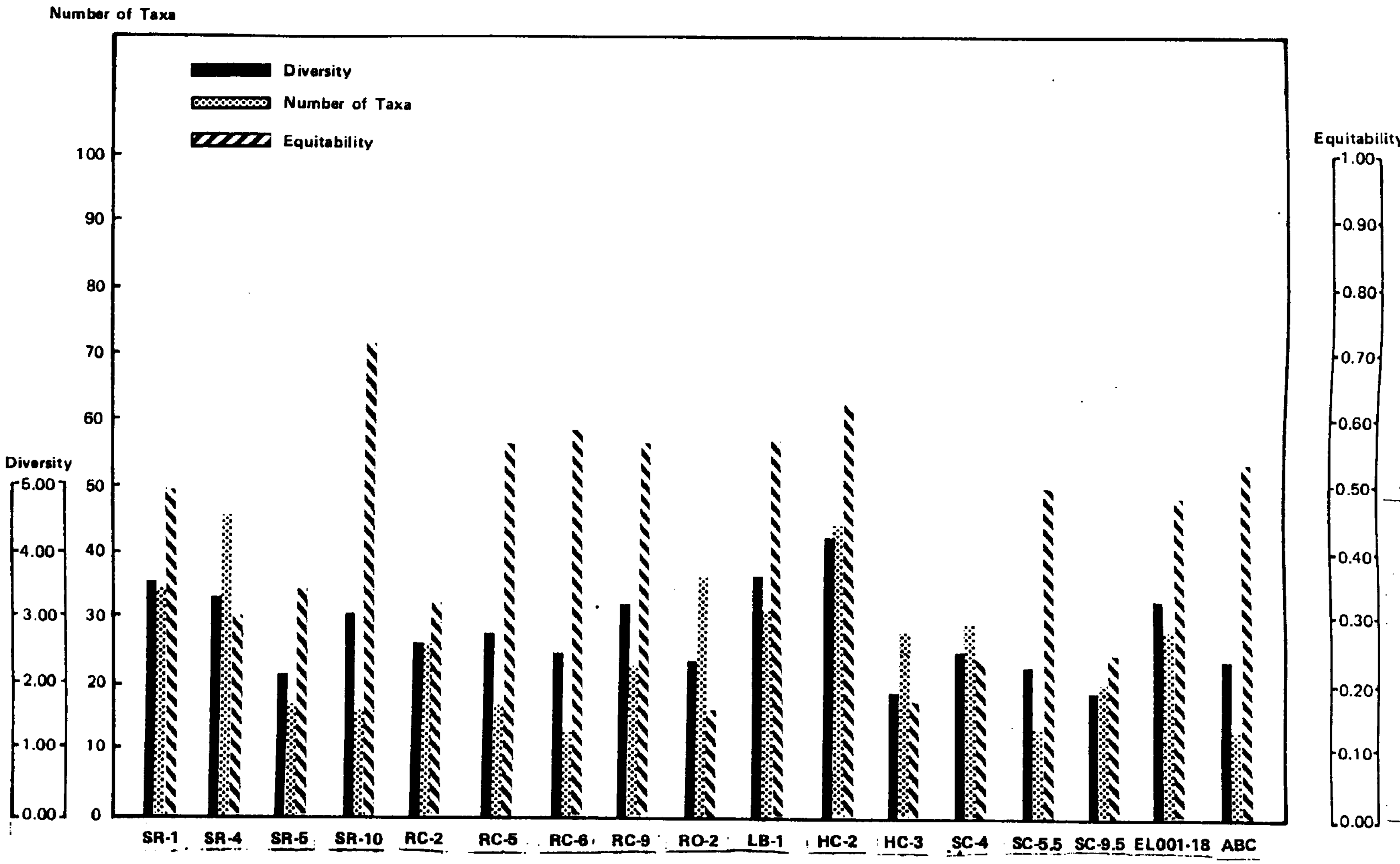


Figure 3.3-4. Diversity, Number of Taxa, and Equitability of Periphyton Samples, September 1981.

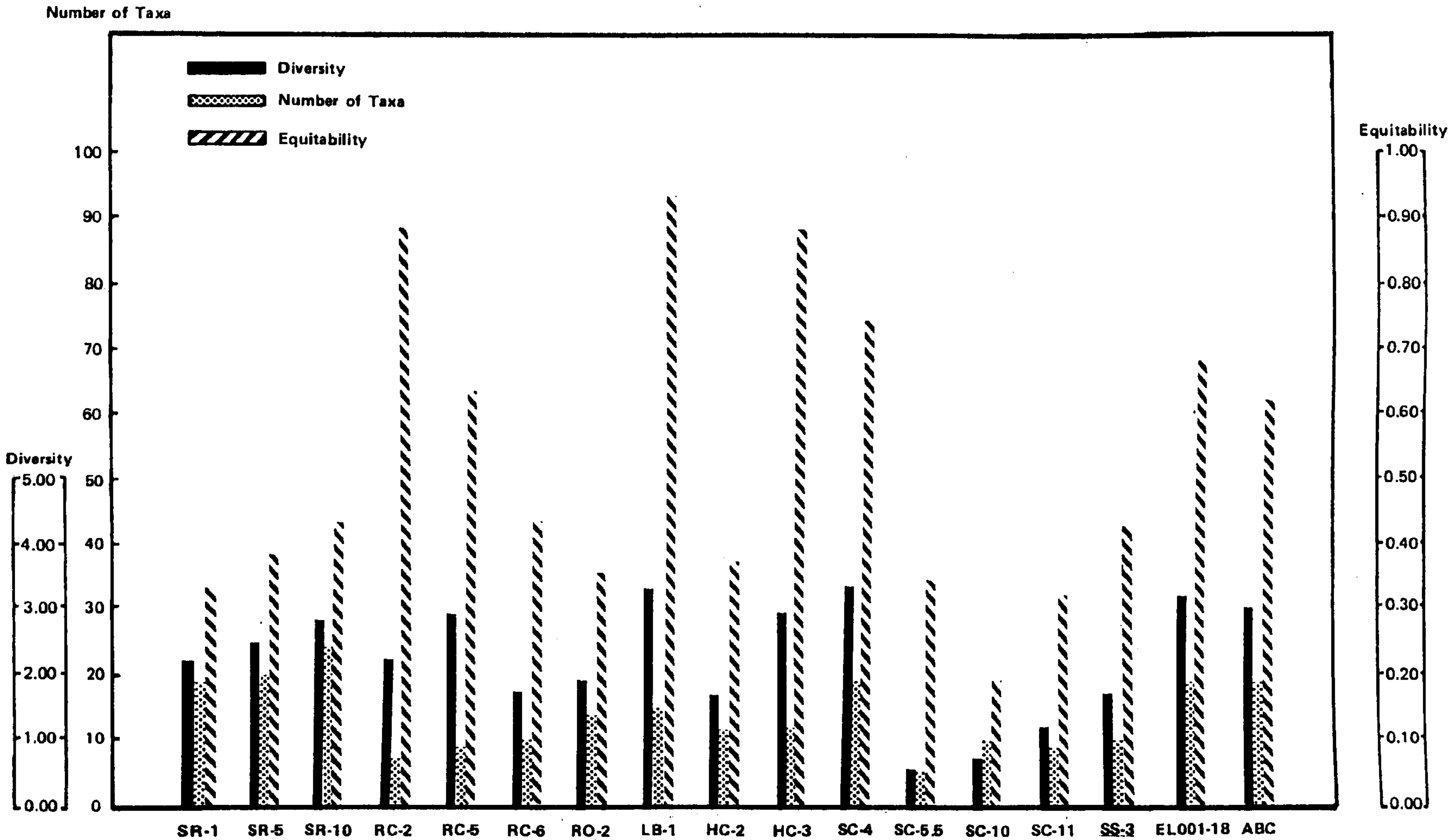


Figure 3.3-5. Diversity, Number of Taxa, and Equitability of Periphyton Samples, February 1982.

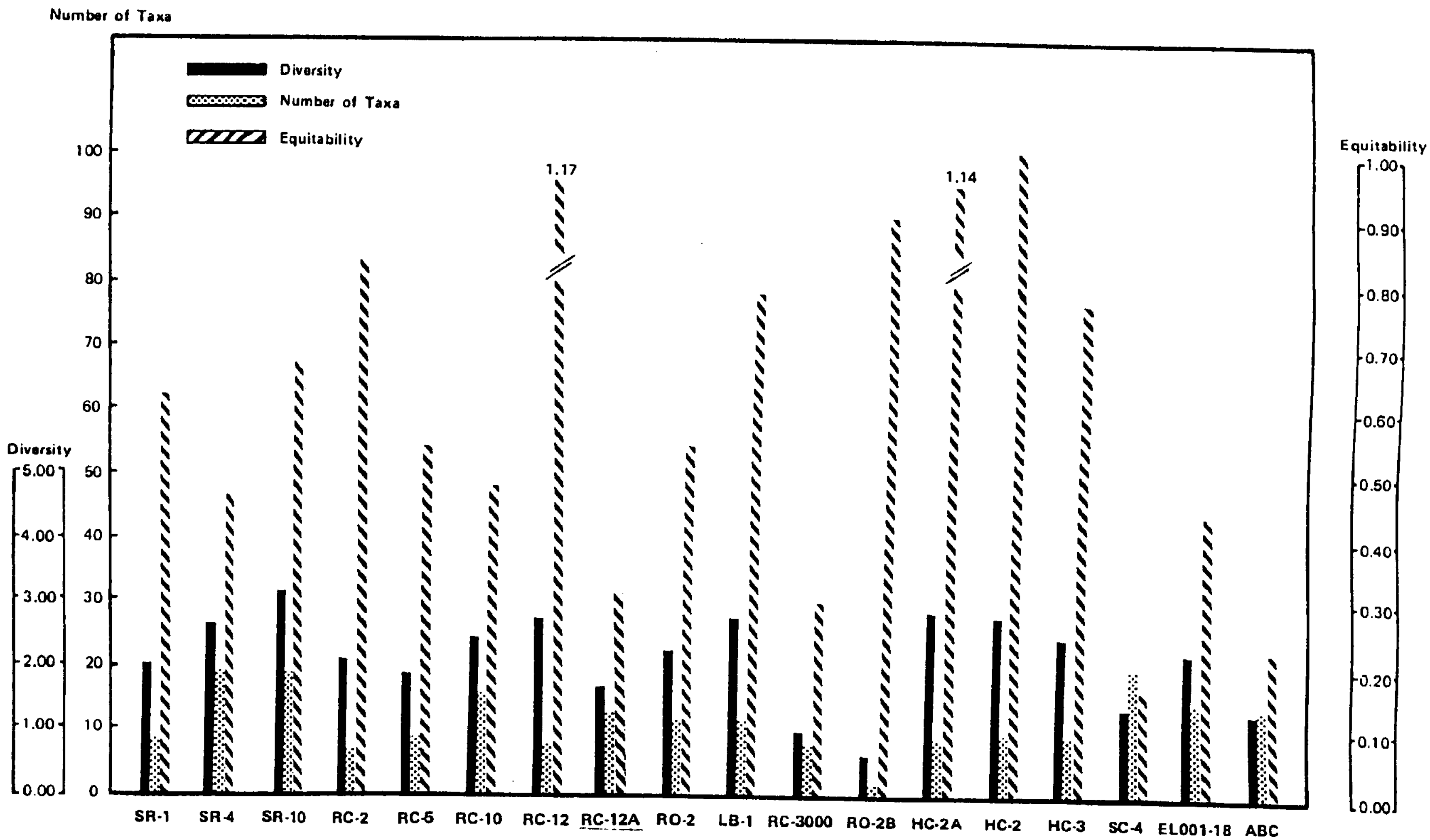


Figure 3.3-6. Diversity, Number of Taxa, and Equitability of Periphyton Samples, May 1982.

Roaring Creek was dominated by centric diatoms, which comprised 42-70% of the periphyton community during the three sampling periods. Blue-green algae were absent from the samples; Chlorophyta comprised only 2% of the community in September 1981 and <1% during the other sample periods. Pennate diatoms comprised 27-55% of the community seasonally, with the maximum during February 1982. Members of the Pennales and Centrales comprised 96-97% of all periphyton identified from samples for the three sample periods.

Dominant taxa for Roaring Creek were Eunotia pectinalis, Melosira italica, and M. varians. These three species comprised 86-91% of all species identified for Roaring Creek. Most taxa were found during September 1981 (36) and fewest in May 1982 samples (12). Pennate diatoms exhibited a greater variety of taxa, but centric diatoms were more numerous.

Diversity indices for Roaring Creek ranged from 1.91 to 2.26, and equitability values ranged from 0.15 to 0.55. The lower equitability value for September reflected the dominance of Melosira italica (67%) during the sampling period. Melosira is one of the most frequently encountered centric diatoms and is often found in almost pure strands in slowly flowing streams (Smith 1950).

Rocky Creek was dominated by pennate diatom taxa. Dominant taxa identified were Eunotia pectinalis, E. valida, and Melosira italica. Although Saurastrum americanum and Oscillatoria geminata were dominant at RC-5 in February and RC-10 in May, respectively, Rocky Creek periphyton were generally represented by various species of Eunotia. There does not appear to be a seasonal change in periphyton composition in Rocky Creek.

Diversity indices for Rocky Creek were generally between 1.73 and 3.18, with no obvious seasonal variation. Although some diversity values were low, equitability values were usually >0.5, indicating an unstressed environment. There did not appear to be any trend in equitability values with distance downstream on Rocky Creek.

Three swamp stations were sampled for algal periphyton during May 1982 (Table 3.3-27, Figure 3.3-6). These stations were highly variable in taxonomic composition, diversity, and equitability. Generally, RO-2B was dominated by Cyanophyta, RC-3000 by Chlorophyta, and HC-2A by Chrysophyta (Table 3.3-26).

The blue-green alga Lyngbya sp. was dominant at RO-2B, comprising 83% of the total organisms identified at this station. Only one other species was identified at RO-2B; therefore, diversity was very low (0.65). However, the distribution of taxa resulted in a high equitability value (0.90). Station RC-3000 is an undisturbed marsh area in Bee Haven Bay. The low diversity (1.00) and equitability (0.30) values were due to naturally occurring conditions. The green alga Hyalotheca sp. dominated RC-3000, comprising 83% of the total organisms identified at this station.

The diatom taxa dominated HC-2B, particularly Eunotia spp. which comprised 51% of the total organisms identified at this station. Diversity was 2.88 and equitability was 1.14 (equitability values >1 are unusual and must be viewed with caution).

The swamp stations are naturally subjected to periods of seasonal desiccation and inundation. Such environmental extremes may eliminate or reduce many taxa and preclude the establishment of a definitive algal population. The reestablishment of algal taxa within these areas probably occurs through auxospore germination and passive transport by wind or transient organisms.

Stations Receiving Mine Discharge. Hunter Creek was generally dominated by diatom taxa, though Chlorophyta and Cyanophyta were prevalent during certain sampling periods. The most frequently occurring taxa were Eunotia pectinalis, Oscillatoria geminata, an unidentified diatom designated Sp. A, Dinobryon sp., Dictyosphaerium pulchellum, and Dimorphococcus lunatus. These taxa comprised 50-78% of all taxa identified from Hunter Creek. The greatest number of taxa occurred in fall (44), and the least number occurred in spring (10). Fewer taxa associated with spring samples were the result of fewer diatom taxa identified. There was also a significant decrease (from 22 to 2) in the number of green algal taxa between fall, winter, and spring samples.

Diversity indices for Hunter Creek ranged from 1.77 to 4.22, with no seasonal trends noted. Equitability values ranged from 0.15 to 0.97. Values were high at HC-2 in fall and spring; values were depressed at HC-3 in the fall but were high at other times, indicating an unstressed condition during other sampling periods. Low values in fall resulted from the high density of green algae and diatom taxa at these times, particularly Eunotia pectinalis.

Stations Receiving Mine and Chemical Plant Discharge. During the initial sampling periods, Altmans Bay Canal (ABC) generally was dominated by blue-green algae, but dominance shifted to green algae and diatoms during the spring. In September, Oscillatoria sp. A comprised 51% of the identifiable taxa, and in May, Arthrospira jenneri comprised 79% of the samples. Oscillatoria and A. jenneri are commonly associated with areas of organic enrichment (Palmer 1977). During February, the green alga Micractinium pusillum and the diatom Eunotia pectinalis were the most frequently occurring taxa (38% and 20%, respectively, of all taxa collected). Generally, there was little change in the total number of taxa on a seasonal basis; however, green algae were more abundant during February. Diversity indices ranged from 1.36 to 3.05 during the sampling periods and generally were highest during February and lowest during May. Equitability values ranged from 0.23 to 0.62, indicating that ABC was unstressed during the fall and winter and stressed during the spring. Low equitability in May resulted from the high number of Arthrospira jenneri.

Swift Creek exhibited effects of enrichment on the algal periphyton community in the vicinity of OXY discharges. Those sampling sites closest to the chemical complex were dominated by blue-green algae. Oscillatoria geminata and O. chlorina comprised 80-90% of the taxa at these sites; few pennate diatom taxa were observed and centrics were absent. However, with increasing distance from the chemical complex, diatom taxa tended to dominate. Eunotia pectinalis, Cyclotella sp., Fragilaria sp., and the green alga Micractinium pusillum were the dominant taxa. At these downstream sites, 62-92% of the taxa were again diatoms. Only 4-11% of the taxa were Cyanophyta at these stations. On a seasonal basis there seemed to be little change in the structure of the periphyton community except for a decrease in total Euglenophyta taxa after September 1981.

Diversity indices varied both spatially and temporally on Swift Creek. Stations upstream of SC-4 had indices ranging from 0.56 to 2.25, indicating stressed communities. Equitability values also were depressed on Swift Creek, ranging from 0.17 to 0.49, except for a value of 0.74 at SC-4 in February.

Eagle Lake Canal (EL001-18) was dominated by pennate and centric diatom taxa, principally Eunotia pectinalis, Cyclotella atomus, Achnanthes exigua, Cymbella naviculiformis, and Melosira varians. These species comprised 49-75% of the periphyton community. In summer, M. varians replaced E. pectinalis as the dominant diatom taxon. There was also a decrease in total taxa identified seasonally, with the greatest number (29) occurring in fall and fewest (15) in spring (Figures 3.3-4, 3.3-5, and 3.3-6). However, densities were significantly higher in February samples (Table 3.3-27).

Diversity indices for EL001-18 ranged from 2.30 to 3.24, and equitability ranged from 0.44 to 0.68 (Figures 3.3-4, 3.3-5, and 3.3-6). These values indicate that Eagle Lake Canal generally exhibits a healthy periphyton community.

Similarity values for 1981-1982 are presented in Tables 3.3-28, 3.3-29, and 3.3-30. Though most values were quite low, values for September were generally higher than values for February or May because the number of species was greater in September and there were more species in common among stations. During September, similarity values for HC-3 versus systems not receiving discharge were generally higher than values for other similarity comparisons in the study area, e.g., HC-3 vs. SR-4 was 0.51. Again during February and May some affected stations were similar to unaffected stations. During February, for example, similarity values for SC-5.5 vs. SR-10, SC-5.5 vs. RC-6, and SC-5.5 vs. RO-2 were 0.65, 0.67, and 0.54, respectively. During May, HC-2 and LB-1 were similar (0.53).

Data from 1982 were compared to data collected for the Swift Creek Chemical Complex EIS in 1978 (Table 3.3-31). Because of differences in station locations, it was not possible to compare all stations; in some cases, however, the nearest station was selected as representative of a particular site. Values shown for 1982 are for the February sampling period.

Generally, there did not appear to be a significant difference between 1978 and 1982 data. Exceptions occur, however, at SR-8/SR-5, SC-6/SC-5.5, and SC-9/SC-9.5. At SR-8/SR-5 and SC-9/SC-9.5 equitability values were depressed during the 1982 sampling period, although diversity indices were approximately the same. At SC-5.5 in 1982, diversity

Table 3.3-28. Percent Similarity of Periphyton among Stations in the Study Area, September 1981.

	SR-1	SR-4	SR-5	SR-10	LB-1	RC-2	RC-5	RC-6	RC-9	RO-2	HC-2	HC-3	SC-4	SC-5.5	SC-9.5	EL001-18
SR-4	0.45															
SR-5	0.17	0.23														
SR-10	0.16	0.23	0.50													
LB-1	0.23	0.27	0.29	0.41												
RC-2	0.25	0.24	0.29	0.26	0.29											
RC-5	0.32	0.34	0.42	0.36	0.36	0.30										
RC-6	0.29	0.29	0.40	0.26	0.20	0.29	0.77									
RC-9	0.20	0.13	0.16	0.11	0.09	0.14	0.21	0.22								
RO-2	0.16	0.36	0.08	0.07	0.08	0.23	0.10	0.10	0.07							
HC-2	0.20	0.27	0.22	0.23	0.25	0.14	0.23	0.19	0.15	0.10						
HC-3	0.26	0.43	0.51	0.35	0.21	0.22	0.46	0.44	0.19	0.19	0.26					
SC-4	0.23	0.34	0.31	0.24	0.15	0.19	0.31	0.33	0.17	0.17	0.28	0.58				
SC-5.5	0.09	0.11	0.44	0.33	0.26	0.23	0.27	0.27	0.09	0.04	0.11	0.27	0.20			
SC-9.5	0.07	0.08	0.07	0.11	0.25	0.04	0.03	0.02	0.01	0.03	0.17	0.09	0.07	0.06		
EL001-18	0.22	0.33	0.47	0.29	0.17	0.18	0.34	0.32	0.17	0.13	0.37	0.54	0.54	0.20	0.09	
ABC	0.09	0.15	0.15	0.18	0.16	0.06	0.12	0.04	0.01	0.02	0.18	0.11	0.09	0.18	0.17	0.13

Table 3.3-29. Percent Similarity of Periphyton among Stations in the Study Area, February 1982.

	SR-1	SR-5	SR-10	LB-1	RC-2	RC-5	RC-6	RO-2	HC-2	HC-3	SS-3	SC-4	SC-5.5	SC-10	SC-11	EL001-18
SR-5	0.26															
SR-10	0.39	0.19														
LB-1	0.13	0.05	0.03													
RC-2	0.09	0.02	0.15	0.37												
RC-5	0.04	0.00	0.05	0.12	0.14											
RC-6	0.26	0.16	0.60	0.20	0.08	0.09										
RO-2	0.46	0.25	0.65	0.24	0.11	0.04	0.63									
HC-2	0.18	0.12	0.28	0.19	0.07	0.04	0.16	0.14								
HC-3	0.16	0.05	0.32	0.37	0.18	0.08	0.24	0.19	0.29							
SS-3	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
SC-4	0.00	0.04	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.15					
SC-5.5	0.21	0.10	0.65	0.24	0.12	0.05	0.67	0.54	0.16	0.37	0.00	0.00				
SC-10	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.11	0.00			
SC-11	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.11	0.00	0.04		
EL001-18	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.50	0.00	0.11	0.09	
ABC	0.05	0.25	0.12	0.03	0.01	0.00	0.14	0.13	0.04	0.04	0.00	0.07	0.10	0.01	0.00	0.02

Table 3.3-30. Percent Similarity of Periphyton among Stations in the Study Area, May 1982.

	SR-1	SR-5	SR-10	LB-1	RC-2	RC-5	RC-10	RC-12	RC-12A	RO-2	HC-2A	RC-3000	RO-2B	HC-2	HC-3	SC-4	EL001-18
SR-5	0.18																
SR-10	0.17	0.38															
LB-1	0.23	0.20	0.23														
RC-2	0.55	0.15	0.11	0.27													
RC-5	0.24	0.09	0.07	0.34	0.40												
RC-10	0.00	0.00	0.01	0.00	0.00	0.00											
RC-12	0.10	0.02	0.01	0.07	0.11	0.18	0.00										
RC-12A	0.19	0.15	0.13	0.30	0.35	0.53	0.00	0.13									
RO-2	0.16	0.53	0.35	0.19	0.11	0.07	0.00	0.01	0.13								
HC-2A	0.27	0.06	0.04	0.15	0.33	0.28	0.00	0.34	0.25	0.04							
RC-3000	0.04	0.03	0.02	0.04	0.04	0.05	0.00	0.02	0.05	0.02	0.05						
RO-2B	0.09	0.01	0.01	0.06	0.05	0.06	0.00	0.10	0.04	0.01	0.15	0.01					
HC-2	0.13	0.21	0.32	0.53	0.16	0.20	0.01	0.04	0.32	0.23	0.08	0.03	0.03				
HC-3	0.00	0.05	0.04	0.01	0.00	0.00	0.12	0.00	0.01	0.04	0.00	0.00	0.00	0.02			
SC-4	0.00	0.01	0.01	0.00	0.00	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.10		
EL001-18	0.04	0.18	0.17	0.11	0.04	0.05	0.00	0.01	0.09	0.29	0.01	0.02	0.01	0.14	0.02	0.01	
ABC	0.02	0.07	0.07	0.07	0.02	0.03	0.00	0.00	0.04	0.05	0.01	0.01	0.00	0.08	0.02	0.00	0.05

Table 3.3-31. Comparison of 1977/1978 and 1981/1982 Periphyton Data.

1977/1978*				1981/1982			
Station	No. of Taxa	$\bar{d}$	e	Station	No. of Taxa	$\bar{d}$	e
SR-8	19	3.01	0.58	SR-5	20	2.48	0.38
RO-2	13	1.93	0.38	RO-2	14	1.91	0.35
RC-2	12	2.95	0.92	RC-2	7	2.21	0.88
HC-1	9	1.18	0.31	HC-2	12	1.77	0.37
SC-4	19	3.32	0.79	SC-4	19	3.31	0.74
SC-6	21	2.80	0.48	SC-5.5	5	0.56	0.34
SC-9	9	1.88	0.53	SC-9.5	20	1.87	0.24
ABC	18	2.61	0.49	ABC	19	3.05	0.62

*Data from EPA 1978a.

was depressed while equitability values for SC-5.5 and SC-6 were similar. It is possible that these lowered equitability and diversity values are the result of differences in habitat characteristics at different locations. Based on the historical data, it can generally be concluded that there has been no significant change in the periphyton community between 1978 and 1982.

3.3.4.1.3 Phytoplankton

In August 1981, 112 phytoplankton taxa were collected from the Suwannee River, its tributaries, and reclaimed lake canals (Tables 3.3-32 and 3.3-33). The Suwannee River had the highest number of taxa (48), and Roaring Creek had the lowest number (14) (Table 3.3-32). All other areas sampled had between 29 and 43 taxa. Generally, Chlorophyta exhibited the greatest number of taxa, ranging from 25 in Hunter Creek to 3 in Roaring Creek. The preponderance of chlorophycean taxa is apparently a natural occurrence because these results agree with those of other recent phytoplankton studies of Florida waters (Thompson et al. 1982, EPA 1978a, Taylor et al. 1978). The green algae species *Ankistrodesmus convolutus*, *Crucigenia crucifera*, *Dictyosphaerium pulchellum*, and *Kirchneriella subsolitaria* account for 52% of all Chlorophyta identified.

The Chrysophyta were dominated by pennate diatom taxa in all areas, ranging from 11 taxa in Rocky Creek to 4 taxa in Swift Creek (Table 3.3-32). *Fragilaria* sp. was the dominant pennate diatom, comprising 48% of the taxa enumerated. Centric diatoms were absent from Swift Creek; the number of centrics identified at other stations never exceeded two, and usually only one genus was observed. Euglenophytan taxa were absent from Roaring Creek and were rarely present at other stations.

In general, densities were highest for Cyanophyta and lowest for Cryptophyta. Chlorophyta ranked second in total phytoplankton density, dominating the phytoplankton community of Rocky and Roaring creeks. In addition, centric diatoms of Roaring Creek were as abundant as other non-diatom chrysophycean taxa of this tributary stream.

Generally, Cyanophyta and Chlorophyta comprised 88-99% of all phytoplankton from the sampling areas. The dominance of blue-greens from the August samples reflects the typical seasonal cycle of phytoplankton (Palmer 1977). Although green algae are likely to be abundant in summer, there is usually increased growth of blue-greens in late summer and early fall.

Greatest phytoplankton density occurred in Swift Creek samples (2.9 x 10^5 units/m^3 at SC-5.5), and lowest density was from Roaring Creek (5.7 x 10^2 units/m^3 at RO-2) (Figure 3.3-7, Table 3.3-33). Rocky and Roaring creeks and the Suwannee River sampling stations had very low phytoplankton densities. These stations were generally species-poor, reflecting their low pH, lack of buffering capacity, and shallow photic zone. Most planktonic algae in lotic environments tend to be limited by available nitrogen (Hutchinson 1975) which, for these streams, is low.

Table 3.3-32. Number of Phytoplankton Taxa (T) and Relative Abundance (A), Expressed as Percent Composition of Each Major Algal Division Identified from Suwannee River, Tributary, and Reclaimed Lake Sampling Stations, August 1981.

Algal Division	Suwannee River		Tributaries: Rocky Creek		Tributaries: Roaring Creek		Tributaries: Hunter Creek		Tributaries: Swift Creek		Reclaimed Lake Canals	
	T	A	T	A	T	A	T	A	T	A	T	A
Cyanophyta	8	85	4	15	2	14	3	86	6	96	9	87
Chlorophyta	23	14	12	13	3	9	25	9	14	3	13	1
Chrysophyta												
Bacillariophyceae												
Centrales	1	<1	1	54	1	28	2	<1	0	0	1	<1
Pennales	8	<1	11	12	5	19	8	5	4	<1	5	11
Other (non-diatom)	3	<1	2	5	1	28	1	<1	1	<1	1	<1
Cryptophyta	2	<1	1	<1	2	1	2	<1	2	<1	2	<1
Euglenophyta	3	<1	1	<1	0	0	2	<1	2	<1	2	<1
Total	48		32		14		43		29		33	

Table 3.3-33. Summary Data for Phytoplankton Collected in the Study Area, August 1981.

Station	No. of Taxa	Density (units/m^3)	Diversity	Equitability
SUWANNEE RIVER STATIONS				
SR-1	22	1,415	3.23	0.61
SR-4.1	24	32,986	1.14	0.11
SR-5	8	2,624	0.82	0.25
SR-10	8	2,470	2.10	0.71
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE				
RC-2	15	38,733	0.38	0.10
RC-5	14	771	3.08	0.85
RC-6	12	661	2.47	0.63
RC-9	14	2,629	2.81	0.70
RO-2	14	574	2.75	0.67
STATIONS RECEIVING MINE DISCHARGE				
HC-2	35	78,849	2.50	0.22
HC-3	17	164,932	0.52	0.10
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE				
SC-5.5	21	287,838	0.61	0.08
SC-9.5	15	6,518	1.18	0.18
EL001-18	17	32,934	0.79	0.12
ABC	22	229,091	0.45	0.07

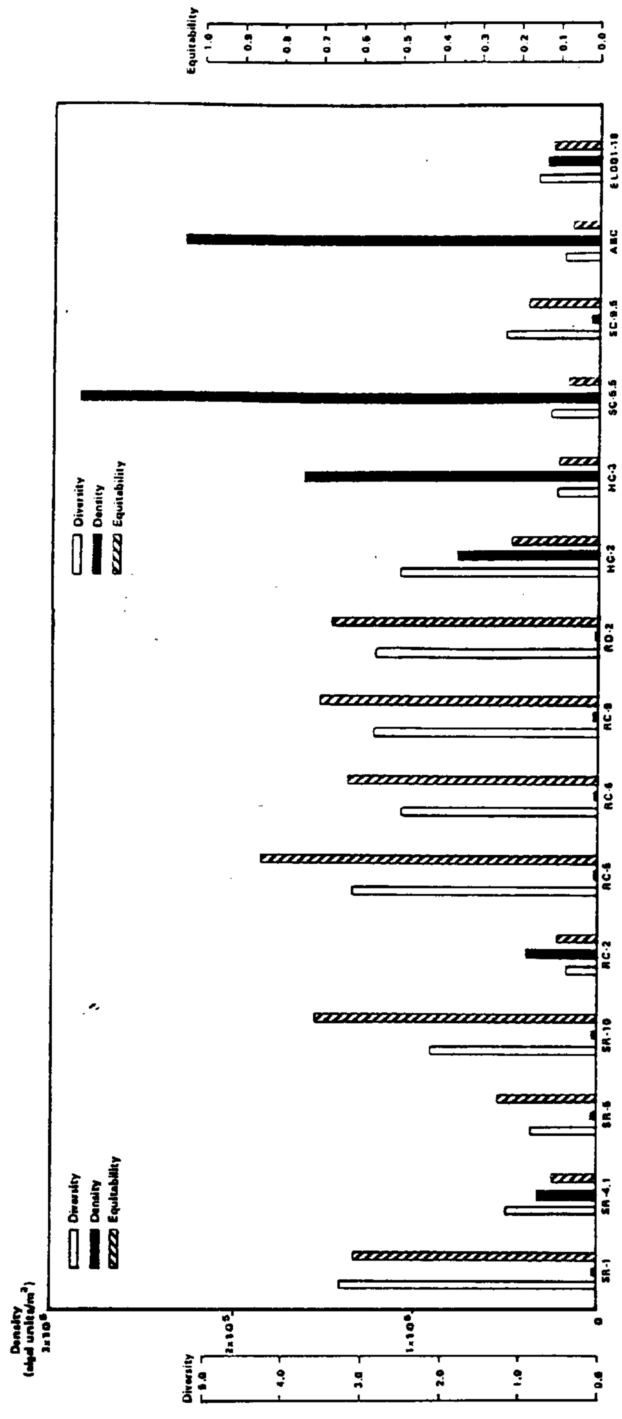


Figure 3.3-7. Diversity, Density, and Equitability of Phytoplankton Samples, August 1981.

Diversity ranged from 3.23 at SR-1 to 0.45 at Altmans Bay Canal (Table 3.3-33). The Suwannee River exhibited a decrease in diversity with distance downstream from SR-1 to SR-5, followed by an increase at SR-10. The increase may be the result of plankton washout from tributaries or an artifact of the sampling procedure. The two Hunter Creek stations exhibited very different diversity indices (2.50 at HC-2 and 0.52 at HC-3). This may be related to natural variations in phytoplankton distribution or to species enrichment between the two stations.

Eagle Lake Canal had moderate phytoplankton density while the value for ABC was high (Figure 3.3-7). Both lakes have hard, moderately alkaline waters with high concentrations of nitrogen and phosphorus (Boyd and Davies 1981) which generally favor high phytoplankton production and consequently high densities.

Phytoplankton data for the Suwannee River collected during January, February, and March 1982 were provided by the Suwannee River Water Management District (SRWMD) and are summarized below. Their sampling stations were at Benton and Suwannee Springs, the approximate locations of SR-1 and SR-10 of the present study.

Location	January		February		March	
	d	e	d	e	d	e
Benton	2.41	0.14	3.86	0.23	3.46	0.21
Suwannee Springs	2.38	0.13	4.02	0.21	3.61	0.19

Diversity for the Benton station was similar to that at SR-1 (Table 3.3-33). Diversity at Suwannee Springs was higher than at SR-10, although this may be due to seasonal variation, sampling methodology, and/or difference in identifying organisms. Equitability was higher at SR-1 than at the Benton station but was similar for Suwannee Springs and SR-10 (Table 3.3-33).

Generally, there was little or no similarity in phytoplankton communities among stations, with nearly 50% of the comparisons producing a 0 value (Table 3.3-34). There were, however, several stations that were very similar. For example, HC-2 vs. SR-4.1, SC-5.5 vs. ABC, and SC-9.5 vs. SR-5 produced values of 0.58, 0.86, and 0.51, respectively. The significance of this is clouded because comparison of other stations on these same streams produced extremely low values. The variability among these comparisons may be the result of habitat differences within the individual streams.

Values for chlorophyll a ranged from a high of 80.18 mg/m^3 for ABC to 0.58 mg/m^3 for SR-5 (Table 3.3-35). Chlorophyll a values were moderate for Eagle Lake and SR-10. There was a large difference between the Hunter Creek stations, with chlorophyll a increasing from 2.44 to 27.73 with distance downstream, mainly due to the variation in the density of _Chroococcus varius_ between these stations. The high chlorophyll a value for ABC reflects the high density of _Oscillatoria agardhii_.

Table 3.3-34. Percent Similarity of Phytoplankton Among Stations in the Study Area, August 1981.

	SR-1	SR-4.1	SR-5	SR-10	RC-2	RC-5	RC-6	RC-9	RO-2	HC-2	HC-3	SC-5.5	SC-9.5	EL001-18
SR-4.1	0.01													
SR-5	0.00	0.00												
SR-10	0.14	0.00	0.03											
RC-2	0.01	0.00	0.00	0.01										
RC-5	0.03	0.00	0.02	0.01	0.00									
RC-6	0.14	0.02	0.01	0.00	0.00	0.29								
RC-9	0.19	0.00	0.00	0.19	0.01	0.21	0.08							
RO-2	0.09	0.01	0.00	0.04	0.01	0.01	0.06	0.04						
HC-2	0.01	0.58	0.05	0.00	0.00	0.00	0.01	0.00	0.00					
HC-3	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.17				
SC-5.5	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00			
SC-9.5	0.00	0.01	0.51	0.02	0.02	0.01	0.00	0.00	0.05	0.05	0.02	0.00		
EL001-18	0.03	0.01	0.00	0.00	0.02	0.00	0.01	0.00	0.01	0.02	0.12	0.02	0.03	
ABC	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.86	0.00	0.00

Table 3.3-35. Concentrations of Chlorophyll a and Pheophytin a for Phytoplankton Samples Collected August 1981.

Station	Chlorophyll a (mg/m^3)	Pheophytin a (mg/m^3)
SUWANNEE RIVER STATIONS		
SR-5	0.58	4.80
SR-10	26.03	8.41
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE		
RC-2	8.33	8.29
RC-5	10.78	9.90
RC-6	1.19	13.72
RO-2	1.13	4.44
STATIONS RECEIVING MINE DISCHARGE		
HC-2	27.73	34.42
HC-3	2.44	18.31
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE		
EL001-18	14.42	9.38
ABC	80.18	3.08

3.3.4.2 Fauna

3.3.4.2.1 Vertebrates

The four major aquatic land use and cover types identified on the OXY site (streams, canals, reclaimed lakes, and ponds) are used by a variety of fish and other vertebrates. Species such as the river otter, beaver, Florida water snake, American alligator, and Florida snapping turtle are typical inhabitants of streams in the project area. These areas receive limited use by avian species, such as the great blue heron and great egret, and chiropteran species, such as the eastern pipistrelle and red bat, which forage along the major streams of the area. Fauna associated with canals on site is similar to that found in streams, although wading birds appear to utilize this habitat more than the stream sites.

Reclaimed lakes usually are convoluted in shape, providing a greater perimeter or shoreline habitat than natural lakes in Florida. Fluctuating water levels often expose extensive mud flats which provide foraging habitat for wading birds such as the little blue heron, black-crowned night-heron, greater yellowlegs, and least sandpiper. Many species use the woody growth areas associated with the shoreline for refuge and nesting sites. Other fauna observed in the reclaimed areas include the river otter, red bat, raccoon, anhinga, double-crested cormorant, green-winged teal, ring-necked duck, northern pintail, northern shoveler, ruddy duck, southern bald eagle, American coot, fish crow, red-winged blackbird, Florida cricket frog, yellow-bellied turtle, American alligator, and Florida cottonmouth.

Natural and man-made (other than phosphate-related) ponds in the project area make up a minor percentage of the open water habitat on site. Within the study area most ponds are man-made and associated with farming operations. Other small ponds are found within some of the forested and non-forested wetlands. Intensity of wildlife usage of farm ponds appears inversely related to use of the farm ponds by domestic animals, which often destroy the aquatic vegetation present. Farm ponds with little domestic use are often highly vegetated and used by herpetofauna such as the bullfrog, treefrogs, Florida water snake, and eastern lesser siren. Fauna encountered in ponds within wetland areas include the river otter, raccoon, wood duck, green heron, pig frog, and Florida cottonmouth.

Fish

Fish were sampled in the Suwannee River and in streams not receiving discharge from phosphate operations. Hunter Creek was also sampled to represent a tributary receiving mine discharge. As Swift Creek is influenced by chemical plant discharge, it was not sampled, because it would not provide data useful to determine the effects of mine discharge.

Thirty-four fish species representing eleven families were collected from the Suwannee River during the summers of 1981 and 1982 (Table 3.3-36). Although fish were more abundant in the Suwannee River than in the tributaries, the number of species in the two areas (25 and 22, respectively) was approximately the same. Only 71 fish species are known to occur in the Suwannee River drainage, and a collection of 34

Table 3.3-36. Numbers of Fish Species Collected from the Suwannee River Drainage, 1981-1982.

Species	Stations										
	SR-1	SR-2	SR-4	SR-5	SR-8	RC-2	RC-5	CB-1.5	RO-3	HC-2	HC-3
Esocidae											
Esox americanus Redfin pickerel						6	10	1	2		2
Umbridae											
Umbra pygmaea Eastern mudminnow						1					3
Cyprinidae											
Notemigonus crysoleucas Golden shiner								3			1
Notropis emiliae Pugnose minnow					1						
Notropis hypselopterus Sailfin shiner								70			
Notropis leedsi Bannerfin shiner	18	2	3	18	261						
Notropis petersoni Coastal shiner			1		1						
Notropis texanus Weed shiner	6		19	1	7						
Notropis venustus Blacktail shiner			1		2						
Catostomidae											
Erimyzon sucetta Lake chubsucker									4		
Minytrema melanops Spotted sucker	6									1	
Ictaluridae											
**Ictalurus* sp.							1				
Ictalurus natalis Yellow bullhead		2				1					1
Ictalurus punctatus Channel catfish		1									

Table 3.3-36 (Continued).

Species	Stations										
	SR-1	SR-2	SR-4	SR-5	SR-8	RC-2	RC-5	CB-1.5	RO-3	HC-2	HC-3
Noturus leptacanthus Speckled madtom		5			1						
Aphredoderidae											
Aphredoderus sayanus Pirate perch						9	3	9	2		
Cyprinodontidae											
Fundulus lineolatus Lined topminnow	2	1	3								
Poeciliidae											
Gambusia affinis holbrooki Mosquitofish	96	80	241		38		1		23	9	40
Heterandria formosa Least killifish	26		15	1	3						
Atherinidae											
Labidesthes sicculus vanhyningi Brook silverside	143	2	367	2	137						
Centrarchidae											
Acantharchus pomotis Mud sunfish								1			
Centrarchus macropterus Flier					4	10	7	1	13	1	3
Elassoma evergladei Everglades pygmy sunfish		2				11	5		5		
Enneacanthus gloriosus Bluespotted sunfish			2			3			1		
Enneacanthus obesus Banded sunfish							3				
Lepomis auritus Redbreast sunfish	58	40	16	1	104			14		21	10
Lepomis gulosus Warmouth			2				1		1		

Table 3.3-36 (Continued).

Species	Stations										
	SR-1	SR-2	SR-4	SR-5	SR-8	RC-2	RC-5	CB-1.5	RO-3	HC-2	HC-3
Lepomis macrochirus Bluegill	4	5			1					4	
Lepomis marginatus Dollar sunfish		2	3						4		
Lepomis microlophus Redear sunfish				1							
Lepomis punctatus Spotted sunfish	1		3					1	2	2	
Micropterus salmoides Largemouth bass	3	5		2	3						
Percidae											
Etheostoma fusiforme barratti Swamp darter			13			1			1	2	
Percina nigrofasciata Blackbanded darter	17	93	78	24				5		31	
No. of specimens	380	240	767	50	563	42	31	105	58	71	60
No. of species	12	13	15	8	13	8	8	9	11	8	7
Species diversity ($\bar{d}$)	2.52	2.19	2.02	1.86	2.03	2.53	2.57	1.69	2.66	2.12	1.61
Equitability	0.64	0.47	0.36	0.59	0.41	0.99	1.02	0.46	0.72	0.79	0.55

*This fish was observed being consumed by a cottonmouth.

species "represents a surprisingly high percentage of the total fauna of the area" (pers. comm. Dr. Carter R. Gilbert, Florida State Museum).

Average diversity and equitability values were 2.12 and 0.49 for the Suwannee River and 2.20 and 0.76 for the tributaries (Table 3.3-36). Less than 100 organisms were collected at some stations; therefore, the index values may not be reliable. Low diversity values probably reflect habitat quality and the sampling methods used. Equitability is a more sensitive index for determining water quality in the southeastern United States (EPA 1973); values for the Suwannee River and the tributaries ranged from 0.36-1.02.

The fish community was most similar among Suwannee River stations (similarity index = 0.46-0.70), somewhat similar among tributary stations, and dissimilar when comparing Suwannee River stations to the tributaries (Table 3.3-37). These trends are expected because the Suwannee River is a continuum, with Station SR-1 being very similar to Station SR-8. Although tributary stations were more similar among themselves than to Suwannee River stations, a great deal of variation does exist among the tributaries.

Lepomis auritus was the most abundant fish in the Suwannee River in both 1970 and 1971 (Cox 1970, Bass and Hitt 1971). This fish was not as abundant in seining samples for 1981, though differences in sampling techniques probably account for this disparity. However, the species still comprises a significant portion of the fish community (11%) and undoubtedly is important to the dynamics of the ecosystem (Table 3.3-38).

The number of species taken from the tributaries for 1981-1982 (22 species) was similar to the number found in 1977 (25 species) (EPA 1978a). Fifteen species were common to the two surveys for a similarity value of 0.64. There were, however, some differences in community composition (Table 3.3-38). During 1977, Gambusia affinis holbrooki (82%), Notropis hypselopterus (5%), Lepomis auritus (3%), Notemigonus crysoleucas (2%), and Lepomis macrochirus (1%) comprised the fish community. Differences in the two surveys are probably not related to environmental or water quality changes, but may be attributed to 1) natural variation due to stream conditions, fish community dynamics, and sampling error, and 2) the difference in sampling efforts (i.e., Swift Creek was not sampled during the 1981-1982 study but was sampled extensively during 1977).

A comparison of fish collected from the Suwannee River drainage in four surveys over a 12-year period indicates a relatively diverse and abundant fauna during each study (Table 3.3-39). Eleven of the most common species occurring in the upper Suwannee River basin were common to all four surveys. The similarity of the results of the 1970 and 1971 surveys and the 1978 and 1982 surveys indicates that differences in the fish community over the years is a result of the design of the individual studies rather than an indication of water quality trends. The 1970 and 1971 studies were conducted only in the Suwannee River using electrofishing techniques, while the 1978 and 1982 surveys were conducted in the Suwannee River and its tributaries using seines and nets. Additionally, river conditions at the time of sampling strongly influence fish survey results.

Table 3.3-37. Similarity of Fish Species Composition Between Stations in the Suwannee River Drainage Based on Presence/Absence.

Station	SR-1	SR-2	SR-4	SR-5	SR-8	RC-2	RC-5	CB-1.5	RO-3	HC-2
SR-2	0.64									
SR-4	0.67	0.50								
SR-5	0.70	0.48	0.52							
SR-8	0.64	0.46	0.57	0.57						
RC-2	0.00	0.19	0.17	0.00	0.10					
RC-5	0.10	0.10	0.17	0.00	0.19	0.38				
CB-1.5	0.29	0.18	0.25	0.24	0.18	0.35	0.35			
RO-3	0.17	0.25	0.46	0.00	0.17	0.63	0.63	0.40		
HC-2	0.60	0.38	0.43	0.25	0.38	0.25	0.25	0.47	0.42	
HC-3	0.21	0.30	0.18	0.07	0.30	0.53	0.53	0.50	0.33	0.40

Table 3.3-38. Dominant Species of Fish Collected in the Suwannee River and Its Tributaries in 1981/1982.

Species	% of Total
SUWANNEE RIVER	
Non-game Species	
Labidesthes sicculus vanhyningi (brook silverside)	33
Gambusia affinis holbrooki (mosquitofish)	23
Notropis leedsi (bannerfin shiner)	15
Percina nigrofasciata (blackbanded darter)	11
Game Species	
Lepomis auritus (redbreast sunfish)	11
TRIBUTARIES	
Non-game Species	
Gambusia affinis holbrooki (mosquitofish)	20
Notropis hypselopterus (sailfin shiner)	19
Percina nigrofasciata (blackbanded darter)	10
Aphredoderus sayanus (pirate perch)	6
Elassoma evergladei (Everglades pygmy sunfish)	6
Esox americanus (redfin pickerel)	6
Game Species	
Lepomis auritus (redbreast sunfish)	12
Centrarchus macropterus (flier)	10

Table 3.3-39. A Checklist of Fishes Collected From the Upper Suwannee River and Its Tributaries During Recent Surveys.

Species	Data Source			
	Cox 1970[1]	Bass and Hitt 1971[2]	EPA 1978a[3]	OXY 1982[4]
Acipenseridae				
Acipenser oxyrhynchus Atlantic sturgeon	X	X		
Amiidae				
Amia calva Bowfin	X	X		
Lepisosteidae				
Lepisosteus oculatus Spotted gar	X	X		
Lepisosteus osseus Longnose gar	X	X		
Lepisosteus platyrhincus Florida gar	X			
Anguillidae				
Anguilla rostrata American eel	X	X		
Clupeidae				
Alosa alabamae Alabama shad	X	X		
Dorosoma cepedianum Gizzard shad	X			
Dorosoma petenense Threadfin shad	X			
Esocidae				
Esox americanus Redfin pickerel	X		X	X
Esox niger Chain pickerel	X	X	X	
Umbridae				
Umbra pygmaea Eastern mudminnow				X

Table 3.3-39 (Continued).

Species	Data Source			
	Cox 1970[1]	Bass and Hitt 1971[2]	EPA 1978a[3]	OXY 1982[4]
Cyprinidae				
Hybopsis harperi Redeye chub	X			
Notemigonus crysoleucas Golden shiner	X	X	X	X
Notropis emiliae Pugnose minnow				X
Notropis hypselopterus Sailfin shiner			X	X
Notropis leedsi Bannerfin shiner	X		X	X
Notropis petersoni Coastal shiner	X		X	X
Notropis texanus Weed shiner	X		X	X
Notropis venustus Blacktail shiner			X	X
Catostomidae				
Erimyzon sucetta Lake chubsucker	X	X		X
Minytrema melanops Spotted sucker	X	X		X
Ictaluridae				
Ictalurus brunneus Snail bullhead		X		
Ictalurus catus White catfish	X			
Ictalurus natalis Yellow bullhead	X	X	X	X

Table 3.3-39 (Continued).

Species	Data Source: Cox 1970[1]	Bass and Hitt 1971[2]	EPA 1978a[3]	OXY 1982[4]
Ictalus nebulosus Brown bullhead	X			
Ictalurus punctatus Channel catfish	X	X		X
Ictalurus serracanthus Spotted bullhead	X			
Noturus gyrinus Tadpole madtom	X			
Noturus leptacanthus Speckled madtom		X		X
Aphredoderidae				
Aphredoderus sayanus Pirate perch	X	X	X	X
Belonidae				
Strongylura marina Atlantic needlefish		X		
Cyprinodontidae				
Fundulus lineolatus Lined topminnow			X	X
Poeciliidae				
Gambusia affinis holbrooki Mosquitofish	X		X	X
Heterandria formosa Least killifish	X		X	X
Lucania goodei Bluefin killifish	X			
Atherinidae				
Labidesthes sicculus vanhyningi Brook silverside	X	X	X	X
Centrarchidae				
Acantharchus pomotis Mud sunfish				X

Table 3.3-39 (Continued).

Species	Data Source: Cox 1970[1]	Bass and Hitt 1971[2]	EPA 1978a[3]	OXY 1982[4]
Centrarchus macropterus Flier	X	X	X	X
Elassoma evergladei Everglades pygmy sunfish			X	X
Elassoma okefenokee Okefenokee pygmy sunfish	X			
Enneacanthus gloriosus Bluespotted sunfish			X	X
Enneacanthus obesus Banded sunfish			X	X
Lepomis auritus Redbreast sunfish	X	X	X	X
Lepomis gulosus Warmouth	X	X	X	X
Lepomis macrochirus Bluegill	X	X	X	X
Lepomis marginatus Dollar sunfish				X
Lepomis microlophus Redear sunfish	X	X		X
Lepomis punctatus Spotted sunfish	X	X	X	X
Micropterus notius Suwannee bass	X	X		
Micropterus salmoides Largemouth bass	X	X	X	X
Pomoxis nigromaculatus Black crappie	X	X		X
Percidae				
Etheostoma edwini Brown darter	X	X		

Table 3.3-39 (Continued).

Species	Data Source			
	Cox 1970[1]	Bass and Hitt 1971[2]	EPA 1978a[3]	OXY 1982[4]
Etheostoma fusiforme barratti Swamp darter				X
Percina nigrofasciata Blackbanded darter	X	X	X	X
Mugilidae				
Mugil cephalus Striped mullet	X	X		
Soleidae				
Trinectes maculatus Hogchoker	X	X		
No. of species	43	30	24	34

[1]Samples collected in Suwannee River by electrofishing.
[2]Samples collected in Suwannee River by electrofishing (data for Stations 1 and 2 only).
[3]Samples collected in Suwannee River and its tributaries by seines and nets.
[4]Samples collected in Suwannee River and its tributaries by seines and nets; unpubl. data collected by OXY consultants for present study.

See text for further explanation of data.

The Florida Game and Fresh Water Fish Commission has periodically sampled fish populations in the Suwannee River above and below the confluence of Swift Creek. Data for four different years, beginning in 1969, are summarized in Table 3.3-40 (FGFWFC 1982). Although there is considerable variation in the data, particularly among years, there is no evidence that Swift Creek has adversely impacted the Suwannee River. In their Annual Report, the FGFWFC (1982) stated that "no consistent differences between the two sample stations are apparent" and there are "no obvious trends since 1969." They concluded that differences between the two stations could be explained "by changes in availability of optimum habitat ... rather than a gross alteration of stream conditions" (FGFWFC 1982).

A comparison of the number of fish collected in the Suwannee River during three surveys over a 20-year period reveals a fairly constant ratio of game to non-game fish (Table 3.3-41). This suggests that the gross structure of the fish community has remained relatively constant over the past two decades.

In summary, despite the variation within and among surveys, it is apparent that 1) the Suwannee River basin supports a diverse fish community; 2) gross structure of the fish community has changed little over the last 20 years; and 3) species composition and abundance are similar in the Suwannee River both above and below Swift Creek, which receives discharges from the mines and chemical plants.

3.3.4.2.2 Macroinvertebrates

Sample Size/Species Area Curves

Samples to determine macroinvertebrate species area curves were taken from four different tributaries and one site on the Suwannee River. The purpose was to determine the number of samples necessary to adequately sample macroinvertebrate communities in the project area, based on a ≤10% increase in number of species in successive samples. For species area curves, ≤10% is the value normally equated with adequate sampling (Oosting 1956).

Ten replicate Hester-Dendy samples were taken from one station each on Rocky and Hunter creeks. The number of samples necessary for a ≤10% increase in number of species in successive samples for artificial substrates was four for both sites, although the fifth sample for RC-5 was 18% (Table 3.3-42). Ten replicate petite Ponar samples were taken at five stations (one station each on Swift, Rocky, Roaring, and Hunter creeks and the Suwannee River). The number of natural substrate samples necessary for a ≤10% increase in number of species ranged from 5 to 8 ($\bar{x}$ = 6, Table 3.3-42). Petite Ponar samples for the species area curves represented a single grab. Species area curves for the two types of samplers are presented in Figure 3.3-8.

To obtain a ≤10% increase in number of taxa in successive samples, more samples are necessary with a Ponar type sampler than by using Hester-Dendy type artificial substrates because of the uniform habitat provided by Hester-Dendy samplers. However, it has been documented that:

Table 3.3-40. Comparison of the Fish Community in the Suwannee River Above and Below the Confluence of Swift Creek.

	Above Swift Creek					Below Swift Creek				
Parameter	3/69	10/80	3/81	11/81	6/82	3/69	10/80	3/81	11/81	6/82
No. fish collected/hr	68	79	140	288	138	98	91	235	170	181
No. of species	10	17	14	15	19	11	19	16	16	28
Species diversity	-	-	-	2.39	2.37	-	-	-	2.65	2.98
Weight of fish/hr (lb)	28.8	19.5	26.0	6.7	28.7	13.4	12.3	55.0	14.8	28.8
No. of game fish/hr	55	35	57	178	110	80	40	57	128	124
% by no. game fish	81	44	41	62	80	81	44	24	75	68
Weight of game fish/hr	4.0	14.9	7.4	6.4	12.7	5.0	7.6	20.2	9.8	19.0
% by weight game fish	14	77	28	95	44	37	62	37	83	66

Source: FGFWFC 1982 (data obtained by using electrofishing techniques).

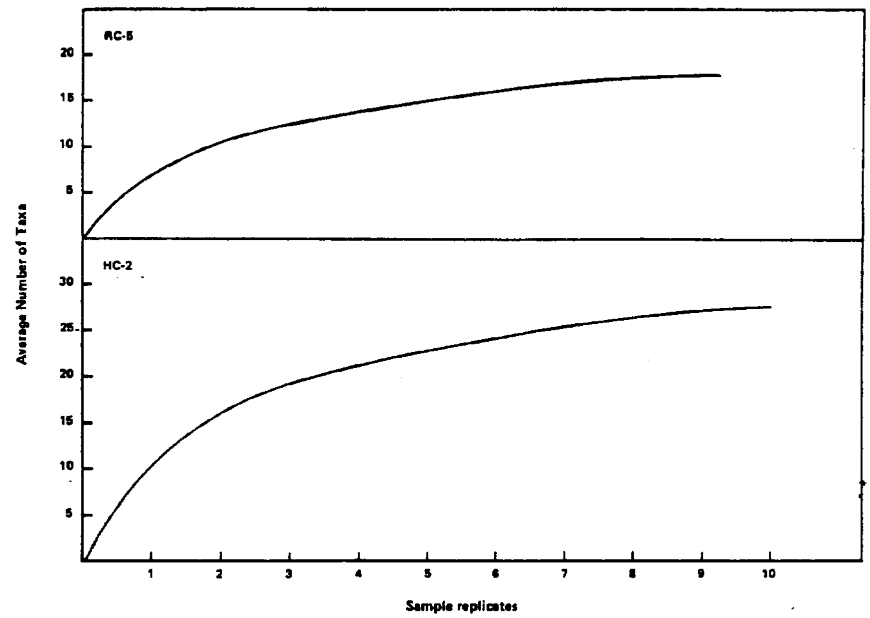
Table 3.3-41. A Comparison of Game and Non-Game Fish Collected from the Suwannee River for Three Different Surveys.

Fish	1961[1]		1970[1]		1980-1982[2]	
	% No.	% Wt.	% No.	% Wt.	% No.	% Wt.
Game	63	39	69	51	61	46
Non-game	36	60	31	49	39	54

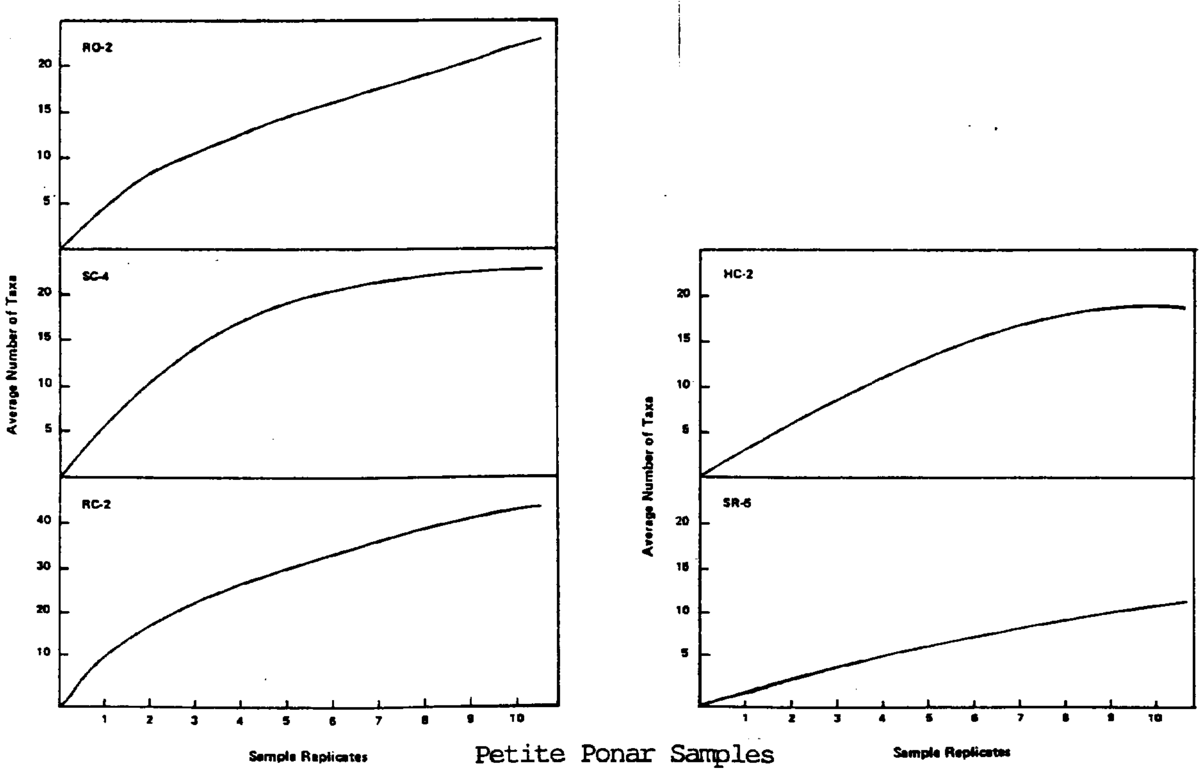
[1]Bass and Hitt 1971.
[2]FGFWFC 1982.

Table 3.3-42. Average Number of Taxa and Percent Increase in Number of Taxa for Successive Macroinvertebrate Samples.

Replicate	Hester-Dendy Samples				Petite Ponar Samples									
	RC-5		HC-2		SC-4		SR-5		RC-2		RO-2		HC-2	
	Avg. No. of Taxa	Percent Increase	Avg. No. of Taxa	Percent Increase	Avg. No. of Taxa	Percent Increase	Avg. No. of Taxa	Percent Increase	Avg. No. of Taxa	Percent Increase	Avg. No. of Taxa	Percent Increase	Avg. No. of Taxa	Percent Increase
1	7.4		10.6		6.3		2.0		10.3		4.9		2.7	
2	10.2	38	15.7	48	11.2	78	2.6	30	17.5	70	8.8	80	5.7	111
3	12.7	25	19.3	23	14.5	29	3.8	46	22.7	30	10.3	17	8.2	44
4	13.5	6	21.1	9	17.3	19	5.2	37	26.3	16	12.7	23	11.8	44
5	15.9	18	22.8	8	18.9	9	6.3	21	29.4	12	14.0	10	14.0	19
6	16.8	6	24.4	7	20.1	6	7.5	19	32.3	10	16.3	16	16.9	21
7	17.0	1	25.6	5	21.5	6	8.5	13	33.8	5	17.5	7	17.4	3
8	17.8	5	26.7	4	22.1	3	9.3	9	37.8	12	18.6	6	17.8	2
9	18.0	1	27.4	2	22.2	0.5	10.0	8	40.5	7	20.6	11	19.0	7
10			28.0	2	23.0	4	11.0	10	43.0	6	22	7		



Hester-Dendy Samples



Petite Ponar Samples

Figure 3.3-8. Species Area Curves for Hester-Dendy and Petite Ponar Samples, September 1981.

1) Artificial substrates select for some species and against others (Mason et al. 1973, Benfield et al. 1974, Tsui and Breedlove 1978);

2) Location of the samplers in a habitat can strongly influence species composition (Mason et al. 1973);

3) Different types of artificial substrates produce different results (Benfield et al. 1974, Seagle et al. 1982).

Based on the species area curves, the sampling regime designed for this study was adequate. FDER requires three replicate Hester-Dendy samplers per station to calculate diversity (Chapter 17-3, FAC). Four replicate Hester-Dendy samples were collected at each station. Although only four petite Ponar samples were collected from each station during the course of the survey, each sample was composed of four grabs, or a total of sixteen samples per season. Sixteen far exceeds the minimum number of samples necessary to show a ≤10% increase in successive samples. In most cases, petite Ponar, Hester-Dendy, and qualitative samples were collected at the same station, making a total of nine samples, more than the maximum required for a ≤10% increase in successive samples.

Qualitative samples were taken from all habitats at a station, and some taxa not typically collected with the dredge and artificial substrates were taken by this method. Most stations were sampled two or three times during the study period, making a yearly total of as many as 23 samples. The use of multiple sampling methods and a seasonal sampling regime undoubtedly provided an "adequate" estimate of the macroinvertebrate communities in the study area.

Natural Substrate Samples

Petite Ponar dredge samples were collected at various stations in 1981 and 1982 to indicate the types and numbers of macroinvertebrates occurring on natural substrates and to compare the communities of areas not receiving phosphate discharges to areas that receive mine water and chemical plant discharges. Although dredge samples provide a good indication of the actual macroinvertebrate community composition in streams, natural substrates are not uniform, and therefore, data generated by this method are often extremely variable.

Areas sampled with a petite Ponar dredge that did not receive OXY discharge included the Suwannee River, Roaring Creek, Long Branch, Rocky Creek, and several swamp and marsh sites. Streams that received no input from OXY produced fairly high composited diversity and equitability values (Tables 3.3-43 and 3.3-44, Figures 3.3-9 through 3.3-12).

Dominant taxa varied seasonally among the unaffected tributaries (Tables 3.3-45 and 3.3-46). In 1981 *Cheumatopsyche* and *Tanytarsus* were the dominant forms. The following spring, *Polypedilum*, Oligochaeta, and *Tanytarsus* dominated samples. During August 1981 the Suwannee River was dominated by *Polypedilum halterale*, *Corbicula manilensis*, and Ceratopogonidae but shifted to *Rheotanytarsus*, *Tanytarsus*, and Oligochaeta during 1982.

Table 3.3-43. Summary of Ecological Parameters for Composited Petite Ponar Samples, August 1981.

Station	No. of Taxa	Density (no./m^2)	Diversity	Equitability
SUWANNEE RIVER STATIONS				
SR-1	18	341	3.06	0.65
SR-4	20	516	2.63	0.43
SR-5	17	381	3.09	0.71
SR-10	18	1559	2.37	0.39
$\bar{x}$	18	699	2.79	0.55
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE				
LB-1	33	510	3.42	0.46
RC-2	39	516	4.54	0.88
RC-5	30	462	3.44	0.52
RC-6	22	309	3.11	0.56
RC-9	23	451	2.74	0.40
RO-2	50	1978	4.03	0.48
$\bar{x}$	33	704	3.55	0.55
$\bar{x}$	27	702	3.24	0.55
STATIONS RECEIVING MINE DISCHARGE				
HC-2	17	276	3.00	0.66
HC-3	39	2967	3.76	0.50
$\bar{x}$	28	1622	3.38	0.58
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE				
SC-4	16	481	2.37	0.44
SC-5.5	14	922	2.59	0.59
SC-9.5	19	4317	2.28	0.35
$\bar{x}$	16	1906	2.41	0.46
EL001-18	26	701	2.99	0.43
ABC	10	6900	0.20	0.12
$\bar{x}$	17	2664	2.09	0.39

Table 3.3-44. Summary of Ecological Parameters for Composited Petite Ponar Samples, April 1982.

Station	No. of Taxa	Density (no./m^2)	Diversity	Equitability
SUWANNEE RIVER STATIONS				
SR-7	26	1459	2.95	0.42
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE				
RO-2	47	1456	4.21	0.58
RC-2	38	548	3.85	0.55
RC-12	26	798	3.47	0.61
RC-12A	16	370	3.03	0.72
$\bar{x}$	32	793	3.64	0.62
SWAMP AND MARSH STATIONS				
HC-2A	9	260	2.18	0.67
RC-3000	25	491	3.31	0.57
RO-2B	10	1411	0.34	0.14
$\bar{x}$	15	721	1.94	0.46
$\bar{x}$	25	849	2.92	0.53
STATIONS RECEIVING MINE DISCHARGE				
HC-2	11	137	2.66	0.79
HC-3	19	7983	2.06	0.29
$\bar{x}$	15	4060	2.36	0.54
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE				
SC-4	20	739	2.43	0.37

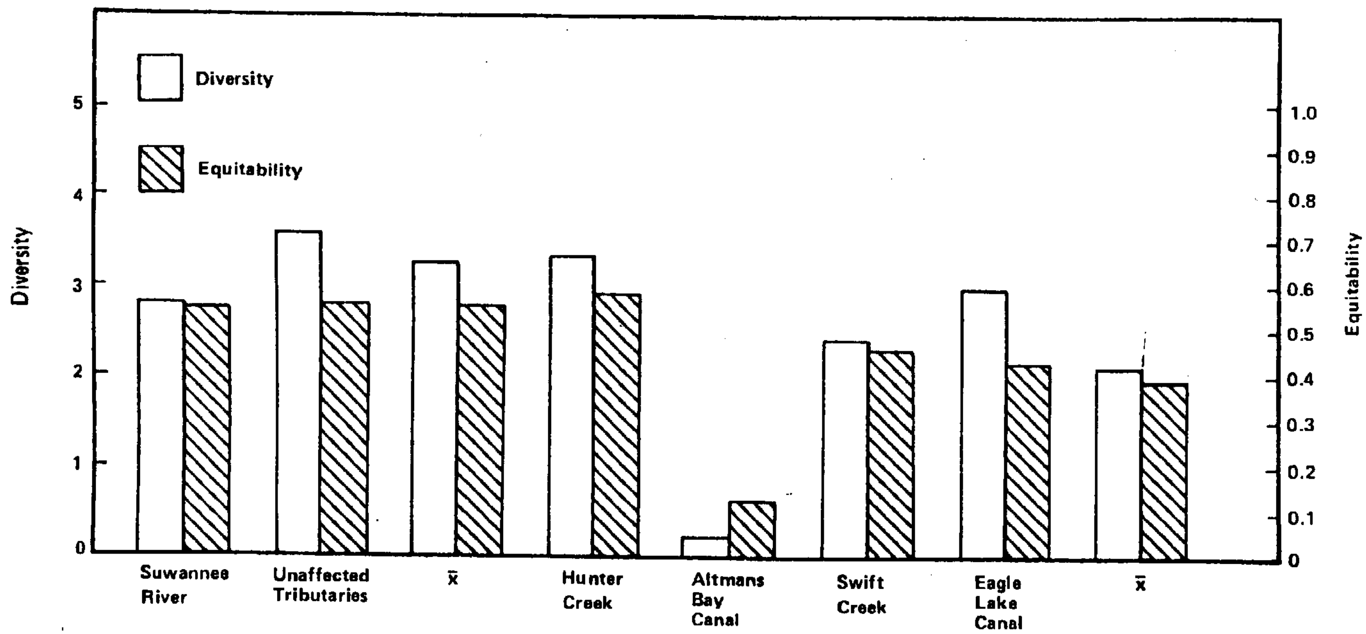
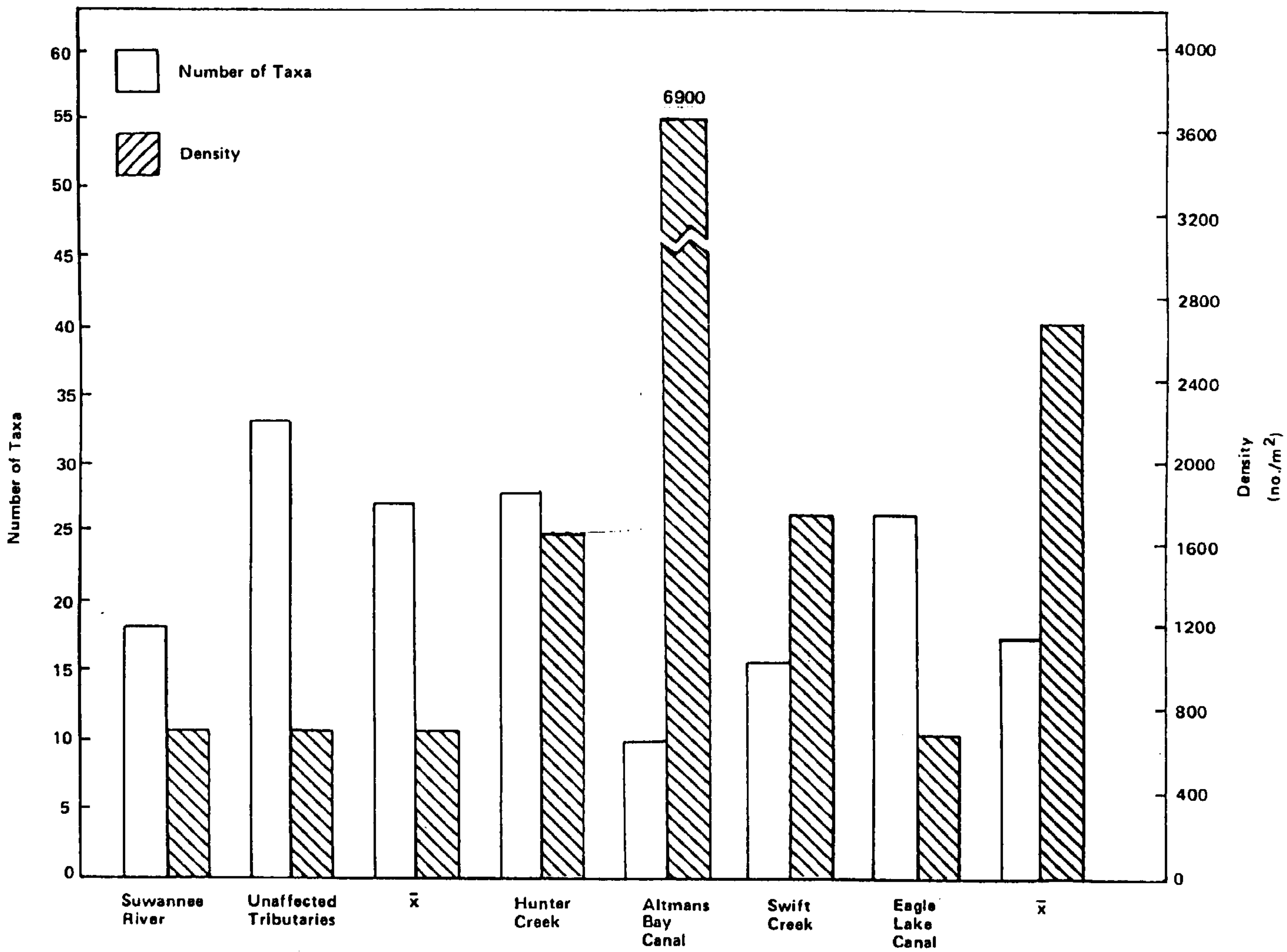


Figure 3.3-9. Mean Diversity and Equitability Values for Petite Ponar Samples, August 1981.



Figue 3.3-10. Mean Number of Taxa and Density for Petite Ponar Samples, August 1981.

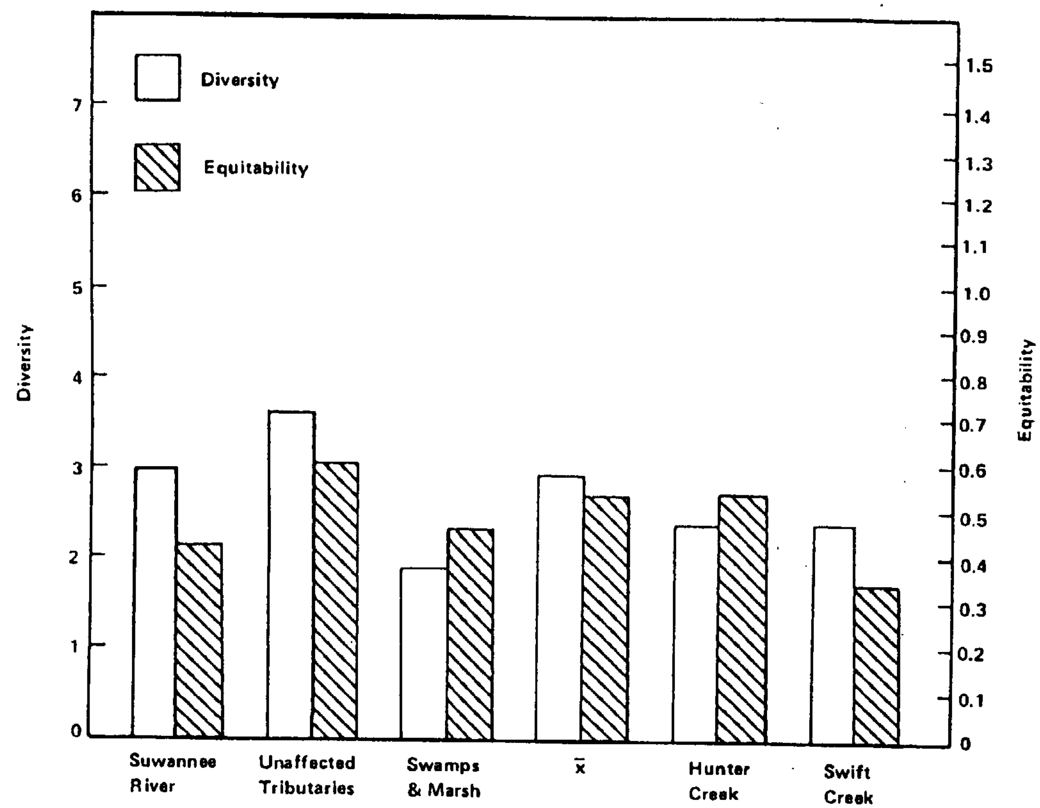


Figure 3.3-11. Mean Diversity and Equitability Values for Petite Ponar Samples, April 1982.

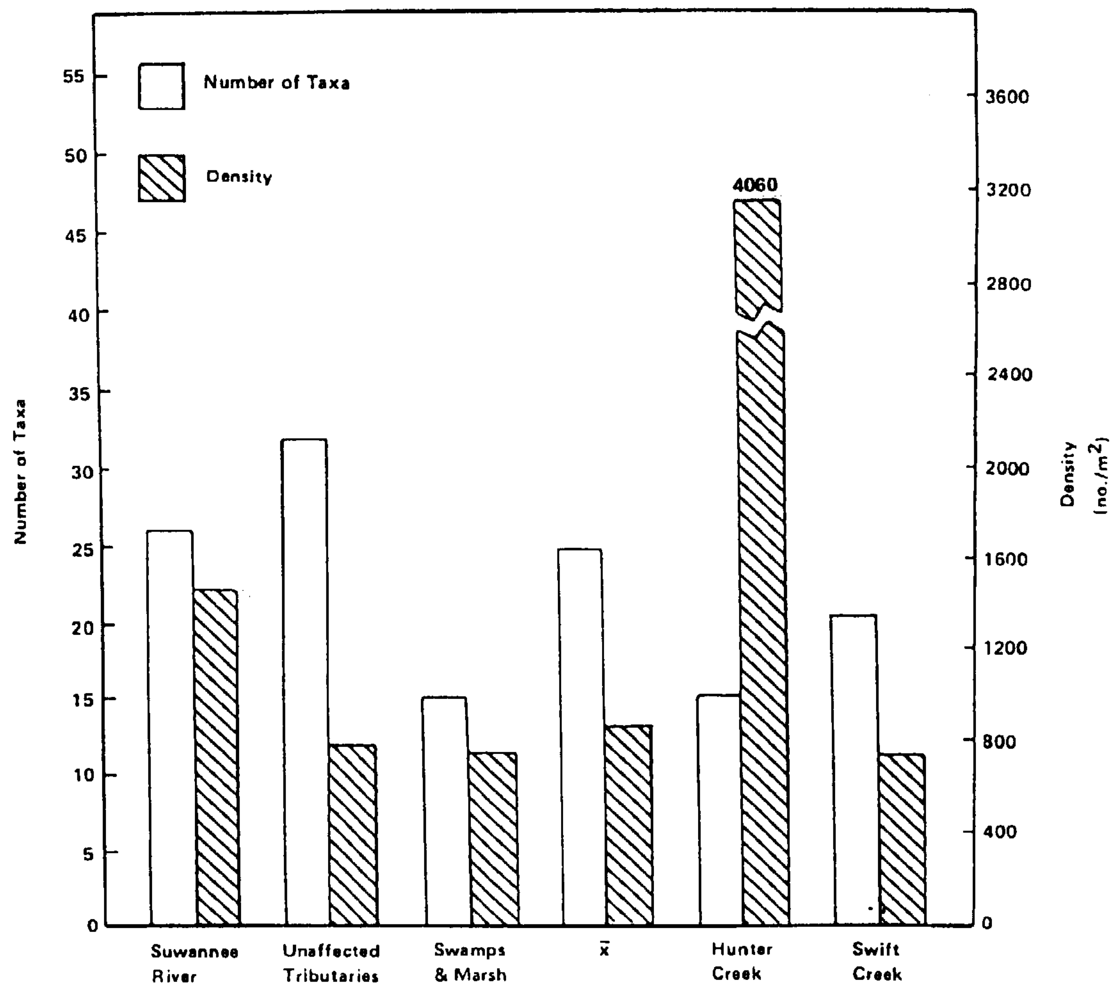


Figure 3.3-12. Mean Number of Taxa and Density for Petite Ponar Samples, April 1982.

Table 3.3-45. Major Macroinvertebrate Components of Petite Ponar Samples, August 1981.

Taxon	% of Total
SUWANNEE RIVER STATIONS	
Polypedilum halterale	42.6
Corbicula manilensis	10.2
Ceratopogonidae	9.6
Tanytarsus sp.	5.8
Oligochaeta	7.4
Cryptochironomus spp.	7.3
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE	
Cheumatopsyche sp.	15.5
Tanytarsus sp.	12.4
Sphaerium sp.	5.9
Larsia sp.	5.6
Sialis sp.	4.6
Caenis diminuta	3.8
STATIONS RECEIVING MINE DISCHARGE	
Hunter Creek	
Hyalella azteca	23.2
Tanytarsus sp.	12.0
Cheumatopsyche sp.	11.9
Oligochaeta	9.4
Polypedilum convictum	7.0
Hirudinea	5.1
Caenis diminuta	4.6
Polypedilum illinoense	3.4
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE	
Swift Creek	
Oligochaeta	48.4
Chironomus sp.	19.4
Hyalella azteca	7.6
Polypedilum convictum	4.7
Eagle Lake Canal	
Hyalella azteca	44.8
Physa sp.	17.6
Oligochaeta	13.0
Altmans Bay Canal	
Oligochaeta	98.0
Chironomus sp.	0.5
Carisella sp.	0.4

Table 3.3-46. Major Macroinvertebrate Components of Petite Ponar Samples, April 1982.

Taxon	% of Total	Taxon	% of Total
SUWANNEE RIVER STATIONS		STATIONS RECEIVING MINE DISCHARGE	
Rheotanytarsus sp.	28.4	Hunter Creek	
Oligochaeta	20.4		
Tanytarsus sp.	20.3	*Simulium* sp.	42.5
Ceratopogonidae	8.8	*Cheumatopsyche* sp.	25.9
Polypedilum sp.	8.7	*Polypedilum* sp.	21.2
		Hyalella azteca	4.6
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE		STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE	
Polypedilum sp.	11.4	Swift Creek	
Oligochaeta	8.7		
Tanytarsus sp.	7.4	Oligochaeta	56.7
Hyalella azteca	6.9	*Polypedilum* sp.	9.5
Lirceus sp.	6.9	*Polypedilum convictum*	6.2
Rheotanytarsus sp.	5.8	*Cryptochironomus* sp.	8.0
Tribelos sp.	5.1	Ceratopogonidae	5.8
Stegopterna sp.	5.1	*Asellus* sp.	5.1
SWAMP AND MARSH STATIONS			
Polypedilum sp.	64.2		
Ceratopogonidae	7.5		
Chironomus sp.	4.4		
Monopelopia sp.	4.4		
Hyalella azteca	3.9		

The swamp and marsh stations, sampled in April 1982, were dominated by tolerant and facultative organisms. Diversity values for HC-2A and RC-3000 were 2.18 and 3.31, respectively (Table 3.3-44). Equitability values for both sites were >0.5. Both HC-2A and RC-3000 appear to be healthy aquatic ecosystems. Station RO-2B is in a natural system which has not been disturbed; however, community parameters indicate that the swamp is stressed. The habitat is a bed of uniform organic material enclosed by a thick canopy. Low habitat diversity and the naturally acidic waters limit the types of organisms that can survive in this swamp.

Hunter Creek receives mine water discharge and was sampled at two sites during August 1981. Hunter Creek samples produced a high number of taxa; mean composited diversities (3.38 in 1981, 2.36 in 1982) and equitability values (0.58 in 1981, 0.54 in 1982) were similar to those recorded for the unaffected tributaries (Tables 3.3-43 and 3.3-44), suggesting that mine water discharge is having little adverse effect on the macroinvertebrate community of Hunter Creek. Seasonal variation in community dominance was apparent in Hunter Creek. In 1981, *Hyalella azteca*, *Tanytarsus*, and *Cheumatopsyche* were the dominant forms, while *Simulium*, *Cheumatopsyche*, and *Polypedilum* dominated in spring 1982 (Tables 3.3-45 and 3.3-46).

Swift Creek, Eagle Lake Canal (EL001-18), and Altmans Bay Canal receive both mine water and chemical plant discharge. The number of taxa in these systems ranged from 10 to 26 while densities ranged from 481/m^2 to 6900/m^2. Composited diversity values for both years in Swift Creek, Eagle Lake Canal, and Altmans Bay Canal ranged from 0.20 to 2.99, indicating stress during some sampling periods. Equitability values ranged from 0.12 to 0.59 for 1981 and 1982 combined.

Petite Ponar samples for Altmans Bay Canal were taken only in August 1981, and these were dominated by Oligochaeta and *Chironomus*, organisms that are tolerant of adverse environmental conditions. The sampling station was located in an area of thick canopy, and the stream substrate was composed primarily of sand. The thick canopy limited light penetration which probably resulted in reduced algal populations, an important food item for many invertebrates. Sand is an unstable substrate that generally supports a limited invertebrate community. The stress may also be related to periodically low dissolved oxygen values from Altmans Bay. The lake receives nutrient input (Boyd and Davies 1981), and phytoplankton levels are high (see Section 3.3.4.1.3). Dissolved oxygen concentrations may be high during the day but may be low at night.

Samples from Altmans Bay Canal exhibited a very high density but low number of species, diversity, and equitability. These values indicate that the community below Altmans Bay is stressed, possibly because of a combination of low dissolved oxygen and poor habitat quality in the canal. Oligochaeta and *Hyalella azteca* dominated the invertebrate community in Swift Creek and Eagle Lake Canal in August 1981. Oligochaeta and *Polypedilum* dominated the Swift Creek community during spring 1982.

The macroinvertebrate communities in the study area were dominated by tolerant forms for both sampling periods, even in the unaffected tributaries. Although there were some differences in macroinvertebrate community composition, nearly all of the species found in unaffected systems were also found in Hunter Creek. Diversity and equitability for Hunter Creek were similar to values found for the Suwannee River and other unaffected study streams, suggesting that mine water discharge has little adverse effect on the macroinvertebrate community of Hunter Creek.

Similarity values for the petite Ponar data were extremely variable and showed few consistent patterns (Tables 3.3-47 and 3.3-48). Similarity usually was greater between stations on different streams than between stations on the same stream. For example, in August 1981, similarity values for SR-1 were 0.17 and 0.16 when compared to SR-5 and SR-10, respectively, but 0.30 and 0.42 when compared to HC-2 and SC-4, respectively. The lack of similarity within streams is probably a function of habitat and water chemistry differences.

Many of the same taxa were present during 1977-1978 (EPA 1978a) and 1981-1982; however, community composition was different at some sites. For example, during 1977-1978 the dominant taxa in Hunter Creek were Polypedilum halterale, Stenochironomus, Oligochaeta, and Tanytarsus. In 1981-1982 the dominant taxa were Hyalella azteca, Tanytarsus, Cheumatopsyche, and Polypedilum convictum. Seasonal and annual shifts in community dominance are normal and are brought about by life cycle patterns and seasonal and long-term climatic trends that alter the environment to favor some species over others. However, secondary production for the two sampling periods is probably equivalent, as reflected in the similar standing crop measurements. Although community composition differed for the two surveys, community structure was similar, i.e., burrowers, predators, and filter-feeders were the dominant forms for both surveys.

Historical Comparison. Community parameters such as diversity and equitability have changed little in the study area since 1977 (EPA 1978a) (Figure 3.3-13). In Hunter Creek during 1982, diversity was lower than in previous years; however, this may be attributed to sampling error, as the stream appears to support a healthy and diverse macroinvertebrate community.

Artificial Substrate Samples

Hester-Dendy artificial substrate samples were collected at 17-22 stations three times during the study period. These samples were used to describe the macroinvertebrate communities associated with various habitat types throughout the study area.

September 1981. The initial set of Hester-Dendy samples was retrieved from 17 stations in September 1981. The ecosystems sampled which do not receive OXY discharge (unaffected tributaries) include the Suwannee River and small tributaries (Long Branch, Rocky Creek, and Roaring Creek.

Table 3.3-47. Percent Similarity of Macroinvertebrate Petite Ponar Samples Among Stations in the Study Area for August 1981.

	SR-1	SR-4	SR-5	SR-10	LB-1	RC-2	RC-5	RC-6	RC-9	RO-2	HC-2	HC-3	SC-4	SC-5.5	SC-9.5	EL001-18
SR-4	0.46															
SR-5	0.17	0.20														
SR-10	0.16	0.33	0.08													
LB-1	0.15	0.18	0.17	0.03												
RC-2	0.17	0.23	0.11	0.05	0.18											
RC-5	0.09	0.18	0.07	0.01	0.02	0.08										
RC-6	0.07	0.08	0.02	0.01	0.01	0.06	0.20									
RC-9	0.02	0.04	0.02	0.01	0.40	0.11	0.12	0.07								
RO-2	0.10	0.14	0.08	0.05	0.20	0.18	0.25	0.08	0.03							
HC-2	0.30	0.31	0.19	0.07	0.16	0.14	0.09	0.06	0.01	0.10						
HC-3	0.05	0.08	0.05	0.04	0.11	0.06	0.18	0.04	0.01	0.39	0.13					
SC-4	0.42	0.27	0.16	0.11	0.09	0.07	0.04	0.03	0.04	0.06	0.52	0.14				
SC-5.5	0.12	0.13	0.16	0.08	0.08	0.06	0.03	0.03	0.02	0.08	0.33	0.34	0.48			
SC-9.5	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.01	0.01	0.06	0.06	0.15	0.13	0.19		
EL001-18	0.01	0.05	0.07	0.02	0.08	0.08	0.02	0.03	0.03	0.06	0.07	0.20	0.10	0.25	0.12	
ABC	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.00	0.01	0.02	0.04	0.04	0.08	0.50	0.40	0.01

Table 3.3-48. Percent Similarity of Macroinvertebrate Petite Ponar Samples Among Stations in the Study Area for April 1982.

	SR-7	RC-2	RC-12	RC-12A	RO-2	HC-2A	RC-3000	RO-2B	HC-2	HC-3
RC-2	0.25									
RC-12	0.24	0.16								
RC-12A	0.06	0.15	0.28							
RO-2	0.40	0.30	0.09	0.18						
HC-2A	0.06	0.05	0.05	0.37	0.08					
RC-3000	0.01	0.12	0.20	0.36	0.00	0.05				
RO-2B	0.09	0.01	0.20	0.02	0.25	0.05	0.01			
HC-2	0.12	0.13	0.10	0.16	0.12	0.23	0.05	0.06		
HC-3	0.06	0.04	0.01	0.02	0.13	0.01	0.02	0.29	0.02	
SC-4	0.41	0.12	0.30	0.15	0.21	0.12	0.03	0.00	0.26	0.03

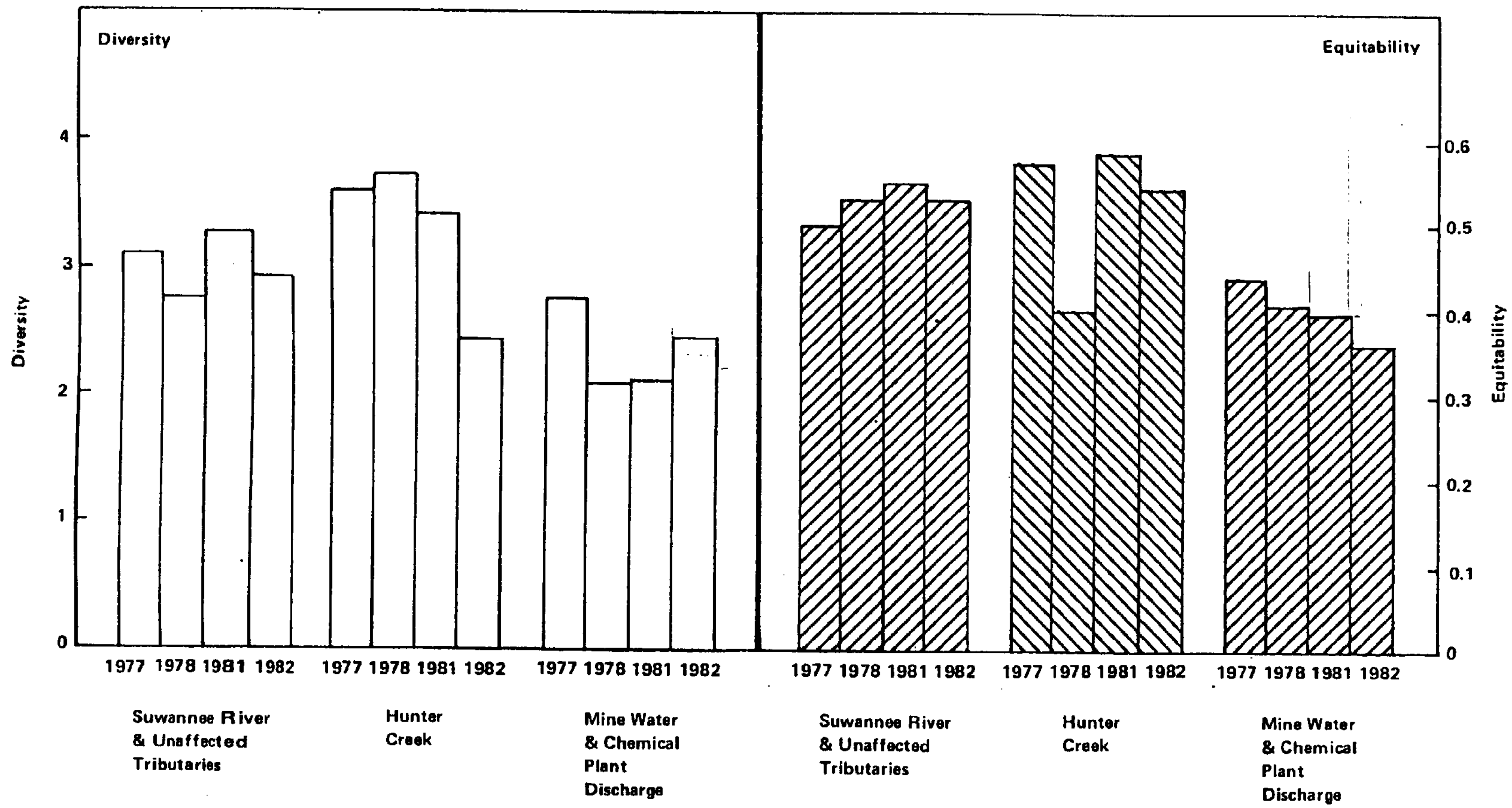


Figure 3.3-13. Comparison of Mean Diversity and Equitability in Petite Ponar Samples from 1977/1978 and 1981/1982 Surveys.

Samples also were collected from systems receiving mine water (Hunter Creek) and systems receiving mine water and chemical plant discharges (Swift Creek, Eagle Lake Canal, and Altmans Bay Canal).

The four stations on the Suwannee River exhibited number of taxa and density values similar to the unaffected tributaries, but higher diversity (>3.00 for all stations except SR-5) and equitability values (near 0.50 or above) (Table 3.3-49). These data indicate fair to good water quality. Invertebrates prevalent in the Suwannee River were *Stenonema exiguum*, *Polypedilum convictum*, and *Caenis diminuta* (Table 3.3-50).

Average diversity in the unaffected tributaries for this sampling period ranged from 1.83 to 3.87 ($\bar{x}$ = 2.77, Table 3.3-49 and Figures 3.3-14 and 3.3-15). Equitability averaged 0.49 and was <0.50 at three of the six stations. These parameters indicate that the invertebrate community has been subjected to some degree of stress in Long Branch, Roaring Creek, and one site on Rocky Creek (RC-5). Based on the EPA (1973) assumption that equitability is a better indicator of stress than diversity in the southeastern United States, stations RC-2, RC-6, and RC-9 appear to be relatively unstressed.

Two stations on Hunter Creek were sampled during September 1981. The data were similar to those for the unaffected tributary stations. HC-2 had a low number of taxa, high density, low diversity, and low equitability, similar to the values for RC-5 and RO-2. However, HC-3 had a high number of taxa, moderate density, and high diversity and equitability, indicative of good water quality. *Polypedilum illinoense* and *Thienemanniella* sp. were the dominant macroinvertebrates in Hunter Creek.

Three stations on Swift Creek and one station each on Eagle Lake and Altmans Bay canals were sampled. The stations on Swift Creek and Altmans Bay Canal exhibited low diversity and equitability. Although the benthic community was somewhat limited, the presence of dense populations of a number of species indicates that water quality conditions were not acutely toxic. Poor equitability and diversity values probably are related to water quality conditions such as low dissolved oxygen and poor habitat quality. The canal leading from Eagle Lake exhibited a diverse community with high equitability. *Polypedilum convictum* dominated Swift Creek while *Kiefferulus dux* and *Parachironomus alatus* dominated Eagle Lake Canal. *Kiefferulus dux* and *Chironomus* sp. dominated the community at Altmans Bay Canal.

Similarity among stations was extremely low, even for stations in the same stream, indicating the variability of benthic data in general (Table 3.3-51). Most high values were for ecosystems similar in size or stress level.

February 1982. Hester-Dendy samples were retrieved from 17 stations in February 1982. The Suwannee River stations generally had moderate diversities and moderate to relatively high equitabilities (Table 3.3-52, Figures 3.3-16 and 3.3-17). Three of the five tributary stations (all on Rocky Creek) exhibited diversities <2.00 and equitabilities <0.50.

Table 3.3-49. Summary of Ecological Parameters for Composited Hester-Dendy Artificial Substrate Samples, September 1981.

Station	No. of Taxa	Density (no./m^2)	Diversity	Equitability
SUWANNEE RIVER STATIONS				
SR-1	24	755	3.51	0.68
SR-4	29	1163	3.32	0.49
SR-5	21	1133	2.86	0.48
SR-10	18	965	3.03	0.64
$\bar{x}$	23	1004	3.18	0.57
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE				
LB-1	23	561	2.37	0.31
RC-2	23	342	3.87	0.93
RC-5	15	607	1.83	0.31
RC-6	20	884	2.85	0.50
RC-9	18	1142	2.87	0.57
RO-2	29	2232	2.83	0.34
$\bar{x}$	21	961	2.77	0.49
$\bar{x}$	22	978	2.93	0.52
STATIONS RECEIVING MINE DISCHARGE				
HC-2	15	3350	1.82	0.31
HC-3	26	1192	3.61	0.68
$\bar{x}$	21	2271	2.71	0.49
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE				
SC-4	10	3459	0.91	0.22
SC-5.5	8	3048	1.27	0.37
SC-9.5	8	3767	1.19	0.35
$\bar{x}$	9	3425	1.12	0.31
EL001-18	20	1984	3.29	0.70
ABC	8	6390	0.73	0.24
$\bar{x}$	11	3730	1.48	0.38

Table 3.3-50. Major Macroinvertebrate Components of Hester-Dendy Artificial Substrate Samples, September 1981.

Taxon	% of Total
SUWANNEE RIVER STATIONS	
Stenonema exiguum	27.0
Polypedilum convictum	9.1
Caenis diminuta	7.2
Arctopelopia fittkavi	6.7
Pentaneura sp.	5.7
Ablabesmyia sp.	4.7
STATIONS NOT RECEIVING OXY DISCHARGE	
Tanytarsus sp.	23.3
Polypedilum illinoense	14.5
Caenis diminuta	10.0
Monopelopia sp.	4.8
Thienemanniella sp.	4.8
Larsia sp.	4.1
Corynoneura sp.	4.0
STATIONS RECEIVING MINE DISCHARGE	
Hunter Creek	
Polypedilum illinoense	37.3
Thienemanniella sp.	28.8
Pedionemus sp.	6.6
Monopelopia sp.	5.8
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE	
Swift Creek	
Polypedilum convictum	43.8
Kiefferulus dux	18.7
Dicrotendipes modestus	17.1
Polypedilum illinoense	11.7
Tanytarsus sp.	5.9
Eagle Lake Canal	
Kiefferulus dux	23.3
Parachironomus alatus	17.1
Pedionemus beckae	14.0
Caenis diminuta	14.0
Ceratopogonidae spp.	10.0
Cheumatopsyche sp.	5.2
Hyalella azteca	4.5
Altmans Bay Canal	
Kiefferulus dux	82.1
Chironomus sp.	17.3

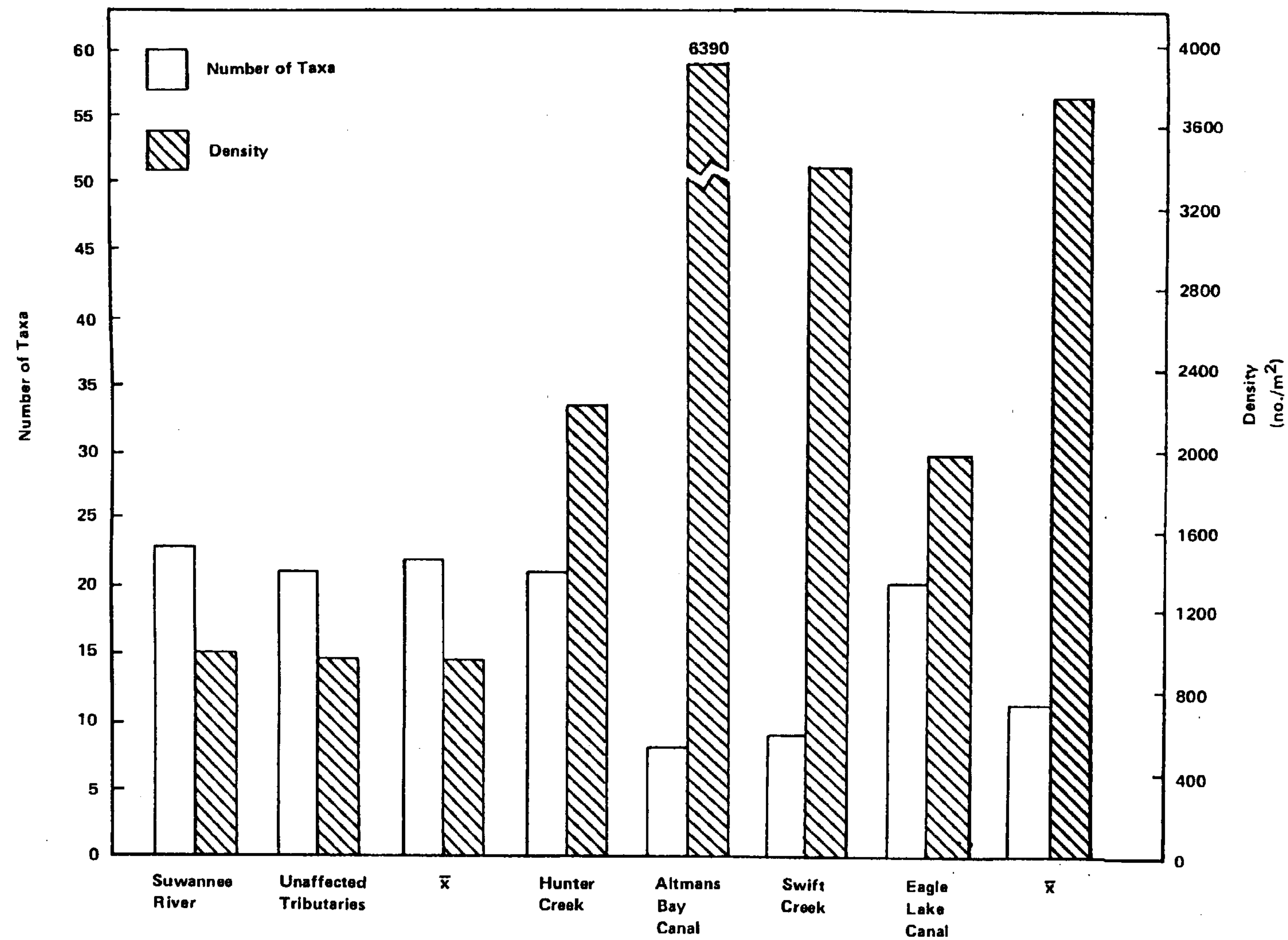


Figure 3.3-14. Mean Number of Taxa and Density for Artificial Substrates, September 1981.

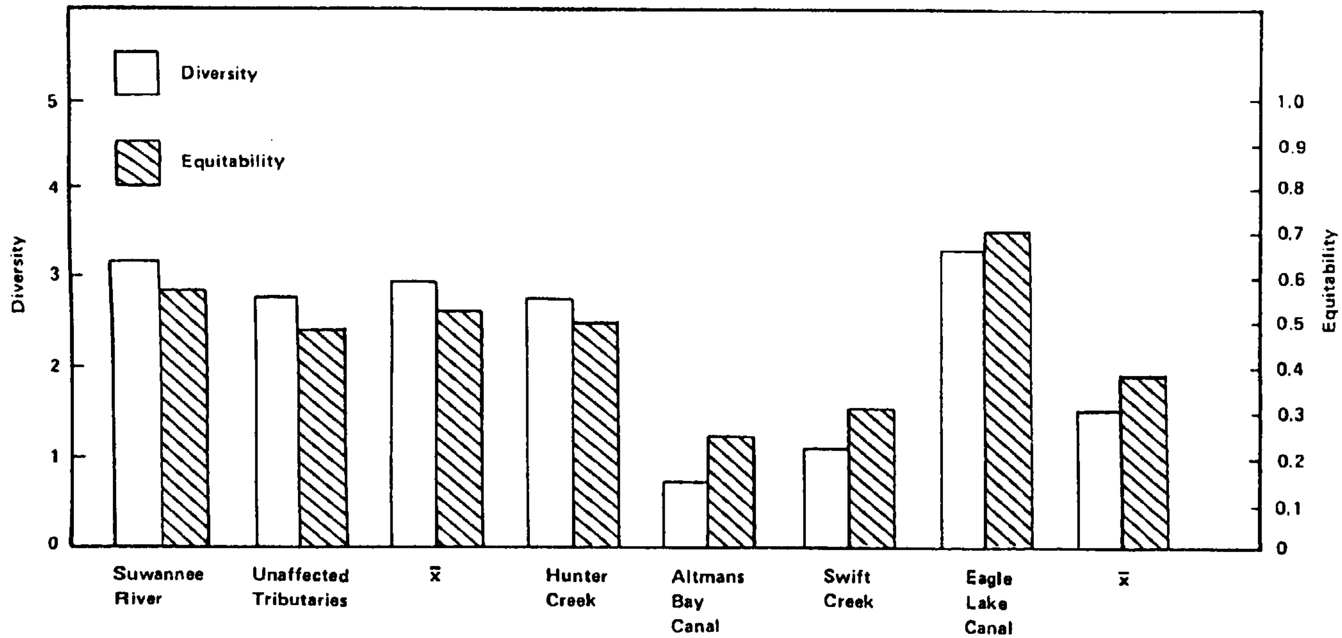


Figure 3.3-15. Mean Diversity and Equitability Values for Artificial Substrates, September 1981.

Table 3.3-51. Similarity Among Stations for Hester-Dendy Samples, September 1981.

	SR-1	SR-4	SR-5	SR-10	LB-1	RC-2	RC-5	RC-6	RC-9	RO-2	HC-2	HC-3	SC-4	SC-5.5	SC-9.5	EL001-18
SR-4	0.23															
SR-5	0.12	0.49														
SR-10	0.16	0.16	0.31													
LB-1	0.06	0.15	0.13	0.14												
RC-2	0.25	0.14	0.11	0.18	0.21											
RC-5	0.05	0.13	0.05	0.01	0.69	0.17										
RC-6	0.06	0.16	0.17	0.13	0.49	0.17	0.55									
RC-9	0.14	0.02	0.02	0.08	0.03	0.08	0.00	0.02								
RO-2	0.15	0.18	0.16	0.06	0.09	0.13	0.14	0.14	0.02							
HC-2	0.02	0.10	0.03	0.04	0.17	0.02	0.17	0.11	0.06	0.13						
HC-3	0.11	0.15	0.09	0.14	0.23	0.08	0.22	0.19	0.14	0.13	0.13					
SC-4	0.01	0.05	0.06	0.12	0.04	0.03	0.01	0.04	0.01	0.11	0.19	0.01				
SC-5.5	0.01	0.07	0.07	0.13	0.21	0.02	0.19	0.13	0.01	0.02	0.40	0.05	0.56			
SC-9.5	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.06	0.01	0.00	0.02	0.00	0.00		
EL001-18	0.16	0.06	0.10	0.12	0.18	0.01	0.01	0.01	0.01	0.16	0.01	0.37	0.01	0.01	0.17	
ABC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.60	0.11

Table 3.3-52. Summary of Ecological Parameters for Composited Hester-Dendy Artificial Substrate Samples, February 1982.

Station	No. of Taxa	Density (no./m^2)	Diversity	Equitability
SUWANNEE RIVER STATIONS				
SR-1	23	1300	2.87	0.44
SR-5	15	1465	2.85	0.67
SR-10	21	3123	2.91	0.50
$\bar{x}$	20	1963	2.88	0.54
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE				
LB-1	15	351	2.87	0.68
RC-2	18	4036	0.97	0.13
RC-5	17	2217	1.73	0.25
RC-6	11	2336	1.60	0.35
RO-2	21	2632	3.05	0.56
$\bar{x}$	16	2315	2.04	0.39
$\bar{x}$	18	2183	2.36	0.45
STATIONS RECEIVING MINE DISCHARGE				
HC-2	12	1200	2.14	0.49
HC-3	16	1555	1.74	0.27
$\bar{x}$	14	1378	1.94	0.38
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE				
SS-3	17	990	2.47	0.45
SC-4	17	3800	2.53	0.46
SC-5.5	16	2792	1.99	0.33
SC-10	23	8361	0.58	0.07
SC-11	18	1063	2.66	0.49
$\bar{x}$	18	3401	2.05	0.36
EL001-18	15	3659	1.58	0.25
ABC	16	8463	2.29	0.41
$\bar{x}$	17	4161	2.01	0.35

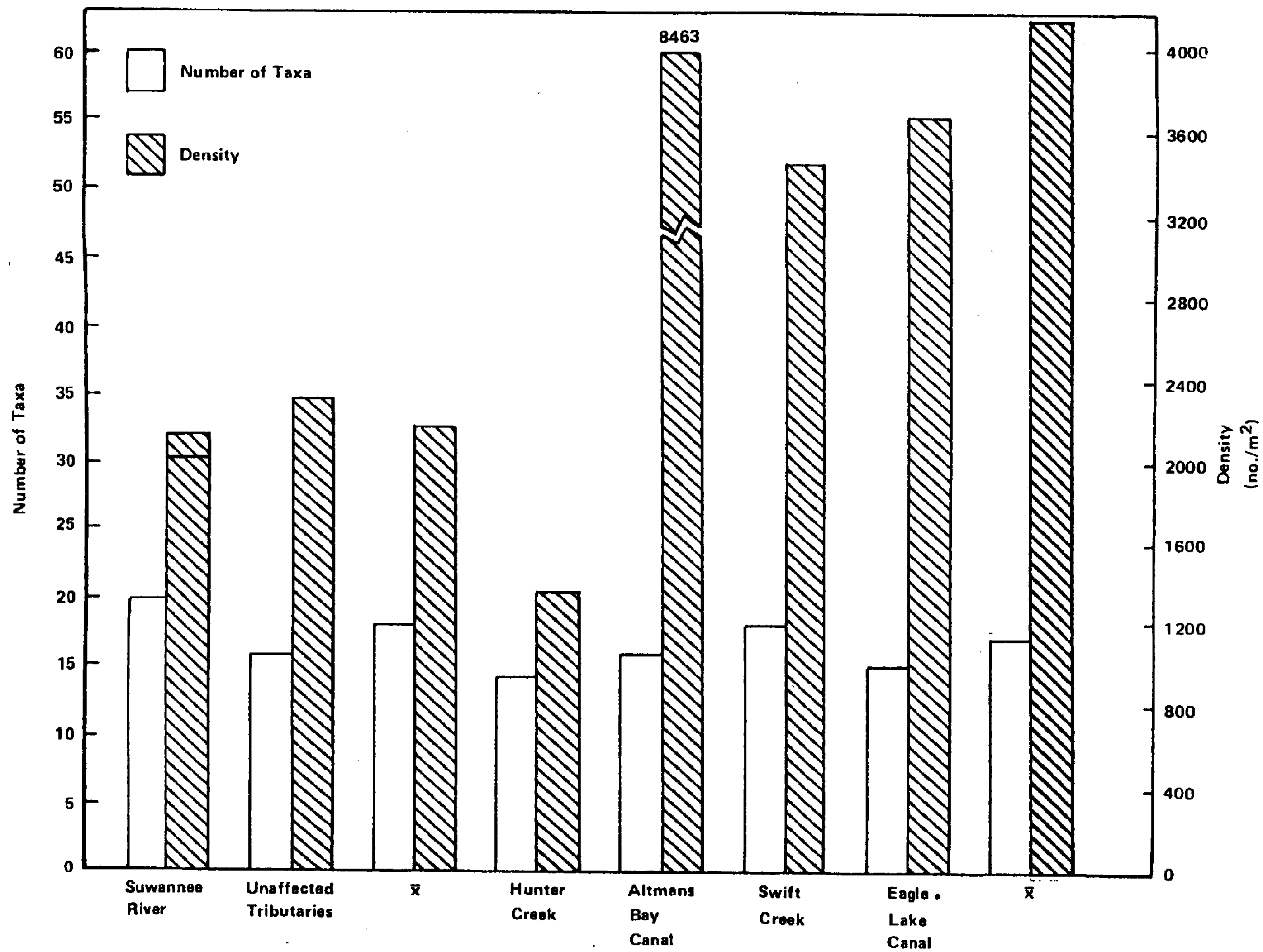


Figure 3.3-16. Mean Number of Taxa and Density for Artificial Substrates, February 1982.

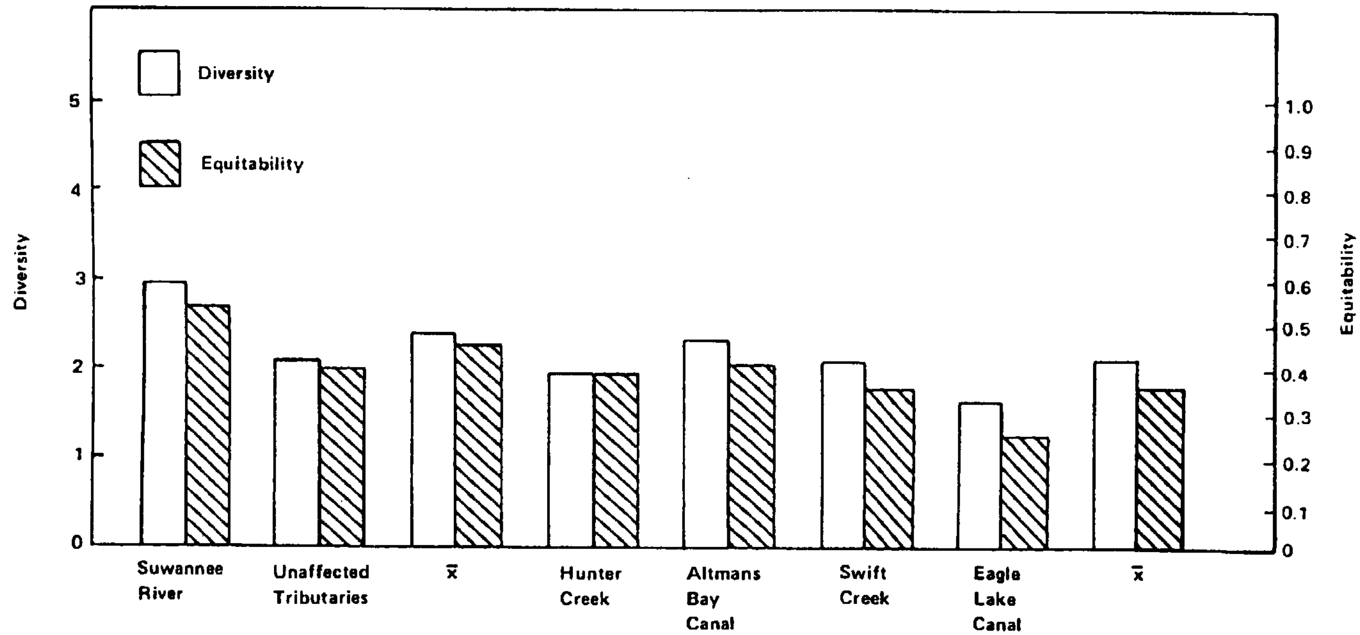


Figure 3.3-17. Mt ,ersity and Equitability Values for Artificial Substrates, February 1982.

Long Branch and Roaring Creek had moderate to high diversity and equitability values. The invertebrate communities indicated that most stations on the Suwannee River and unaffected tributaries had good water quality. However, Rocky Creek appeared to be a stressed ecosystem. Polypedilum convictum, Tanytarsus sp., Polypedilum sp., Thienemanniella sp., and Corynoneura sp. dominated the Suwannee River stations, while the dominant invertebrates in the unaffected tributaries were Simulium sp., Corynoneura sp., and Polypedilum sp. (Table 3.3-53).

Both stations on Hunter Creek had low diversity, and equitability was 0.49 and 0.27 for HC-2 and HC-3, respectively, indicating a mild to moderate level of stress in Hunter Creek, similar to that in Rocky Creek. Dominant invertebrates at the two Hunter Creek stations were Thienemanniella sp. and Polypedilum convictum.

To characterize systems receiving mine water and chemical plant discharge, five stations on Swift Creek and one station each from the Eagle Lake and Altmans Bay discharge canals were sampled. Diversity and equitability values in Swift Creek ranged from 0.58 to 2.66 and 0.07 to 0.49, respectively (Table 3.3-52). Although Station SC-10 had the greatest number of taxa, density was extremely high and the organisms were distributed unevenly among the taxa, resulting in extremely low diversity and equitability values. Diversity and equitability for the Swift Creek stations (except for SC-10) were similar to values for many of the unaffected tributary and Suwannee River stations. The ecosystem at SC-10 appears moderately stressed. However, stations both upstream and downstream of SC-10 exhibited better diversity and equitability values; therefore, the low values at SC-10 appear to be site-specific and may be the result of poor habitat quality. Thienemanniella sp. and Polypedilum convictum dominated the invertebrate community in Swift Creek.

The number of taxa collected in Altmans Bay Canal was similar to that collected in Hunter Creek and at some of the unaffected tributary stations. However, benthic density (8463 organisms/m^2) was much greater than at other sites sampled in February. Although diversity and equitability were rather low, values were higher than those for Rocky and Hunter creeks. The principal macroinvertebrates in Altmans Bay Canal were Simulium sp., Hyalella azteca, Polypedilum sp., and Psectocladius sp. (Table 3.3-53).

Diversity and equitability for Eagle Lake Canal were low. Although a variety of organisms occurred in the lake outlet, evenness was low. The principal taxon collected at this site was Cheumatopsyche (67% of the community), a net-spinning caddisfly. These organisms are often abundant below lake outfalls because of the abundance of food items, particularly plankton. Hence, the low diversity and equitability values were the result of the particular environmental conditions that were conducive to a large standing crop of one taxon.

Similarity values for the stations sampled in February 1982 were extremely variable, ranging from no similarity (LB-1 vs. ABC, LB-1 vs. SC-10, SR-1 vs. SC-10) to 0.89 (RC-5 vs. RC-6) (Table 3.3-54). There was one case of similarity between unaffected and affected stations,

Table 3.3-53. Major Macroinvertebrate Components of Hester-Dendy Artificial Substrate Samples, February 1982.

Taxon	% of Total	Taxon	% of Total
SUWANNEE RIVER STATIONS		STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE	
Polypedilum convictum	18.1		
Tanytarsus sp.	14.2	Swift Creek	
Polypedilum sp.	12.5		
Thienemanniella sp.	10.9	Thienemanniella sp.	57.7
Corynoneura sp.	10.1	Polypedilum convictum	16.3
Orthocladius sp.	8.4	Polypedilum sp.	5.4
Rheotanytarsus sp.	6.8	Cheumatopsyche sp.	3.0
		Simulium sp.	2.8
		Cricotopus sp.	2.4
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE		Eagle Lake Canal	
		Cheumatopsyche sp.	67.2
Simulium sp.	59.4	Simulium sp.	16.0
Corynoneura sp.	7.9	Thienemanniella sp.	9.6
Polypedilum sp.	7.5	Platyhelminthes	2.3
Rheotanytarsus sp.	5.3	Prostoma graecense	2.1
Thienemanniella sp.	4.8		
Polypedilum convictum	4.3	Altmans Bay Canal	
		Simulium sp.	44.0
STATIONS RECEIVING MINE DISCHARGE		Hyalella azteca	16.7
		Polypedilum sp.	16.4
Hunter Creek		Psectocladius sp.	10.0
		Parachironomus sp.	8.0
Thienemanniella sp.	45.1		
Polypedilum convictum	25.3		
Rheotanytarsus sp.	9.8		
Simulium sp.	6.5		
Polypedilum sp.	4.7		
Cheumatopsyche sp.	3.4		

Table 3.3-54. Similarity Among Stations for Hester-Dendy Samples, February 1982.

	SR-1	SR-5	SR-10	LB-1	RC-2	RC-5	RC-6	RO-2	HC-2	HC-3	SS-3	SC-4	SC-5.5	SC-10	SC-11	EL001-18
SR-5	0.15															
SR-10	0.19	0.23														
LB-1	0.04	0.24	0.09													
RC-2	0.05	0.12	0.12	0.05												
RC-5	0.14	0.14	0.26	0.07	0.46											
RC-6	0.16	0.13	0.25	0.06	0.49	0.89										
RO-2	0.20	0.37	0.58	0.11	0.14	0.24	0.18									
HC-2	0.04	0.40	0.42	0.09	0.09	0.03	0.03	0.46								
HC-3	0.05	0.19	0.36	0.07	0.14	0.15	0.15	0.42	0.26							
SS-3	0.02	0.05	0.04	0.02	0.03	0.02	0.02	0.05	0.05	0.07						
SC-4	0.07	0.10	0.51	0.03	0.11	0.16	0.17	0.36	0.37	0.55	0.03					
SC-5.5	0.05	0.10	0.42	0.03	0.13	0.13	0.13	0.36	0.45	0.28	0.03	0.54				
SC-10	0.00	0.02	0.15	0.00	0.03	0.06	0.06	0.11	0.03	0.25	0.02	0.28	0.06			
SC-11	0.02	0.08	0.26	0.03	0.07	0.16	0.15	0.18	0.15	0.33	0.14	0.23	0.16	0.16		
EL001-18	0.02	0.02	0.11	0.01	0.15	0.20	0.20	0.17	0.11	0.21	0.03	0.24	0.24	0.06	0.12	
ABC	0.01	0.02	0.11	0.00	0.58	0.32	0.36	0.04	0.01	0.06	0.06	0.09	0.07	0.04	0.08	0.10

i.e., SC-4 vs. SR-10 (0.51). However, most values were <0.25, and patterns of similarity were unclear.

May 1982. The last set of Hester-Dendy samples was collected in May 1982 (Table 3.3-55, Figures 3.3-18 and 3.3-19). Diversity and equitability for the Suwannee River stations were relatively low, with Stations SR-4 and SR-4.5 exhibiting the lowest values. The dominant invertebrates in the Suwannee River were *Simulium* sp., *Rheotanytarsus* sp., and *Polypedilum* sp. (Table 3.3-56).

Diversity values for the tributaries not receiving discharge ranged from 1.00 (RC-12) to 3.26 (RO-2). Seven of the eleven tributary stations had diversity values <3.00 ($\bar{x}$ = 2.50). Equitability was higher than the previous sampling periods, with eight of the eleven stations having values >0.50 ($\bar{x}$ = 0.53). The three low equitability values in Rocky Creek indicate stressed environmental conditions. The most abundant organisms colonizing artificial substrates in the tributaries were *Corynoneura* sp., *Polypedilum* sp., *Tanytarsus* sp., and *Polypedilum convictum* (Table 3.3-56).

Although a high number of taxa was collected at the two Hunter Creek stations, diversity and equitability were low. However, the values were comparable to those at some of the unaffected tributary and Suwannee River stations and should not necessarily be considered indicative of poor water quality. The assemblage of organisms collected in Hunter Creek was also similar, with *Polypedilum convictum*, *Rheocricotopus* sp., *Cheumatopsyche* sp., and *Rheotanytarsus* sp. dominating the community.

Diversity and equitability from Swift Creek stations indicated that SC-10 and SC-11 were stressed while SC-4 exhibited values comparable to some unaffected stations. The stress reflected by the benthic community is a combination of altered water quality, such as nutrient input by OXY, and poor habitat quality. The improvement in benthic parameters from upstream to downstream stations reflects improved water quality and/or habitat in Swift Creek farther downstream. *Polypedilum* sp. and *Polypedilum convictum* dominated the Swift Creek invertebrate community.

Density in Altmans Bay Canal was extremely high (20,811 organisms/m^2), and this tended to depress diversity and equitability. Although community parameters indicate that Altmans Bay Canal is a stressed ecosystem, diversity and equitability values were comparable to values for several of the unaffected stations. The stress probably was related to a combination of low dissolved oxygen and poor habitat quality. The invertebrate community in Altmans Bay Canal was dominated by *Cheumatopsyche* sp., *Polypedilum* sp., *Hyalella azteca*, and *Parachironomus* sp. (Table 3.3-56). It should be noted that chemical plant contaminated nonprocess water and treated process water enter the canal above the sampling point and may have affected the aquatic communities.

Parameters for Eagle Lake Canal also indicated a stressed ecosystem; however, this was the result of natural conditions, i.e., the unevenness in the benthic community was the result of an abundant food supply for filtering organisms. *Cheumatopsyche* sp. and *Simulium* sp. comprised >95% of the invertebrate community at EL001-18.

Table 3.3-55. Summary of Ecological Parameters for Composited Hester-Dendy Artificial Substrate Samples, May 1982.

Station	No. of Taxa	Density (no./m^2)	Diversity	Equitability
SUWANNEE RIVER STATIONS				
SR-1	19	519	3.15	0.66
SR-4	17	14,053	1.26	0.17
SR-4.5	15	541	2.37	0.47
SR-10	20	10,584	2.53	0.39
$\bar{x}$	18	6,424	2.33	0.42
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE				
HB-2	18	256	3.04	0.64
LB-1	18	319	3.22	0.74
RC-2	16	1,015	2.82	0.61
RC-5	15	750	2.10	0.38
RC-6	11	1,523	2.08	0.51
RC-9	14	855	1.28	0.21
RC-10	22	1,082	3.20	0.59
RC-11	13	359	2.92	0.82
RC-12	9	405	1.00	0.27
RC-12A	15	209	2.54	0.53
RO-2	27	661	3.26	0.51
$\bar{x}$	16	676	2.50	0.53
$\bar{x}$	17	2,209	2.41	0.49
STATIONS RECEIVING MINE DISCHARGE				
HC-2	29	4,779	2.61	0.29
HC-3	26	3,394	2.31	0.26
$\bar{x}$	28	4,087	2.46	0.27
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE				
SC-4	16	5,061	2.38	0.44
SC-10	16	2,928	1.22	0.18
SC-11	15	4,432	0.36	0.10
$\bar{x}$	16	4,141	1.32	0.24
EL001-18	12	3,815	0.61	0.15
ABC	15	20,811	2.16	0.40
$\bar{x}$	15	7,409	1.35	0.25

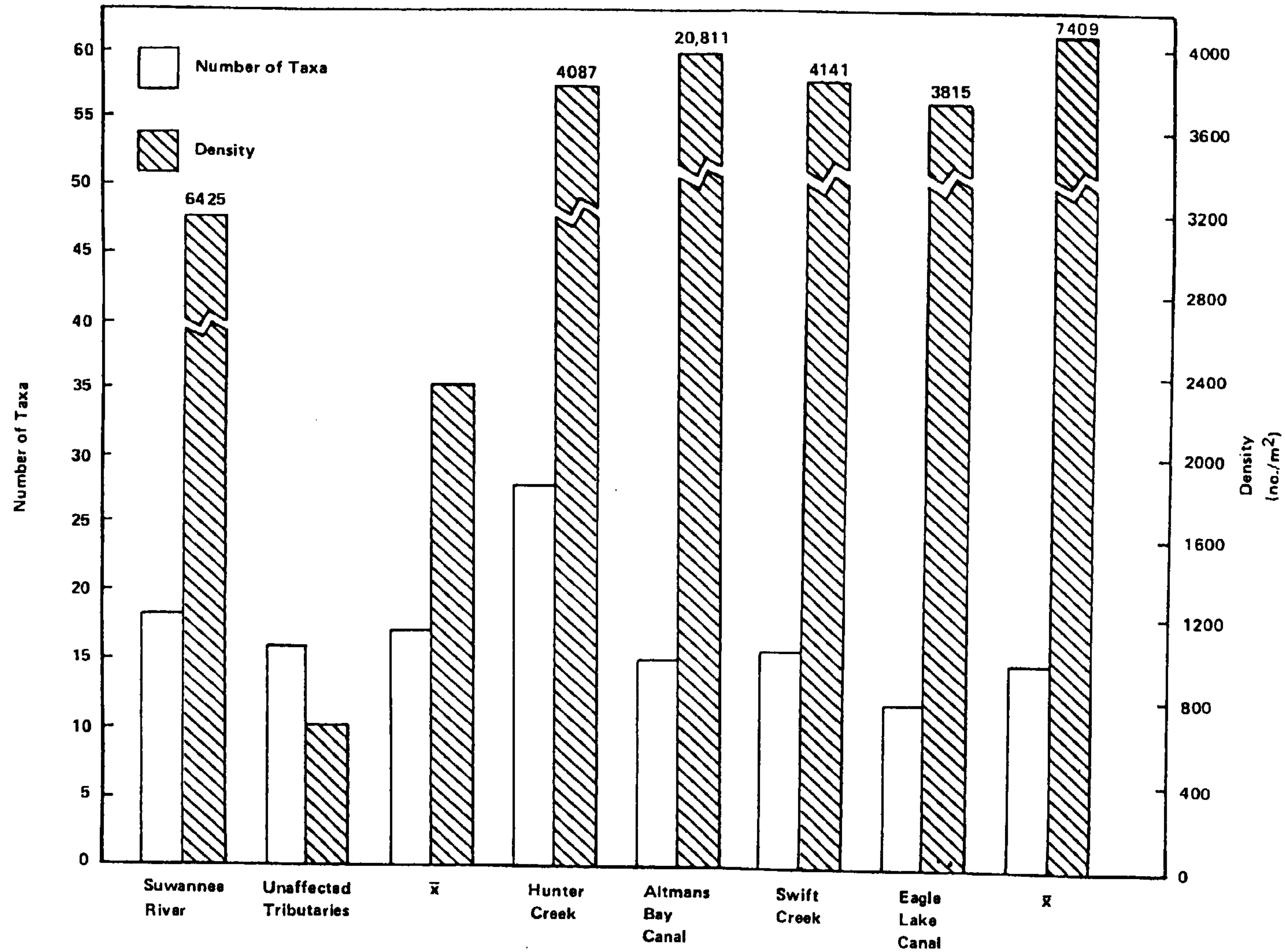


Figure 3.3-18. Mean Number of Taxa and Density for Artificial Substrates, May 1982.

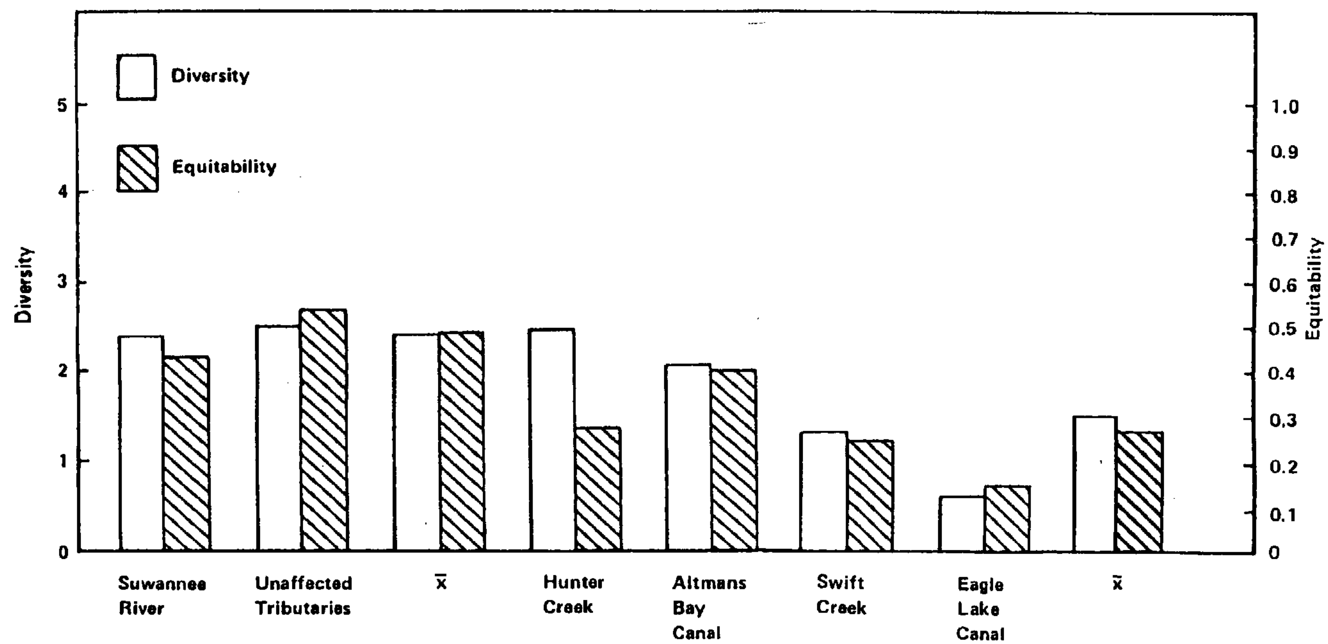


Figure 3.3-19. **Mean Diversity and Equitability Values for Artificial Substrates, May 1982.**

Table 3.3-56. Major Macroinvertebrate Components of Hester-Dendy Artificial Substrate Samples, May 1982.

Taxon	% of Total
SUWANNEE RIVER STATIONS	
Simulium sp.	49.3
Rheotanytarsus sp.	11.2
Polypedilum sp.	10.4
Cardiocladius sp.	7.7
Polypedilum convictum	6.0
Hirudinea	5.1
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE	
Corynoneura sp.	20.5
Polypedilum sp.	15.3
Tanytarsus sp.	11.5
Polypedilum convictum	9.6
Cheumatopsyche sp.	7.3
Cricotopus sp.	4.3
STATIONS RECEIVING MINE DISCHARGE	
Hunter Creek	
Polypedilum convictum	44.5
Rheocricotopus sp.	14.5
Cheumatopsyche sp.	12.9
Rheotanytarsus sp.	12.2
Hyalella azteca	4.9
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE	
Swift Creek	
Polypedilum sp.	69.6
Cheumatopsyche sp.	11.1
Polypedilum convictum	8.0
Thienemanniella sp.	4.1
Chironomus attenuatus	1.2
Eagle Lake Canal	
Cheumatopsyche sp.	91.8
Simulium sp.	3.5
Polypedilum convictum	1.3
Platyhelminthes	1.2
Physa sp.	1.1
Altmans Bay Canal	
Cheumatopsyche sp.	33.3
Polypedilum sp.	27.9
Hyalella azteca	23.5
Parachironomus sp.	11.2
Tribelos sp.	1.8

Similarity among stations for May 1982 was similar to the two previous sampling periods, i.e., values were generally low and extremely variable (Table 3.3-57).

Summary. In summary, the Hester-Dendy data for the three sampling periods were extremely variable. Stress was indicated for some stations in Swift Creek, Eagle Lake Canal, and Altmans Bay Canal during some of the sampling periods. Although depressed diversity and equitability also indicated stress at some stations on the Suwannee River and unaffected tributaries during each of the sampling periods, the lower values may be a natural condition resulting from various climatic, hydrologic, and other environmental conditions. These same natural conditions also combined to produce periodically low diversity and equitability values in Hunter Creek. Poor habitat quality seems primarily responsible for periodically low diversity and equitability values in Eagle Lake Canal and Altmans Bay Canal, while OXY activities may be responsible for the stressed conditions in portions of Swift Creek.

Historical Comparison. A comparison of diversity and equitability values for 1977-1978 (EPA 1978a) and 1981-1982 is presented in Figure 3.3-20. One apparent trend is the decline in diversity and equitability in all ecosystems over time. This trend is apparent in unaffected streams as well as affected streams; thus, the reason for the decline in values probably is related to factors other than mining activity. One factor leading to lower values during 1981-1982 for ecosystems receiving mine water discharges is that Altmans Bay Canal (ABC) was not sampled in 1977-1978. During 1981-1982 ABC typically exhibited low diversity and equitability. Community composition and structure are similar for the two surveys. Species found in 1977-1978 also were present in the 1981-1982 study.

Drift Samples

Drift refers to the downstream transport of aquatic organisms in stream currents. Macroinvertebrates actively enter the water column as drift for varying durations and distances and at different densities, i.e., very low during the day and high at night. Drift serves to regulate macroinvertebrate populations and the carbon-fixing processes in streams and results in the transport of food to various trophic levels. Muller (1954), Elliott (1967), Hynes (1970), and Waters (1962) provide good reviews on macroinvertebrate drift. Few data on drift are available for Florida; however, some studies have been conducted (e.g., Cowell and Carew 1976).

Samples were taken at various points along the Suwannee River and its tributaries to 1) compare drift among streams affected by mine waters and plant discharge with those not affected by these discharges, and 2) determine the relative contribution of drift from tributary streams to the Suwannee River.

Table 3.3-57. Similarity Among Stations for Hester-Dendy Samples, May 1982.

	SR-1	SR-4	SR-4.5	SR-10	HB-2	LB-1	RC-2	RC-5	RC-6	RC-9	RC-10	RC-11	RC-12	RC-12A	RO-2	HC-2	HC-3	SC-4	SC-10	SC-11	EL001-18
SR-4	0.01																				
SR-4.5	0.20	0.04																			
SR-10	0.03	0.11	0.04																		
HB-2	0.19	0.02	0.10	0.04																	
LB-1	0.31	0.01	0.16	0.01	0.16																
RC-2	0.15	0.06	0.20	0.10	0.11	0.10															
RC-5	0.21	0.04	0.11	0.08	0.29	0.10	0.23														
RC-6	0.14	0.07	0.08	0.08	0.05	0.06	0.22	0.36													
RC-9	0.06	0.11	0.06	0.24	0.27	0.06	0.06	0.30	0.03												
RC-10	0.31	0.02	0.11	0.05	0.10	0.14	0.11	0.31	0.35	0.09											
RC-11	0.37	0.02	0.07	0.06	0.57	0.22	0.11	0.35	0.07	0.30	0.24										
RC-12	0.05	0.00	0.00	0.12	0.09	0.02	0.04	0.01	0.14	0.07	0.22	0.10									
RC-12A	0.16	0.00	0.02	0.04	0.21	0.05	0.06	0.03	0.13	0.08	0.24	0.18	0.48								
RO-2	0.25	0.04	0.27	0.05	0.10	0.29	0.19	0.18	0.27	0.05	0.19	0.12	0.00	0.04							
HC-2	0.04	0.01	0.00	0.38	0.02	0.01	0.24	0.01	0.09	0.03	0.09	0.02	0.18	0.07	0.04						
HC-3	0.04	0.00	0.01	0.31	0.02	0.01	0.06	0.01	0.06	0.02	0.09	0.02	0.18	0.06	0.04	0.64					
SC-4	0.04	0.10	0.00	0.43	0.05	0.02	0.21	0.07	0.08	0.25	0.08	0.07	0.14	0.06	0.02	0.40	0.27				
SC-10	0.02	0.10	0.01	0.30	0.09	0.05	0.03	0.14	0.00	0.48	0.01	0.12	0.00	0.01	0.02	0.02	0.02	0.51			
SC-11	0.00	0.08	0.00	0.24	0.04	0.00	0.04	0.08	0.00	0.26	0.00	0.05	0.00	0.00	0.01	0.01	0.01	0.42	0.56		
EL001-18	0.01	0.03	0.00	0.04	0.00	0.00	0.24	0.00	0.10	0.00	0.02	0.00	0.02	0.02	0.01	0.14	0.15	0.32	0.02	0.02	
ABC	0.00	0.06	0.00	0.10	0.01	0.01	0.06	0.02	0.02	0.07	0.01	0.01	0.00	0.00	0.00	0.04	0.03	0.26	0.16	0.34	0.30

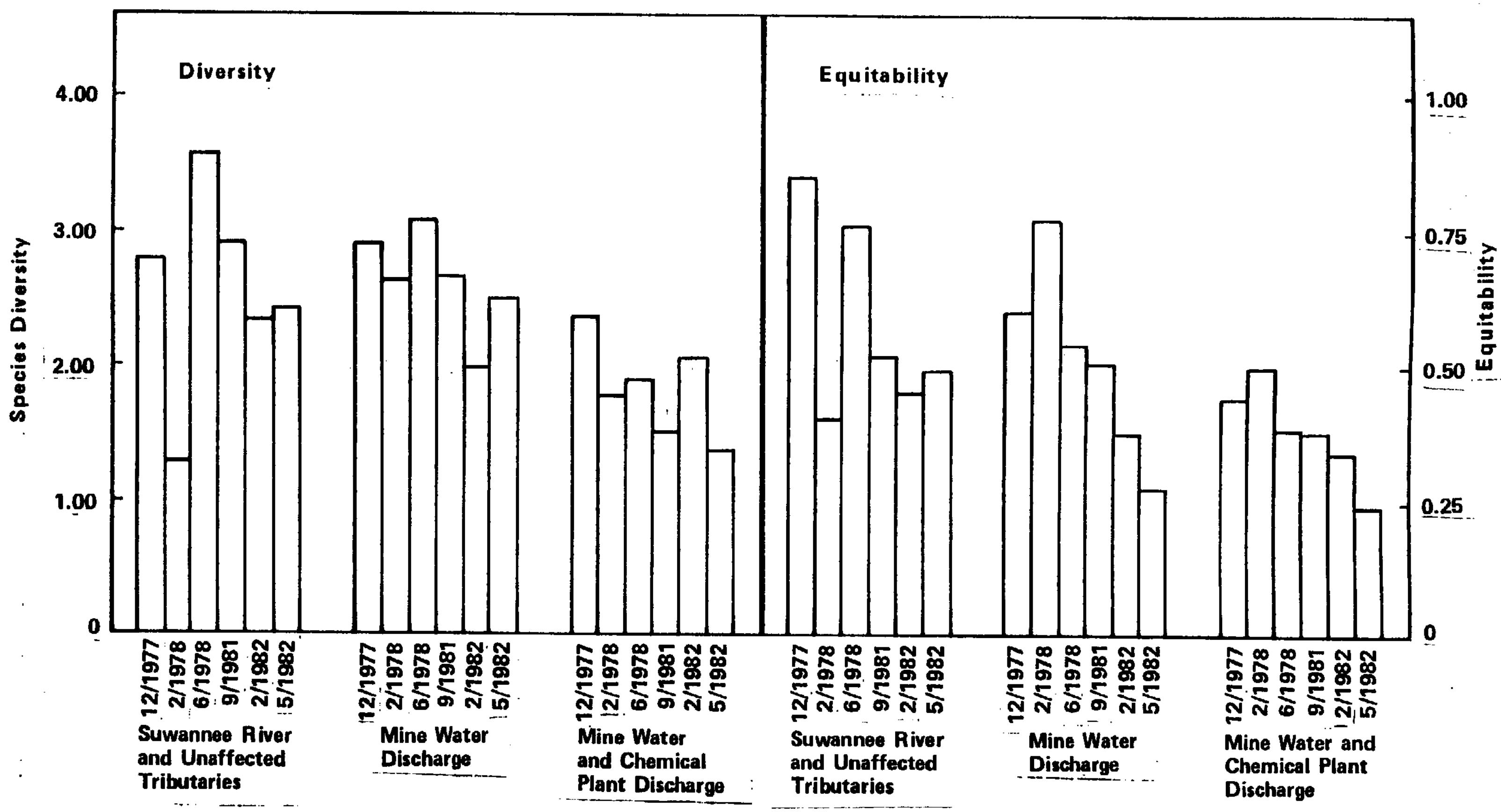


Figure 3.3-20. Comparison of Mean Diversity and Equitability in Artificial Substrate Samples from 1977/1978 and 1981/1982 Surveys.

August Drift. During August, drift was sampled for a portion of the night and day at five stations on the Suwannee River, from the upper to the lower portion of the study area (Table 3.3-58). Number of drifting taxa at night ranged from 13 (SR-5) to 33 (SR-4), while invertebrate density ranged from 8.8 (SR-3) to 179.4 (SR-5) individuals/100 m^3. Mean values for number of taxa and density in the Suwannee River were similar to values for the unaffected tributaries sampled but had a much wider density range (Table 3.3-58 and Figure 3.3-21). Suwannee River drift was dominated by Chaoborus sp. (33%), Stenelmis fuscata (16%), Caenis sp. (12%), and Kiefferulus dux (11%, Table 3.3-59). The lowest invertebrate biomass values for August were from the Suwannee River, ranging from 0.0011 to 0.1275 g/100 m^3 (Table 3.3-60).

Drift was sampled from three Suwannee River tributaries unaffected by mine activity or discharges (Rocky Creek, Roaring Creek, and Long Branch). Highest night drift densities occurred in Long Branch (110.5 individuals/100 m^3) and Rocky Creek ($\overline{x}$ = 119.9 individuals/100 m^3). The lowest value was for Roaring Creek (20.8 individuals/100 m^3). The average number of taxa in night drift for the three tributaries was 25, higher than for all other ecosystems (Figure 3.3-21). Drift in these tributaries was dominated by Cheumatopsyche sp. (17%), Larsia sp. (13%), Psectocladius sp. (9%), and Corydalus cornutus (7%, Table 3.3-59). Night invertebrate drift biomass in the unaffected tributaries ranged from 0.0410 g/100 m^3 in Rocky Creek to 0.2059 g/100 m^3 in Roaring Creek (Table 3.3-60).

Macroinvertebrate drift was sampled over a 24-hr period in Hunter Creek, a stream that receives mine water discharge. Drift density in Hunter Creek exhibited the typical diel pattern (Hynes 1970, Waters 1972), i.e., highest density at night and lowest density during the day (Figure 3.3-22).

Invertebrate drift in Hunter Creek increased sharply after 2100 hr, peaking between 2100 and 2300 hr, and tapering off through the night. Drift densities averaged 13.3 individuals/100 m^3 during the day and 53.9 individuals/100 m^3 at night (Table 3.3-58). Drift in Hunter Creek was dominated by Hyalella azteca (36%), Caenis sp. (18%), Cheumatopsyche sp. (17%), and Polypedilum sp. (12%, Table 3.3-59).

Invertebrate drift biomass for Hunter Creek increased sharply after sunset, continued to increase throughout the night, and decreased sharply during the day (Figure 3.3-22). The highest drift biomass value (0.071 g/100 m^3) was recorded at approximately 0800 hr, and the lowest value (0.000035 g/100 m^3) occurred at approximately 1700 hr.

Mean invertebrate drift density during the night for Swift Creek, a stream that receives mining and chemical plant discharges, was approximately 4X greater at SC-9.5 than in the Suwannee River or its tributaries (Table 3.3-58). At SC-2, 14 taxa were represented, producing a night density of 50.5 individuals/100 m^3. Although the number of taxa was somewhat low, density was similar to values from other sampling sites. At SC-9.5, both the number of taxa (21) and drift density (628.2 individuals/100 m^3) were high. Chaoborus sp. (76.1%), Polypedilum sp. (6.1%), and Ablabesmyia janta (5.7%) were the major components of invertebrate

Table 3.3-58. Summary of Macroinvertebrate Drift, August 1981.

Station	Day			Night		
	No. of Taxa	No. of Individuals	Density (no./100 m^3)	No. of Taxa	No. of Individuals	Density (no./100 m^3)
SUWANNEE RIVER AND TRIBUTARY STATIONS						
SR-1	4	6	2.1	15	239	32.1
SR-3	11	49	3.5	15	190	8.8
SR-4	13	197	50.5	33	460	37.1
SR-5	8	16	4.9	13	930	179.4
SR-8	-	-	-	20	2,099	114.1
RC-1	21	54	25.4	35	565	119.0
RC-5	7	45	31.4	37	443	120.8
RO-1	9	16	17.7	18	61	20.8
LB-1	4	6	3.7	22	129	110.3
$\bar{x}$	10	49	17.4	23	568	82.5
STATIONS RECEIVING MINE DISCHARGE						
HC-3	25	305	13.3	18	556	53.9
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE						
SC-2	9	284	16.9	14	1,156	50.5
SC-9.5	11	59	10.9	21	5,997	628.2
EL001-18	15	460	343.9	18	54,529	61,126.4
ABC	4	144	6.0	15	8,991	470.0
$\bar{x}$	10	237	94.4	17	17,668	15,568.8

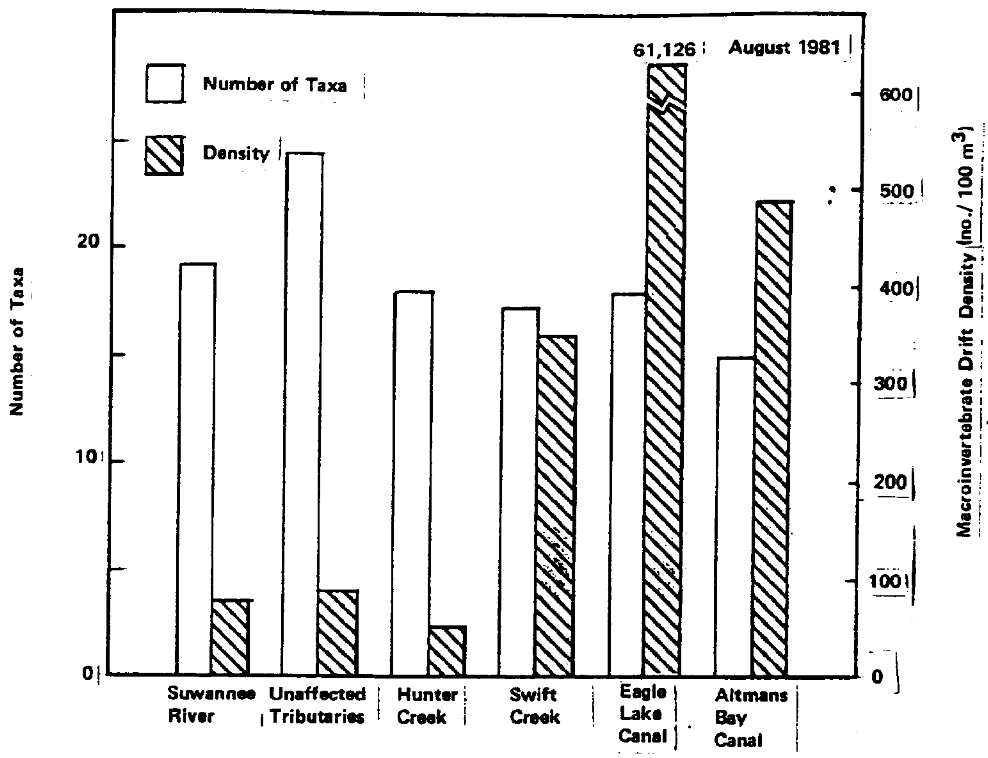


Figure 3.3-21. Mean Number of Taxa and Density of Drifting Invertebrates for Night Samples, August 1981.

Table 3.3-59. Major Components of Macroinvertebrate Drift, August 1981.

Taxon	% of Total	Taxon	% of Total
SUWANNEE RIVER STATIONS		STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE	
Chaoborus sp.	33		
Stenelmis fuscata	16	Swift Creek	
Caenis sp.	12		
Kiefferulus dux	11	*Hyalella azteca*	41
Hyalella azteca	8	*Suphisellus parsoni*	26
Ablabesmyia sp.	4	*Chaoborus* sp.	16
		Eagle Lake Canal	
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE			
		Chaoborus sp.	96
		Hyalella azteca	3
Cheumatopsyche sp.	17		
Larsia sp.	13	Altmans Bay Canal	
Psectocladius sp.	9		
Corydalus cornutus	7	*Chaoborus* sp.	54
Stenelmis sp.	6	*Chironomus* sp.	20
Caenis sp.	6	*Kiefferulus dux*	18
Polypedilum spp.	5		
Labrundinea sp.	4		
STATIONS RECEIVING MINE DISCHARGE			
Hunter Creek			
Hyalella azteca	36		
Caenis sp.	18		
Cheumatopsyche sp.	17		
Polypedilum sp.	12		
Laevipex sp.	5		

Table 3.3-60. Summary of Drift Biomass, August 1981.

Station	Invertebrates			
	Day		Night	
	Wt. (g)	Density (g/100 m^3)	Wt. (g)	Density (g/100 m^3)
SUWANNEE RIVER AND TRIBUTARY STATIONS				
SR-1	0.15	0.0526	0.10	0.0134
SR-3	0.0001	<0.0003	0.05	0.0025
SR-4	0.0072	0.0018	0.50	0.0403
SR-5	0.0012	0.0003	0.05	0.0011
SR-8	-	-	2.35	0.1275
RC-1	0.0010	0.0470	0.25	0.0526
RC-5	0.11	0.0770	0.15	0.0410
RO-1	0.0015	0.0018	0.60	0.2059
LB-1	0.0011	0.0007	0.05	0.0427
$\bar{x}$	0.0340	0.0227	0.46	0.0600
STATIONS RECEIVING MINE DISCHARGE				
HC-3	0.0026	0.0152	0.70	0.0410
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE				
SC-2	0.10	0.0060	0.70	0.0307
SC-9.5	0.05	0.0092	2.95	0.3090
EL001-18	0.30	0.2242	10.45	11.7143
ABC	0.10	0.0042	40.50	2.1168
$\bar{x}$	0.14	0.0609	13.65	3.5427

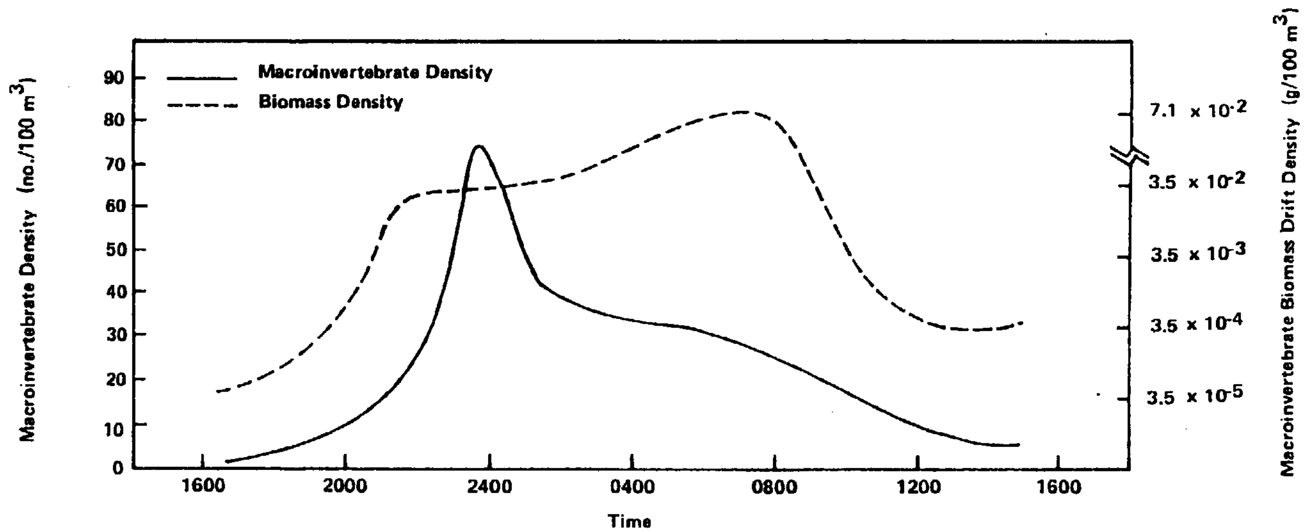


Figure 3.3-22. Diel Macroinvertebrate Drift in Hunter Creek (HC-3), August 1981.

drift at SC-2, while Hyalella azteca (48%) and Suphisellus parsoni (31.2%) were most numerous at SC-9.5. Day drift density for Swift Creek was typically low and was <4% of the total drift sampled.

Night invertebrate drift biomass at SC-9.5 (0.3090 g/100 m^3) was higher than values for the tributaries and Suwannee River sites. The night invertebrate biomass value at SC-2 was 0.0307 g/100 m^3.

Drift samples were taken from the outlet channels of Altmans Bay and Eagle Lake; the outlet channels receive both mine and chemical plant discharge. Fifteen taxa and a density of 470.0 individuals/100 m^3 were recorded for Altmans Bay Canal from night drift samples (Table 3.3-58). Although this station is a considerable distance from the lake outflow, the high density resulted, at least partially, from invertebrates flowing from the lake. Drift was dominated by Chaoborus sp. (54%), Chironomus sp. (20%), and Kiefferulus dux (18%, Table 3.3-59). Invertebrate drift biomass for Altmans Bay Canal (2.1168 g/100 m^3) was the second highest value for August (Table 3.3-60).

The highest drift density value recorded for night drift was from Eagle Lake Canal (61,126.4 individuals/100 m^3). Although 18 taxa were collected from this site, 95.6% of the drift was accounted for by the phantom midge, Chaoborus (Table 3.3-59). As expected from the tremendous number of drift organisms, invertebrate drift biomass was also very high (11.7143 g/100 m^3, Table 3.3-60).

Organisms flowing out of lentic ecosystems cannot be considered drift in the classic sense. Drift refers to and is defined as the component of the invertebrate community that normally resides on the substrate but for a period of time enters the stream water column and moves down the channel via stream currents. Organisms drifting from epilimnitic releases of lakes, particularly insects, must possess the mobility to remain in the upper lake strata long enough to be carried out of the lake. In lakes with large populations of planktonic organisms (e.g., Chaoborus), drift density can be extremely high. However, the number of species is generally low because few invertebrates can sustain a position in the epilimnion long enough to flow out of a lake. Chutter (1963) and Cushing (1963) have shown that large numbers of plankton and other invertebrates move into the epilimnion of lakes, particularly at night, and pass out of the lake into the receiving stream.

Similarity of August drift among sampling sites was low (0-0.42, Table 3.3-61) as the result of sampling many different types of habitats and the variable nature of invertebrate data. In general, higher similarity values were shown for similar types of habitats (e.g., Suwannee River stations), while values were low for dissimilar habitats.

February Drift. Macroinvertebrate drift was sampled under high flow conditions (i.e., higher than August 1981) and only at night during February 1982 to compare drift in different seasons and under different flow conditions. For most stations, the number of macroinvertebrate drift taxa and density values were greater for August than for February (Tables 3.3-58, 3.3-60, 3.3-62, and 3.3-63 and Figures 3.3-21 and 3.3-23). The decrease in macroinvertebrate drift during February is

Table 3.3-61. Percent Similarity (Presence/Absence) of Macroinvertebrate Drift Among the Study Area Streams for August 1981.

	SR-1	SR-3	SR-4	SR-5	SR-8	LB-1	RO-1	RC-1	RC-5	HC-3	SC-2	SC-9.5	EL001-18
SR-3	0.29												
SR-4	0.30	0.42											
SR-5	0.22	0.33	0.23										
SR-8	0.26	0.23	0.13	0.21									
LB-1	0.23	0.20	0.18	0.09	0.18								
RO-1	0.19	0.21	0.27	0.24	0.27	0.29							
RC-1	0.27	0.28	0.30	0.21	0.24	0.36	0.25						
RC-5	0.25	0.19	0.34	0.25	0.17	0.31	0.13	0.41					
HC-3	0.12	0.11	0.24	0.00	0.20	0.18	0.18	0.30	0.26				
SC-2	0.23	0.15	0.23	0.23	0.27	0.19	0.10	0.25	0.29	0.21			
SC-9.5	0.09	0.16	0.20	0.09	0.17	0.15	0.08	0.19	0.21	0.17	0.14		
EL001-18	0.11	0.19	0.16	0.11	0.31	0.18	0.09	0.15	0.17	0.20	0.22	0.39	
ABC	0.18	0.10	0.17	0.24	0.33	0.05	0.00	0.13	0.18	0.13	0.36	0.37	0.40

Table 3.3-62. Summary of Macroinvertebrate Drift, February 1982 (samples collected at night).

Station	No. of Taxa	No. of Individ.	Density (no./100 m^3)
SUWANNEE RIVER AND TRIBUTARY STATIONS			
SR-1	18	208	14.1
SR-3	28	722	44.8
SR-4	16	136	5.6
SR-5	11	95	14.8
SR-7	24	224	20.8
SR-8	20	223	13.4
SR-10	19	239	28.6
RC-1	21	153	16.6
RC-5	16	633	179.4
RC-10	12	72	20.8
HB-2	9	31	21.5
RO-1	25	664	142.3
RO-5	12	207	42.4
LB-1	15	182	297.7
CB-1.5	18	106	101.7
$\bar{x}$	18	260	64.3
STATIONS RECEIVING MINE DISCHARGE			
HC-1	28	1125	83.7
HC-3	25	418	29.0
HC-4	15	473	194.2
$\bar{x}$	23	672	102.3
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE			
SC-2	6	18	2.6
SC-9.5	16	220	54.7
EL001-18	6	1071	181.9
ABC	8	1568	121.1
$\bar{x}$	9	719	90.1

Table 3.3-63. Summary of Drift Biomass, February 1982 (samples collected at night).

Station	Invertebrates Weight (g)	Invertebrates Density (g/100 m^3)
SUWANNEE RIVER AND TRIBUTARY STATIONS		
SR-1	0.05	0.0035
SR-3	0.30	0.0187
SR-4	0.05	0.0021
SR-5	0.05	0.0078
SR-7	0.15	0.0138
SR-8	0.05	0.0028
SR-10	0.05	0.0060
RC-1	0.15	0.0162
RC-5	0.60	0.1698
RC-10	0.05	0.0145
HB-2	0.10	0.1444
RO-1	0.05	0.0102
RO-5	0.10	0.0215
LB-1	0.05	0.0816
CB-1.5	0.20	0.1921
$\bar{x}$	0.13	0.0470
STATIONS RECEIVING MINE DISCHARGE		
HC-1	0.20	0.0148
HC-3	0.15	0.0205
HC-4	0.10	0.0409
$\bar{x}$	0.15	0.0254
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE		
SC-2	0.05	0.0071
SC-9.5	0.05	0.0124
EL001-18	3.55	0.6031
ABC	0.45	0.0346
$\bar{x}$	1.02	0.1643

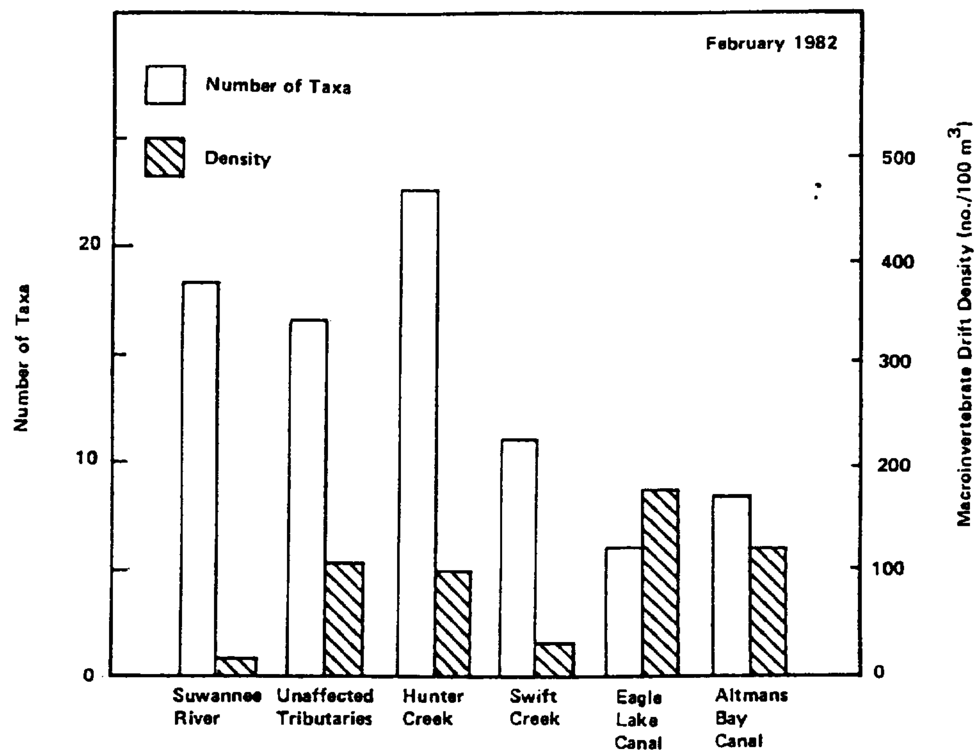


Figure 3.3-23. Mean Number of Taxa and Density of Drifting Invertebrates, February 1982.

probably the result of decreased secondary production during the cooler months.

The number of taxa drifting in the Suwannee River was high ($\bar{x}$ = 19.4), but mean invertebrate drift density (20.3 g/100 m^3) was lower than for any of the other ecosystems for February. Various species of Diptera, particularly Simulium and midges, dominated drift in the Suwannee River (Table 3.3-64).

The mean value for invertebrate drift biomass in the Suwannee River (0.0078 g/100 m^3) was lower than for all other aquatic ecosystems sampled during February. Invertebrate drift biomass for the Suwannee ranged from 0.0021 g/100 m^3 (SR-4) to 0.0187 g/100 m^3 (SR-3) (Table 3.3-63).

Macroinvertebrate drift density measured in five tributary streams that received no mining discharge produced an average of 117.2 individuals/100 m^3 (stations pooled, Table 3.3-62, Figure 3.3-23). Greatest drift densities were recorded for Long Branch (297.7 individuals/100 m^3 at LB-1) and Rocky Creek (179.4 individuals/100 m^3 at RC-5). Rocky Creek (RC-1 and RC-10) and Hogans Branch (HB-2) produced the lowest values (16.6, 20.8, and 21.5 individuals/100 m^3, respectively). A wide variety of invertebrates was collected from the tributaries, and in most cases ≥15 taxa were represented in the samples (Table 3.3-62). Although in some cases the same organisms were prevalent in different ecosystems, the variation in species and percent composition indicates the dissimilarity of macroinvertebrate drift among ecosystems. Polypedilum sp., Coptotomus interrogatus, Psectocladius sp., and Simulium sp. were dominant drifters and comprised approximately 52% of total drift density (Table 3.3-64). Individual species were not evenly distributed in the drift from the tributaries, e.g., Coptotomus interrogatus comprised 16% of total drift but only occurred in one tributary. Greatest invertebrate drift biomass densities were recorded for Camp Branch (0.1921 g/100 m^3), Rocky Creek (0.1698 g/100 m^3), and Hogans Branch (0.1444 g/100 m^3) (Table 3.3-63).

Winter drift in Hunter Creek was composed primarily of Hyalella azteca (17%), Simulium sp. (15%), Caenis sp. (11%), and Ablabesmyia ornata (6%, Table 3.3-64). The mean number of taxa drifting in Hunter Creek (22.7) was higher than for all other ecosystems, while density (102.3 individuals/100 m^3) was comparable to the mean value for other tributaries during February. Mean invertebrate biomass (0.0254 g/100 m^3) was in the mid-range of values for other ecosystems during February.

Drift in Swift Creek was dominated by the Diptera families Chironomidae, Ceratopogonidae, and Chaoboridae (Table 3.3-64). At Station SC-9.5, 16 taxa were collected and drift density was 54.7 individuals/100 m^3 (Table 3.3-62). In lower Swift Creek (SC-2), only 6 taxa and 2.6 individuals/100 m^3 were collected. The low value for drift density may be the result of the flow regime in Swift Creek or the location of the sampling nets. Invertebrate biomass values for Swift Creek were 0.0071 and 0.0124 g/100 m^3 for stations SC-2 and SC-9.5, respectively (Table 3.3-63).

Table 3.3-64. Major Components of Macroinvertebrate Drift, February 1982.

Taxon	% of Total	Taxon	% of Total
SUWANNEE RIVER STATIONS		STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE	
Simulium sp.	23		
Ablabesmyia spp.	14	Swift Creek	
Polypedilum convictum	10		
Cardocladius sp.	9	*Cricotopus* sp.	27
Orthocladine	7	*Ceratopogonidae*	20
Conchalopeia sp.	7	*Chaoborus* sp.	11
		Hyalella azteca	11
		Tanypus sp.	10
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE			
		Eagle Lake Outlet	
Polypedilum sp.	19		
Coptotomus interrogatus	16	*Simulium* sp.	61
Psectocladius sp.	9	*Cheumatopsyche* sp.	29
Simulium sp.	8	*Chaoborus* sp.	10
Nanocladius sp.	6		
Centroptilium hobbsi	4		
Cargonyx sp.	3	Altmans Bay Canal	
		Hyalella azteca	61
STATIONS RECEIVING MINE DISCHARGE		*Parachironomus* sp.	31
		Chaoborus sp.	4
Hunter Creek		*Simulium* sp.	4
Hyalella azteca	17		
Simulium sp.	15		
Caenis sp.	11		
Ablabesmyia ornata	6		
Parachironomus sp.	4		
Dytiscidae	3		
Procladius sp.	3		

Eagle Lake and Altmans Bay canals produced the lowest number of drifting taxa for February (6 and 8, respectively, Table 3.3-62). The enormous number of drifting organisms observed during August was not evident for February, but mean drift density was comparatively high (121.1 and 181.9 individuals/100 m^3 for Altmans Bay and Eagle Lake canals, respectively). Hyalella azteca (61%) and Parachironomus (31%) were dominant drifters in Altmans Bay Canal, while Simulium (61%) and Cheumatopsyche (29%) dominated drift in Eagle Lake outlet (Table 3.3-64). Mean biomass values for the lake outlets were among the highest recorded for February; however, values from the individual canals were very different (Table 3.3-63). Invertebrate drift biomass for Eagle Lake Canal (0.6031 g/100 m^3) was >3X higher than any other value generated for February. By comparison, the value for Altmans Bay Canal was 0.0346 g/100 m^3. The difference in data from Eagle Lake and Altmans Bay canals demonstrates the problems that may be encountered when trying to compare drift between different ecosystems. Differences in drift between similar types of ecosystems may be related to differences in predator populations, the invertebrate community, competition, riparian and aquatic vegetation, and water quality.

Similarity values for February (Table 3.3-65) are much the same as the values generated for August (Table 3.3-61). Values were low, even among similar ecosystems, generally ranging from 0.10 to 0.40. The greatest similarity was noted between similar areas (e.g., most Suwannee River stations when compared among themselves had values in the 0.20-0.50 range). However, similarity was extremely low when different ecosystems were compared.

Qualitative Samples

The results of qualitative collections made during 1981 and 1982 are summarized in Table 3.3-66. The Suwannee River and unaffected tributaries exhibited relatively high Florida Index values and a high number of taxa, with generally more intolerant than tolerant invertebrates present (EPA 1973). Swamp and marsh stations were sampled only in April 1982. Tolerant and facultative invertebrates dominated at these stations.

The species assemblage in Hunter Creek was somewhat different from systems not receiving OXY discharge, but total number of taxa and Florida Index values were similar. In September 1981 and April 1982, only a few more species were collected in systems not receiving discharge than in Hunter Creek, while in January 1982 the Hunter Creek stations generally averaged more species. Intolerant and facultative invertebrates dominated the Hunter Creek community.

Altmans Bay Canal generally exhibited a low number of taxa and low Florida Index values; tolerant and facultative invertebrates dominated the invertebrate community. Samples from Swift Creek and Eagle Lake Canal produced comparatively lower numbers of taxa and Florida Index values, although two samples had >20 taxa. Florida Index values for these stations were usually <4 and never exceeded 6. Although some intolerant invertebrates were present, the communities in Swift Creek and Eagle Lake Canal were dominated by tolerant and facultative organisms.

Table 3.3-65. Percent Similarity (Presence/Absence) of Macroinvertebrate Drift Among the Study Area Streams for February 1982.

	SR-1	SR-3	SR-4	SR-5	SR-7	SR-8	SR-10	LB-1	CB-1.5	HB-2	RO-1	RO-5	RC-1	RC-5	RC-10	HC-1	HC-3	HC-4	SC-2	SC-9.5	EL001-18
SR-3	0.43																				
SR-4	0.53	0.50																			
SR-5	0.41	0.36	0.44																		
SR-7	0.48	0.35	0.45	0.23																	
SR-8	0.37	0.29	0.33	0.26	0.55																
SR-10	0.32	0.34	0.40	0.20	0.42	0.51															
LB-1	0.30	0.23	0.19	0.15	0.31	0.34	0.43														
CB-1.5	0.17	0.13	0.12	0.07	0.10	0.26	0.22	0.30													
HB-2	0.07	0.05	0.08	0.10	0.00	0.14	0.07	0.25	0.11												
RO-1	0.23	0.42	0.15	0.17	0.20	0.27	0.27	0.35	0.37	0.12											
RO-5	0.20	0.25	0.21	0.26	0.22	0.19	0.19	0.07	0.07	0.38	0.11										
RC-1	0.26	0.29	0.27	0.31	0.22	0.24	0.25	0.06	0.15	0.13	0.22	0.36									
RC-5	0.06	0.09	0.06	0.07	0.05	0.11	0.06	0.06	0.06	0.24	0.05	0.14	0.11								
RC-10	0.07	0.10	0.07	0.09	0.06	0.06	0.06	0.22	0.13	0.19	0.27	0.00	0.00	0.14							
HC-1	0.35	0.57	0.45	0.26	0.35	0.38	0.34	0.14	0.13	0.11	0.38	0.25	0.33	0.30	0.17						
HC-3	0.42	0.26	0.29	0.22	0.24	0.13	0.27	0.20	0.28	0.18	0.38	0.16	0.14	0.10	0.06	0.19					
HC-4	0.30	0.23	0.26	0.31	0.21	0.29	0.18	0.20	0.24	0.08	0.25	0.15	0.10	0.27	0.00	0.19	0.40				
SC-2	0.17	0.12	0.09	0.12	0.07	0.23	0.24	0.29	0.17	0.13	0.13	0.00	0.07	0.00	0.00	0.06	0.26	0.29			
SC-9.5	0.24	0.09	0.13	0.15	0.10	0.11	0.06	0.06	0.06	0.08	0.05	0.07	0.05	0.06	0.14	0.05	0.29	0.19	0.27		
EL001-18	0.25	0.24	0.18	0.24	0.13	0.23	0.24	0.19	0.25	0.00	0.19	0.22	0.11	0.18	0.11	0.18	0.26	0.38	0.33	0.09	
ABC	0.15	0.17	0.18	0.32	0.13	0.14	0.15	0.09	0.15	0.00	0.18	0.20	0.07	0.08	0.00	0.17	0.24	0.61	0.14	0.08	0.43

Table 3.3-66. Number of Taxa and Florida Index for Qualitative Samples Collected During 1981 and 1982.

Station	September 1981		January 1982		April 1982	
	No. of Taxa	Florida Index	No. of Taxa	Florida Index	No. of Taxa	Florida Index
SUWANNEE RIVER STATIONS						
SR-1	26	15	22	10	22	14
SR-4	17	12	23	5	12	6
SR-5	21	9	-	-	16	9
SR-10	36	28	14	9	12	2
$\overline{x}$	25	16	20	8	16	7.8
TRIBUTARY STATIONS NOT RECEIVING OXY DISCHARGE						
LB-1	32	9	19	4	12	9
HB-2	-	-	-	-	15	8
RO-2	22	9	32	13	17	11
RC-2	34	13	30	15	19	8
RC-5	30	13	26	8	18	9
RC-6	20	5	23	6	15	6
RC-9	15	1	-	-	-	-
RC-12	-	-	-	-	13	7
RC-12A	-	-	-	-	9	5
$\overline{x}$	26	8.3	26	9.2	15	7.9
SWAMP AND MARSH STATIONS						
HC-2A	-	-	-	-	10	1
RC-3000	-	-	-	-	13	5
RO-2B	-	-	-	-	6	0
$\overline{x}$					10	2
$\overline{x}$	25	11.4	24	8.8	14	6.7
STATIONS RECEIVING MINE DISCHARGE						
HC-2	20	10	26	6	14	6
HC-3	21	8	24	8	7	5
$\overline{x}$	21	9	25	7	11	5.5

Table 3.3-66 (Continued).

Station	September 1981		January 1982		April 1982	
	No. of Taxa	Florida Index	No. of Taxa	Florida Index	No. of Taxa	Florida Index
STATIONS RECEIVING MINE AND CHEMICAL PLANT DISCHARGE						
SC-4	12	2	16	6	10	3
SC-5.5	-	-	15	6	-	-
SC-9.5	21	1	16	2	-	-
SC-10	-	-	23	0	19	2
SC-11	-	-	16	1	-	-
$\bar{x}$	17	1.5	17	3	15	2.5
EL001-18	19	3	6	4	-	-
ABC	13	0	14	2	10	5
$\bar{x}$	16	1.5	15	3.0	13	3.3

The number of taxa as well as the number of species listed on the Florida Index decreased at unaffected stations from September 1981 through April 1982. Number of taxa collected at Swift Creek and Hunter Creek stations also dropped in April 1982. The reduction in number of taxa may have been a response to dry season low flow.

3.3.5 Forestry and Agricultural Resources

3.3.5.1 Forestry Resources

Approximately 260,000 acres of Hamilton County (79% of the total county land use) is in forest (EPA 1978a). Industry owns 57% of this forested land, with all but about 0.5% classified as commercial (McClure 1970). Within the project area, approximately 24,861 acres (25%) are in planted pinelands (Level III Type 441, Section 3.3.2.1).

Forestry products include pulpwood, saw timber, and naval supplies. About 60% of the planted pine is in longleaf or slash pine, most of which is intensively managed for pulpwood production on a 25-year or less rotation (EPA 1978a).

Site class values for Hamilton County pinelands range from 3 to 5, indicating an average productivity of 50-85 cu ft/acre annually. This is typical of the northeast Florida region.

Cypress is logged in the project area on an occasional basis. No data are available on the intensity of logging activities for this forest crop. An effort was made to determine the marketable cypress in the general project area. Five wetlands areas containing cypress were evaluated. Height and diameter at breast height (dbh) were measured on cypress in these selected wetlands (Table 3.3-67). The average height was determined to be 59.4 ft, and the average dbh was determined to be 7.7 in. Generally, cypress with a dbh of ≥5 in are logged, while those trees <5 in are usually not cut. Using a 5.5 in dbh as a cutoff point, approximately 70% of the cypress trees in a given wetland could potentially be harvested. The average density of cypress in the sampled wetlands was 89 trees/acre. Using the average dbh and height of these cypress trees and the percentage of potentially harvestable cypress trees, volume/acre for available cypress can be calculated. Volume (cu ft) was obtained from data compiled by Mr. N.G. Laine, Regeneration Specialist, Florida Department of Agriculture and Consumer Services (correspondence to Mr. L.L. Yarlett from Mr. Laine, 20 September 1982). The volume of harvestable cypress/acre was estimated to be 671 cu ft or approximately 7.9 standing cords/acre.

3.3.5.2 Agricultural Resources

Agricultural resources within the project site include:

- Row crops (Type 211);
- Field crops (Type 212);
- Improved pasture (Type 213);
- Deciduous fruit orchard (Type 222);
- Pecan orchard (Type 231);
- Confined feeding operations (Type 242); and
- Scrub/brush rangeland (Type 323).

The total acreage of these seven land uses is only 7945 acres or 8% of the project area (Table 3.3-68). Major row crops on the project site occur along and within a short distance of CR 137, CR 135 and CR 6. The

Table 3.3-67. Frequency of Height and Diameter at Breast Height (dbh) of Cypress in Five Selected Wetlands on the OXY Project Site.

	Height (ft)												
dbh (in)	20-25	26-39	40-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	Total	%
2.5-3.4	0	1	0	0	2	1	1	0	0	0	0	5	1.8
3.5-4.4	0	1	2	4	9	3	2	1	2	0	1	25	9.2
4.5-5.4	1	3	5	5	12	10	8	6	2	0	0	52	19.1
5.5-6.4	0	1	6	4	8	3	5	7	8	0	0	42	15.4
6.5-7.4	0	1	1	6	5	1	3	1	1	0	0	19	7.0
7.5-8.4	0	1	1	1	4	6	5	3	5	1	0	27	9.9
8.5-9.4	0	0	0	2	5	5	7	4	2	0	0	25	9.2
9.5-10.4	0	0	0	4	3	6	5	9	3	0	0	30	11.0
10.5-11.4	0	0	1	0	1	9	2	6	2	0	0	21	7.7
11.5-12.4	0	0	1	0	1	2	0	0	2	0	0	6	2.2
12.5-13.4	0	0	0	1	2	3	4	3	0	0	0	13	4.8
13.5-14.4	0	0	0	1	0	1	0	0	0	0	0	2	0.7
14.5-15.4	0	0	0	0	0	1	1	0	0	0	0	2	0.7
15.5-16.4	0	0	0	0	0	0	1	0	0	0	0	1	0.4
16.5-17.4	0	0	0	0	0	1	0	0	1	0	0	2	0.7
17.5-18.4	0	0	0	0	0	0	0	0	0	0	0	0	0.0
18.5-19.4	0	0	0	0	0	0	0	0	0	0	0	0	0.0
19.5-20.4	0	0	0	0	0	1	0	0	0	0	0	1	0.4
TOTAL	1	8	17	28	52	53	44	40	28	1	1	273	100
%	0.4	2.9	6.2	10.3	19.1	19.4	16.1	14.7	10.3	0.4	0.4	100	

Table 3.3-68. Land Use Types and Percentages for the Project Area.

Land Use	Level III Code	Acres	Percent of Total Site
Row crops	211	3976	4.0
Field crops	212	2509	2.5
Improved pasture	213	1302	1.3
Deciduous fruit orchard	222	1	<0.1
Pecan orchard	231	1	<0.1
Confined feeding operations (poultry)	242	51	<0.1
Scrub/brush rangeland	323	105	0.1
TOTAL		approx. 7945	7.9

major row crop is corn, with some field peas and soybeans. Old tobacco sheds indicate that tobacco was once a major row crop in the project area. Field crops are usually oats or rye planted in the fall and used for temporary grazing December through March. Improved pastures have been established on fairly well-drained soils of the flatwoods type. These pasture areas usually are planted in either bahia grass (Paspalum notatum) or coastal bermuda (Cynodon dactylon).

Acreages of row crops, field crops, and improved pasture for Hamilton County are difficult to assess. However, the following crops and acreages (where available) are reported for Hamilton County by the Jasper office of the U.S. Department of Agriculture (USDA) Agricultural Stabilization and Conservation Service:

Crop	Acreage
Corn	18,579
Wheat	1,104
Cotton	1,972
Oats	No record kept
Soybeans	Unknown

3.3.5.3 Prime and Unique Farmland

The definition and final ruling on prime farmland was published in the Federal Register on 31 January 1978. The final rule set forth the USDA Soil Conservation Service's policy to implement specific criteria which designate prime farmland. In general:

> Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

Soil scientists at the Soil Conservation Service (SCS) area office in Lake City, Florida estimate that there are <1000 acres of prime farmland in Hamilton County (correspondence to Mr. L.L. Yarlett from Mr. D.A. Howell [SCS], 12 January 1982). Additionally, it was estimated that ≤50 acres (0.05% of the project area) of prime farmland are in the vicinity of phosphate mining activities. However, these are estimates and may be somewhat inaccurate due to the lack of certified soil maps for Hamilton County.

3.3.6 Game and Migratory Wildlife

A significant portion of the project area is used for hunting, including portions of the Suwannee River Mine. Game species of primary importance include the white-tailed deer, feral hog, wood duck, and numerous migratory puddle and diving ducks. Deer and hog are hunted primarily in the Cypress Creek Wildlife Management Area north of CR 6. The 25,972-acre management area consists of approximately 70% pine-palmetto flatwoods, 25% cypress-blackgum area, and 10% hardwood hammock. Only 3200 acres (12%) of the Cypress Creek Wildlife Management Area are within the delineated study area. Hunting pressure for the Cypress Creek area during the 1980 and 1981 seasons was 2860 hunt-days and 3710 hunt-days, respectively (Table 3.3-69). In the Cypress Creek area, hunt-day/animal taken was 23.2 in 1980 and 23.8 in 1981 (Table 3.3-69). These statistics are probably indicative of hunt pressure in lands on the project area leased by various hunt clubs.

The majority of duck hunting is conducted in the Suwannee River Mine area, although wood ducks are hunted in wetlands areas throughout the project area. Statistics for duck hunting indicate a use of 815 hunt-days in 1980 and 802 hunt-days in 1981. Take ratios on ducks were 3.7 ducks/hunt-day for 1980 and 3.4 ducks/hunt-day for 1981 (Table 3.3-70). According to the Florida Game and Fresh Water Fish Commission, these success ratios were comparable to those recorded in other areas of the state, including other game management areas. Species most commonly taken by duck hunters during the 1981 season were (in order): ruddy duck, scaup, and blue-winged teal, which made up almost 75% of all ducks taken. Considering the high hunter success rates (an average of 3.5 birds per hunt-day for the last two years), it appears that the creation of aquatic habitats has been a bonus for duck hunters in the region.

Other species hunted in the area, but for which statistics are not available, include the northern bobwhite, eastern cottontail, and mourning dove. Some trapping is conducted in the area, with bobcat and raccoon the preferred trap animals; however, effort spent pursuing these species is minor compared to that for deer and ducks.

Only 13% of the 235 bird species expected to occur in the area are non-migratory. The remainder are either transients or winter or summer residents. Migratory species primarily utilize man-made open water habitats in the area, i.e., settling areas, mine pits, and reclaimed lakes. Terrestrial habitats in the area are used by some wintering field and woodland birds. One local non-migratory subspecies (southeastern American kestrel, *Falco sparverius paulus*) shares the area with the northern migratory sub-species during the winter (*F. s. sparverius*).

In addition to birds, one migratory mammal, the hoary bat (*Lasiurus cinereus*) passes through the study area (Zinn and Baker 1979).

Table 3.3-69. Cypress Creek Wildlife Management Area Hunting Statistics for 1980 and 1981 Seasons.

	1980	1981
Archery		
Deer	2	14
Hogs	13	5
Total hunt-days	175	575
Muzzle-loader		
Deer	17	15
Hogs	6	14
Total hunt-days	300	185
General		
Deer	69	82
Hogs	16	26
Total hunt-days	2385	2950
Total animals taken	123	156
Total hunt days	2860	3710
Hunt-days per animal	23.2	23.8

Source: FGFWFC, Lake City Area Office unpublished data, 1982.

Table 3.3-70. Duck Hunting Statistics for the 1980 and 1981 Seasons at the Occidental Chemical Complex.

	1980	1981
Puddle ducks	978	904
Diving ducks	2022	1780
Total ducks taken	3000	2684
Hunting (hunt-days)	815	802
Ducks per hunt-day	3.7	3.4

Source: FGFWFC, Lake City Area Office, 1982.

3.3.7 Rare and Endangered Species

During the course of general fieldwork and species-specific surveys, four of the seven federally protected vertebrate species that potentially inhabit the project area were observed on site. One federally protected plant occurs on the project site. Of the fauna protected by the state (Ch. 39-27.01-05, Rules of the Florida Game and Fresh Water Fish Commission), eleven vertebrate species were observed on the site (including the four federally listed species). Of the plant species protected under Section 581.185, Florida Statutes (Preservation of Native Flora of Florida Act, as revised), two species listed as endangered potentially occur on the project site, and other species (included in generic categories) listed as threatened may occur on site.

Consultation pursuant to Section 7 of the Endangered Species Act of 1973, as amended, was initiated 14 July 1981 by Mr. A.J. Salem, Acting Chief, ACOE Planning Division, in correspondence addressed to Mr. Donald J. Hankla, FWS Area Manager. Subsequent correspondence to Mr. Hankla from Mr. Salem on 10 November and 10 December 1981 provided information on the ACOE biological assessment addressing threatened and endangered species which may inhabit the project area. Correspondence of 30 November from Mr. Donald J. Hankla and 22 December 1981 from Mr. Jerry C. Grover, FWS Acting Area Manager, to Mr. A.J. Salem concurred with the ACOE "no effect" determinations on federally threatened and endangered species. Consultation pursuant to Section 7 of the Endangered Species Act of 1973, as amended, was completed per correspondence from Mr. Jerry C. Grover to Mr. A.J. Salem on 22 December 1981.

3.3.7.1 Flora

Plants were first included in the Federal Endangered Species Act (PL 93-205) in August 1977 (45 FR 40685). Based on current federal lists, consultation with the FWS Office of Endangered Species in Jacksonville, Florida, and review of previous studies conducted in the area, it was determined that one federally protected plant species occurs on the site. Chapman's rhododendron (Rhododendron chapmanii), federally designated as endangered, was found previously on the project site along Swift Creek, Rocky Creek, Roaring Creek, Camp Branch, and the Suwannee River, as well as within pine flatwoods communities within the study area (EPA 1978a). However, the occurrence of this species was not confirmed during surveys of these stream systems for this EIS. This species is endemic to Florida and was previously known to occur in Gadsden, Liberty, and Gulf counties in the region of the Apalachicola River and as a small disjunct population in Clay County (Clewell 1971, Godfrey 1979). Specimens also have been collected from Baker and Bradford counties, but these may have originated from cultivated plants (NFWL 1978). This species is the only evergreen rhododendron in Florida. It occurs primarily in flatwoods and in the Apalachicola region; it also occurs along borders of titi swamps (Godfrey 1979).

Several protected plants listed as endangered or threatened under Section 581.185, FS, were observed or potentially occur on the site (Table 3.3-71). The stated intent of this statute is to "... provide an orderly and controlled procedure for restricting harvesting of native

Table 3.3-71. Endangered, Threatened, and Rare Plants Occurring or Potentially Occurring on the OXY Project Site.

Species	Status[1] Federal	State	FCREPA	Habitat[2]
Asimina pygmaea (pink pawpaw)		E		411
**Rhododendron chapmanii* (Chapman's rhododendron)	E	E	E	411
Orchids--all species native to the state, except those listed as Endangered		T		Various upland and wetland habitats
Ferns--all species native to the state except those listed in 581.185, FS		T		Various upland and wetland habitats
Ilex--all species (holly) except those listed in 581.185, FS		T		Various upland and wetland habitats
Rhododendron--all native species (azalea), except those listed as Endangered		T		Various upland and wetland habitats
Peltandra sagittifolia			R	641
Smilax smallii			T	621
Ulmus crassifolia			R	621

[1]Federal = FWS 1980a
State = Section 581.185, FS
FCREPA = Florida Committee on Rare and Endangered Plants and Animals (Ward 1979)
E = Endangered
T = Threatened
R = Rare

[2]See Table 3.3-1 for description of habitat codes.
*Observed on site.

flora from the wilds, thus preventing wanton exploitation or destruction of Florida native plant populations." The majority of the species observed in the project area fall into this category. Their distribution is primarily associated with wetland habitat types 621 and 631 and upland habitat type 411. Much of the habitat in the project area has been cleared, logged, and/or intensively managed for forestry, thus reducing the value of these areas for legally protected species. None is presently in danger of extirpation from the State of Florida. Some species listed by the Florida Committee on Rare and Endangered Plants and Animals (Ward 1979) may also occur in the project area.

3.3.7.2 Fauna

Federal regulations concerning endangered vertebrates were finalized into law in 1973 (PL 93-205 and amendments PL 94-325, PL 94-359, PL 95-212, PL 95-632, and PL 96-159). The most current federal listings, consultation with the FWS Office of Endangered Species in Jacksonville, Florida, and review of previous studies in the project area (EPA 1978a) revealed that seven federally protected endangered or threatened species and two species currently under review may occur in the project area (Table 3.3-72). Four federally protected species were observed on site.

State regulations concerning endangered, threatened, and special concern species were promulgated in 1979 (Ch. 39-27.01-05, Rules of the Florida Game and Fresh Water Fish Commission). Eleven species (including those under federal protection) of the twenty-two potentially occurring were actually observed in the project area (Table 3.3-72). The status of these species as determined by the Florida Committee on Rare and Endangered Plants and Animals (FCREPA) is also presented for informational purposes (Table 3.3-72), although the FCREPA list has no legal protection associated with it.

Amphibians and Reptiles. The Florida gopher frog (*Rana areolata*) is a medium-sized frog, 3-4 in long, that inhabits high pineland, scrub, and xeric hammocks. The species is commensal with the gopher tortoise, utilizing burrows as refugia. It typically breeds in isolated highland ponds (Carr 1940). Small patches of suitable habitat with gopher tortoise burrows occur within the project area. However, suitable breeding habitat is extremely limited. This situation is similar to that encountered in nearby Osceola National Forest (NFWL 1978). This species was not observed in the project area, and its occurrence is probably extremely limited.

The American alligator (*Alligator mississippiensis*) has been observed in the project area in ponds, streams, rivers, and most of the phosphate mine waste clay settling areas, abandoned mine pits, and reclaimed lakes. However, populations in the project area appear to be lower than expected for such habitats. These low numbers may be due to either unknown ecological factors or excessive mortality due to poaching or indiscriminate destruction of the animals by humans (NFWL 1978).

The Suwannee cooter (*Chrysemys concinna suwanniensis*) is an inhabitant of rivers, spring runs, and estuarine areas. Population densities reach their extremes in areas of turtle grass flats such as the Suwannee Sound

Table 3.3-72. Endangered, Threatened, Rare, and Special Concern Fauna of the OXY Project Site.

Species	Status[1]			Habitat Preference[2]	Comments
	Federal	State	FCREPA		
AMPHIBIANS AND REPTILES					
Gopher frog *Rana areolata*		SSC	T	421	Occurrence not likely due to limited habitat and breeding sites.
*American alligator *Alligator mississippiensis*	T	SSC	SSC	511,513,521,561, 631,641,742,751	Observed in the Suwannee River and waste clay settling areas.
Suwannee cooter *Chrysemys concinna suwanniensis*	UR	SSC	T	511	Observed in past studies on Suwannee River.
*Gopher tortoise *Gopherus polyphemus*		SSC	T	421,431	Observed in Swift Creek watershed and along natural levees of the Suwannee River.
Short-tailed snake *Stilosoma extenuatum*	UR	T	E	421	Due to habitat preferences, probably does not occur on site.
Eastern indigo snake *Drymarchon corais couperi*	T	T	SSC	411,421,431,441, 451,621,631,641	Probably occurs on site at low population levels.
BIRDS					
*Wood stork (*Mycteria americana*)	E	E	E	513,521,621,631, 641,742,751	Observed feeding in mine areas.
*Southern bald eagle *Haliaeetus l. leucocephalus*	E	T	T	152,190,521,742,751	Immature and migratory individuals observed feeding on reclaimed mine pits and waste clay settling areas.
Southeastern kestrel *Falco sparverius paulus*		T	T	190	Likely to occur in open fields and thinly wooded lands.
*Peregrine falcon *Falco peregrinus*	E	E	E	152,190,521,742,751	Migratory species observed feeding in waste clay settling areas.
*Florida sandhill crane *Grus canadensis pratensis*		T	T	190,211,212,213, 222,631,751	Observed flying over site; unlikely to breed on project site.
*Little blue heron *Egretta caerulea*		SSC	SSC	513,521,561,621, 631,641,742,751	Observed in water habitats created by mining.

Table 3.3-72 (Continued).

Species	Status[1] Federal	State	FCREPA	Habitat Preference[2]	Comments
*Snowy egret *Egretta thula*		SSC	SSC	513,521,561,621, 631,641,742,751	Nesting colonies in habitats created by mining.
*Tricolored heron *Egretta tricolor*		SSC	SSC	513,521,631,641, 742,751	Nesting colonies in habitats created by mining.
*Least tern *Sterna albifrons*		T	SSC	521,742,751	Nesting colonies in habitats created by mining.
Red-cockaded woodpecker *Picoides borealis*	E	T	E	411,441	Not likely to occur due to lack of adequate habitat.
MAMMALS					
Gray bat *Myotis grisescens*	E	E	E	511	Not likely to occur due to lack of suitable breeding habitat.
Sherman's fox squirrel *Sciurus niger shermani*		SSC	T	411,421,431,441, 451	May occur in pineland systems, but population extremely low.
Florida mouse *Peromyscus floridanus*		T	T	411,421,441,451	Unlikely to occur on site based on past trapping efforts.
*Florida black bear *Ursus americanus floridanus*		T	T	411,421,431,441, 451,621,631	Scat found in Bee Haven Bay; small population likely in northern study area.
FISH					
Atlantic sturgeon *Acipenser oxyrhynchus*		SSC	T	511	Not collected; probably present in Suwannee River near White Springs.
Suwannee bass *Micropterus notius*		SSC	R	511	Not collected; probably not present in Upper Suwannee River.

[1]Federal = FWS 1980a.
State = Ch. 39-27.01-05, Rules of the Florida Game and Freshwater Fish Commission.
FCREPA = Florida Committee on Rare and Endangered Plants and Animals (Pritchard 1978).
E = Endangered T = Threatened UR = Status under review R = Rare SSC = Species of Special Concern.
[2]See Table 3.3-1 for habitat codes.
*Observed on site.

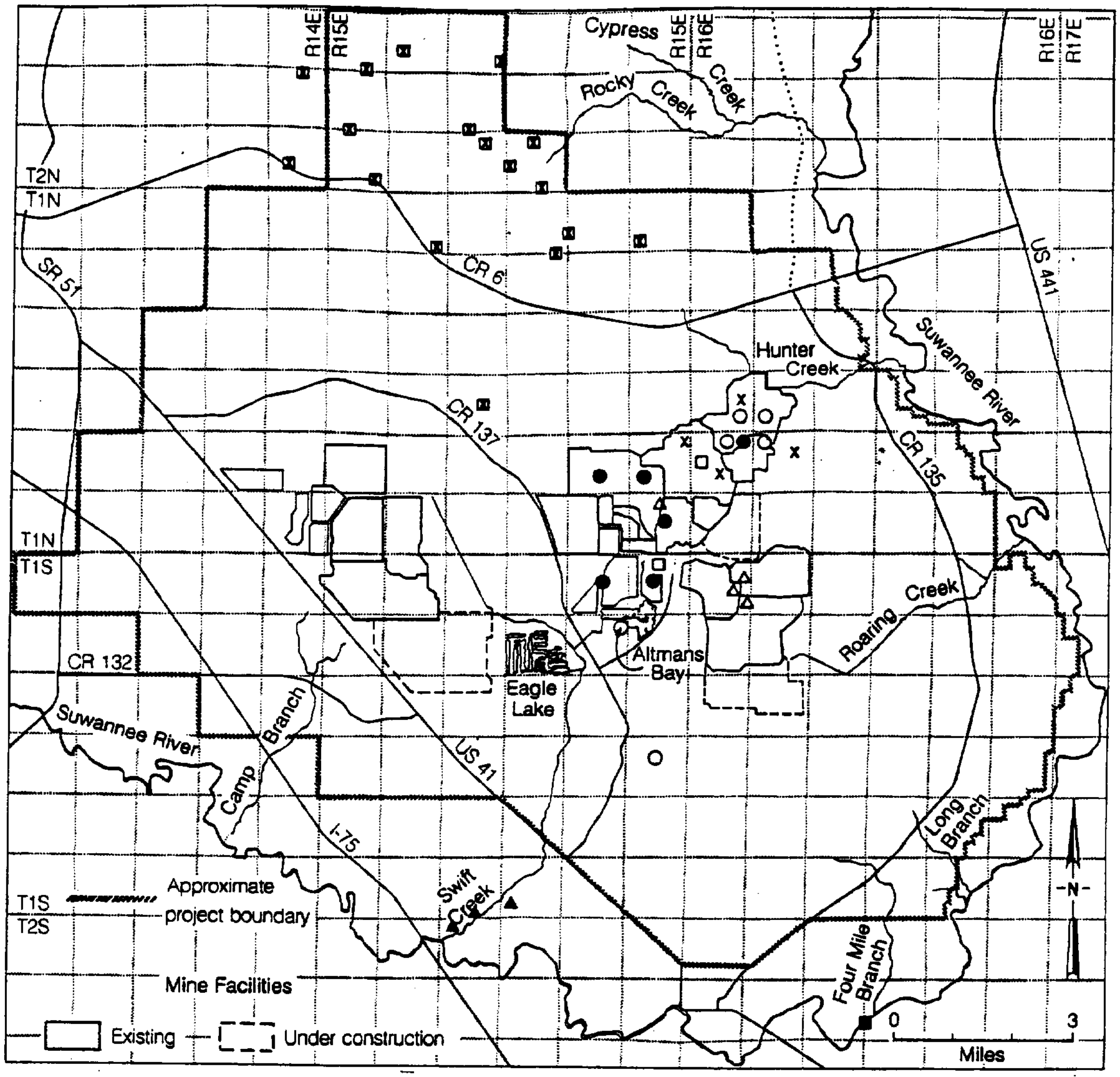
(Carr 1952). Geographically, the Suwannee cooter ranges from the Gulf of Mexico, from the vicinity of Pinellas County to Franklin County in the Panhandle, eastward to Columbia County. This species has been collected north of Little Shoals near White Springs (Florida State Museum No. UF 39895) (Figure 3.3-24). Turtles thought to be this species (although not confirmed) have been observed basking on the Suwannee River between White Springs and the CR 6 bridge (NFWL 1978). The Suwannee cooter is considered a part of the herpetofauna for the study area; however, population levels are considered low due to limited aquatic vegetation in the upper Suwannee River (NFWL 1978).

The gopher tortoise (Gopherus polyphemus) usually occurs in open, well-drained, sandy areas. Burrows constructed in these areas range from 1.9-14.0 m long and 1.4-2.8 m deep (Hanson 1953). These burrows also serve as homesites or shelter to the Florida mouse, indigo snake, and Florida gopher frog, as well as a number of invertebrates (Carr 1952). The gopher tortoise is completely herbivorous, taking a wide variety of grasses and herbs (Auffenberg 1966). Geographically, this species ranges from southern South Carolina and Georgia to the tip of the Florida peninsula. It also occurs in Alabama, Mississippi, Louisiana, and west into Texas and southeastern Arkansas. Active gopher tortoise burrows were noted in several localities of high pinelands in the Swift Creek basin (Figure 3.3-24) and occur as scattered populations along the natural levees of the Suwannee River.

The short-tailed snake (Stilosoma extenuatum) is endemic to Florida. Geographically, it occurs in longleaf pine - turkey oak and xeric hammocks in Suwannee and Columbia counties southward to Hillsborough, Orange, and Highlands counties (Campbell 1978). The short-tailed snake seems to select habitats which are over Norfolk, Blanton, or St. Lucie fine soils. It is primarily a burrowing species and is seldom seen above-ground except in the spring and fall. Little is known of its ecological requirements. The chief concern for this species is its restriction to a habitat type which is dwindling (Campbell 1978). The short-tailed snake has been collected near Lake City (NFWL 1978). Although a limited amount of appropriate habitat (xeric oak) does exist on site, the likelihood of occurrence of this species is minimal.

The eastern indigo snake (Drymarchon corais couperi) is a large, iridescent, blue-black snake. It has been found in a variety of habitats including wet pine-palmetto flatwoods, bay swamps, glades and hammocks, and xeric sites. Its preferred habitat is believed to be mesic hammocks (Kochman 1978). Its presence in xeric sites appears to depend on sufficient cover, usually gopher tortoise burrows, to prevent desiccation (Kochman 1978). Indigo snakes have not been observed within the study area, but xeric habitat with gopher tortoise burrows and other suitable habitats along streams and tributaries are present. This species likely occurs within the study area, but the paucity of sightings indicates that population levels may be low. One specimen has been collected in the Osceola National Forest (Florida State Museum No. UF 39974), and a juvenile was observed on the Suwannee River at Dowling Park (NFWL 1978).

Birds. Wood storks (Mycteria americana) have been observed feeding and roosting in the mine areas (Figure 3.3-24). Fluctuating water levels of



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

- ● Wood stork
- ○ Southern bald eagle
- □ Peregrine falcon
- x Little blue heron, snowy egret, tricolored heron*
- △ Least tern
- ■ Suwannee cooter
- ▲ Gopher tortoise
- ⊠ Florida black bear

*These species have been observed in settling areas, hydraulic ditch systems, and reclaimed lake areas throughout the project area.

Figure 3.3-24. Sighting Locations of Endangered, Threatened, Rare, and Special Concern Fauna.

waste clay settling areas and mine pits simulate the preferred feeding habitat for this species--receding waters where prey species are concentrated and trapped (Ogden et al. 1976). Other habitats in the project area where wood storks feed, especially during droughts, include cypress heads, creek and stream beds, bayheads, areas along the Suwannee River, low ponds, and drainage ditches. Swift Creek, during low water, could serve as a feeding habitat for this species, especially the upstream portions above the existing discharge points. Cypress heads and dead trees over water serve as roosts and rookeries for this species. No rookeries were found in the project area or in Hamilton County (Colonial Bird Register 1981). The storks observed in the project area are believed to be non-breeding or post-breeding wanderers.

The southern bald eagle (Haliaeetus l. leucocephalus) is listed as threatened by the State of Florida and endangered by the U.S. Fish and Wildlife Service. The status is different because southern bald eagle populations in Florida have been less severely impacted than those in areas outside Florida (Hammerstrom et al. 1975, Peterson and Robertson 1978). The FWS listing status reflects the species' regional status and not its Florida status.

The southern bald eagle has been observed feeding and roosting on the Suwannee River Mine clay settling areas (Figure 3.3-24). Most of the individuals observed were in immature plumage, and no nesting or courtship activity has been observed. There are probably no nesting sites within the project area. The absence of nest sites in the area has been confirmed by the Florida Game and Fresh Water Fish Commission (pers. comm. Steve Nesbitt). The birds appear to be restricted to this one area within the project area.

A non-migratory subspecies of the American kestrel, the southeastern kestrel (Falco sparverius paulus) occurs throughout the Southeast. In winter, the northern subspecies (F. s. sparverius) invades the range of the southeastern kestrel, creating problems in winter censusing of the southern subspecies. The northern kestrel is larger, and subspecific differences can be detected with the bird in hand. Habitat is available for this species in the project area; the species is likely to occur in open fields and thinly wooded areas. It often nests in woodpecker cavities in dead trees and feeds on insects, small mammals, and reptiles. Habitat destruction and pesticide poisoning are the major causes of population decline for this species (Wiley 1978).

Only two sightings of peregrine falcons (Falco peregrinus) have been noted in the area--both at Suwannee River Mine settling areas (EPA 1978a, J.H. Wester pers. comm., Figure 3.3-24). Both were probably transient individuals. The site's abandoned mines, settling areas, and reclaimed lakes, which attract large concentrations of waterfowl, and numerous dead tree snags and tree perches make these areas suitable habitat for migrating peregrine falcons. The bird does not breed in Florida, but some overwinter in the state. Its optimal habitat is in coastal areas where there are numerous water birds and suitable roosting sites (Snyder 1978). This species is expected to use suitable habitat in the project area only during its fall and spring migratory flights.

Sandhill cranes (Grus canadensis) have been observed flying over the study area (EPA 1978a). These birds were probably the northern migratory subspecies. The Florida sandhill crane has been found in the southern end of the Okefenokee Swamp in Pinhook Swamp and in Impassable Bay in nearby Osceola National Forest (Williams and Phillips 1972, NFWL 1978). Bee Haven Bay, which is within the study area, is very similar to Pinhook Swamp and Impassable Bay, but this bird has not been observed there during aerial reconnaissance (EPA 1978a), nor has it been seen or heard during recent vegetation work in Bee Haven Bay. It is unlikely that this species maintains a viable population on the project site.

The little blue heron (Egretta caerulea), snowy egret (Egretta thula), and tricolored heron (Egretta tricolor) are all dependent on wetlands. The tricolored heron is more commonly found along coastal areas, and its numbers are not as great as the other two species. Surveys of wading bird breeding colonies on the Suwannee River Mine site's clay settling areas have included the little blue heron (460 individuals), snowy egret (140 individuals), and tricolored heron (90 individuals, Colonial Bird Register 1981). The clay settling areas provide suitable foraging habitat and safety from terrestrial predators. These birds were observed almost exclusively on the mining lands (Figure 3.3-24), although a few individuals were observed in non-mining areas such as roadside ditches, streams, cypress heads, bayheads, agricultural ponds, and the Suwannee River. The large amount of open water/marsh wetland habitat created by the mining process favors these species.

The least tern (Sterna albifrons) has historically nested on coastal beaches. Loss of habitat and human disturbance have eliminated many of the Florida colonies, while others have shifted to roof tops and sand tailings areas at phosphate mines (Fisk 1978). This small, shrill-voiced tern nests on bare or lightly-vegetated sand tailings at the Suwannee River Mine. Three colonies (Figure 3.3-24) were monitored in 1979 by the Colonial Bird Register (1981), and all colonies had successful nests. Whether many of the hatched young lived to fledge is unclear. The abundance of terrestrial and aerial predators in the area probably causes a very high mortality rate among the young birds. Nevertheless, population numbers in the three colonies began at approximately 140 and climbed to at least 230 during the hatching period; some young were undoubtedly reared successfully. This species is favored by the presence of sand tailings habitat, although the habitat is probably not the most suitable for the birds. The birds will probably remain on the site as long as appropriate sand tailings habitat is present. Nesting colonies would only be present during May, June, and July.

The red-cockaded woodpecker (Picoides borealis), a medium-sized woodpecker with basically black and white markings, is very habitat-specific, requiring open, mature to over-mature pine flatwoods, a subclimax condition caused by frequent burning (Sprunt 1954). Fire control and timber management practices have reduced this type of habitat so that today this species is endangered. Much of the study area is covered in pinelands, but the age of the pines and the understory in the pinelands make the habitat unsuitable for this endangered woodpecker. Most pineland areas of suitable age were surveyed on foot, and no evidence of this bird's presence was found. It is very unlikely, therefore, that the red-cockaded woodpecker occurs within the project area.

Mammals. The gray bat (*Myotis grisescens*) ranges throughout Alabama, Kentucky, Missouri, Tennessee, and the Florida panhandle (Barbour and Davis 1969). The species is limited in its tolerance of roosting habitats, requiring caves with narrow temperature ranges (Humphrey and Tuttle 1978), although two summer colonies have been reported outside of caves (Barbour and Davis 1969). Migrations of long distances often occur between summer and winter roosts. Foraging occurs over streams, rivers, reservoirs, and adjacent vegetation (Humphrey and Tuttle 1978).

One specimen has been collected near Lake City (Florida State Museum), and two were collected in the Osceola National Forest (NFWL 1978), one of which was a juvenile. The age of the specimen and season of collection indicate a nursery colony nearby. There is appropriate foraging habitat in the project area (Swift Creek, Camp Branch, Rocky Creek, Suwannee River, Hunter Creek) and possible roosting areas. However, occurrence within the project area is highly unlikely due to the rarity of this species and the lack of suitable caves in the area.

Sherman's fox squirrel (*Sciurus niger shermani*) was an inhabitant of the virgin pine forests of the southeastern coastal plain (Moore 1957). These forests are for the most part gone, and this species is now found in open pine-palmetto flatwoods, high pinelands, swamp borders, and bayheads (Moore 1957). The primary concern for this species is loss and alteration of habitat (Ehrhart 1978). Fox squirrels were observed in the nearby Osceola National Forest (NFWL 1978), and one specimen was collected near Lake City (Florida State Museum No. UF 4742).

As habitat preferences (pine flatwoods) of the Sherman's fox squirrel and red-cockaded woodpecker overlap in the Osceola National Forest (NFWL 1978), it is probable that the habitat present in the project area is unsuitable for Sherman's fox squirrel because the area does not meet the requirements of the red-cockaded woodpecker. This and previous studies (EPA 1978a) have failed to record this species within the project area. Population levels of Sherman's fox squirrel, if present, would be very low.

The Florida mouse (*Peromyscus floridanus*) is endemic to Florida. It is restricted to xeric scrub vegetation associations such as high pinelands and xeric hammocks (Layne 1963). Burrows of the gopher tortoise and southeastern pocket gopher (*Geomys pinetis*) are used for nest sites (Blair and Kilby 1936, Johnson and Layne 1961). The current known geographical range is just south of the project area (Layne 1978). Efforts to collect this species have not been successful in either the Osceola National Forest (NFWL 1978) or in a previous study of the Swift Creek basin (EPA 1978a). One specimen has been collected near Falmouth, Suwannee County, >30 mi from the project area. The presence of the Florida mouse in the project area is possible because of suitable habitat, but trapping efforts and geographical range data make it more likely that this species is absent.

The basis for the threatened classification of the Florida black bear (Ursus americanus floridanus) is habitat loss (Williams 1978). Williams (1978) maintains that there are only two areas in Florida that support substantial populations: 1) Apalachicola National Forest and 2) Okefenokee Swamp south, up to and including Osceola National Forest. Optimal habitat for this species is a combination of pine-palmetto, flatwoods, swamps, scrub oak, bayheads, and hammocks (Harlow 1962). Food habits vary seasonally, with herbaceous matter and occasionally insects and armadillos taken (Harlow 1962, NFWL 1978). Florida black bears have been observed in the study area, and one was reported killed in the Bee Haven Bay area (EPA 1978a). Bear scat was collected in Bee Haven Bay during vegetation surveys for this study, and several unconfirmed hunter sightings have been reported in the project area (Figure 3.3-24). It is expected that the bears in the study area, similar to those in the National Forest, use the ecotone around the bay as foraging areas and the interior of the bay itself as a refuge from man (NFWL 1978). Although present in the study area, population levels are believed to be relatively low. Black bears are hunted in the Osceola National Forest and the Apalachicola National Forest.

Fish. The Atlantic sturgeon (Acipenser oxyrhynchus) occurs on the Atlantic coast from Labrador southward to the St. Johns River. In the Gulf, it occurs from the Mississippi River to Tampa Bay (Gilbert 1978a). It is an anadromous species, ascending the Suwannee River in March and returning to the sea in November (Huff 1975). Spawning sites are believed to be between Ellaville and White Springs, but exact locations are not known. Related species and the Atlantic coast subspecies are known to spawn in shoal areas. Shoal areas do exist between Ellaville and White Springs on the Suwannee River. Adult sturgeon have been observed in Ellaville during the spawning season (Huff 1975).

The Suwannee bass (Micropterus notius) inhabits shoal areas with moderate currents and either hard bottoms, such as limestone, or sand bottoms (Gilbert 1978b). Food items include a variety of aquatic organisms such as crayfish and smaller fish (Bass and Hitt 1973). The range of this species is the lower Ochlockonee and lower Suwannee River systems, with the latter system including the Sante Fe and Ichetucknee Rivers. This species is not found in the upper Suwannee.

3.3.8 Upland Habitat Evaluation

The upland habitats in the project area were evaluated using the Habitat Evaluation System (HES) developed by the U.S. Army Corps of Engineers (ACOE 1980). The modified procedure used to evaluate the subject area is contained in Section 3.3.11.4. This evaluation system was chosen because of its:

- applicability to a broad range of habitats and wildlife species;
- ability to be easily modified in consideration of geographical, seasonal, climatic, and land use factors;
- capability of yielding results that can be replicated;
- capability of implementation within reasonable time and cost constraints; and
- high potential for application in the ACOE decision-making process (Erickson et al. 1980).

This evaluation system quantifies general habitat characteristics, both abiotic and biotic factors, as the basis for scoring habitat quality rather than basing the evaluation on usage by selected species, which is the basis of the U.S. Fish and Wildlife Service Habitat Evaluation Procedure (FWS 1980b).

The main constraint identified with HES is its geographical restriction to the lower Mississippi River valley (Erickson et al. 1980). However, with slight modification the procedure is easily applied to Florida and other areas of the southeastern U.S.

Upland habitats in the project area were categorized into one of three habitat types:

1) Bottomland hardwoods
   - Mixed forest
2) Upland forest
   - Pine flatwoods
   - Other hardwoods
   - Planted pine-coniferous
   - Clearcut areas
3) Open lands
   - Row crops
   - Field crops
   - Improved pasture
   - Deciduous orchard
   - Poultry

Developed areas (Table 3.3-1) were excluded from the evaluation.

Selected abiotic and biotic characteristics were evaluated and scores weighted to provide an overall habitat value (scale 0-100) for the habitat categories (Section 3.3.11.4). Habitats were evaluated in four major tributary drainage basins in the project area: Hunter Creek, Roaring Creek, Rocky Creek, and Swift Creek. Mixed forest communities were evaluated using the bottomland hardwoods criteria of HES because of their location next to the creek. They were not classified as wetlands, as they did not meet the criteria or definition of wetlands used for this study (Section 1.2). These mixed forest areas were evaluated only along Swift and Hunter creeks. This habitat category was not evaluated or mapped in the Roaring Creek and Rocky Creek basins due to the extreme narrowness of the vegetation strips along the creeks.

Results of the evaluation indicate that upland habitats in the project area are generally of low to moderate value (Table 3.3-73). Upland forest habitat values range from 32.8 to 42.1, with an average of 35.9 for the project area (Table 3.3-73). This value is relatively low based on the 0-100 scale of evaluation. Much of the upland forest category is planted pine which scores low for several of the evaluation characteristics, particularly percent understory and ground cover, number of mast trees, and number of large trees (Section 3.3.11.4), as a result of silviculture practices and harvesting schedules.

Habitat values of open lands range from 50.3 to 62.6, with an average value for the project area being moderate (57.3).

Values for bottomland hardwoods range from 57.4 to 65.3, with an average of 64.7 for the project area. These higher values are the result of greater vegetative complexity and maturity in bottomland hardwoods than in upland forest systems in the project area.

These results indicate that the project area's habitat value for upland fauna ranges from low to moderate and that, based on the habitat evaluation results, there are no significant areas of high habitat value in the project area.

Table 3.3-73. Summary of Habitat Values by Basin.

Basin/Habitat Category	No. of Sites	No. of Plots	Calculated Habitat Value	Standard Deviation	Coefficient of Variation
Hunter Creek					
Bottomland Hardwoods	2	13	57.4	19.0	0.3
Upland Forest	5	73	36.2	15.5	0.4
Open Lands	3	30	62.6	7.0	0.1
Roaring Creek					
Bottomland Hardwoods*	-	-	-	-	-
Upland Forest	6	69	35.1	12.3	0.4
Open Lands	2	10	56.5	10.6	0.2
Rocky Creek					
Bottomland Hardwoods*	-	-	-	-	-
Upland Forest	9	118	32.8	11.7	0.4
Open Lands	2	10	56.8	5.0	0.1
Swift Creek					
Bottomland Hardwoods	2	10	65.3	10.9	0.2
Upland Forest	5	67	42.1	14.5	0.3
Open Lands	2	21	50.3	12.9	0.3
Entire Project Area					
Bottomland Hardwoods	4	23	64.7	25.5	0.4
Upland Forest	25	327	35.9	13.6	0.4
Open Lands	9	71	57.3	10.6	0.2

*Habitat not of sufficient size to evaluate; see text.

3.3.9 Wetlands Evaluation

3.3.9.1 Wetlands Definition

Wetlands are lands where saturation with water is the dominant factor determining the nature of the soil and type of plant and animal communities in the soil and on its surface. For this study, the ACOE definition of wetlands as cited in 33 CFR 320 was used:

> ...those areas that are inundated or saturated by surface or groundwater at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

A variety of natural services are attributed to wetlands in Section 404 of the Clean Water Act (Public Law 92-500, as amended), President Carter's May 24, 1977 Executive Order on wetlands protection, and other statutory and administrative authorities. These services are summarized in the following examples:

1) Wetlands which serve important natural biological functions, including food chain production, general habitat, and nesting, spawning, rearing, and resting sites for aquatic and land species.

2) Wetlands set aside for study of the aquatic environment, sanctuaries, or refuges.

3) Contiguous wetland areas whose destruction or alteration would affect detrimentally the natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, current patterns, or other environmental characteristics of the above areas.

4) Wetlands which are significant in shielding other areas from wave action, erosion, or storm damage (such as barrier beaches, islands, reefs, and bars).

5) Wetlands which serve as valuable storage areas for storm and flood waters.

6) Wetlands which are prime natural recharge areas, i.e., locations where surface and groundwater are directly interconnected.

7) Wetlands which through natural water filtration serve to purify water.

Although many people perceive wetlands as valuable natural resources providing these services, the extent or value of the service(s) performed depends on many factors such as prior disturbance, hydrological connection, vegetation structure and diversity, and size. The relationship of these parameters to wetland values is discussed further in the following subsections. Additionally, selected wetlands on the project site were evaluated utilizing a modification of the Wetlands Evaluation Procedure (WEP) developed by the U.S. Army Corps of Engineers (Reppert et al. 1979) and the Method for Wetland Functional Assessment developed for the Federal Highway Administration (Adamus 1983). The results of these evaluations are presented in Appendix C.

3.3.9.2 Regional Wetland Communities

There are >1,000,000 acres of wetlands in the Suwannee River basin which includes 12 counties in north Florida and 17 counties in south Georgia (Table 3.3-74). Florida estimates were based on a U.S. Department of Agriculture study (USDA 1977) of the Northeast Gulf river basins in which seven wetlands communities were delineated and acreages estimated. Table 3.3-75 lists the species typically found in the seven community types. Wetlands in the Georgia portion of the Suwannee River basin were delineated on acetate overlays of c. 1979 black-and-white photography (scale 1:40,000) and ground-truthed, with wetland communities classified in the same manner as those in the USDA (1977) survey. The B.1 community (sawgrass marsh) of the USDA survey could not reliably be distinguished from the B.2 community (cattail-bulrush-maidencane marsh) on a scale of 1:40,000 for the Georgia portion of the basin; thus, both of these freshwater types were classified as B.2. Forested wetlands (Categories A.1, A.2, and A.3) comprise 91.5% of the wetland acreage in the Suwannee River basin, while freshwater marshes (B.1, B.2, and B.3) and saltwater marshes (C) comprise 7.5% and 1.0%, respectively.

The value of these wetland communities is related to the degree of hydrological connection to flowing water systems, vegetation structure and diversity, and size, all of which affect habitat potential. Wetland systems that are directly tied hydrologically to flowing water systems serve more functions and serve them more efficiently than isolated or weakly-tied systems. Certain wetlands may be considered special case wetlands in that they are perceived to have higher values based on their uniqueness, cultural history, and/or recognition as nature study areas or refuges. The Okefenokee Swamp would be such a special case wetland. It is the largest wetland within the Suwannee River basin and serves as the headwaters of both the Suwannee and St. Marys rivers. The Okefenokee Swamp ranks as a valuable wetland based on its uniqueness, size, and recognition as an important natural resource (Wright and Wright 1932, Schlesinger 1978, Wharton 1978, and Bosserman 1981).

A hierarchy of freshwater wetland types in the Suwannee River basin can be established based on hydrological connection, vegetation structure and diversity, size, and/or uniqueness. This hierarchy, in order of ascending value, is as follows:

Table 3.3-74. Wetland Communities of the Suwannee River Basin.

Category*	Community	Florida Acreage	Georgia Acreage	Total Acreage	% of Total
A.1	River, creek, and lake overflow areas	37,500	119,200	156,700	14.6
A.2	Bogs and bayheads	59,400	377,950	437,350	40.7
A.3	Inland ponds and sloughs	156,700	231,800	388,500	36.2
B.1	Sawgrass marshes[1]	9,220	0	9,220	0.9
B.2	Cattail-bulrush-maidencane marshes[2]	2,530	56,600	59,130	5.5
B.3	Wet prairies	0	12,100	12,100	1.1
C	Spartina and needlerush marshes	10,600	0	10,600	1.0
	TOTAL	275,950	797,650	1,073,600	100.0

*See Table 3.3-75.

[1]Included under cattail-bulrush-maidencane marshes in Georgia study area.

[2]Includes sawgrass marshes in Georgia study area.

Source: USDA 1977 and EIS field studies.

Table 3.3-75. Major Species Found In Wetland Communities of the Suwannee River Basin.

A. Freshwater Swamps

1. River, creek, and lake overflow areas

- Pond cypress (*Taxodium ascendens*)
- Bald cypress (*Taxodium distichum*)
- Red maple (*Acer rubrum*)
- River birch (*Betula nigra*)
- Black willow (*Salix nigra*)
- Coastal plain willow (*Salix caroliniana*)
- Swamp tupelo (*Nyssa biflora*)
- Ogeechee tupelo (*Nyssa ogeche*)
- Water hickory (*Carya aquatica*)
- Water ash (*Fraxinus caroliniana*)
- Buttonbush (*Cephalanthus occidentalis*)
- Sweetbay (*Magnolia virginiana*)

2. Bogs and bayheads

- Pond pine (*Pinus serotina*)
- Loblolly bay (*Gordonia lasianthus*)
- Sweetbay (*Magnolia virginiana*)
- Red bay (*Persea borbonia*)
- Titi (*Cyrilla racemiflora*)
- Sphagnum moss (*Sphagnum sp.*)
- Water willow (*Decodon verticillatus*)
- Fetterbush (*Lyonia lucida*)
- Sweet pepperbush (*Clethra alnifolia*)
- Buttonbush (*Cephalanthus occidentalis*)
- Virginia willow (*Itea virginica*)
- Swamp tupelo (*Nyssa biflora*)

3. Inland ponds and sloughs

- Pond cypress (*Taxodium ascendens*)
- Swamp tupelo (*Nyssa biflora*)
- Water tupelo (*Nyssa aquatica*)
- Titi (*Cyrilla racemiflora*, *C. parviflora*)
- Black titi (*Cliftonia monophylla*)
- Willow (*Salix* sp.)
- Primrose willow (*Ludwigia peruviana*)
- Pond apple (*Annona glabra*)
- Red maple (*Acer rubrum*)
- Fetterbush (*Lyonia lucida*)
- Waxmyrtle (*Myrica cerifera*)

B. Freshwater Marshes

1. Sawgrass marshes

- Sawgrass (*Cladium jamaicense*)
- Arrowhead (*Sagittaria* spp.)
- Maidencane (*Panicum hemitomon*)
- Cattail (*Typha domingensis*, *T. latifolia*)
- Pickerelweed (*Pontederia cordata*)
- Buttonbush (*Cephalanthus occidentalis*)
- Spartina (*Spartina bakeri*)
- Switchgrass (*Panicum virgatum*)

2. Cattail-bulrush-maidencane marshes

- Bulrush (*Scirpus validus*, *S. americus*, *S. robustus*, *S. cyperinus*)
- Cattail (*Typha latifolia*, *T. domingensis*)
- Maidencane (*Panicum hemitomon*)
- Spartina (*Spartina bakeri*)
- Pickerelweed (*Pontederia cordata*)
- Water lily (*Nymphaea* spp.)
- Spatterdock (*Nuphar advena*)
- Buttonbush (*Cephalanthus occidentalis*)
- Soft rush (*Juncus effusus*)
- Common reed (*Phragmites communis*)
- Bladderwort (*Utricularia* spp.)
- Sawgrass (*Cladium jamaicense*)
- Arrow-arum (*Peltandra virginica*)
- Arrowhead (*Sagittaria lancifolia*, *S. latifolia*)

3. Wet prairies

- Maidencane (*Panicum hemitomon*)
- Cordgrasses (*Spartina bakeri*)
- Spike rush (*Eleocharis* spp.)
- Beak rush (*Rhynchospora* spp.)
- St. John's wort (*Hypericum* spp.)
- Spiderlily (*Hymenocallis palmeri*)
- Swamplily (*Crinum americanum*)
- Yellow-eyed grass (*Xyris* spp.)
- Whitetop sedge (*Dichromena colorata*)

Table 3.3-75 (Continued).

C. Saltwater Marshes

Spartina and needlerush marshes

Cordgrasses (*Spartina alterniflora*, *S. patens*, *S. cynosuroides*, *S. spartinae*)
Needlerush (*Juncus roemerianus*)
Seashore saltgrass (*Distichlis spicata*)
Saltwort (*Batis maritima*)
Glassworts (*Salicornia* spp.)
Finger rush (*Fimbristylis castanea*)
Salt dropseed (*Sporobolus virginicus*)
Seaside daisy (*Borrichia frutescens*)
Salt jointgrass (*Paspalum vaginatum*)

Wetland Type	USDA (1977) Category
° seasonal wet prairie depressions	B.3
° small, isolated marshes	B.1, B.2
° small, isolated cypress domes and bayheads	A.2, A.3
° marshes bordering perennial streams	B.1, B.2
° forested wetlands bordering perennial streams	A.1
° marshes bordering river systems	B.1, B.2
° forested wetlands bordering river systems	A.1
° special case areas (e.g., Okefenokee Swamp)	All

3.3.9.3 Extent of Wetlands in the Project Area

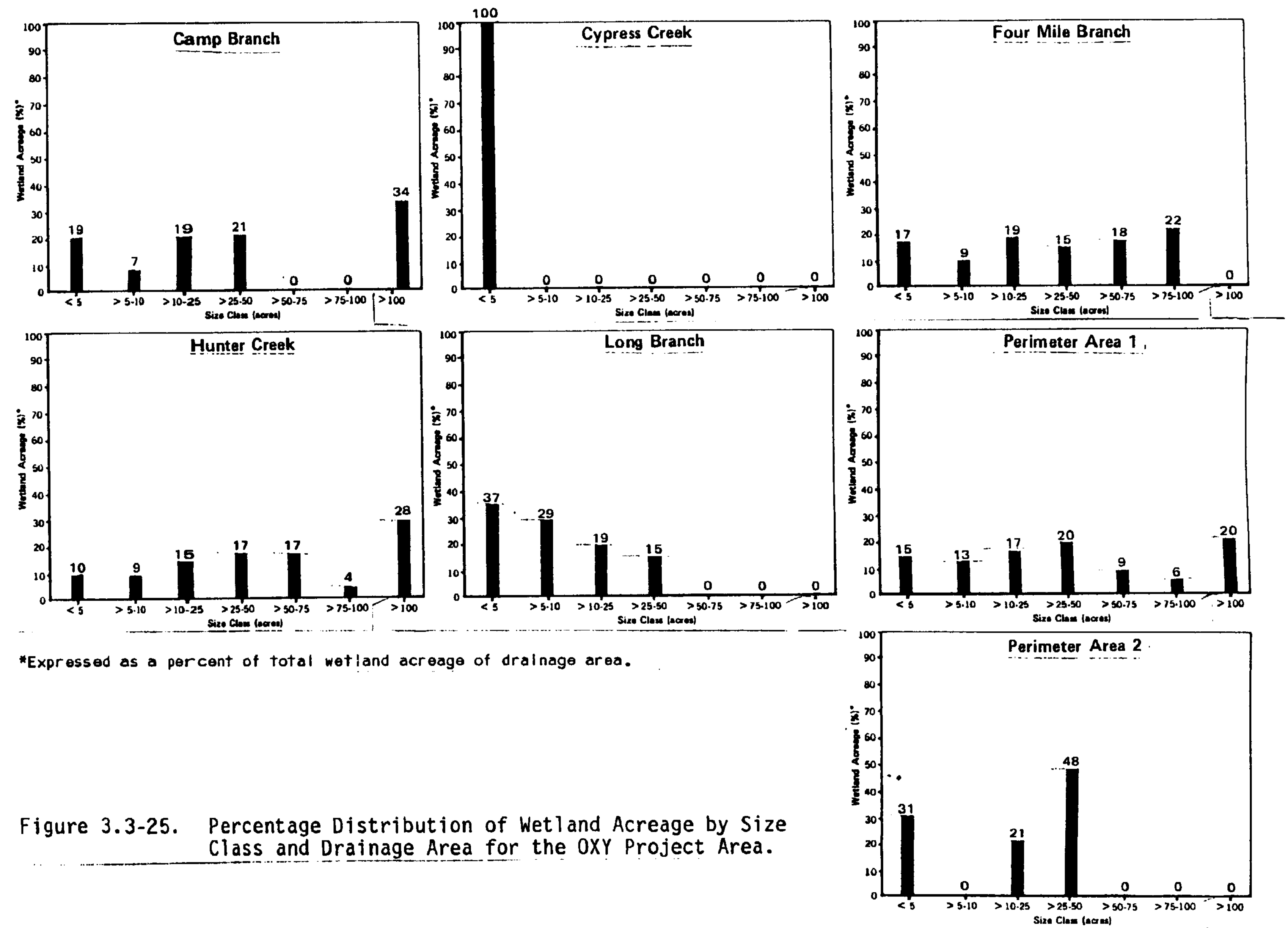
The project area lies within the Suwannee River basin in Hamilton County, Florida. The total land area of Hamilton County is approximately 327,578 acres (Barr, Dunlop, and Associates, Inc. 1976). The National Wetlands Reconnaissance Survey by the U.S. Fish and Wildlife Service reported 73,481 acres of wetlands in Hamilton County and 11,432,462 wetland acres in the State of Florida, of which 10,351,494 acres are freshwater wetlands (FWS unpublished data). In the project area, approximately 25,000 acres of wetlands have been delineated and classified (Section 3.3.3); a maximum of 37% of this wetland acreage will be affected by the proposed mining or mine support activities. The wetland acreage in the project area accounts for 2% of wetlands in the Suwannee River basin and 34% in Hamilton County; a maximum of 0.9% of the Suwannee River basin wetlands and 13% of the Hamilton County wetlands will be affected by mining and mine support activities. On a statewide basis, the acreage of wetlands in the project area accounts for 0.2% of the wetland acreage in Florida; <0.1% of this acreage would be disturbed. Percentages of forested and non-forested wetlands are presented in Table 3.3-76.

In the project area, 1762 individual wetland units cover approximately 24,735 acres or 25% of the total project area. Approximately 92% of the wetland units in the project area are <25 acres (Figures 3.3-25 and 3.3-26, Table 3.3-77); 8% of the wetland units account for 76% of the wetland acres, the largest wetland tracts being Swift Creek Swamp and Bee Haven Bay.

Wetland acreage within drainage basins in the OXY project area varies from 6% to 61% of the total drainage basin acreage in the project area, with the average wetland composition of drainage areas being approximately 30% (Table 3.3-78 and Figure 3.3-27). The number of individual wetlands within drainage areas ranges from 2 (<1% of total wetland units) to 333 individual wetland units (19%).

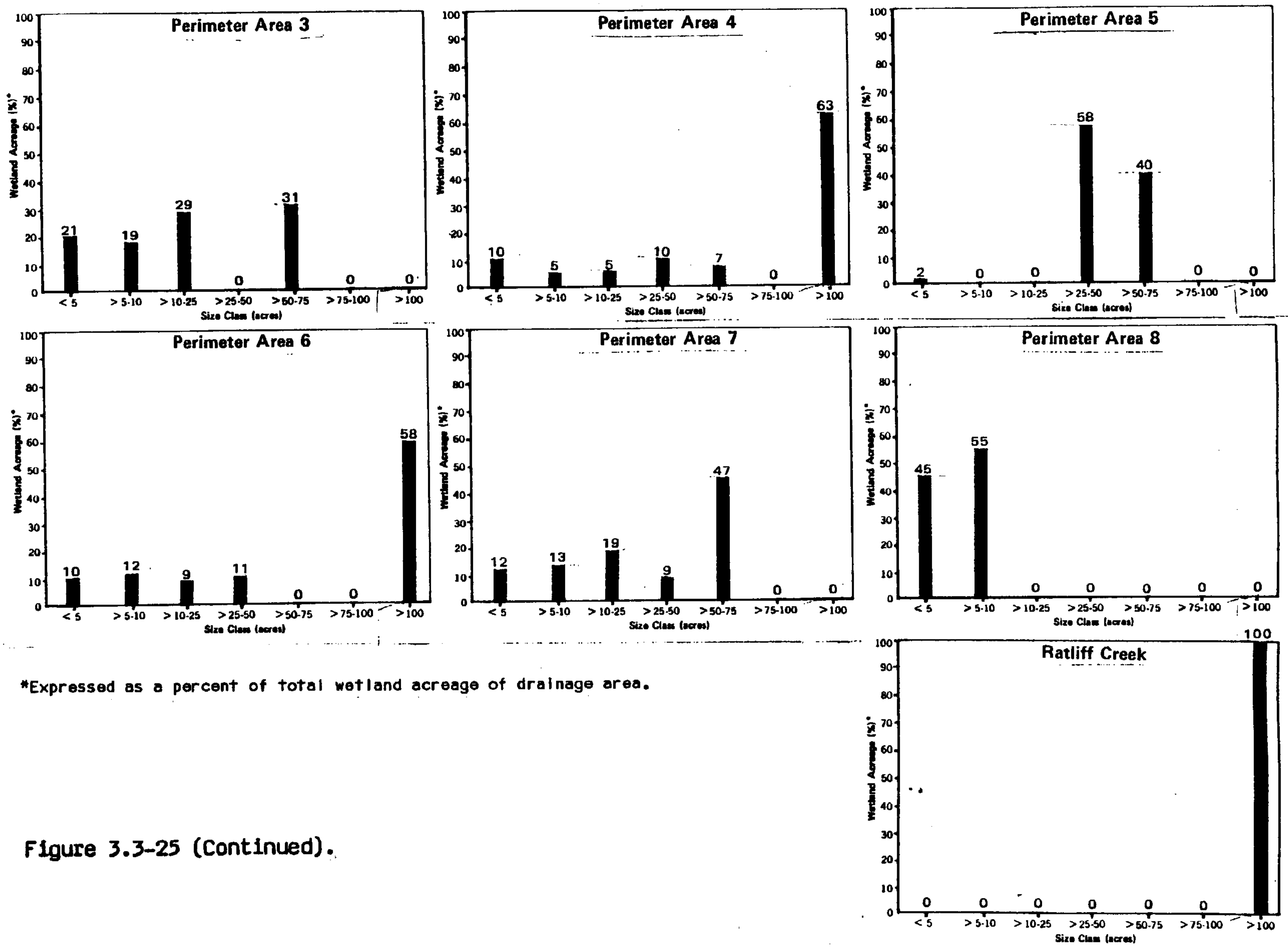
Table 3.3-76. Acreages of State and Regional Wetlands.

Area	Wetland Type		Total
	Forested	Non-Forested	
Project area wetlands	24,305	430	24,735
% of Hamilton County wetlands	33	1	34
% of Suwannee River basin wetlands	2	<0.1	2
% of Florida wetlands	0.2	<0.1	0.2



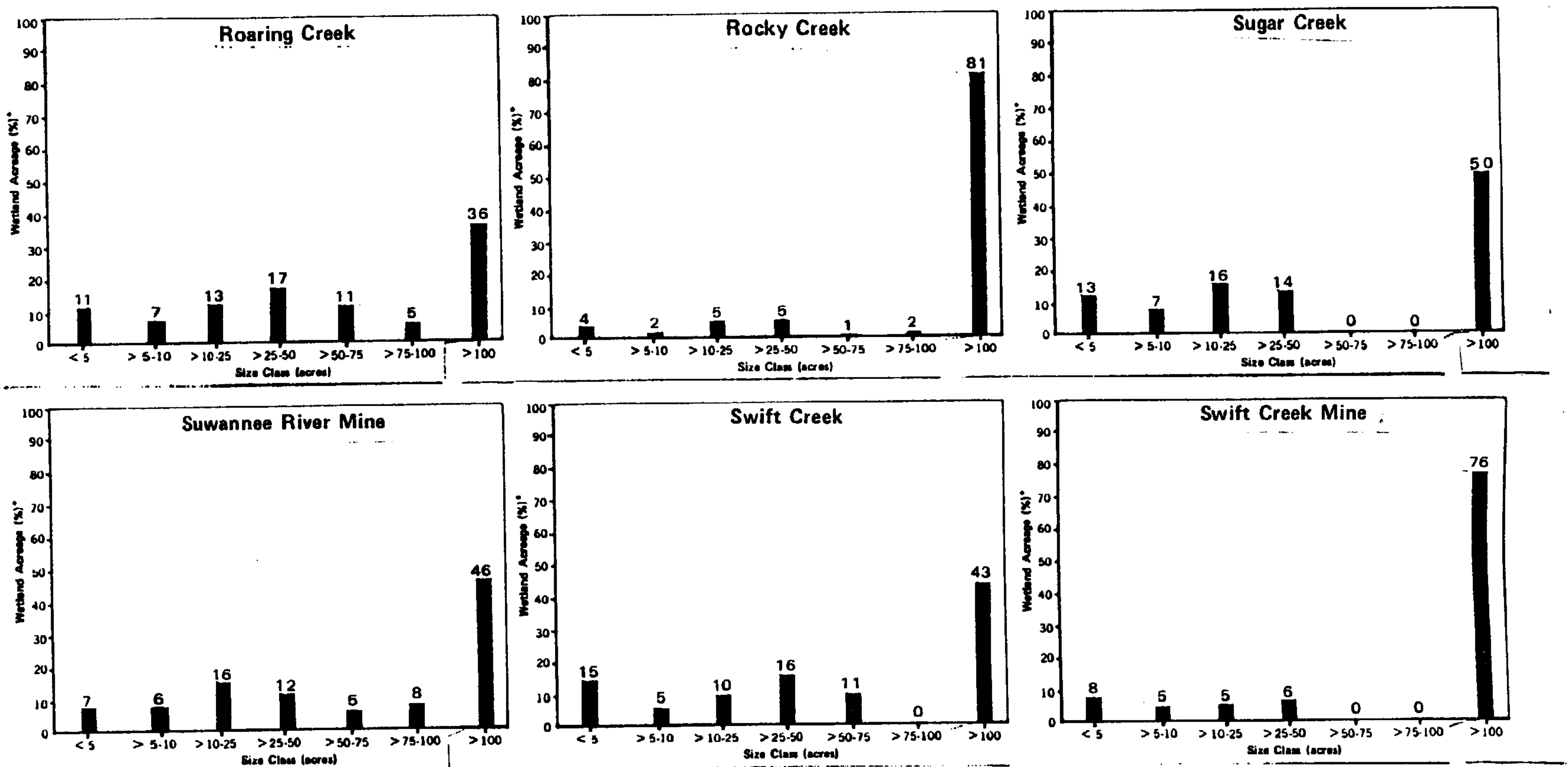
*Expressed as a percent of total wetland acreage of drainage area.

Figure 3.3-25. Percentage Distribution of Wetland Acreage by Size Class and Drainage Area for the OXY Project Area.



*Expressed as a percent of total wetland acreage of drainage area.

Figure 3.3-25 (Continued).



*Expressed as a percent of total wetland acreage of drainage area.

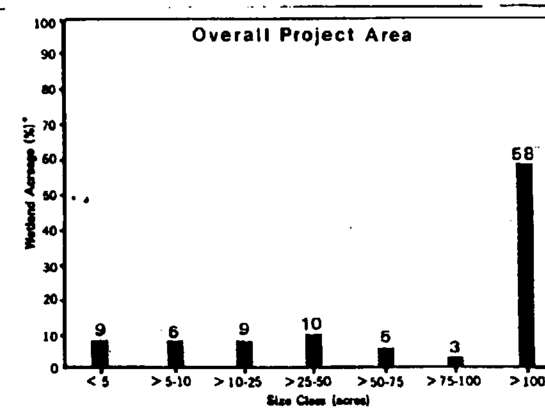


Figure 3.3-25 (Continued).

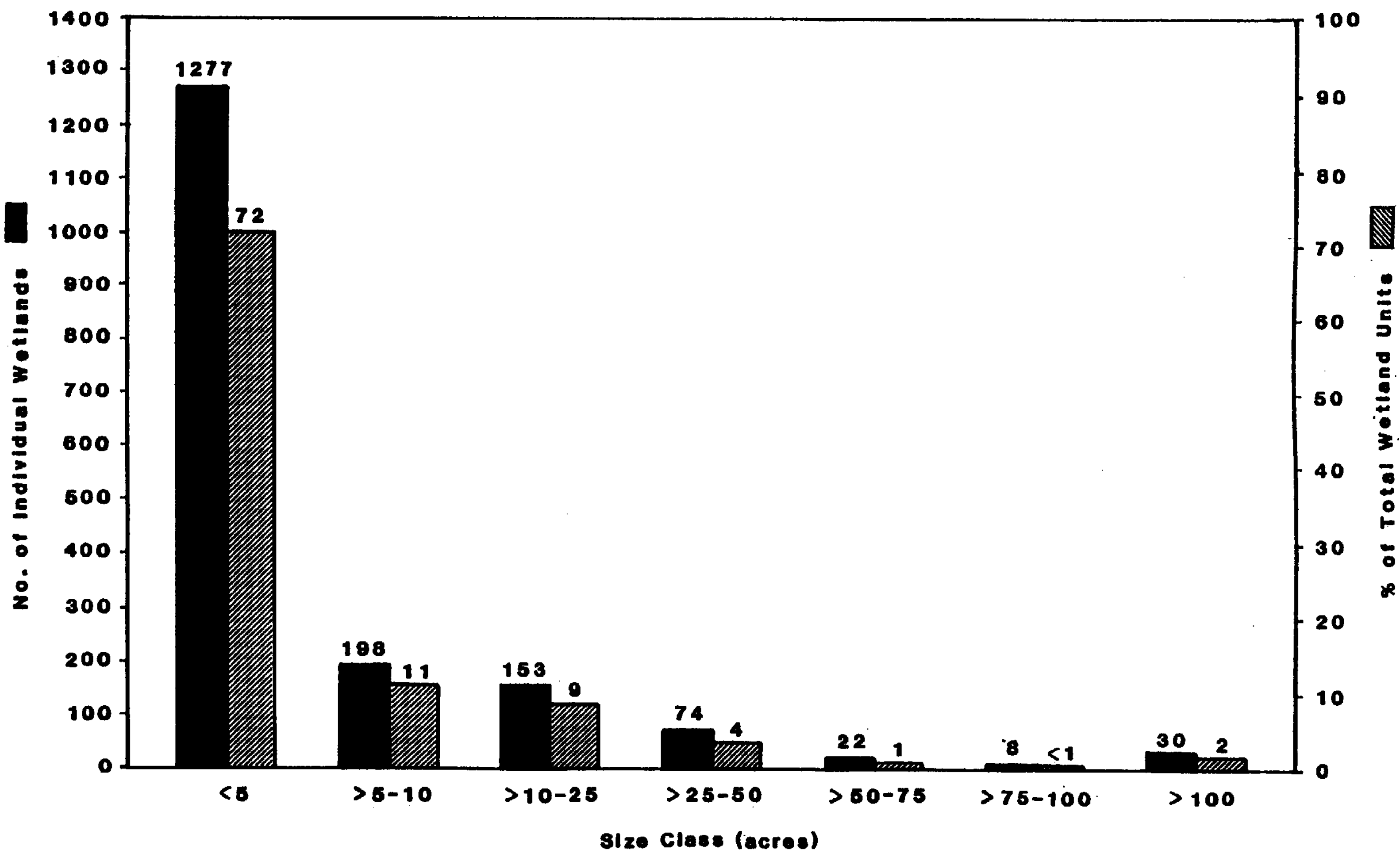


Figure 3.3-26. Size Class Distribution of Individual Wetlands in the OXY Project Area.

Table 3.3-77. Size Class Distribution of Individual Wetlands.

Size Class (acres)	No. of Individual Wetlands	%
<5	1277	72
>5-10	198	11
>10-25	153	9
>25-50	74	4
>50-75	22	1
>75-100	8	<1
>100	30	2

Table 3.3-78. Total Wetland Acreage and Number of Individual Wetland Units Within Drainage Areas on the OXY Project Site.

Drainage Area*	Total Acreage On Site	Wetland Acreage On Site	% of Drainage Area	No. of Wetland Units	% of Total
Camp Branch	5,356	1,092	20	160	9
Cypress Creek	143	9	6	8	<1
Swift Creek Mine	14,152	3,269	23	186	11
Four Mile Branch	1,887	387	21	53	3
Hunter Creek	8,395	2,100	25	209	12
Long Branch	2,374	223	9	68	4
Ratliff Creek	461	278	60	2	<1
Rocky Creek	18,690	9,462	51	333	19
Suwannee River Mine	18,576	2,174	12	156	9
Roaring Creek	6,519	1,425	22	117	7
Swift Creek	5,219	672	13	70	4
Sugar Creek	2,144	494	23	54	3
Perimeter Area 1	5,039	1,308	26	156	9
Perimeter Area 2	859	56	7	12	<1
Perimeter Area 3	1,725	172	10	40	2
Perimeter Area 4	3,505	708	20	49	3
Perimeter Area 5	423	121	29	4	<1
Perimeter Area 6	1,695	327	19	34	2
Perimeter Area 7	2,362	406	17	36	2
Perimeter Area 8	680	52	8	15	<1
TOTAL	100,204	24,735	25	1,762	100

*See Figure 3.3-27.

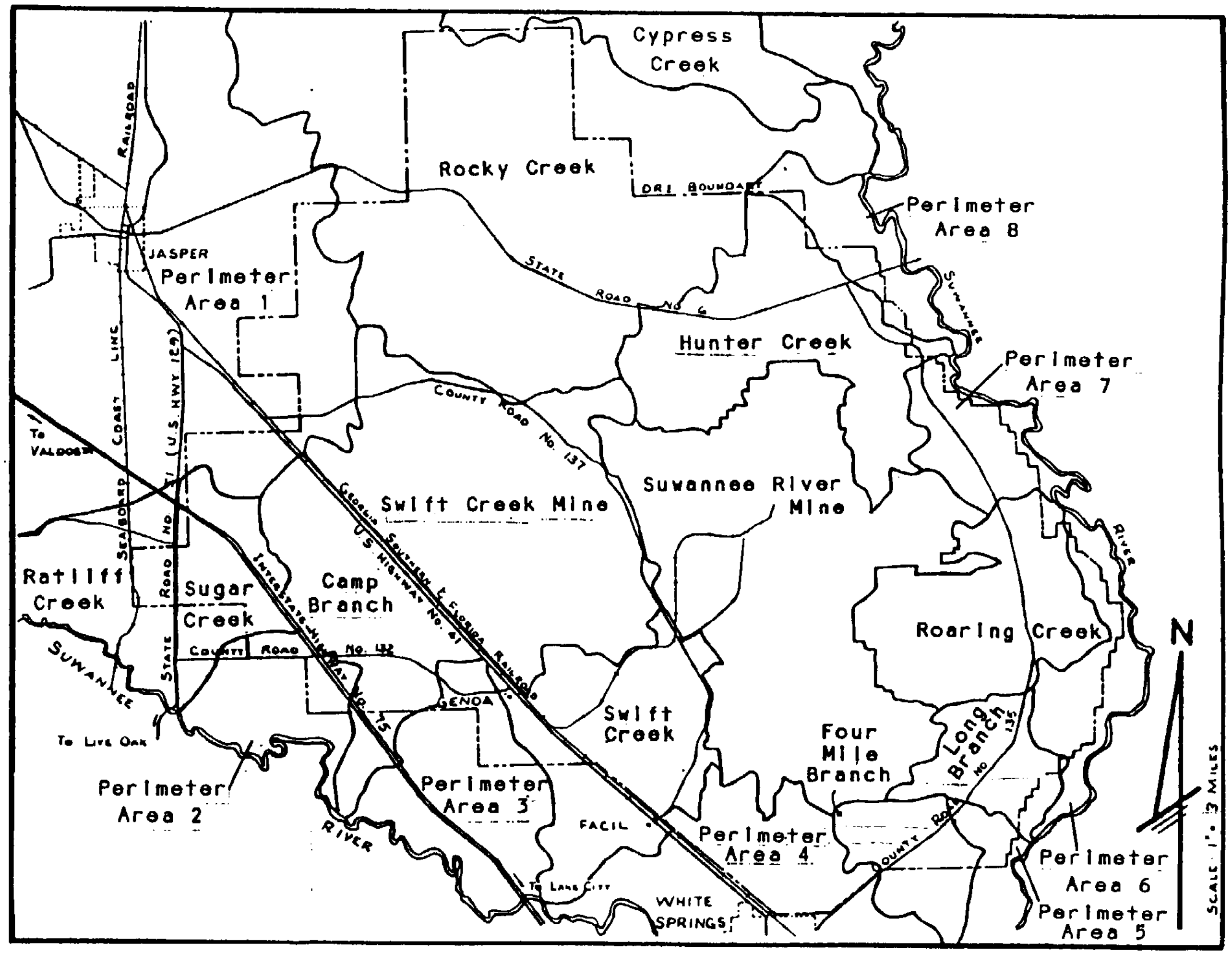


Figure 3.3-27. Drainage Areas as of 1 January 1982.

3.3.10 Reclaimed Lands

3.3.10.1 Land Reclamation Regulations--State of Florida

Reclamation of lands mined in Florida for the extraction of phosphate rock is regulated under Chapter 378 and Chapter 211, Part II, of the Florida Statutes (FS). Chapter 211, Part II, FS, requires the mandatory reclamation of all lands mined for the extraction of phosphate since 1 July 1975. Chapter 16C-16 of the Florida Administrative Code (FAC) implements the law and establishes the applications to be submitted, standards to be achieved, inspection procedures, program release procedures, and reporting requirements. The Florida Department of Natural Resources (FDNR) is responsible for administering the reclamation process. The inset material in the following sections is taken directly from Chapters 16C-16 and 16C-17, FAC.

3.3.10.1.1 Chapter 16C-16, FAC, Applications

An approved reclamation program is necessary prior to an operator commencing reclamation activities. A conceptual reclamation plan must be submitted for each individual mine. Chapter 16C-16.041, FAC, states:

> (2) The conceptual plan shall include at least the following information concerning all lands subject to the provisions of Chapter 211, Part II, Florida Statutes:
>
> (a) The present or proposed location of structures which will or may remain beyond the completion of mining operations.
>
> (b) The present or proposed location of gypsum piles and other solid waste storage areas.
>
> (c) The present or proposed location of clay wastes storage areas and whether such storage will be above or below natural grade, as well as how long such areas will be used in mining operations.
>
> (d) The general contours, land uses, waterbodies, wetlands, and surface drainage patterns, including demarcation of watershed boundaries, for all affected lands and for one-quarter (1/4) mile of the area beyond the boundaries of the affected lands as they existed or exist prior to mining operations.
>
> (e) The general contours, land uses, waterbodies, wetlands, and surface drainage patterns, including demarcation of watershed boundaries, which can be expected after reclamation is completed.
>
> (f) The habitat types and vegetation communities which existed or exist before mining and which can be expected after reclamation or restoration is complete.

(g) The presence and location of any endangered or threatened plant or animal species and their critical habitat which existed or exist before mining operations and what restoration is planned.

(h) Identification of areas which will not be mined to remove ore and how the natural resources will be conserved and preserved, as specified in 16C-16.053, Florida Administrative Code.

(i) A description of other appropriate reclamation and restoration activities which the operator plans to engage in to meet the requirements of 16C-16.051, Florida Administrative Code.

(j) Identification of affected lands within the mine which are not subject to the requirements of Chapter 211, Part II, Florida Statutes, and the status of these lands.

(k) Identification of the lands within the mine which will not be disturbed by the mining operations.

(l) Identification of areas for which permits, licenses, or other regulatory permissions or permissions to use state or federal lands prior to undertaking mining operations may need to be obtained or have been obtained.

In addition to submittal of conceptual plans, Chapter 16C-16.032, FAC, requires:

(1) Each applicant shall submit annually an application for approval of a reclamation and restoration program on the form included in this chapter.

(a) The application submitted shall be filed with the bureau each year on or before either:

1. The anniversary date of the final approval of the Development of Regional Impact if the mining unit is included in an area approved pursuant to 380.06, Florida Statutes, or

2. A date acceptable to the bureau for a mining unit not included in an area approved pursuant to 380.06, Florida Statutes.

3. In implementing Subsection (1), this requirement shall take effect on January 1, 1981. However, this should not be construed to prevent an operator from voluntarily filing an application pursuant to this Section prior to January 1, 1981.

(b) The application shall include:

1. A description of the proposed mining unit indicating the quarter-quarter section, township, range, and county, and otherwise describe the land so that it may be located and distinguished from other lands. The proposed mining unit will cover a one-year period of mining, such year to commence six (6) months from the date the application is due to be filed with the bureau as specified above.

2. A proposed reclamation and restoration program for the mining unit in compliance with the provisions of this chapter.

3. A report of radioactivity monitoring in compliance with Rule 16C-16.051(8).

(c) The operator may elect to file a biennial application which covers two annual mining units. The biennial application shall be filed in accordance with the requirements of Paragraphs (1)(a) and (b) above.

3.3.10.1.2 <u>Chapter 16C-16, FAC, Standards</u>

Chapter 16C-16.051, FAC, sets forth the minimum criteria and standards which must be addressed in a program application in order for the program to be approved. The standards are:

(1) Safety.

(a) Site cleanup. All lands reclaimed shall be completed in a neat, clean manner by removing or adequately burying all visible debris, litter, junk, worn-out or unuseable equipment or materials, as well as all footings, poles, piling, and cables. If any large rocks or boulders exist as a result of mining, these should be left either at the surface where they are distinctly visible or placed in mined-out areas and covered to a minimum depth of four (4) feet. For limestone, dolomite, and hard-rock phosphate pits, the boulders should be placed at the base of any highwalls to assist in the establishment of acceptable slopes or in the absence of a highwall they should be placed in a common location.

(b) Structures. All temporary mining buildings, pipelines, and other man-made structures used in the mining operations shall be removed with the exception of those that are of sound construction with potential use compatible with the reclamation goals. Temporary roads shall be returned at least to grade where their existence interferes with drainage patterns.

(c) Fencing. If an operator demonstrates that he cannot meet the slope requirements of this rule, the department may require protective fencing where potential hazards may exist.

(2) Backfilling and Grading. The proposed land use after reclamation and the types of landforms shall be those best suited to enhance the recovery of the land into mature sites with high potential for the use desired.

(a) Slopes of any reclaimed land area shall be no steeper than four (4) feet horizontal to one (1) foot vertical to enhance slope stabilization and provide for the safety of the general public. For long continuous slopes, mulching, contouring, or other suitable techniques shall be used to enhance stabilization. Should washes or rills develop after revegetation and before final release of the area, the operator shall repair the eroded areas and stabilize the slopes by a method approved by the department. At limestone, dolomite, and hardrock phosphate pits where the operator cannot meet this requirement or in areas where the original slopes prior to mining operations are steeper than 4:1, slopes greater than 4:1 may be approved if justified. In no case will slopes greater than 2:1 be approved where mining has extended to the boundary of the owner's property. Slopes above 4:1 will be approved only where adequate stabilization can be assured.

(b) Where consolidated ores are mined below the water table, slopes of the bottom of artificially created waterbodies shall not be steeper than a gradient of 4:1 within 25 feet of the shoreline as measured from the lowest anticipated water line. Where the 4:1 gradient cannot be achieved, there shall be a minimum 10 foot wide perimeter subaqueous bench, at an elevation one foot below the lowest anticipated water line, and if the gradient exceeds 2:1, a sturdy fence shall be erected to preclude unauthorized access which shall be marked to notify the public that a hazard exists.

(c) The operator shall inform the department of the nature and an estimate of the amount of strata removed during mining operations which is unsuitable for general reclamation use because of its potential hazard to the health and safety of the general public. Material of this type shall be replaced in the mine cut beneath all other backfill material or in another manner expressly approved by the department.

(3) Overburden and Soil Zone.

(a) The use of good quality topsoils is encouraged especially in areas of reclamation of the natural succession.

(b) Where topsoil is not used, the operator shall use a suitable growing medium for the type vegetative communities planned.

(4) Wetlands which are within the reclamation plan area which are affected by mining operations shall be restored to at least premining surface areas.

(5) Wetlands and Waterbodies. The design of artificially created wetlands and waterbodies shall be consistent with health and safety, maximize beneficial contributions within local drainage patterns, provide aquatic and wetland wildlife habitat values, and maintain downstream water quality by preventing erosion and providing nutrient uptake. Waterbodies should incorporate a variety of emergent habitats, a balance of deep and shallow water, fluctuating water levels, high ratios of shoreline length to surface area and a variety of shoreline slopes.

(a) At least 25% of the highwater surface area of waterbodies in a reclamation proposal shall consist of an annual zone of water fluctuation to encourage emergent and transition zone vegetation. This area will also qualify as wetlands under the requirements of (4) above if requirements in 16C-16.051(10) are met. In the event that sufficient shoreline configurations, slopes, or water level fluctuations cannot be designed to accommodate this requirement, this deficiency shall be met by constructing additional wetlands adjacent to and hydrologically connected to the waterbody.

(b) At least 20% of the lake surface will consist of a zone between the annual low water line and -6 feet annual low water to provide fish bedding areas and submerged vegetation zones.

(c) The operator shall give a high priority to a lake perimeter green belt of vegetation consisting of tree and shrub species indigenous to the areas in addition to ground cover.

(d) A berm of earth shall be constructed around each waterbody which is of sufficient size to retain at least the first one inch of runoff. The berm shall be set back from the edge of the waterbody so that it does not interfere with the other requirements of Subsection (5).

(6) Water Quality.

(a) All waters of the state on or leaving the property under control of the taxpayer shall meet applicable water quality standards of the Florida Department of Environmental Regulation, Chapter 17-3, FAC.

(b) Water within all wetlands and waterbodies shall be of sufficient quality to allow recreation or support fish and other wildlife.

(7) Flooding and Drainage.

(a) The operator shall take all reasonable steps necessary to eliminate the risk that there will be flooding on lands not controlled by the operator caused by silting or damming of stream channels, channelization, slumping or debris slides, uncontrolled erosion, or intentional spoiling or diking or other similar actions within the control of the operator.

(b) The operator shall restore the original drainage pattern of the area to the greatest extent possible. Watershed boundaries shall not be crossed in restoring drainage patterns but shall be restored within their original boundaries.

(8) Radioactivity. Where areas to be mined are declared by the Department of Health and Rehabilitative Services to have potential enhanced radioactivity caused by such mining, the mine operator shall be responsible for performing a gross gamma exposure rate survey of the area both before mining and after reclamation. Where practical the before and after data survey sites shall be identical.

(a) The gross gamma exposure rate shall be determined on a 200-foot grid interval (one per acre), with readings taken approximately three feet above the land surface, and reported in microroentgens/hours. Data survey sites are not required in submerged lands. The data shall be submitted on a map format, scale one inch equals 400 feet, with each terrestrial data survey site indicated with the gamma value plotted.

(9) Waste Storage.

(a) Clay wastes.

1. Retention areas shall be reclaimed as expeditiously as possible. Experimental methods which speed reclamation which are consistent with these rules are encouraged.

2. To the greatest extent practical, all waste clays shall be disposed of below grade, in a manner that avoids the long-term existence of elevated clay disposal areas. The Board may grant exceptions to this general requirement if it determines that such exceptions are in the public interest.

3. Above ground retention areas shall be reclaimed in a manner so that long-term stabilization of retention dikes and dams is assured.

4. Where appropriate to the land use in the general area and the restoration of surface drainage patterns, reclamation of retention areas as wetlands is encouraged.

(b) Sand tailings.

1. Sand tailings should not be permanently spoiled above natural grade unless needed to meet regulatory or environmental requirements.

2. The operator shall give highest priority to the use of sand tailings for backfilling mine cuts, for accelerating the thickening of waste clays, or as a soil enhancement by mixing the sand with the surface clays on clay storage areas. Sand tailings may be used in the construction of dams or other construction uses.

(c) Subsection (9) does not apply to the temporary storage awaiting sale of clay or sand which is the ore material being mined.

(10) Revegetation. The operator shall develop a revegetation plan adapted to achieve permanent revegetation which will minimize soil erosion, conceal the effects of surface mining, and recognize the requirements for appropriate habitat for fish and wildlife.

(a) The operator shall develop a schedule for the proposed revegetation, including the species of grasses, shrubs, trees, aquatic and wetlands vegetation to be planted, the spacing of vegetation, and, where necessary, the program for treating the soils to prepare them for revegetation.

(b) All land areas must have established ground cover through the approved growing season over 80% of the reclaimed land area excluding roads, groves, or row crops. Bare areas shall not exceed one-quarter (1/4) acre.

(c) Upland forested areas shall be established to resemble premining conditions where practical and where consistent with proposed land uses. At a minimum, 10% of the upland area will be revegetated as upland forested areas with a variety of indigenous hardwoods and conifers. Upland forested areas shall be protected from grazing, mowing, or other adverse land uses to allow establishment. An area will be considered to be reforested if a stand density of 200 trees/acre is achieved at the end of one growing season.

(d) All wetland areas shall be restored and revegetated in accordance with the best available technology. Herbaceous wetlands shall achieve a ground cover of at least 50% at the end of one growing season and will be protected from grazing, mowing, or other adverse land uses for three growing seasons to allow establishment. Wooded wetlands shall achieve a stand density of 200 trees/acre at the end of one growing season and will be protected from grazing, mowing, or other adverse land uses for five years or until such time as the trees are ten feet tall.

(e) All species used in revegetation shall be indigenous species except for agricultural crops, grasses, and temporary ground cover vegetation.

(11) Wildlife.

(a) The operator shall identify what measures have been incorporated into the plan to offset fish and wildlife values lost as a result of mining activities and shall identify special programs to restore, enhance, or reclaim particular species or habitats, especially endangered and threatened species.

(b) The operator may designate specific locations within the mining area as "Wildlife Areas" and include a plan for reclamation and management for sites so designated. Slopes, revegetation and erosion control requirements may be waived or modified by the Department in such areas on a case-by-case basis where such changes will benefit the overall plan for production of wildlife areas.

(12) Timetable.

(a) Each operator shall develop a timetable for completion of the reclamation process in the area covered by the application. The timetable shall include:

1. When removal of ore in the area will be completed.

2. A schedule for the completion of any other mining operations in the area.
3. When the reclamation process will be initiated.
4. When the grading and contouring will be started and when completed.
5. When revegetation will be started and completed.
6. When the growing season requirement will be met.

(b) Completion date.

1. Reclamation and restoration shall be completed within two (2) years of the completion of mining operations, exclusive of the required growing season to ensure the growth of vegetation except that where sand-clay mix or other innovative technologies are used, the department may specify a later date for completion. The required completion date may vary within a mining unit depending upon the specific type of mining operation conducted.

2. The length of the necessary growing season shall be determined as part of the approval of the application.

(c) Changes in timetable.

1. Changes in the approved timetable beyond 30 days shall be reported to the bureau.

2. Changes in the approved timetable beyond 90 days shall be submitted to the department as an amendment to the program.

(13) Exceptions and Innovations. In order to encourage the development of new technology which will hasten reclamation or improve the quality of restored lands, the Board may grant exceptions to any of the requirements of Rule 16C-16.051 at the time of approval of a reclamation program for the following circumstances:

(a) Experimental or innovative techniques where the technology is not proven.

(b) Methods which will increase the overall quality of the reclamation program through the creation of particular landforms or habitats.

(14) Reclamation Advisory Committee. The department will submit each application for approval of a reclamation program to the Reclamation Advisory Committee for their advice concerning the criteria set forth in the Rule. The recommendations of the Committee shall be considered by the staff in making their final recommendations to the Board.

3.3.10.1.3 Chapter 16C-16, FAC, Inspections

Inspection frequencies are outlined in Chapter 16C-16.067, FAC. The inspections "shall occur on an irregular basis at a frequency necessary to insure compliance with the provisions of these rules." Inspections must be made by the FDNR at least quarterly.

3.3.10.1.4 Chapter 16C-16, FAC, Program Release Procedures

A reclamation program can be released after the mine operator notifies the Executive Director of the FDNR that the program has been completed (16C-16.068, FAC). A final inspection is made by the Executive Director's authorized inspector to confirm that all requirements of the approved reclamation program have been met.

3.3.10.1.5 Chapter 16C-16, FAC, Annual Reports

Chapter 16C-16.091, FAC, requires that:

(1) On or before February 1 of each year, each operator shall submit a detailed report for each mine under its control describing the area affected by mining operations during the previous calendar year. The report shall include:

- (a) A legal description of the actual area mined during the preceding calendar year.
- (b) An accounting of the materials encountered as described in 16C-16.051(2)(c) and how they were handled.
- (c) The reclamation and restoration activities carried out during the preceding calendar year.
- (d) Maps and overlays or aerial photographs which show the area which has been affected by the mining operations, reclamation performed, and other uses for the mined area. The report shall also include but not necessarily be limited to present location of water bodies, pipelines, recirculating water systems, water quality sampling points and waste settling ponds and other waste storage or disposal areas on affected lands.

3.3.10.1.6 Chapter 16C-17, FAC, Applications

In 1978, the Florida Legislature approved a bill which became Ch. 378, FS. This statute established the Nonmandatory Reclamation Trust Fund. Lands which were mined or disturbed by the severance of phosphate rock prior to 1 July 1975 were surveyed and their eligibility determined to participate in a nonmandatory reclamation refund program. The nonmandatory reclamation program is funded from a portion of the severance tax presently paid by existing phosphate mining operations. Applicants for programs need not be nor ever have been a mine operator. This program is administered by the FDNR under Ch. 16C-17, FAC.

Ch. 16C-17, FAC, entitled "Master Reclamation Plan for Lands Disturbed by the Severance of Phosphate Prior to July 1, 1975," requires the FDNR to:

- identify and provide guidelines for reclamation of lands mined or disturbed prior to 1 July 1975;
- encourage the reclamation of those disturbed lands; and
- provide grants of funds from the Nonmandatory Land Reclamation Trust Fund.

Programs under this chapter are submitted as (1) proposed plans, and/or (2) application (detailed plans). Applicants are encouraged to submit proposed plans which the Board (governor and cabinet) would approve or deny. With an approved proposed plan, the applicant could work with the Executive Director of the FDNR for approval of the application or detailed plan within certain cost constraints. Participation in the nonmandatory reclamation program is voluntary and dependent on available funding. Reclamation of nonmandatory lands as proposed in this report is contingent upon program approval.

3.3.10.2 Current Reclamation Techniques

OXY has operated in Hamilton County since 1965 and, thus, has mined lands that fall under both sets of reclamation regulations (Figure 3.3-28). Lands mined or disturbed prior to 1 July 1975 (nonmandatory lands) may be reclaimed under Ch. 16C-17, FAC, regulations; those mined after that date (mandatory lands) must be reclaimed under Ch. 16C-16, FAC, regulations. The general types of reclamation techniques will be similar regardless of the set of rules applied to the reclaimed area. However, specific requirements, such as slope criteria, may be different.

The following discussion on reclamation techniques is based on the mandatory reclamation regulations in Ch. 16C-16, FAC. Most of the actual data are based on plans developed for OXY's Conceptual Reclamation Plans required by Ch. 16C-16, FAC. Each data table contains a footnote explaining the basis of the table. Information on both mandatory and nonmandatory reclamation is included to present a complete picture of the post-mining land types.

Current reclamation techniques used by OXY and incorporated into the Conceptual Reclamation Plans (Section 3.3.10.3) include 1) land and lakes, 2) elevated fill, and 3) tailings fill. The following discussions of current reclamation techniques are based on the Conceptual Reclamation Plans developed for Alternative B, which maximizes utilization of known economically recoverable reserves. Acreage figures indicated in the following sections are therefore applicable to Mining Alternative B. The concepts and techniques discussed also apply to

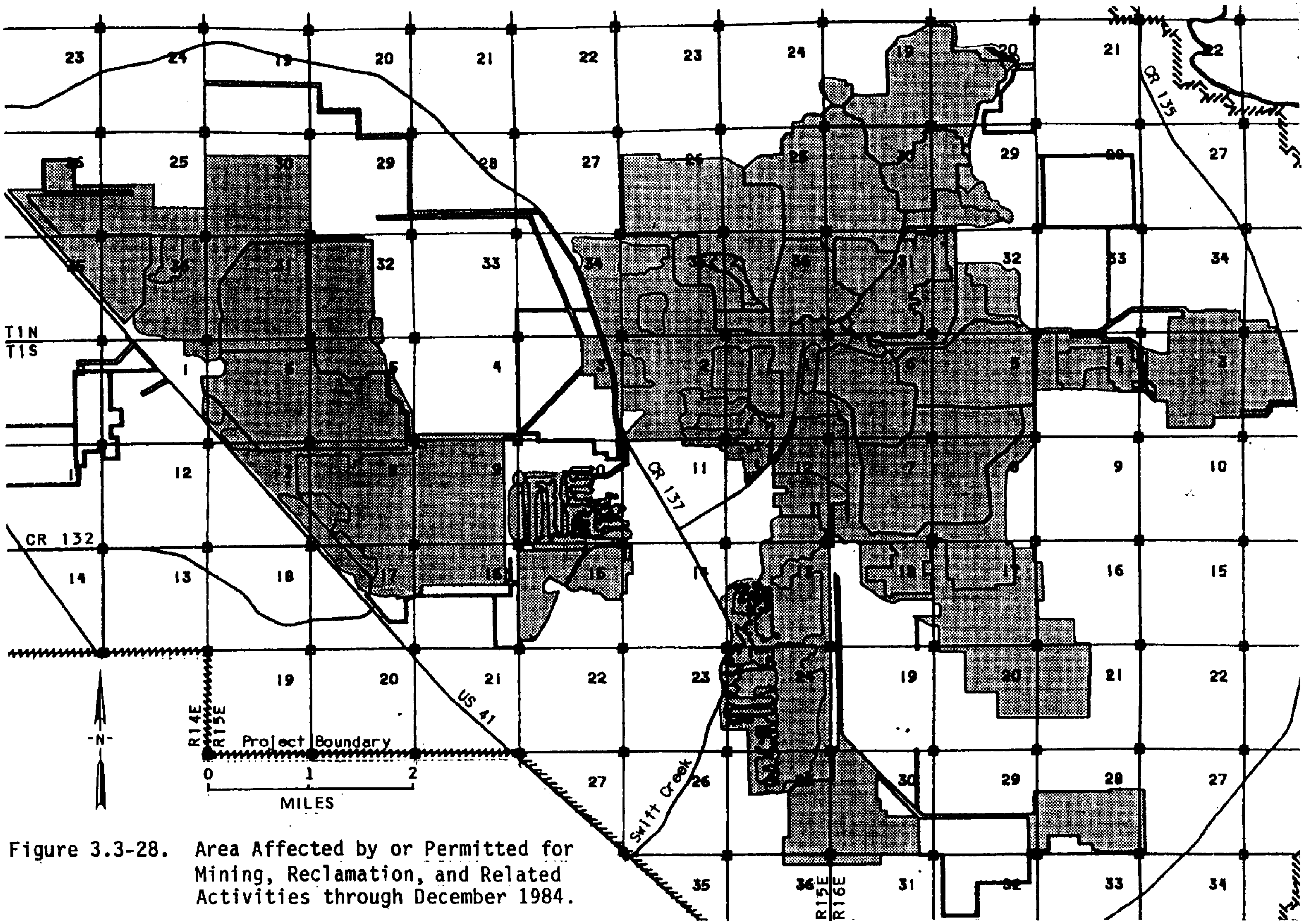


Figure 3.3-28. Area Affected by or Permitted for Mining, Reclamation, and Related Activities through December 1984.

Mining Alternatives A, C, and D, but the total acreage subject to reclamation per Ch. 16C-16, FAC, is less for these alternatives than for Mining Alternative B.

Use of these three reclamation techniques results in creation of uplands, wetlands, and open waterbodies. These techniques are designed to meet requirements to replace wetlands and pre-mining drainage patterns, reduce flooding, and incorporate requirements for design of open waterbody systems. Consideration is also given to the creation of fish and wildlife habitat and to future land uses such as agriculture and silviculture.

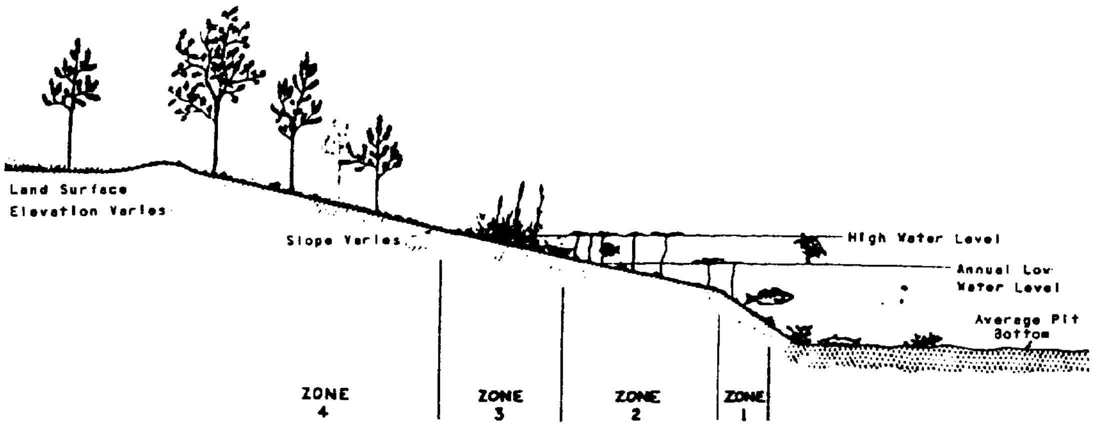
3.3.10.2.1 Land and Lakes

Without introduction of outside earthen materials such as tailings sand, waste clays, or mudballs, the void left by removal of the matrix will result in the creation of a lake. Reclamation of mined areas which are not needed to support other mining activities may begin immediately following mining. In these areas reclamation must be complete within two years of completion of mining operations, exclusive of the growing season.

During mining, the overburden materials that overlie the matrix (ore) are usually cast (spoiled) into adjacent mined-out areas. Use of different spoiling techniques allows creation of various habitat types. Prior to mining, the direction and technique to be used for spoiling is planned. Placement of the overburden must consider characteristics of the ore body, dragline constraints, and reclamation plans.

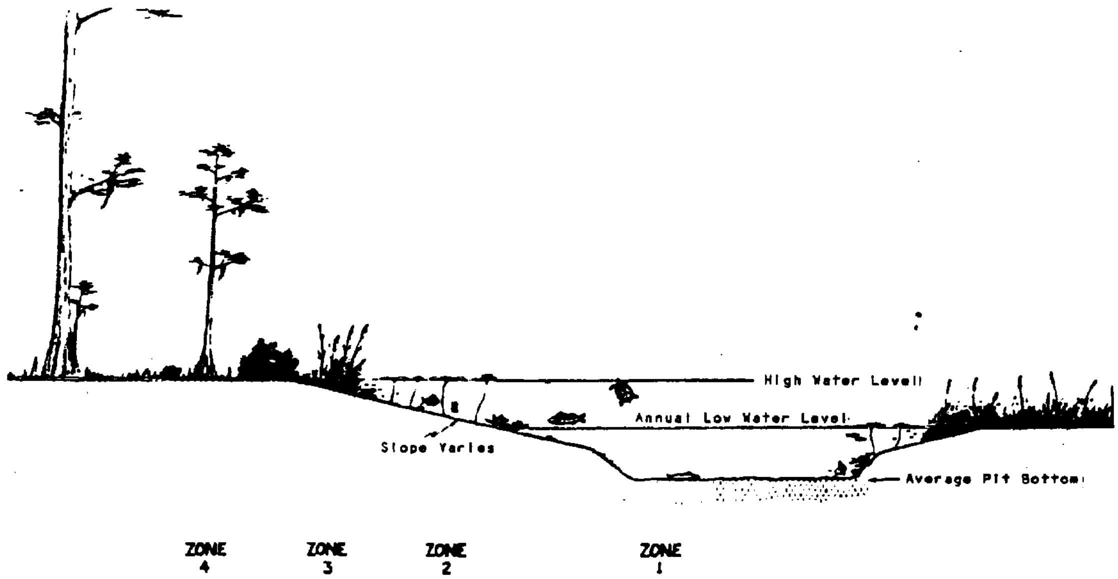
Following mining with the large dragline, earthmoving continues using conventional earthmoving equipment such as bulldozers, scraper pans, and small draglines. The selection of equipment is based on reclamation types to be achieved, haul and push distances, stability of the materials, and other factors common to earthmoving operations. These operations generally begin by capping or striking spoil piles to a predetermined design elevation, usually near the original ground elevation. Following general leveling, slopes are graded to the planned lake water level and 6 ft below the planned water level. Water, if present, must be lowered to allow grading to the proper elevation. To comply with reclamation requirements, a littoral zone of 20% of the low water surface area and a minimum zone of fluctuation of 25% of the lake high water surface area must be achieved during grading. These areas are based on the size and design water level of the waterbody. Figures 3.3-29 and 3.3-30 illustrate the technique used to achieve the littoral zone and zone of fluctuation requirements.

When earthmoving is completed, the area is revegetated according to the specific habitat type to be created, i.e., littoral zones, wetlands, marshes, and/or uplands with grasses, shrubs, and/or trees. The selection of vegetation to be used is matched to soil and water conditions, i.e., wetland plants require saturated soils or soils slightly inundated at various times of the year. Sloped areas are mulched and stabilized with grasses and may be planted with trees.



COMMON NAME	SCIENTIFIC NAME	ZONE 4	ZONE 3	ZONE 2	ZONE 1
PASPALUM	PASPALUM FLUITANS		•		
MAIDEN CANE	PANICUM HEMITOMON		•		
WILLOW	SALIX NIGRA	•	•		
PRIMROSE WILLOW	LUDWIGIA PERUVIANA		•	•	
SOFT RUSH	JUNCUS EFFUSUS		•		
GIANT FOXTAIL	SETARIA MAGNA		•		
SMART WEED	POLYGONIUM SPP		•	•	
CATTAILS	TYPHA SPP		•	•	
ELDERBERRY	SAMBUCUS SIMPSONII		•		
PENNYWORT	HYDROCOTYLE UMBELLATA		•	•	
DUCKWEED	(LEMNACEAE FAMILY)		•	•	•
BROOM SEDGE	ANDROPOGON SPP	•	•		
SALTBUSH	BACCHARIS SPP	•			
RED MAPLE	ACER RUBRUM	•	•		
BLACKBERRY	RUBUS SPP	•	•		
HAIRY INDIGO	INDIGOFERA HIRSUTA	•			
SHOWY CROTALARIA	CROTALARIA SPECTABILIS	•			
OAKS	QUERCUS SPP	•			
GALLBERRY	ILEX VOMITORIA	•			
WAX MYRTLE	MYRICA CERIFERA	•			
SUMAC	RHUS COPALLINA	•			
SWEETGUM	LIQUIDAMBAR STYRACIFLUA	•	•		
WATER HYACINTH	EICHORNIA CRASSIPES		•	•	•
SLASH PINE	PINUS ELLIOTTII	•			
LONG LEAF PINE	PINUS PALUSTRIS	•			
SAND PINE	PINUS CLAUSA	•			
BALD CYPRESS	TAXODIUM DISTICHUM	•	•		
SESBANIA	SESBANIA VESICARIA	•	•		
SEDGES	CYPERUS SPP		•		

Figure 3.3-29. Typical Waterbody Design With Shoreline Wetlands.



Typical Vegetation by Zone

COMMON NAME	SCIENTIFIC NAME	ZONE 4	ZONE 3	ZONE 2	ZONE 1
PASPALUM	PASPALUM FLUITANS	•	•	•	
MAIDEN CANE	PANICUM HEMITOMON	•	•	•	
WILLOW	SALIX NIGRA	•	•		
PRIMROSE WILLOW	LUDWIGIA PERUVIANA	•	•	•	
SOFT RUSH	JUNCUS EFFUSUS		•		
GIANT FOXTAIL	SETARIA MAGNA	•	•	•	
SMART WEED	POLYGONIUM SPP.		•	•	
CATTAILS	TYPHA SPP		•	•	
ELDERBERRY	SAMBUCUS SIMPSONII	•			
PENNYWORT	HYDROCOTYLE UMBELLATA	•	•	•	
DUCKWEED	(LEMNACEAE FAMILY)			•	•
BROOM SEDGE	ANDROPOGON SPP				
SALTBUSH	BACCHARIS SPP				
RED MAPLE	ACER RUBRUM	•			
BLACKBERRY	RUBUS SPP				
HAIRY INDIGO	INDIGOFERA HIRSUTA				
SHOWY CROTALARIA	CROTALARIA SPECTABILIS				
OAKS	QUERCUS SPP				
GALLBERRY	ILEX VOMITORIA	•			
WAX MYRTLE	MYRICA CERIFERA				
SUMAC	RHUS COPALLINA				
SWEETGUM	LIQUIDAMBAR STYRACIFLUA	•			
WATER HYACINTH	EICHORNIA CRASSIPES			•	•
SLASH PINE	PINUS ELLIOTTII	•			
LONG LEAF PINE	PINUS PALUSTRIS				
SAND PINE	PINUS CLAUSA				
BALD CYPRESS	TAXODIUM DISTICHUM	•			
SESBANIA	SESBANIA VESICARIA	•			
SEDGES	CYPERUS SPP	•	•	•	

Figure 3.3-30. Typical Wetlands Design With Waterbody.

In general, land and lakes projects create land areas near the premining land elevation, with waterbodies replacing the void left by removal of the matrix. Major costs include earthmoving and revegetation costs associated with uplands, wetlands, and subaqueous slopes. Figure 3.3-31 schematically illustrates land and lakes reclamation.

A total of 15,314 acres exists and/or is planned for land and lakes reclamation under Mining Alternative B. Total land area, including the zone of fluctuation, will be 9822 acres (64%), with water occupying a surface area of 5492 acres (36%). Land and water acres and average depths for lakes created in the drainage areas on site for Mining Alternative B are shown in Table 3.3-79.

Land areas will be revegetated as either forest or pasture in accordance with Ch. 16C-16 or 16C-17, FAC. More specifically, ground cover, as required for erosion control or pasture, will be established to achieve an 80% cover through the approved growing season, and bare spots will not exceed 0.25 acre in size. Reforestation will be conducted to achieve a minimum stand density of 200 trees/acre.

All proposed lake systems will be designed to meet Ch. 16C-16 requirements such that a minimum of 25% of the high water surface area will consist of an annual zone of fluctuation, and at least 20% of the lake surface area will consist of a zone bounded by the annual low water line and 6 ft below annual low water (Ch. 16C-16, FAC). The lake systems to be created on the project site will contain four zones (Table 3.3-80):

Zone	Estimated % of Water Surface Area
Zone of fluctuation	30
Littoral zone	20
Transition zone	27
Deep water zone	23

The zone of fluctuation will encourage the growth of emergent and transition zone wetland vegetation. This area will also be considered wetlands [per Ch. 16C-16.051(5)(a)], provided requirements of Ch. 16C-16.051(10) are met. These requirements include a 50% ground cover in herbaceous wetlands at the end of one growing season or a stand density of 200 trees/acre in forested wetlands at the end of one growing season.

Typical wetlands designs associated with waterbodies are depicted in Figures 3.3-29 and 3.3-30. The zones depicted in these figures refer to vegetation zones of species expected to be planted and/or naturally established, dependent on various inundation frequencies and depths.

3.3.10.2.2 Elevated Fill

During processing (beneficiation) of the phosphate matrix, clays are removed from the ore and introduced into settling areas as a slurry at approximately 3% solids. The solids settle and the resulting clear

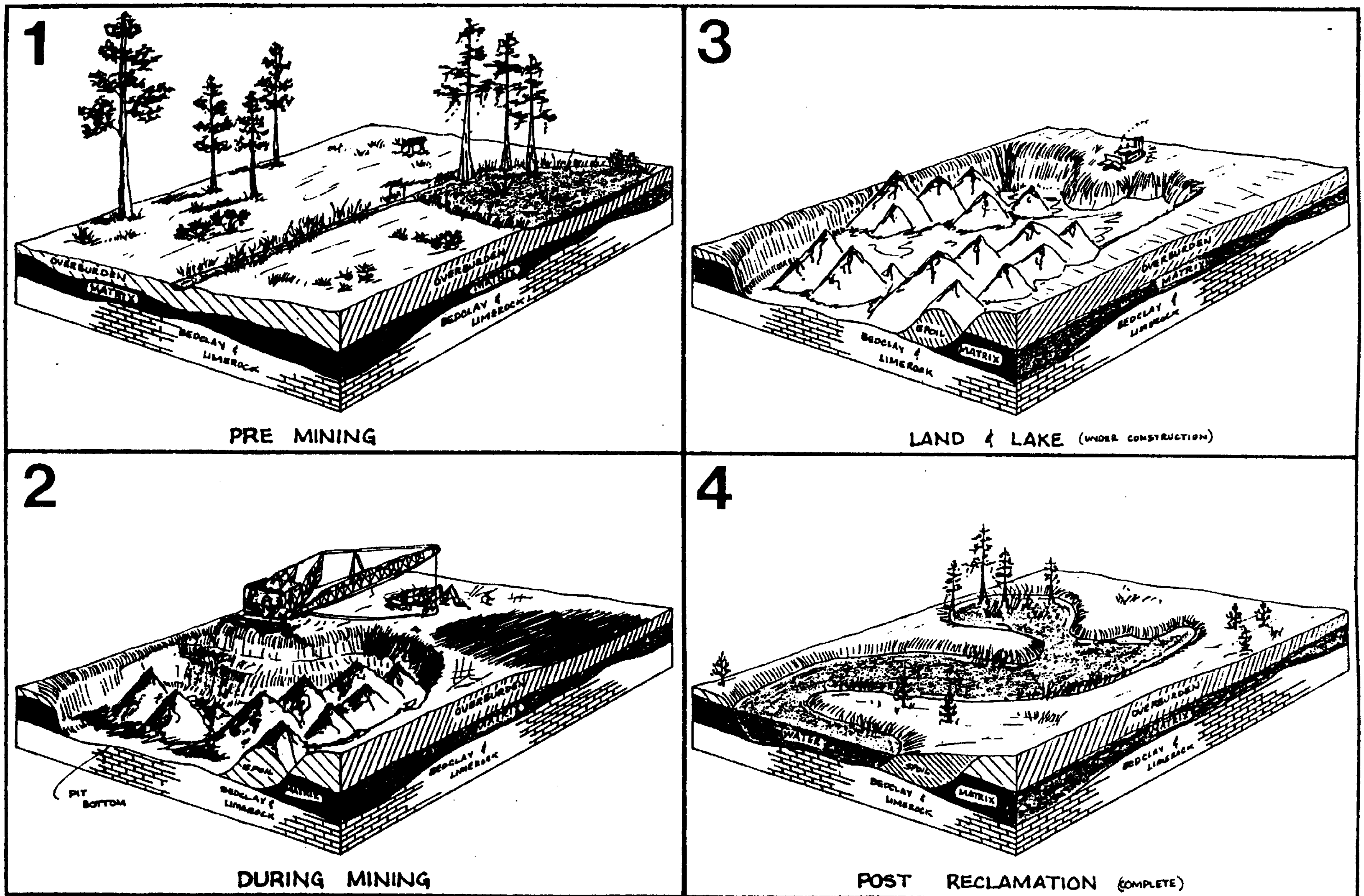


Figure 3.3-31. Schematic of Land and Lakes Reclamation.

Table 3.3-79. Land and Water Acres and Estimated Average Depths for Lakes Created in the Drainage Areas on Site.[1]

Drainage Area	Total Acres[2]	Upland Acres	Total Water	
			Acres	Average Depth
Camp Branch	1,037	415	622	15
Swift Creek	2,380	1,190	1,190	10
Four Mile Branch	960	480	480	11
Long Branch	1,087	554	533	12
Roaring Creek	3,190	1,595	1,595	12
Hunter Creek	709	333	376	18
Rocky Creek	3,175	1,461	1,714	13
Unnamed branches	2,776	1,360	1,416	11
Total	15,314	7,388	7,926	12

[1]Includes both mandatory and nonmandatory reclamation lands and assumes that nonmandatory lands will be reclaimed under Chapter 378, FS, and Chapter 16C-17, FAC.

[2]Includes 941 acres of land and lakes reclamation type reclaimed prior to January 1982.

Table 3.3-80. Lake Reclamation Statistics by Drainage Area.[1]

Drainage Area	Total Area[2] (Acres)	Zone of Fluctuation[3]		Littoral Zone		Transition Zone		Deep Water Zone	
		Acres	Depth[4]	Acres	Depth[4]	Acres	Depth[4]	Acres	Depth[4]
Camp Branch	622	156	1	93	4	112	17	261	27
Swift Creek	1190	393	1	238	4	381	17	178	25
Four Mile Branch	480	168	1	96	4	120	17	96	27
Long Branch	533	187	1	112	4	176	21	58	33
Roaring Creek	1595	526	1	319	4	510	20	240	33
Hunter Creek	376	94	1	56	4	134	22	92	38
Rocky Creek	1714	429	1	326	4	360	17	599	25
Unnamed branches	1416	481	1	283	4	340	16	312	26
Total	7926	2434	1	1523	4	2133	18	1836	28

[1]Includes both mandatory and nonmandatory reclamation lands.

[2]Includes 941 acres of land and lakes reclamation type reclaimed prior to January 1982.

[3]This zone is considered wetlands under Ch. 16C-16, FAC.

[4]Average depth in ft at high water level.

water is recirculated to the beneficiation plant or the mine hydraulic water system for reuse. In order to increase the volume of the area to be used to store clays, dikes are usually constructed around the mined-out areas into which clays are deposited. The FDER administers the construction and abandonment of above-grade waste clay settling areas, as required by Ch. 17-9, FAC ("Minimum Requirements for Earthen Dams, Phosphate Mining and Processing Operations"). In order to comply with Chapter 17-9, FAC, settling areas must maintain a minimum of 5 ft of freeboard on the retaining dikes. When this condition can no longer be met, the area is considered exhausted and reclamation can begin. Reclamation of settling areas can be accomplished by two basic methods: 1) the traditional drying and consolidation technique, or 2) the capping technique. The goals of both methods are the same: to stabilize the clays to support personnel and equipment and to speed reclamation.

The drying and consolidation process is the first step toward reclamation of settling areas. After clays are no longer introduced into the area and all the surface water is withdrawn, the perimeter of the area is ditched with equipment operating from the dam. As consolidation progresses, ditching is conducted within the settling area to facilitate the removal of water. When the area is adequately dry, the dams are breached and/or pushed onto the surface of the clay material. A drainageway from the settling area is maintained for surface water runoff from rainfall.

The sand capping method begins with removal of as much surface water as possible through existing spillways. The surface of the area is allowed to consolidate and desiccate. Tailings sands and/or mudballs are pumped over the area to provide a cap (Figure 3.3-32). The weight of the capping materials causes additional consolidation. As deposition of the sands and/or mudballs progresses, some clays are forced up to the surface and can be used along with the available spoils and dam materials as a soil amendment to provide a growing medium. Areas where wetlands are to be created are not capped but rather are left as slight depressions which will retain water from the clay as well as from rain or runoff from the surrounding area. The consolidated clay bottom will act as a seal to retain water and provide a hydroperiod with regular wet/dry cycles, thereby maintaining a wetland community. Typical wetlands design is illustrated in Figure 3.3-33.

A total of 18,112 acres of land will be reclaimed using the elevated fill technique under Mining Alternative B. Upland areas will be revegetated in the same manner as described previously for land and lakes.

3.3.10.2.3 Tailings Fill

The tailings fill technique utilizes sand tailings from the beneficiation plant to backfill mined-out areas. Tailings sand is hydraulically pumped into mined-out areas by locating a pipeline between the rows of overburden material, with tailings sands pumped into the mined area to a pre-determined elevation. Overburden material protruding above the tailings sand is then spread over the tailings to provide a sandy-clay growing medium for revegetation (Figure 3.3-34). Upland

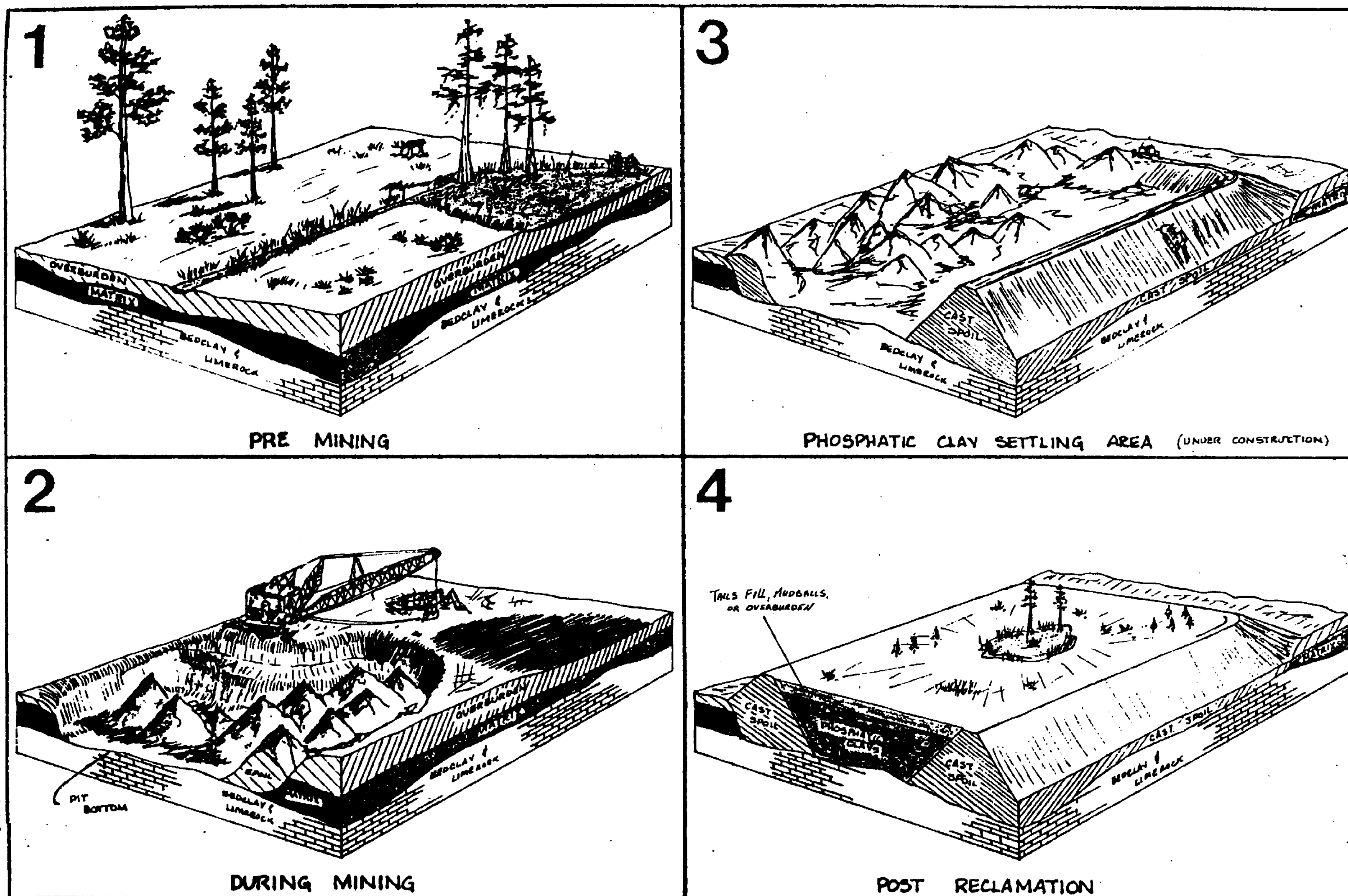
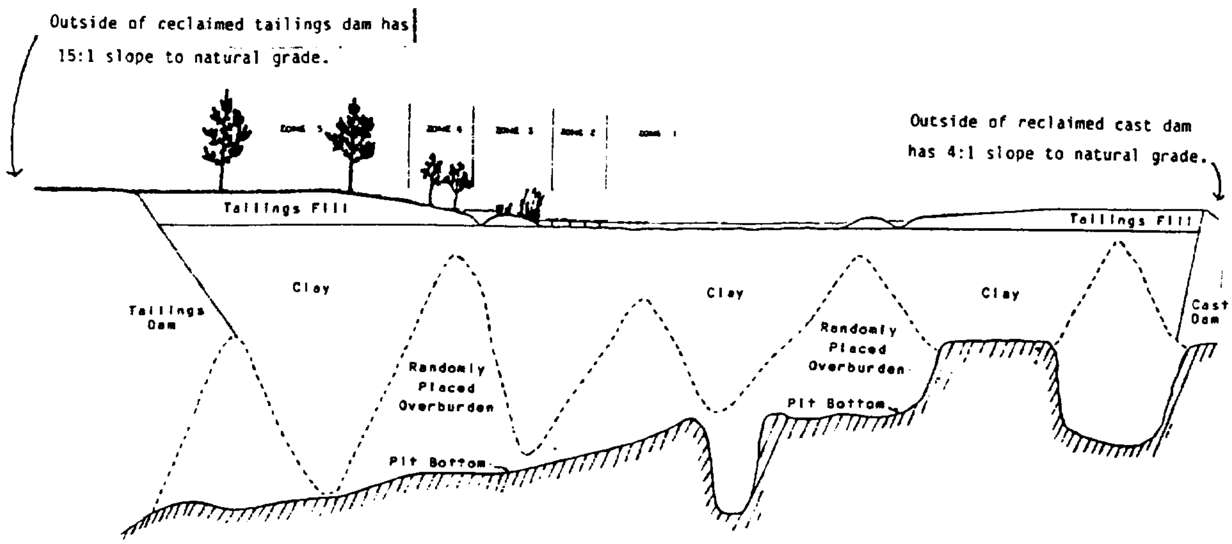


Figure 3.3-32. Schematic of Elevated Fill Reclamation.



Transects performed in settling area of the Suwannee River Mine indicate species and zones.

Common Name	Scientific Name	Zone 5	Zone 4	Zone 3	Zone 2	Zone 1
Paspalum	Paspalum fluitans		●	●		
Maidencane	Panicum hemitomon		●	●	●	
Willow	Salix nigra	●	●	●		
Primrose willow	Ludwigia peruviana			●	●	
Soft rush	Juncus effusus		●	●		
Giant foxtail	Setaria magna		●	●		
Smartweed	Polygonum spp.		●	●	●	
Cattails	Typha spp.			●	●	
Elderberry	Sambucus simpsonii		●	●		
Pennywort	Hydrocotyle umbellata				●	
Duckweed	(Lemnaceae)					●
Broomsedge	Andropogon spp.		●	●		
Saltbush	Baccharis spp.	●				
Red maple	Acer rubrum		●			
Blackberry	Rubus spp.		●	●		

Figure 3.3-33. Typical Wetlands Design Without Waterbody.

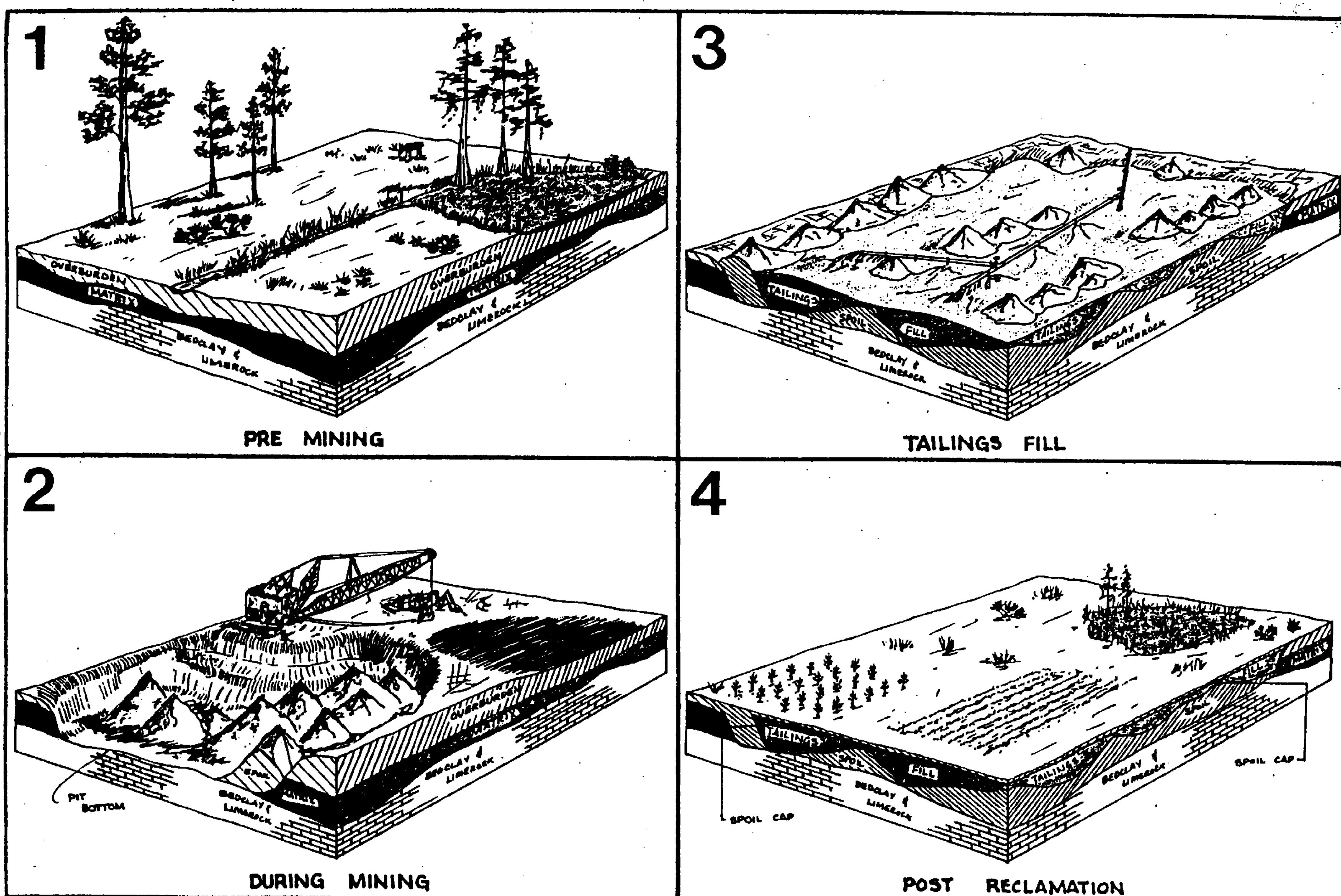


Figure 3.3-34. Schematic of Tailings Sand Fill Reclamation.

areas are then grassed or planted in trees. Where wetlands are to be created, tailings sand is pumped to a lower elevation than the surrounding area, resulting in a slight depression. The surrounding higher elevation areas provide water to the wetlands from surface runoff from rainfall, and the clayey overburden used to cover the tailings sands provides a bottom seal in the depression so water is retained. This technique produces uplands and wetlands at approximately pre-mining elevations.

Approximately 7310 acres of tailings fill are proposed under Mining Alternative B. Upland areas will be revegetated in the same manner as described previously for land and lakes reclamation.

3.3.10.3 Conceptual Reclamation Plan

To comply with requirements of Ch. 16C-16, FAC, OXY submitted conceptual plans for lands subject to mandatory reclamation for both the Suwannee River and Swift Creek mines in October 1981. The plans recognize and incorporate the following:

- mine plans
- waste disposal plan
- timing
- land ownership
- existing environmental regulations
- existing reclamation regulations
- mining characteristics
- topography
- physical constraints (railroads, roads)
- available prospecting data
- ore recovery
- timely receipt of necessary permits
- pumping distances
- geometry of the deposit

A significant change in any one of these or other items could result in major changes in the plans. Additional information was submitted in February, May, and August 1983. In November 1983, specific wildlife habitat considerations were incorporated into the plans. The conceptual plans were developed for reclamation of areas covered under the mine plan developed for maximum utilization of known economically recoverable reserves (Mining Alternative B). OXY received approval of these conceptual plans from the Governor and Cabinet, as the head of FDNR, on 20 March 1984. The concepts and techniques discussed for these plans also apply to Mining Alternatives A, C, and D, but less acreage is subject to reclamation per Ch. 16C-16, FAC, for these alternatives than for Mining Alternative B (Section 2.2). The following sections present details of the conceptual plans.

3.3.10.3.1 Physiography and Contours

The majority of the lands within the project boundaries range from 125 to 150 ft NGVD. While not exactly reproducing the existing conditions, post-mining physiography and contours as proposed by the conceptual reclamation plans will generally approximate the pre-mining topography.

3.3.10.3.2 Drainage Areas

While not exactly reproducing the existing conditions, acreages of the post-mining drainage areas are nearly the same as those in the pre-mining drainage areas (Figures 3.3-35 and 3.3-36, Table 3.3-81). Based on the total project area, no significant changes between pre- and post-mining flows are predicted (Section 3.4.1).

3.3.10.3.3 Vegetation and Land Use

Pursuant to requirements of Ch. 16C-16, FAC, for conceptual reclamation plans, pre- and post-mining (reclaimed) vegetation and land use are to be illustrated with acreage delineations. In their conceptual reclamation plans, OXY provided both tabulated and graphic presentations of pre-mining and post-mining vegetation and land use of all areas mined since 1 July 1975 (Tables 3.3-82 and 3.3-83). The Swift Creek and Suwannee River mine boundaries enclose approximately 36,474 and 24,427 acres, respectively (Figures 3.3-37 and 3.3-38).

A large percentage of the post-mining lands will be revegetated as planted pine forest. As future land uses are determined, additional acreage may be converted from agricultural use (land use type 210) to planted pine forest (type 441). Planted hardwoods (type 442) will be part of a greenbelt around the reclaimed wetland areas within waste clay settling areas. This greenbelt will be a minimum of 100 ft wide with a ≥50 ft wide strip planted with woody wetland species and the remainder planted as upland hardwoods. A minimum stand density of 200 trees/acre for this greenbelt area will be achieved.

Wildlife areas are proposed for wetland areas within the waste clay settling areas. Areas designated as wildlife areas will be reclaimed in conjunction with the surrounding uplands. The greenbelt of woody wetland and upland hardwood species will be planted around each wildlife area. The remainder of the wildlife area will be aerially seeded with a minimum of three woody wetland species.

3.3.10.4 Post-Mining Reclamation Areas

Reclamation schedules and acreages for all four mining alternatives are presented in Tables 3.3-84 through 3.3-86. Under Alternative B, which maximizes reserve recovery, 38,851 acres of both mandatory and non-mandatory lands will be reclaimed by OXY. A total of 2804 acres of reclaimed lands presently exist within the project boundary; thus, the total reclaimed area will be 41,655 acres. The largest reclamation type (18,112 acres or 43%) is elevated fill (Table 3.3-87). Land and lakes and tailings fill account for 15,314 acres (37%) and 7310 acres (18%), respectively, of the total acreage to be reclaimed.

3.3.10.5 Special Considerations

3.3.10.5.1 Stream Channel Reclamation

Reclamation of stream systems will be designed to approximate the pre-mining functions. Existing stream channels typically do not have wide

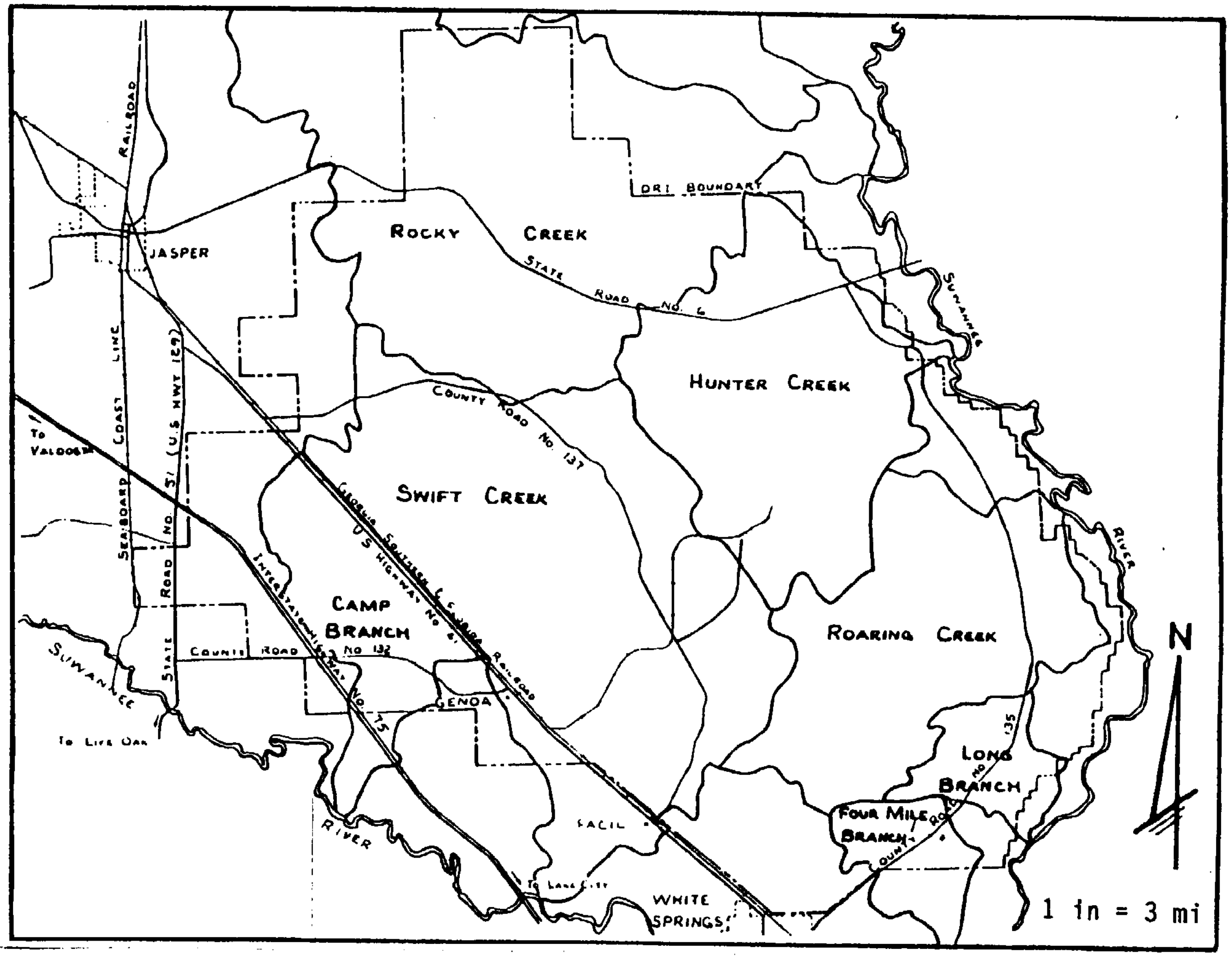


Figure 3.3-35. Pre-Mining Drainage Patterns.

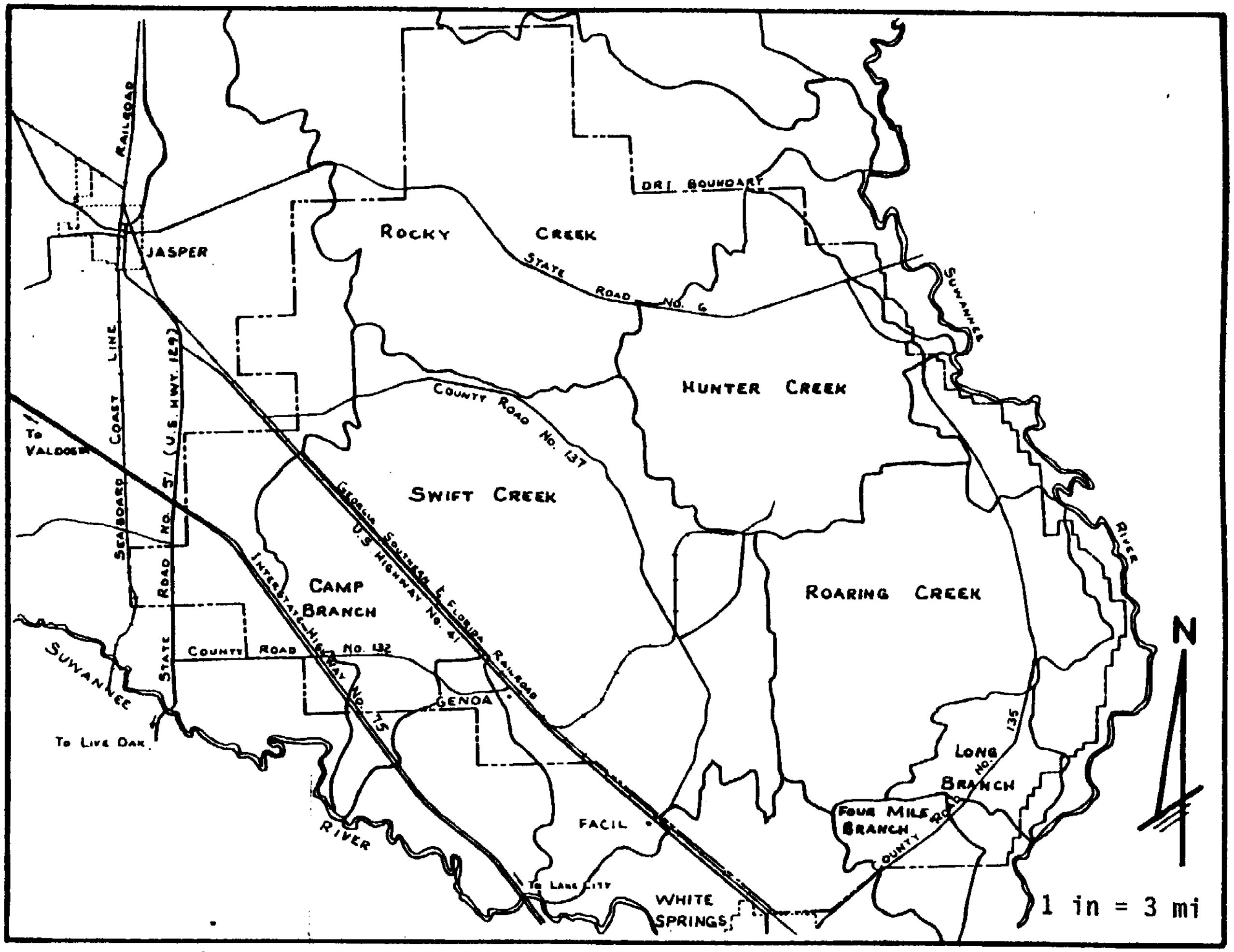


Figure 3.3-36. Post-Mining Drainage Patterns.

Table 3.3-81. Comparison of Drainage Area Acreages Before and After Mining.

Drainage Area	Pre-Mining	Post-Mining
Camp Branch	5,388(5)	5,388(5)
Four Mile Branch	1,864(2)	1,864(2)
Hunter Creek	14,930(15)	14,085(14)
Long Branch	2,411(2)	2,411(2)
Roaring Creek	13,744(14)	14,458(14)
Rocky Creek	18,624(19)	18,463(19)
Swift Creek	24,424(24)	24,749(25)
Unnamed branches	18,615(19)	18,582(19)
Total project area	100,000(100)	100,000(100)

Note: Number in parentheses indicates percent of project area.

Table 3.3-82. Vegetation Communities and Acreages of Affected Lands Prior to Mining the Swift Creek (SC) and Suwannee River (SR) Mines.[1]

Level II Category[2]	Description	SC Mine Acres	SR Mine Acres	Total	%
210	Cropland and pastureland	2,640	1,061	3,701	6.1
UPLANDS					
410	Coniferous forest	2,349	6,910	9,259	15.2
420	Hardwood forest	2,140	610	2,750	4.5
430	Mixed forest	2,239	796	3,035	5.0
440	Planted forest	13,907	7,910	21,817	35.8
450	Clearcut areas	1,417	612	2,029	3.3
	Subtotal	22,052	16,838	38,890	63.8
WETLANDS					
610	Coniferous forest	716	658	1,374	2.3
620	Hardwood forest	790	48	838	1.4
630	Mixed forest	10,068	5,822	15,890	26.1
640	Non-forested	208	0	208	0.3
	Subtotal	11,782	6,528	18,310	30.1
	TOTAL	36,474	24,427	60,901	100.0

[1]Based only on lands mined after 1 July 1975; taken from OXY's conceptual reclamation plans.

[2]Florida Land Use and Cover Classification System.

Table 3.3-83. Post-Mining Vegetation Communities and Acreages for the Swift Creek (SC) and Suwannee River (SR) Mines.[1]

Level II Category[2]	Description	SC Mine Acres	SR Mine Acres	Total	%
210	Cropland and pastureland	7,312	5,484	12,796	21.0
520	Lakes	1,780	2,546	4,326	7.1
	Subtotal	9,092	8,030	17,122	28.1
UPLANDS					
410	Coniferous forest	485	338	823	1.4
420	Hardwood forest	413	35	448	0.7
430	Mixed forest	1,589	126	1,715	2.8
440	Planted forest	13,113	9,370	22,483	36.9
	Subtotal	15,600	9,869	25,469	41.8
WETLANDS					
610	Coniferous forest	263	77	340	0.6
620	Hardwood forest	5,707	2,768	8,475	13.9
630	Mixed forest	5,604	3,683	9,287	15.2
640	Non-forested	208	-	208	0.3
	Subtotal	11,882	6,528	18,310	30.1
	TOTAL	36,474	24,427	60,901	100.0

[1]Based only on lands mined after 1 July 1975; taken from OXY's conceptual reclamation plans.

[2]Florida Land Use and Cover Classification System.

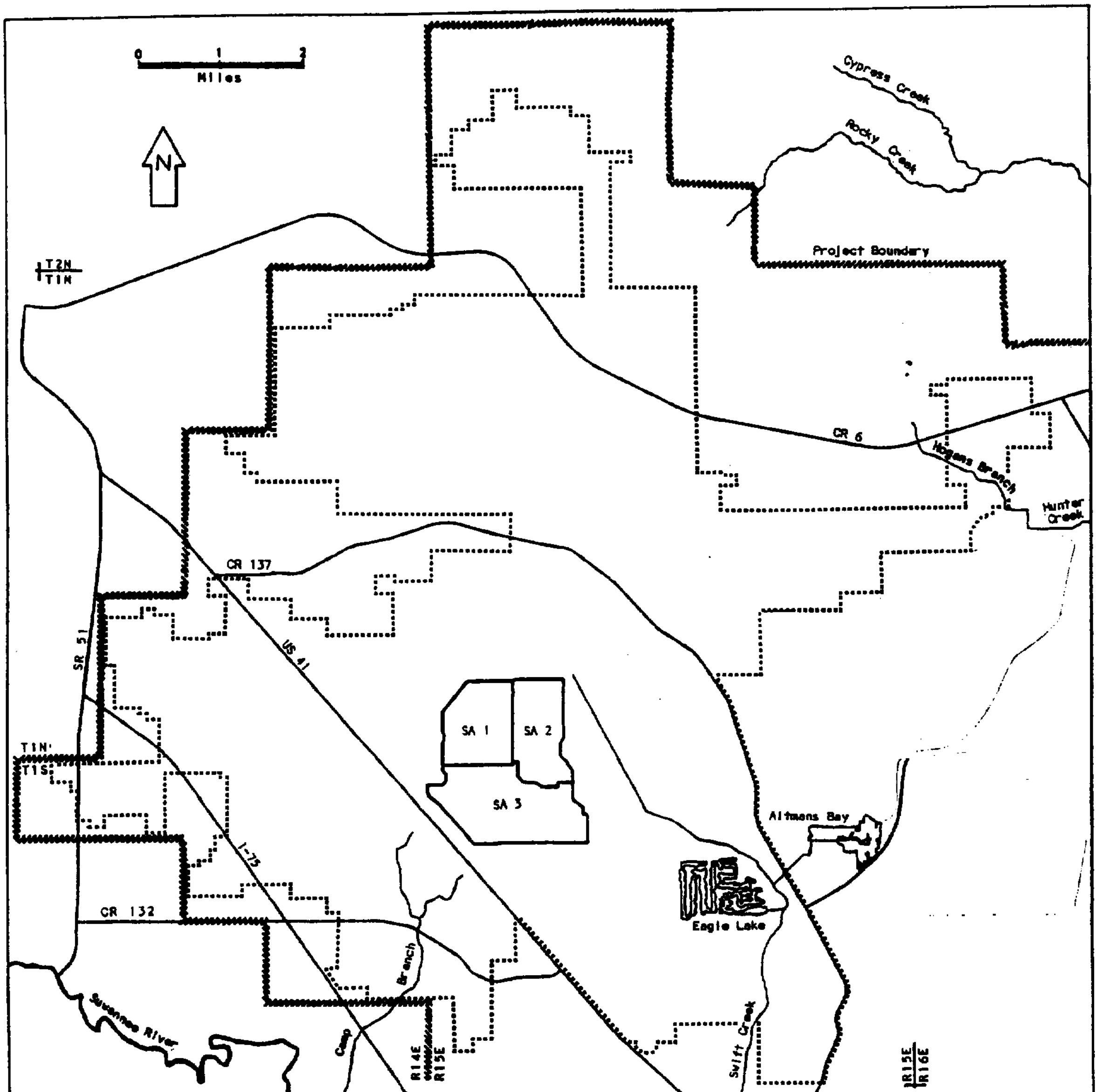


Figure 3.3-37. Boundary of Swift Creek Mine.

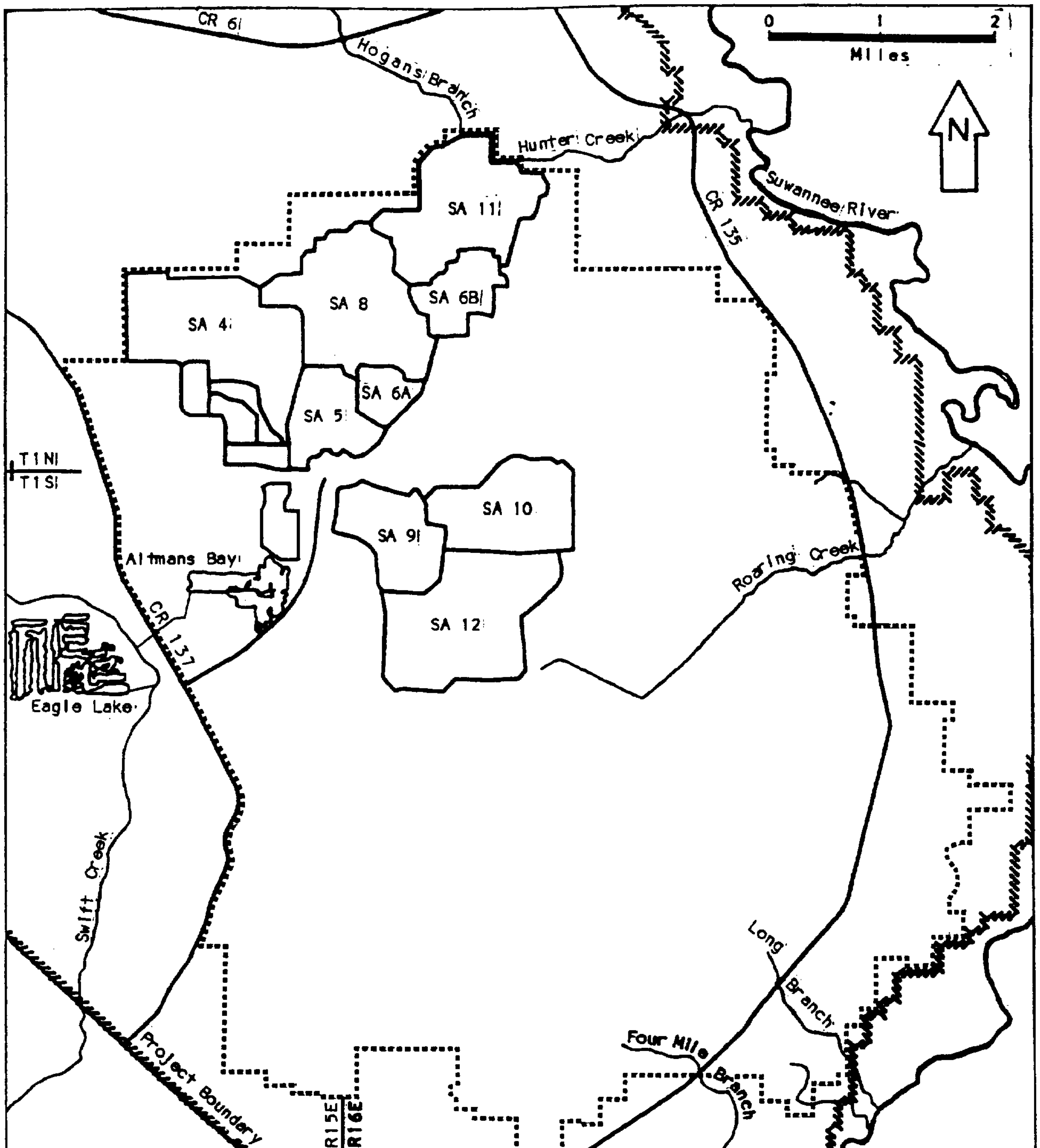


Figure 3.3-38. Boundary of Suwannee River Mine.

Mine boundary

Table 3.3-84. Reclamation Schedules and Acreages for Mining Alternatives at the Suwannee River Mine.

Year	Alternative A	Alternative B	Alternative C	Alternative D
1	110	110	110	110
2	435	275	306	306
3	214	24	214	41
4	629	205	230	230
5	796	355	355	355
6	542	313	357	312
7	577	441	348	317
8	1,292	753	809	601
9	797	1,094	1,316	959
10	957	319	587	261
11	5,220*	817	924	837
12		748	961	736
13		670	1,028	672
14		1,470	505	1,691
15		367	2,186	470
16		655	915	1,019
17		639	4,091*	590
18		914		930
19		645		500
20		726		747
21		1,256		7,345*
22		492		
23		1,560		
24		5,614*		
Total	11,569	20,462	15,242	19,029

*Reclamation completed at designated year.

Note: Includes both mandatory and nonmandatory reclamation lands and assumes that nonmandatory lands will be reclaimed under Chapter 378, FS, and Chapter 16C-17, FAC.

Excludes 2804 acres comprised of land and lakes (941 acres) and tailings fill (944 acres) reclamation types reclaimed prior to January 1982 and cooling ponds/gypsum stacks (919 acres).

Table 3.3-85. Reclamation Schedules and Acreages for Mining Alternatives at the Swift Creek Mine.

Year	Alternative A	Alternative B	Alternative C	Alternative D
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	20	20	20	20
5	102	102	102	102
6	640	111	171	71
7	705	434	659	583
8	631	240	560	567
9	469	416	408	235
10	638	186	4	234
11	738	579	213	304
12	1,208	900	328	1,172
13	1,776*	1,030	917	763
14		1,145	1,176	817
15		697	422	902
16		808	988	532
17		1,200	487	1,156
18		290	336	560
19		538	499	503
20		1,002	1,998	354
21		718	2,360*	991
22		524		1,124
23		742		462
24		293		1,015
25		967		931
26		1,317		668
27		1,645		1,199
28		469		2,004*
29		2,016*		
Total	6,927	18,389	11,648	17,269

*Reclamation completed at designated year.

Note: Includes both mandatory and nonmandatory reclamation lands and assumes that nonmandatory lands will be reclaimed under Chapter 378, FS, and Chapter 16C-17, FAC.

Excludes 2804 acres comprised of land and lakes (941 acres) and tailings fill (944 acres) reclamation types reclaimed prior to January 1982 and cooling ponds/gypsum stacks (919 acres).

Table 3.3-86. Summary of Total Acreage Mined and Reclaimed, Beginning January 1982, and Extent of Reclamation Types for All Mining Alternatives on the Suwannee River and Swift Creek Mines.

Reclamation Type	Alternative A	Alternative B	Alternative C	Alternative D
Suwannee River Mine				
Total acres mined[1]	4,396	11,294	7,518	10,006
Total reclaimed[2]	11,569	20,462	15,242	19,029
Land and lakes	5,097	7,370	6,738	6,321
Tailings fill	450	2,010	1,052	1,911
Elevated fill	6,022	11,082	7,452	10,797
Swift Creek Mine				
Total acres mined[1]	4,769	14,605	9,228	14,151
Total reclaimed[2]	6,927	18,389	11,648	17,269
Land and lakes	2,440	7,003	4,308	6,319
Tailings fill	1,447	4,356	2,530	4,255
Elevated fill	3,040	7,030	4,810	6,695
Total				
Acres mined[1]	9,165	25,899	16,746	24,157
Acres reclaimed[2]	18,496	38,851	26,890	36,298
Land and lakes	7,537	14,373	11,046	12,640
Tailings fill	1,897	6,366	3,582	6,166
Elevated fill	9,062	18,112	12,262	17,492

[1]Estimated acres to be mined during period beginning 1 January 1982 and ending at mine-out.

[2]Includes both mandatory and nonmandatory reclamation lands and assumes that nonmandatory lands will be reclaimed under Chapter 378, FS, and Chapter 16C-17, FAC.

Excludes 2804 acres comprised of land and lakes (941 acres) and tailings fill (944 acres) reclamation types reclaimed prior to January 1982 and cooling ponds/gypsum stacks (919 acres).

Table 3.3-87. Post-Mining Reclamation Areas Within Project Boundary.

Drainage Area	Land and Lakes		Tailings Fill	Elevated Fill	Cooling Pond/ Gypsum Stack	Total Reclaimed	Unmined/ Unreclaimed	Total
	Land	Water						
Camp Branch	415	622	2,080	0	0	3,117	2,271	5,388
Swift Creek	1,190	1,190	2,584	7,130	919	13,013	11,736	24,749
Four-Mile Branch	480	480	0	0	0	960	904	1,864
Long Branch	554	533	0	0	0	1,087	1,324	2,411
Roaring Creek	1,595	1,595	1,005	5,661	0	9,856	4,602	14,458
Hunter Creek	333	376	117	5,321	0	6,147	7,938	14,085
Rocky Creek	1,461	1,714	0	0	0	3,175	15,288	18,463
Unnamed branches	1,360	1,416	1,524	0	0	4,300	14,282	18,582
Total[1]	7,388	7,926[2]	7,310	18,112	919	41,655[3]	58,345	100,000
% of reclaimed land	18	19	18	43	2	100	-	-
% of project area	7	8	7	18	1	42	58	100

[1]Includes both mandatory and nonmandatory reclamation lands and assumes that nonmandatory lands will be reclaimed under Chapter 378, FS, and Chapter 16C-17, FAC.

[2]Includes 2,434 acres of wetlands.

[3]Includes 2,804 acres of existing reclaimed lands (reclaimed prior to January 1982).

floodplains. Some streams do have adjacent wooded wetland areas which may become connected during high flows following heavy rainfall. The streams typically have wooded wetlands in their headwater areas.

Due to site-specific characteristics of each stream system and the potential for changes in mine plans, detailed design of the reclaimed streams will not be attempted until a dredge and fill permit for the specific area is filed with the ACOE and FDER. Final design of stream reclamation will be based on input from the regulatory agencies.

Conceptual stream reclamation is shown in Figure 3.3-39. Where practical, wooded wetlands will be placed in discrete pockets along the streams instead of in a long narrow band. The wetland areas will be constructed at an elevation which will allow flooding of the areas during high flows. Upland drainage will be directed to the wetland areas, to the extent practical, so that upland runoff will have the opportunity to be modified by the wetland areas.

The stream channel itself will be meandered so as to slow the current velocity and to create shallow pools and backwater areas in the bends. Log debris or other objects will be placed in the channel to hasten the establishment of habitat for fish and other aquatic organisms. The stream banks will be stabilized using grasses and mulch to prevent erosion and turbid waters from entering the streams.

3.3.10.5.2 Agricultural/Silvicultural Uses

Much of the reclaimed area will be in agricultural (pasture) and silvicultural (forestry) use under the submitted conceptual plans. An evaluation of the forage use potential, agricultural usefulness, and potential for practicing forest management was conducted on OXY reclaimed lands and overburden material.

Agricultural/Forage Evaluation. Chemical and physical characteristics of reclaimed land, overburden material, and natural soils of the project area were compared (Tables 3.3-88 and 3.3-89). Natural soils investigated in the OXY project area were classified as Troup and Leon fine sands (Blue 1981). Reclaimed land and overburden materials were generally less acidic than the undisturbed soils in the project area (Table 3.3-88). They also contained more extractable phosphorus, calcium, and magnesium but were similar in concentrations of micronutrients (Table 3.3-89). Organic matter, an important source of mineral nutrients and a positive influence on water-holding and cation exchange capacities, was generally lower on reclaimed lands and in overburden material than in natural soils. However, water-holding capacities of all three materials were similar (Table 3.3-88). The reduced organic matter in reclaimed and overburden material was compensated for by the presence of more clay (Blue 1981).

With proper management, establishment of forage species on Troup and Leon soils is not difficult, and establishment of forage species on reclaimed land and overburden material should be comparable to that on natural soils (Blue 1981).

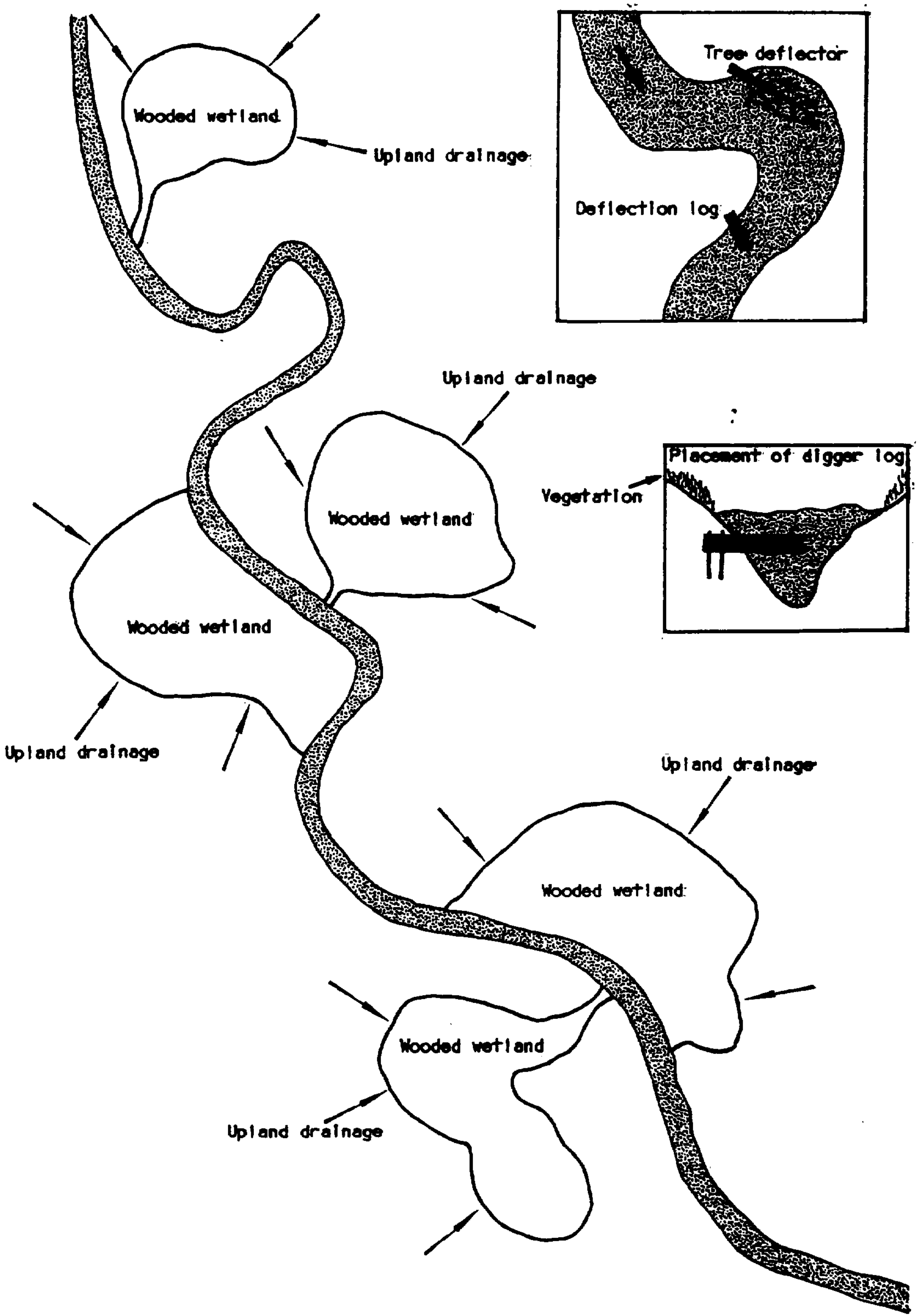


Figure 3.3-39. Conceptual Plan View of Reclaimed Stream Channel.

Table 3.3-88. Chemical and Physical Characteristics of Reclaimed Land, Overburden Material, and Natural Soils on the OXY Project Site.

Sample No.	Depth (in)	Organic Matter (%)	pH		Textural Classification	Water Holding Capacity (%)
			H_2O	KCl		
Reclaimed Land						
1	0-8	0.45	6.3	4.4	-	7.0
	36-40	0.19	5.6	4.2	FSL	8.1
	76-80	0.12	5.1	3.9	SC	10.0
2	0-8	0.41	6.3	4.8	SCL	9.7
	36-40	0.41	6.5	4.8	SCL	11.1
	76-80	0.46	6.4	4.5	FSL	10.2
3	0-8	0.55	5.6	4.2	FSL	5.9
	36-40	0.08	5.4	4.0	FSL	7.7
	76-80	0.08	5.3	3.8	FSL	6.8
Overburden Pile						
1	Hilltop	0.02	5.4	4.1	LS	4.4
	Midslope	0.08	5.6	4.0	LS	6.4
	Bottom	0.10	5.7	4.1	FSL	7.2
2	Hilltop	0.19	6.9	5.1	SL	8.3
	Midslope	0.02	5.6	4.7	SL	8.0
	Bottom	0.19	5.5	4.1	FSL	4.8
3	Hilltop	0.02	5.9	4.4	S	4.1
	Midslope	0.15	5.4	4.3	LS	4.6
	Bottom	0.36	6.0	4.7	LS	4.8
Natural Soils						
Troup fs	0-8	1.86	5.4	4.3	FS	10.6
	36-40	0.13	5.4	4.6	-	2.7
	70-80	0.13	5.2	3.9	-	5.7
Leon fs	0-8	2.52	4.7	3.3	FS	8.0
	22-38	1.48	4.5	3.7	-	4.4
	71-80	0.21	6.1	5.0	-	4.8

FSL = fine sandy loam.
SC = sandy clay.
SCL = sandy clay loam.
LS = loamy sand.
SL = sandy loam.
S = sand.
FS = fine sand.

Source: Blue 1981.

Table 3.3-89. Nutrient Characteristics of Reclaimed Land, Overburden Material, and Natural Soils on the OXY Project Site.

Sample No.	Depth (in)	Mehlich 1 Extractable Nutrients* (ppm)								
		P	K	Ca	Mg	Mn	Zn	Cu	Fe	Al
Reclaimed Land										
1	0-8	1666	28	2720	64	4.4	0.8	0.4	40	520
	36-40	2160	20	5120	80	5.2	1.1	0.5	25	720
	76-80	276	8	652	52	1.4	0.2	0.1	24	272
2	0-8	1380	36	3440	200	5.6	0.3	0.5	68	284
	36-40	1024	20	2040	228	5.2	0.2	0.5	64	168
	76-80	1480	20	3000	160	6.4	0.3	0.9	112	212
3	0-8	930	28	1660	60	4.0	0.6	0.2	30	368
	36-40	832	16	1780	64	3.4	0.4	0.4	56	288
	76-80	380	16	840	64	3.7	0.2	0.2	44	252
Overburden Pile										
1	Hilltop	30	8	92	24	1.2	0.1	0.1	3	40
	Midslope	44	12	196	68	1.9	0.1	0.1	6	72
	Bottom	38	12	228	84	2.2	0.1	0.2	4	64
2	Hilltop	2460	12	6560	96	4.0	1.6	1.2	48	380
	Midslope	41	8	700	64	0.6	0.2	0.2	40	68
	Bottom	70	8	264	36	0.9	0.2	0.2	60	84
3	Hilltop	1420	4	4280	12	4.4	0.8	0.7	17	480
	Midslope	220	8	112	16	0.8	0.2	0.1	22	800
	Bottom	2060	8	4160	32	6.8	1.3	0.4	30	736
Natural Soils										
Troup fs	0-8	196	8	576	24	8.4	0.5	0.1	16	236
	36-40	14	4	28	T	0.4	0.1	T	7	96
	70-80	65	8	232	36	0.3	0.2	T	20	200
Leon fs	0-8	6	8	116	16	0.6	0.3	0.1	7	48
	22-38	46	4	12	T	T	0.1	T	4	576
	71-80	34	8	484	52	0.4	0.4	0.4	48	128

*Mehlich 1 extractant: 0.05 N HCl + 0.025 N H_2SO_4.
T = Trace.

Source: Blue 1981.

Due to the higher clay content of the overburden and reclaimed land, as opposed to natural, undisturbed soils, and the predicted increase in organic matter of the reclaimed land and overburden material as a result of revegetation, nutrient loss by leaching should be no more serious than that found in natural soils. Nitrogen, potassium, sulfur, and micronutrient requirements should be similar for all soil and materials investigated at the OXY site, with requirements for lime and phosphorus being substantially less on reclaimed land and overburden material than on undisturbed or natural soils.

Grass species, such as Pensacola bahia grass (Paspalum notatum) and coastal bermuda grass (Cynodon dactylon), and legume species such as sweet clover (Melilotus sp.), hairy indigo (Indigofera hirsuta), and Aeschynomene should produce well on reclaimed land with proper management (Blue 1981). Thus, these lands would be suitable for beef production. Blue (1981) indicated that reclaimed overburden has an equivalent productive capacity with possibly less maintenance cost than natural, undisturbed soils.

In an effort to determine the usefulness of reclaimed lands for agricultural purposes, a 10-acre experimental plot was established to investigate the possibility of producing vegetables and locally grown farm crops on reclaimed lands using the same techniques and soil amendments as used on unmined lands in the general area. The 10-acre site was prepared by harrowing, and crops were planted by hand and machine, with initial fertilization of 500 lb/acre of 5-10-15 or 6-6-12, depending on the crop. Crop maintenance included cultivation, appropriate fertilization, and insect control. The following crops were planted and harvested:

Corn
- Coker 77 (field corn)
- Silver Queen (sweet corn)

Cucumbers

Tomatoes

Melons
- Cantaloupe
- Watermelon

Peanuts

Soybean

Peas and beans
- Cream 12
- Cream 40
- Black-eyed peas
- White butter beans
- String beans

Peppers

Greens
- Mustard
- Collard
- Turnip

Rye

Specific yield analyses for the project area were not possible as a result of unauthorized harvesting by the public. However, the results did indicate that vegetables and locally grown farm crops will grow on reclaimed soils using normal fertilization, cultivation, and insect and disease control methods. Techniques adapted to agricultural operations on clayey soils may be helpful in working reclaimed lands, where soils are more clayey than pre-mining soils.

Silvicultural Evaluation. Pines planted on reclaimed lands at OXY and on native soils were compared in terms of stand density, site quality, and yield (Table 3.3-90). Stand density for both reclaimed and native soils was approximately 300-400 trees per acre. Total height averaged 13.5 ft for 6-yr-old pine planted at Altmans Bay, which is comparable to 6-yr-old pine tree heights located throughout the general geographic area.

Site quality, a measure of the total direct effects on tree growth of climatic, soil, biotic, and physical factors in the environment and their interaction, was estimated to be 50 and 68 for Troup and Leon soils, respectively. Average site quality for native soils over the entire OXY project area was estimated to be 60 (Gooding 1981). Based on soil examination and chemical analysis data (Tables 3.3-88 and 3.3-89), a site quality value of 65 was assigned to the reclaimed soil (Gooding 1981). Expected yields (cords/acre) at rotation age 25 years are expected to be slightly higher for pines managed on reclaimed lands than on native soils (Table 3.3-90). Thus, reclaimed lands offer the ability to support an economically and operationally feasible forest management system.

3.3.10.5.3 Fish and Wildlife Uses

Designated wildlife areas are proposed in the conceptual reclamation plans. Approximately 2200 acres on the Swift Creek Mine and 2500 acres on the Suwannee River Mine are proposed wildlife areas. The total of 4700 acres of proposed wildlife areas are to be created in wetland areas within the reclaimed phosphatic clay settling areas. Areas designated as wildlife areas will be reclaimed in conjunction with the surrounding uplands. A greenbelt of woody wetland and hardwood upland species will be planted around each wildlife area. This greenbelt will be ≥100 ft wide with achievement of a minimum stand density of 200 trees/acre. The remainder of the wildlife area will be aerially seeded with a mixture of at least three varieties of woody wetland species.

The management plan for these wildlife areas will be directed toward creation of suitable habitat for the Florida black bear (*Ursus americana floridana*), designated by the State as Threatened. Suitable habitat is described as dense cover, usually of a type that is considered nearly impenetrable. This species is also known to use wooded uplands near dense cover.

Suitable habitat will be created in wetlands on reclaimed above-ground settling areas (elevated fill) and adjacent uplands. The elevated fill areas will be reclaimed by capping with sand tailings or mudballs except in the area which will be wetlands. The wetland areas will be left uncapped and at a slightly lower elevation, providing retention areas for runoff water during and following rain events. The surrounding uplands will serve as a drainage area for the wetlands, resulting in fluctuating water levels as a result of changing weather conditions. Following reclamation, the wetland areas are expected to vegetate with early successional species such as willow, red maple, and saltbush. A

Table 3.3-90. Forestry Characteristics of Native and Reclaimed Soils on the OXY Project Site.

Stand Density on Reclaimed Soils of the OXY Project Site	
Stand Age (yr)	Density (trees/acre)
1	487
2	323
3	388

Standard Yield for Rotation Age 25 on Native and Reclaimed Lands

Land Type	Site Quality	Density (trees/acre)	Yield (cords/acre)
Native	60	300	30.0
		400	33.3
Reclaimed	65	300	36.4
		400	45.6

Source: Gooding 1981.

greenbelt around the upland areas will be planted as described previously, with the interior wetland areas being aerially seeded.

The upland areas surrounding the wetlands will be reforested to a commercial forest condition. The location of these wooded uplands has been planned away from major highways and to tie into the existing commercial forest areas outside the mine boundaries. These areas may also serve as travel corridors for wildlife.

Fish and Wildlife Habitat Evaluation of Existing Reclaimed Systems

Two land and lakes areas reclaimed within the last three years, Eagle Lake and Section 13 Lake, were evaluated for their ability to provide fish and wildlife habitat. The lakes are irregular in shape and receive water from mining operations and runoff from mine areas as well as unmined areas.

The land areas contain both upland and wetland habitat. The upland areas have a permanent grass cover and have been planted with trees, mainly slash pine. Wetland areas are restricted to the land-lake interface in the zone of fluctuation of the lake. They are narrow and linear and have been planted with a variety of herbaceous species such as rushes (*Juncus* spp.), maidencane, and smartweed (*Polygonum* spp). Both upland and wetland areas have been invaded by a variety of indigenous species.

Uplands and open aquatic systems were evaluated using the Habitat Evaluation System (HES) developed by the U.S. Army Corps of Engineers (ACOE 1980). This evaluation system is the same one used for evaluating other upland systems on the OXY project site (Section 3.3.8). Wetland components of the reclaimed system were considered as part of the open aquatic system and thus not evaluated separately.

Uplands. As both Eagle Lake and Section 13 Lake uplands were planted in pine, the HES Upland Forest category was chosen for the evaluation (see Section 3.3.11.4 for methodology). This was consistent with other upland evaluations conducted (Section 3.3.8). Results of the reclaimed uplands evaluations (Tables 3.3-91 and 3.3-92) indicate lower Habitat Quality Index (HQI) scores than for existing forested uplands (Table 3.3-93). Total scores for Eagle Lake uplands and Section 13 Lake uplands were 28.6 and 26.1, respectively (possible score of 100), as compared to scores of 32.8-42.1 for other forested uplands in the project area. The lower scores are primarily the result of the young age of the reclaimed areas (trees <5 years old), thereby allowing little development of an understory, mast trees, or trees ≥16 in dbh and precluding the existence of standing dead trees.

Future habitat value scores for Eagle Lake were projected, using a time frame of post-reclamation plus 15-20 years, i.e., a 15-20 year planted pine habitat. During this time, it could reasonably be expected that ground cover will be reduced to 60% coverage and understory cover will increase to 40% coverage. The age of the tract still would preclude the presence of producing mast trees, existence of standing dead trees, and

Table 3.3-91. Reclaimed Upland Evaluation Results for Eagle Lake.

Parameter	No. of Samples	$\bar{x}$ HQI Score	Weight	$\bar{x}$ Weighted HQI Score	Comments
Species association	20	0.3	17	5.1	Planted pine
Number of mast trees	20	0.0	16	0.0	None
Percent understory coverage	20	0.0	14	0.0	None
Percent ground cover	20	0.9	15	13.1	-
Number of trees ≥16 in dbh	20	0.0	14	0.0	None
Number of standing dead trees	20	0.0	11	0.0	None
Tract size (acres)	20	0.8	13	10.4	app. 300
Habitat value				28.6	

Source: OXY consultants field and laboratory data.

Table 3.3-92. Reclaimed Upland Evaluation Results for Section 13 Lake.

Parameter	No. of Samples	$\bar{x}$ HQI Score	Weight	$\bar{x}$ Weighted HQI Score	Comments
Species association	20	0.3	17	5.1	Planted pine
Number of mast trees	20	0.0	16	0.0	None
Percent understory coverage	20	0.0	14	0.0	None
Percent ground cover	20	0.9	15	13.2	-
Number of trees ≥16 in dbh	20	0.0	14	0.0	None
Number of standing dead trees	20	0.0	11	0.0	None
Tract size (acres)	20	0.6	13	7.8	app. 120
Habitat value				26.1	

Source: OXY consultants field and laboratory data.

Table 3.3-93. Comparison of HES Upland Forest Category Scores for Reclaimed Lands and Existing Terrestrial Habitats in the Project Area.

Area	Habitat Value*
Eagle Lake reclaimed uplands	28.6
Section 13 Lake reclaimed uplands	26.1
Hunter Creek basin upland forest	36.2
Roaring Creek basin upland forest	35.1
Rocky Creek basin upland forest	32.8
Swift Creek basin upland forest	42.1
Eagle Lake reclaimed uplands + 15-20 yrs (projected)	37.6

*Possible total score = 100.

Source: OXY consultants field and laboratory data.

trees ≥16 in dbh. Based on the change in understory and ground cover, the resultant habitat value would be 37.6 (Table 3.3-94), comparable to the values found in the upland forests evaluated elsewhere on the project site.

Results of trapping studies conducted previously in the area indicate that populations of small mammals in reclaimed areas are higher than in natural communities (Table 3.3-95), primarily as a result of the ground cover density in the reclaimed upland areas. However, as these systems mature and vegetation structure changes (e.g., less ground cover due to shading by canopy species), densities of small mammal populations will decline. Species commonly observed in these areas include the Virginia opossum, least shrew, short-tailed shrew, cotton mouse, hispid cotton rat, eastern cottontail, striped skunk, northern bobwhite, palm warbler, red-winged blackbird, southern toad, and ground skink.

Open Aquatic Areas. Aquatic components of the reclaimed systems were evaluated using the HES lake evaluation format (ACOE 1980). The habitat value scores were calculated to be 80.95 for Eagle Lake and 79.20 for Section 13 Lake out of a possible score of 100, indicating moderate to high habitat quality (Table 3.3-96). A comparison with Watertown Lake located in adjacent Columbia County near Lake City, Florida indicates that results of the evaluation are comparable for natural lakes (score of 79.10, Table 3.3-96).

A recent study compared the sediment and morphometric characteristics of the two reclaimed lake systems with those of Watertown Lake (Boyd and Davies 1981). Sediment patterns in the reclaimed lakes are typical of lakes and ponds (Frink 1969, Boyd 1977). Reclaimed lakes sediments changed from sand to fine sand, silt, and clay with depth and distance from shore, while Watertown Lake sediments changed from sand to fine-grained material, mostly organics (Table 3.3-97). Percent organic matter increased in all three lakes with increasing depth, though sediments in Watertown Lake were higher in percent organic matter than in the reclaimed lakes. Watertown Lake has not been subject to frequent oxygen depletion, and it can reasonably be assumed that the reclaimed lakes would not be subject to oxygen depletion from organic sediment demand (Boyd and Davies 1981). Phosphorus was higher in the reclaimed lakes than in Watertown Lake (Table 3.3-97), as a result of the phosphate minerals in the sediments (Boyd and Davies 1981).

Ten morphometric parameters were compared for the three lakes (Table 3.3-98). Shoreline length and shoreline development index are greater in the reclaimed systems than in Watertown Lake because the reclaimed lakes are larger and more irregular in shape. Long shorelines and large shoreline development values contribute to potential lake productivity by increasing the amount of littoral zone available, thus favoring greater diversity and stability (Wetzel 1975, Boyd and Davies 1981). The depth and average width of the littoral zone in all three lakes were comparable; however, the proportion of littoral zone as a percent of lake area was higher in the reclaimed lakes than in Watertown Lake (Table 3.3-98). From a morphometric standpoint, the reclaimed lakes offer better fish and wildlife habitat than Watertown Lake (Boyd and Davies 1981).

Table 3.3-94. "Potential" Reclaimed Upland Evaluation Results for Eagle Lake.

Parameter	Weight	HQI Score	Weighted HQI Score	Comments
Species association	17	0.3	5.1	Planted pine 15-20 years in age.
Number of mast trees	16	0.0	0.0	Assume mast-bearing trees have invaded area but not of sufficient size to become pertinent to evaluation.
Percent understory coverage	14	0.7	9.2	Assume development and increase to 40% coverage.
Percent ground cover	15	0.9	12.9	Assume decrease to 60% coverage.
Number of trees ≥16 in dbh	14	0.0	0.0	No trees to reach this size as of yet.
Number of standing dead trees	11	0.0	0.0	Small probability of snag trees at this time; assume no snag trees.
Tract size (acres)	13	0.8	10.4	Approximately 300.
Habitat value			37.6	

Table 3.3-95. Results of Small Mammal Trapping in a Suwannee River Mine Reclaimed Area and Natural Communities.

Community	No. of Species	No. Individuals Collected	Trap Success[3]
Suwannee River mine reclaimed area[1]	3	13	10.8
Swift Creek basin high pinelands[1]	2	3	1.7
Swift Creek basin pine/palmetto flatwoods[1]	3	5	2.8
Swift Creek basin mixed hardwood swamps[1]	1	2	1.1
Swift Creek basin cypress swamp systems[1]	2	3	1.7
North-central Florida longleaf pine sandhill[2]	7	28	2.0
North-central Florida longleaf pine flatwoods[2]	6	163	6.3
North-central Florida slash pine flatwoods[2]	4	45	3.1
North-central Florida xeric hammock[2]	7	96	4.2
North-central Florida mesic hammock[2]	7	93	8.3
North-central Florida hydric hammock[2]	4	37	2.7
North-central Florida pine plantation[2]	3	20	2.2
North-central Florida deciduous oak[2]	5	30	1.5
North-central Florida pasture[2]	4	24	1.8
North-central Florida developed land[2]	5	24	3.9

[1]Source: EPA 1978a.
[2]Source: FGFWFC 1976a.
[3]Trap success = $\frac{\text{no. individuals}}{\text{total trap nights}} \times 100$.

Table 3.3-96. HES Lake Evaluation for Eagle Lake, Section 13 Lake, and Watertown Lake.

Parameter	Eagle Lake			Section 13 Lake			Watertown Lake		
	Weight	Score	Weighted Score	Weight	Score	Weighted Score	Weight	Score	Weighted Score
Total dissolved solids (mg/l)	30	1.00	30.00	30	1.00	30.00	30	1.00	30.00
Mean depth (ft)	15	1.00	15.00	15	1.00	15.00	15	1.00	15.00
Turbidity (JTU)	15	1.00	15.00	15	0.96	14.40	15	1.00	15.00
Chemical type	15	1.00	15.00	15	1.00	15.00	15	1.00	15.00
Shoreline development index	5	0.39	1.95	5	0.16	0.80	5	0.02	0.10
Spring flood index	20	0.20	4.00	20	0.20	4.00	20	0.20	4.00
Total score			80.95*			79.20*			79.10*

*Possible total score = 100.

Table 3.3-97. Sediment Characteristics of Eagle Lake, Section 13 Lake, and Watertown Lake.

		Particle Size (% of Total)						
Depth (ft)	Distance from Shore (ft)	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt and Clay	Organic Matter (%)	Dilute Acid-Extractable Phosphorus (ppm)
Eagle Lake								
0	0	0	12.5	33.1	53.1	1.3	0.90	3,000
1	25	3.1	31.3	31.5	41.2	3.0	2.11	6,000
3	35	5.8	25.6	29.8	30.6	7.9	2.62	8,000
5	50	2.3	30.2	26.2	35.4	5.7	4.60	8,600
9	80	0	0	0	100*		11.10	14,200
13	100	0	0	0	100*		8.84	17,600
Section 13 Lake								
0	0	1.1	32.5	37.1	28.1	1.2	1.71	11,600
2	25	0.7	26.7	37.0	35.1	0.5	1.61	12,800
3	50	4.1	21.6	32.1	39.0	3.2	2.83	11,200
6	75	0	0	0	100*		11.20	13,800
9	100	0	0	0	100*		14.60	16,200
Watertown Lake								
2	20	3.5	13.6	37.8	44.9	0.06	1.97	2
4	25	3.3	10.4	32.0	54.2	0.08	2.61	2
5	35	9.1	17.6	24.7	47.3	1.2	15.71	4
7	50	19.7	51.9	9.7	16.0	2.7	40.19	8
10	100	32.8	34.3	8.5	20.5	3.7	63.66	4

*The entire sample was a mixture of fine sand and silt/clay combined.

Source: Boyd and Davies 1981.

Table 3.3-98. Morphometric Data for Eagle Lake, Section 13 Lake, and Watertown Lake.

Parameter	Aquatic System: Eagle Lake	Section 13 Lake	Watertown Lake
Area (acres)	106	63	46
Shoreline (mi)	8.5	4.4	1.0
Shoreline development index	5.9	4.0	1.0
Average depth (ft)	14.2	10.6	13.1
Maximum depth (ft)	33.0	18.5	19.0
Volume (ac-ft)	1505	668	472
Average width of littoral zone (ft)	40.1	34.6	36.9
Area of littoral zone (acres)	24.8	11.2	4.3
Proportion of littoral zone (% of lake area)	23.4	17.8	9.4
Slope of bottom in littoral zone (horizontal to vertical)	8:1	7:1	7:1

Source: Boyd and Davies 1981.

Types and intensity of data collected on floral and faunal resources of the reclaimed lakes are varied. Periphyton and phytoplankton data were collected in Eagle Lake and Altmans Bay, another reclaimed land and lakes system, in September 1981 and February and May 1982 (see Sections 3.3.4.1.2 and 3.3.4.1.3). Generally, periphyton and phytoplankton densities are high as a result of the hard, moderately alkaline waters with high concentrations of nitrogen and phosphorus which generally favor high production (Boyd and Davies 1981).

Macroinvertebrates collected by petite Ponar in Eagle Lake and Section 13 Lake indicate relatively high density and ecologically stable benthic communities adequate to provide benthic fish food (Boyd and Davies 1981):

Waterbody	No. of Taxa	Density (no./m^2)	Diversity	Equitability
Eagle Lake	17	4782	3.74	0.57
Section 13 Lake	9	2771	2.09	0.37
Suwannee River*	20	851	2.82	0.52

*Suwannee River data collected for this EIS are presented for comparison; values are means of pooled samples from two different sampling dates and a total of five stations.

Additional macroinvertebrate data for reclaimed lakes and naturally occurring waterbodies (streams and rivers) are discussed in Section 3.3.4.2.2.

Both Eagle Lake and Section 13 Lake receive fishing pressure as is evidenced by vehicle trails and field observations. Fish commonly caught include bass, bream, crappie, and catfish. Fish were not artificially stocked but were introduced naturally from connecting water systems. A fish assessment survey of Eagle Lake and Section 13 Lake was conducted by Boyd and Davies (1981) in cooperation with the Florida Game and Fresh Water Fish Commission. The Eagle Lake survey showed an abundance of young-of-the-year largemouth bass. Electrofishing samples indicated the occurrence of black crappie, brown bullhead, bowfin, golden shiner, and threadfin shad (Boyd and Davies 1981). Largemouth bass or bluegill of quality-size were not collected. The few bream collected in Section 13 Lake and their relatively good condition reflect a fishery system that appears to be in balance (Boyd and Davies 1981).

Boyd and Davies (1981) concluded that the stocks of the two reclaimed systems are poorly structured by size, resulting in a slow rate of recruitment of harvestable-size fish. The poor structure of the fisheries was not considered to be a result of water quality problems or reclamation type, but rather lack of management (Boyd and Davies 1981).

Creel censuses conducted by Boyd and Davies (1981) indicated that the three reclaimed lakes on the OXY property received approximately 2000 hours of fishing pressure each month during the study or 4.5 fishermen per daylight hour. Those fishermen interviewed indicated that 44% of their fishing trips per year were to one of the three OXY lakes. Records of the fishermen's home counties indicates some from counties as much as 50 mi from the sites and many from Georgia.

During 1982, the Florida Game and Fresh Water Fish Commission (FGFWFC) removed approximately 6000 fingerling bass from Eagle Lake to stock lakes managed by the FGFWFC in Duval County. These fish were obtained by seining the lakes from the shore with a drag-type seine pulled by two men.

In the January-February 1984 issue of Florida Wildlife, an article on Tenoroc State Reserve discussed the fishery potential of an area of reclaimed and unreclaimed phosphate-mined lands. The article stated that "bass fishery potential was about 4X better than the state average." These lakes are being managed for recreational use such as fishing, camping, and hunting.

Other fauna studies in the reclaimed lake systems were limited to encounters in the conduct of other fieldwork, except for an avifauna survey conducted for a previous EIS (EPA 1978a). More bird species were observed at reclaimed lakes than in other habitats (Section 3.3.2). The most abundant species were the ring-billed gull, great egret, double-crested cormorant, red-winged blackbird, Bonaparte's gull, and American coot (Table 3.3-99). It should be noted that the avifauna sampling area for the reclaimed lakes included uplands as well as the aquatic component. Other vertebrate species encountered included the river otter, raccoon, Virginia opossum, rice rat, brown water snake, leopard frog, bullfrog, yellow-bellied turtle, Florida softshell, and American alligator.

3.3.10.6 Type and Extent of Reclaimed Lands

As of June 1983, OXY had completed reclamation on >1200 acres of mandatory lands, i.e., areas mined after 1 July 1975 as defined by Ch. 16C-16, FAC. Uplands, wetlands, and open aquatic systems have been produced utilizing primarily the land and lakes reclamation technique. Uplands have also been created by grading overburden material, backfilling mined-out areas with tailings sands, and grading overburden material over the fill (tailings fill). Wetlands have been achieved around lakes in areas of fluctuating water levels. No wetlands have been created on the tailings fill. Open aquatic systems have also been created using the land and lakes reclamation technique. Prior to mining and reclamation, there were few, if any, open aquatic systems within the project area.

The upland systems created were planted with grasses such as bahia (Paspalum notatum) and bermuda (Cynodon sp.), with quick-germinating grasses such as browntop millet (Panicum sp.) and winter rye (Lolium sp.) used as a soil binder to prevent erosion on slopes. Tree species planted on uplands include slash pine (Pinus elliottii), longleaf pine (P. palustris), sand pine (P. clausa), spruce pine (P. glabra), sweetgum (Liquidambar styraciflua), red maple (Acer rubrum), elm (Ulmus americana), cottonwood (Populus deltoides), dogwood (Cornus sp.), green ash

Table 3.3-99. Birds of the Suwannee River Mine's Reclaimed Area.

Species	Birds/Hour
Ring-billed gull	452
Great egret	216
Double-crested cormorant	113
Red-winged blackbird	106
Bonaparte's gull	75
American coot	45
Turkey vulture	30
Herring gull	28
Anhinga	27
Boat-tailed grackle	25
Wood stork	22
Great blue heron	18
Hooder merganser	14
Pied-billed grebe	13
Black-crowned night-heron	9
Blue-winged teal	5
Snowy egret	4
Belted kingfisher	4
Northern shoveler	3
Wood duck	3
Killdeer	3
Song sparrow	3
Common loon	2
Ring-necked duck	2
House wren	2
Savannah sparrow	2
Little blue heron	1
White-crowned sparrow	1
Red-tailed hawk	1

Birds Observed in Habitat but Not During Counts

Horned grebe
White pelican
Cattle egret
White ibis
Canada goose
Mallard
Gadwall
American wigeon
Lesser scaup
Bufflehead
Ruddy duck
Red-breasted merganser
Black vulture
Red-shouldered hawk
Bald eagle
Marsh hawk
American kestrel
Common snipe
Greater yellowlegs
Lesser yellowlegs
Least sandpiper
Dowitcher
Common flicker
Eastern phoebe
Northern mockingbird
Gray catbird
Loggerhead shrike
Eastern meadowlark
Swamp sparrow

Source: EPA 1978a.

(Fraxinus pennsylvanica), live oak (Quercus virginiana), sycamore (Platanus occidentalis), red cedar (Juniperus virginiana), and hawthorne (Crataegus sp.). However, the vast majority of the upland areas were planted in pine, primarily slash pine, for silvicultural purposes, as forestry was the predominant pre-mining land use and slash pine the predominant tree species in the project area.

Prior to the revision of Chapter 16C-16, FAC, in late 1980, replacement of wetlands was not required by mandatory reclamation regulations. Therefore, large wetland reclamation projects do not exist on site. However, two projects with wetlands totaling approximately 100 acres are currently underway at the Suwannee River Mine [projects OCC-SR-SP(4) and OCC-SR-SP(5)].

Presently, most reclaimed wetland areas are situated within the zone of fluctuation of land and lakes projects. While these areas will revegetate naturally, some have been planted with a variety of herbaceous species such as rushes (Juncus spp.), maidencane (Panicum hemitomon), pickerelweed (Pontederia sp.), arrowhead (Sagittaria sp.), smartweed (Polygonum spp.), and bloodroot (Lachnanthes sp.). Forested wetlands have been reclaimed by planting cypress (Taxodium distichum), red maple (Acer rubrum), sweetgum (Liquidambar styraciflua), and blackgum (Nyssa spp.). OXY has recently planted cypress seedlings on their SR-8 reclamation project at the rate of 400 per acre. After the first growing season, OXY reports a survival rate of well over 80%.

Flow through the land and lakes systems is derived from rainfall runoff or mining activities; therefore, an abundance of seeds is present in the water system. After cessation of mining, these flows will be maintained by rainfall runoff (Section 3.4.1). Seeds in the water are deposited on the shoreline where they germinate and grow, creating a littoral zone vegetation area. Species observed growing in these areas include smartweed, rushes, pickerelweed, maidencane, arrowhead, lizard tail (Saururus cernuus), woolgrass bulrush (Scirpus cyperinus), barnyard grass (Echinochloa crusgalli), flatsedge (Cyperus odoratus), willow (Salix spp.), water primrose (Ludwigia octovalis), red ludwigia (L. repens), cattails (Typhus spp.), blueflag (Iris spp.), buttonbush (Cephalanthus occidentalis), and duckweed (Lemna spp.).

A wetland test site constructed on a 49-acre tract in central Florida was the subject of a 3-year study conducted by the Office of Environmental Services of the Florida Game and Fresh Water Fish Commission. Gilbert et al. (1981) summarized the results of the study as "encouraging in terms of the ability to create favorable conditions for the establishment of wetland habitat on post-mining overburden soils." Other studies indicate that wetlands on reclaimed lands provide habitat utilized by species typically occurring in wetlands (Schnoes and Humphrey 1979).

3.3.11 Methods

3.3.11.1 Vegetation Mapping and Characterization

Wetland and upland plant communities were determined through photointerpretation of low-altitude aerial photography, ground-truthing surveys, and quantitative transect sampling. A vegetation and land use map was prepared from these data (Figure 3.3-2). The quantitative transect data were compared with previous studies reported in the literature.

Mapping. Wetland and upland vegetation and land use were mapped using false color infrared aerial photography (scale 1:12,000), flown 30 November and 19 December 1979 by Kucera and Associates, Inc. The 1979 photography was updated by inspection of January 1981 black-and-white photography provided by OXY to note significant land use changes since the 1979 photography. Initial ground-truthing was conducted to gain site familiarity and to determine vegetative composition of the various photographic signatures. Photointerpretation was performed utilizing either a Bausch and Lomb or Zeiss stereoscope. Wetlands vegetation was delineated and classified to the dominance level of the FWS classification (Cowardin et al. 1979) and to Level III of the Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976). Upland areas were mapped to Level III of the Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

Field verification of the photointerpretation was performed by randomly sampling 5% of the wetland units for accuracy of classification. Also, a contiguous 2.5-acre area of uplands extending out in the four cardinal directions from the randomly selected wetlands was ground-truthed.

In order to evaluate the effects of the various mining plan alternatives on the wetlands of the project area, wetland and upland vegetation and land use delineations were transferred to the OXY hypothetical mining grid system composed of uniform 2.5-acre grid cells. A photo mosaic of each of the major drainage areas in the project area was constructed using the Kucera 9x9 color infrared prints. Section lines were transferred to this mosaic from USGS topographic maps using obvious physical features such as roads and vegetation breaks. Each section was then transferred visually, using a grid overlay system, to the OXY hypothetical mining grid. Acreages were then calculated, coded, and entered into a computer data management system.

Description of Plant Communities. To characterize the vegetation of the project area for comparison with past studies, wetlands were selected to encompass the range of variation in wetland size and species composition. Along each transect in the selected wetlands, trees ≥4 in. diameter at breast height (dbh) were sampled on a point-quarter system (50 ft or 100 ft point-center, Phillips 1959), trees and shrubs ≥4 in. dbh were sampled on a modified point-quarter system, and herbaceous vegetation and seedlings were sampled on a 0.5 x 2 m quadrat at each point-center. Data were recorded on summary data sheets (Table 3.3-100). The following formulas were used to obtain quantitative data (Table 3.3-100, Phillips 1959):

- Density = number of individuals of each species per square meter
- Relative density = $\frac{\text{number of individuals of a species}}{\text{number of individuals of all species}} \times 100$
- Basal area = mean basal area x density
  (mean basal area = mean dbh converted to basal area)
- Frequency = $\frac{\text{number of points of occurrence of a species}}{\text{total points taken}}$
- Relative frequency = $\frac{\text{number of points of occurrence of a species}}{\text{number of points of occurrence of all species}} \times 100$
- Relative dominance = $\frac{\text{total basal area of a species}}{\text{total basal area of all species}} \times 100$
- Importance = relative density + relative frequency + relative dominance

These methods were selected to allow comparison of current data and historical data collected by Monk (1965, 1966). No quantitative data on upland vegetation were collected, but qualitative descriptions were prepared based on field investigations within each of the upland community types.

3.3.11.2 Fauna

Prior to site visits, faunal lists from recognized state and project area references were reviewed (Peterson 1947, Carr and Goin 1955, Conant 1958, Hall and Kelson 1959, Burt and Grossenheider 1964, Robbins et al. 1966, Cochran and Goin 1970, Stevenson 1976, NFWL 1978, EPA 1978a). The following recognized authorities were consulted to determine presence of certain species on site:

- J. William Hardy, Florida State Museum - avifauna
- Paul Mohler, Florida Game and Fresh Water Fish Commission - herpetofauna
- Robert W. Repenning, University of Florida - avifauna
- Stephen R. Humphrey, Florida State Museum - mammals
- Steven K. Stafford, Florida Game and Fresh Water Fish Commission - game species

Table 3.3-100. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland ______________ Wetland No. ______ Drainage ______________

Type ________ Size (ac) ______ Surrounding area ______________

Disturbance ______________ Plot interval (ft) ______

Total length of transect (ft) ______ Location ______________

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density

Mean distance (ft) ______ Mean area/individual (sq ft) ______ Density/acre ______

Total basal area (sq ft) ______

Evidence of species occurrence was collected during vegetation studies, wetland studies, and upland evaluations. No formal faunal searches were conducted, except on a qualitative basis using primarily encounter techniques. Direct observations of foraging individuals were noted and evening auditory surveys were made. Sightings, calls, tracks, droppings, nests, and burrows were recorded during all site visits.

The Colonial Bird Register, a computerized data base, was searched for documentation of colonial bird nesting sites within the project boundaries. The Florida State Museum holdings also were searched for documented occurrence of species in the project area.

Sensitive Species. Endangered, threatened, and rare species, and species of special concern were compiled from the following lists:

- 50 CFR 17.11-17.12 [Part II, July 27, 1983, Federal Register (48 FR 34182-34196)]
- Florida Game and Fresh Water Fish Commission (1981)
- Rare and Endangered Biota of Florida (Pritchard 1978).

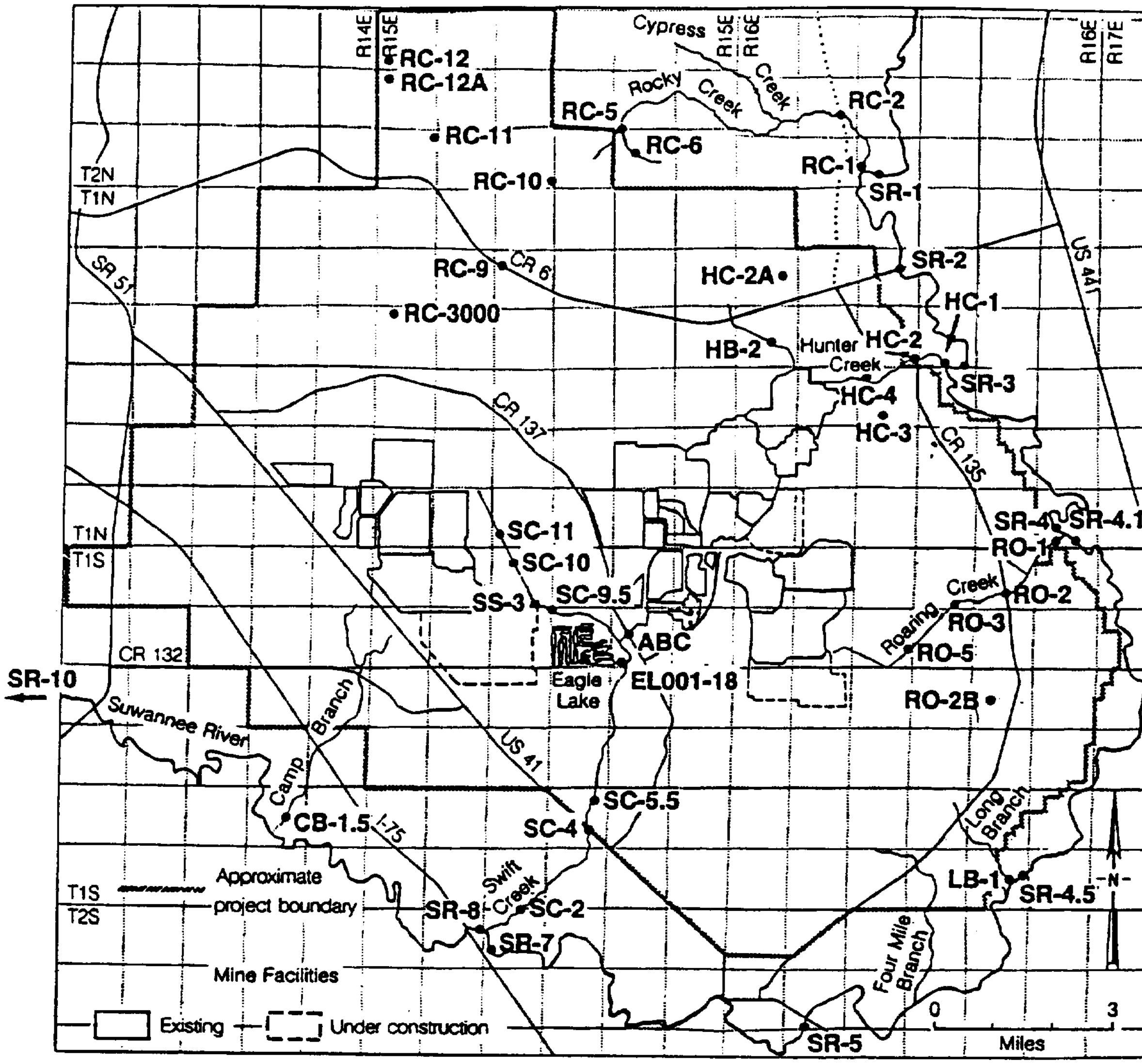
The Federal Register was reviewed for critical habitats of sensitive species occurring on site. No critical habitat is within the project area boundary. The Florida Audubon Society, Florida Game and Fresh Water Fish Commission, and Florida State Museum were contacted to determine occurrences of sensitive species not recorded in the literature. Specific habitats were examined where sensitive species were suspected or reported. Additional searches for sensitive species were conducted during other fieldwork, particularly during vegetation mapping and wetlands and uplands field evaluations. Species-specific searches were conducted for the red-cockaded woodpecker, bald eagle, American alligator, and eastern indigo snake.

3.3.11.3 Aquatic Ecology

3.3.11.3.1 Field Collections

Establishment of Sampling Stations. Forty-two stations for sampling aquatic biological components were established throughout the OXY project area. The stations were located in such a manner as to generate biological data that best represented the prevailing ecological conditions of the area. The locations and descriptions of these stations are presented in Figure 3.3-40 and Table 3.3-101. In many cases, sampling stations were located near bridges and culverts for accessibility. However, the actual sampling site was located away from the influence of these structures and in areas representative of local natural conditions.

Phytoplankton. Vertical composite phytoplankton samples were collected in August 1981 (Figure 3.3-40) by filtering 20 liters of water through a plankton-straining bucket (Model 49B, Wildlife Supply Company, Saginaw, Michigan). Retained material was rinsed into appropriate containers and



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

• Aquatic sampling station

Figure 3.3-40. Aquatic Sampling Sites for Wetlands Mining EIS, 1981-1982.

Table 3.3-101. Locations and Descriptions of Aquatic Sampling Stations for Wetlands Mining EIS, 1981-1982.

Station	Location	Substrate	Stream Width (m)	Stream Depth (m)	Percent Canopy
SR-1	Suwannee River upstream of Rocky Creek	Sand/pebbles	36	1.5-3.0	20
SR-2	Suwannee River upstream of CR 6 bridge	Sand/pebbles	40	1.5-4.5	10
SR-3	Suwannee River upstream of Hunter Creek	Sand/pebbles	19	0.8-1.5	20
SR-4	Suwannee River upstream of Roaring Creek	Sand/pebbles	26	2.1-4.5	50
SR-4.1	Suwannee River downstream of Roaring Creek	Sand/pebbles	27	1-2	20
SR-4.5	Suwannee River upstream of Long Branch	Sand/pebbles	27	1-2	20
SR-5	Suwannee River at White Springs, US 41 bridge	Sand/silt/organic	27	1.4	30
SR-7	Suwannee River upstream of Swift Creek	Sand/organic	36	1-2	15
SR-8	Suwannee River downstream of Swift Creek	Sand/organic	36	1-2	20
SR-10	Suwannee River upstream of Suwannee Springs	Sand/organic	37	0.9-3.6	30
RC-1	Rocky Creek near the mouth	Sand/organic	5	0.4-1.5	70
RC-2	Rocky Creek upstream of bridge on Woodpecker Road	Sand/organic	3	0.4-1.5	70
RC-5	Rocky Creek upstream of unmaintained wooden bridge	Sand/organic	12	0.3-1.0	80
RC-6	Rocky Creek upstream of culvert on Christie Tower Road	Sand/organic	4	0.2-0.6	85
RC-9	Rocky Creek upstream of CR 6 bridge	Organic	5	0.2-0.6	0
RC-10	Rocky Creek, northeast section of Bee Haven Bay at culvert	Sand/organic	20	1.2-1.8	5
RC-11	Rocky Creek downstream of culvert on Christie Tower Road	Sand/organic	4	0.3-0.6	20
RC-12	Rocky Creek upstream of culvert on Cypress Creek Road	Organic	3	0.3-0.6	60
RC-12A	Rocky Creek downstream of culvert on Cypress Creek Road	Sand/organic	3	0.3-0.6	90
RC-3000	Rocky Creek drainage, Bee Haven Bay, marsh transect	Organic	-	0.1-0.4	0
RO-1	Roaring Creek near the mouth	Sand/pebble/bedrock	2	0.1-1.2	40
RO-2	Roaring Creek at CR 135 bridge	Sand/organic/pebbles	3	0.3-1.0	50
RO-2B	Roaring Creek drainage, swamp transect	Organic	-	0.1-0.4	90
RO-3	Roaring Creek 1 mi upstream of RO-2 and 0.5 mi north of Eight Mile Still Road	Sand/organic	5	0.1-1.2	60
RO-5	Roaring Creek off Eight Mile Still Road	Sand/organic	6	0.3-1.5	50
CB-1.5	Camp Branch downstream of CR 225A culvert	Sand/organic	3	0.5-1.5	60
LB-1	Long Branch near the mouth	Sand/organic	3	0.2-0.6	60
HB-2	Hogans Branch downstream of culvert on Sugar Ridge Road	Sand/organic	3	0.5-3.0	50

Table 3.3-101 (Continued).

Station	Location	Substrate	Stream Width (m)	Stream Depth (m)	Percent Canopy
HC-1	Hunter Creek near the mouth	Sand/organic/pebbles	5	0.2-0.7	90
HC-2	Hunter Creek downstream of CR 135 bridge	Sand/organic/pebbles	12	0.3-1.2	70
HC-2A	Hunter Creek drainage in Bear Bay, swamp transect	Organic	10	0.1-0.4	90
HC-3	OXY mine water drainage canal to Hunter Creek	Sand/organic	3	0.3-0.8	60
HC-4	Hunter Creek approximately 0.5 mi west of CR 135	Sand/organic	3	0.2-0.6	60
ABC	Altmans Bay Canal downstream of CR 137 bridge	Sand/organic/pebbles	3	0.6-1.0	70
EL001-18	Eagle Lake Canal below exit control structure	Sand/organic/pebbles	6	0.4-0.7	0
SC-2	Swift Creek upstream of CR 225A bridge	-	7	1.2-1.8	-
SC-4	Swift Creek downstream of US 41 bridge	Sand/organic/pebbles	7	0.6-1.8	80
SC-5.5	Swift Creek downstream of wooden bridge approximately 0.5 mi north of US 41	Sand/silt	7	0.6-1.8	40
SC-9.5	Swift Creek immediately upstream of creek control structure	Silt	3	0.6-1.5	0
SC-10	Swift Creek approximately 1 mi upstream of creek control structure	Silt	10	1.2-3.0	0
SC-11	Swift Creek approximately 1.5 mi upstream of creek control structure	Silt	9	0.5-1.0	0
SS-3	Swift Creek downstream of swamp near creek control structure	Silt	5	0.4-1.0	0

preserved with Volvox or M^3 fixative (APHA 1980). A 1-liter replicate water sample also was collected for pigment analysis (chlorophyll a and pheophytin), fixed in the field with 90% aqueous acetone, frozen, and stored in the dark.

Periphyton. Periphyton was collected during September 1981 and February and May 1982 (Figure 3.3-40). Samples of attached algal communities were collected on artificial substrates consisting of 28 standard glass microscope slides (25 mm X 75 mm) placed vertically in stainless steel racks. The racks were suspended at a depth of 10 cm by anchored styrofoam floats (FDER 1975) and incubated in situ for 30 days (EPA 1973). At the end of the incubation period, ten slides were randomly selected for identification and enumeration of the periphyton community. These slides were scraped with a razor, composited, and preserved in Volvox fixative. In addition, ten slides were randomly selected for chlorophyll a and pheophytin content. These slides were scraped, dispersed in 90% aqueous acetone, and stored in the dark on ice.

Macroinvertebrates. Quantitative and qualitative macroinvertebrate samples were collected during August-September 1981, January-February 1982, and April-May 1982 (Figure 3.3-40). Quantitative collections were made using a petite Ponar and Hester-Dendy artificial substrates (Hester and Dendy 1962).

Petite Ponar grabs (sampling area = 0.0232 m^2) were taken at approximately equal intervals across the stream channel at each station. Four replicates, each composed of four grabs, were taken at each station. All natural substrate samples were sieved in the field using a U.S. Standard Sieve No. 30, and the material retained was preserved in 70% ethanol and stained with Rose Bengal for later sorting and identification.

Four Hester-Dendy samplers (each sampling an area of 0.13 m^2) were allowed to colonize at selected stations for four weeks (FDER 1975). Each sampler was suspended in the euphotic zone by floats, at approximately 0.3 m or mid-depth, whichever was less, and anchored in position by cinder blocks or tied to stationary objects. When the samples were collected, they were placed in wide-mouth plastic jars, preserved in 70% ethanol, and stained with Rose Bengal.

Qualitative samples were collected using a variety of techniques: petite Ponar, collecting by hand, and dip nets. Each station was sampled for approximately 30 minutes, and all habitats were sampled thoroughly. The material collected was sieved, preserved in 70% ethanol, and stained with Rose Bengal.

Substrate type, current velocity, and water depth were characterized at each sampling location to help define factors influencing the structure of macroinvertebrate communities. General substrate type and organic content were determined by visual examination during all sampling periods. Current velocity, measured in feet per second, and discharge, measured in cubic feet per second (cfs), were determined using a pygmy and/or Price AA flow meter (Buchanan and Somers 1969). Average stream width and depth were recorded at each station, and in situ water quality measurements were made for dissolved oxygen, pH, temperature, and specific conductivity.

Seven sets of samples were taken from five streams to develop species area curves (Oosting 1956, Southwood 1978). Five sets of ten petite Ponar samples were taken from Hunter Creek, Roaring Creek, Rocky Creek, Swift Creek, and the Suwannee River. Two additional collections were taken from Hunter Creek and Rocky Creek using Hester-Dendy multiplate samplers. The purpose was to determine the number of samples necessary to adequately sample macroinvertebrate communities in the study area, based on a $\leq$10% increase in number of species in successive samples.

Drift Nets. Drift samples were collected during August-September 1981 and February 1982 (Figure 3.3-40). For the initial sampling period, drift samples were collected for approximately 3 hr during mid-day and 6-8 hr at night, beginning several hours before dusk to approximately 0100 hr. In 1982, nets were placed in the water several hours before dusk and retrieved at approximately midnight. The mouth opening of the drift net was 30.5 x 45.7 cm and the net mesh was 600 μ. Depth and water velocity were measured upon placement and retrieval of nets. Material collected was placed in containers, preserved in 70% ethanol, and stained with Rose Bengal. In small streams such as Rocky Creek, one net was sufficient to collect a representative sample; however, in larger streams two to four nets were employed, depending on stream size. When multiple nets were used, they were placed to collect a representative sample of drift through an entire cross-section of the stream. For example, on the Suwannee River four nets were used simultaneously: samples were taken from both sides of the channel, mid-channel just below the surface, and mid-channel near the bottom. Discharge (cfs) was measured at each sampling site, where possible. Flow determinations were made using either a pygmy or Price AA flow meter (Buchanan and Somers 1969).

Fish. Fish were sampled from the Suwannee River during October 1981 using dip nets, seines, and blocknets (Figure 3.3-40). Attempts to sample the major tributaries to the Suwannee River in the vicinity of OXY were unsuccessful due to high, swift waters resulting from recent rains. The tributaries were successfully sampled during June 1982. Each habitat type was sampled at each station until no new species were collected. Specimens were field-preserved in 10% formalin and later transferred to 70% ethanol.

Aquatic Macrophytes. Qualitative estimates of macrophytes were made for selected sites in the project area. Additional information was obtained from recent studies on macrophytes in Hamilton County (EPA 1978a, PELA 1977).

3.3.11.3.2 Laboratory Analyses

Phytoplankton and Periphyton. Preserved samples were adjusted to a known volume and aliquots withdrawn and isolated in 10 ml sedimentation chamber slides. After a 4-hr settling time, slides were examined under a Wilde M40 inverted plankton microscope (Wilde Heerbrugg Instruments, Inc., Farmingdale, Long Island, New York) at 400X magnification (Utermohl 1958). Cells were counted in a strip 10 mm long by field diameter width. For each sample, two diagonals were counted in each of two chambers. Periphyton and phytoplankton densities were enumerated as number of units per ml. Samples were identified to the lowest practical taxonomic level using the following keys: Huber-Pestalozzi 1938; Prescott 1951, 1964; Drouet 1968; Bourrelly 1968; Weber 1971; Hansmann 1973; Whitford and Schumacher 1973.

Chlorophyll a was measured by the acid addition method (APHA 1980) using a double-beam spectrophotometer (Model 100-20, Hitachi, Ltd., Tokyo, Japan). Samples were filtered on Whatman HA membrane filters of 0.45 µ porosity. Pigments were extracted by macerating the filter in a fluted teflon tissue grinder and steeping with an acetone-magnesium carbonate solution (90:10% V/V) at -10°C for 24 hr. Chlorophyll a levels were determined spectrophotometrically using the equations of Strickland and Parsons (1972). Concentrations were reported as mg chlorophyll a per m^2 for periphyton and mg chlorophyll a per m^3 for phytoplankton.

Macroinvertebrates. All samples (natural substrate, artificial substrate, and qualitative) were sieved again in the laboratory using a U.S. Standard Sieve No. 30, sorted by hand from sediment and debris, and stored in 70% ethanol. Organisms were identified to the lowest practical taxon with appropriate keys (Usinger 1956, Beck 1976, Edmunds et al. 1976, Wiggins 1977, and Merritt and Cummins 1978). Dr. Sidney Dunkle of the University of Florida identified the specimens. Identifications of unknown or unusual specimens were verified by Dr. William Beck of Jacksonville, Florida (chironomids) and Dr. Minton Westfall of the University of Florida (odonates and other aquatic insects).

Drift Nets. Drift samples were processed in a manner identical to other macroinvertebrate samples. Biomass measurements of macroinvertebrates and detritus were made for selected samples to determine the concentration of organic material in the Suwannee River and the input of various streams to the Suwannee River system. Alcohol was decanted off the samples, and the organisms were blotted dry and placed in a crucible. Organisms and detritus were dried at 60°C until a constant weight was reached (EPA 1973, Southwood 1978).

Fish. Fish collected during the field survey were identified to species by Dr. Carter Gilbert of the Florida State Museum in Gainesville.

Aquatic Macrophytes. Identifications were performed using appropriate keys (Radford et al. 1968; Tarver et al. 1978; and Godfrey and Wooten 1979, 1981).

3.3.11.3.3 Data Reduction and Analysis

Phytoplankton. Phytoplankton samples were divided into groups of species indicative of good water quality and species groups indicative of stressed ecosystems. Data were tabulated by station and species, with counts in cells/ml. Similarity of species composition among stations was calculated (Boesch 1977). Diversity and equitability were calculated for all samples (Shannon and Weaver 1963, EPA 1973). Collections for this study were compared to historic data (EPA 1978a, Figure 3.3-41) to determine temporal changes in species composition.

Periphyton. Data were reduced to tabular format with species listed by station. Number of taxa, number of individuals, density, species diversity (Shannon and Weaver 1963), and equitability (EPA 1973) were calculated for all samples. Similarity indices were calculated between stations for pooled samples. Differences in number and density among and within the periphyton communities at various stations were compared graphically. Periphyton collections were compared to historic collections (EPA 1978a) for changes in community composition.

Macroinvertebrates. Data were reduced to a tabular format by station and sampling period. Data analysis consisted of the following elements:

- number of taxa
- total number of organisms
- faunal density (number of organisms per m^2)
- species diversity (Shannon and Weaver 1963)
- equitability (MacArthur 1957, Lloyd and Ghelardi 1964, EPA 1973)
- Florida index (Beck 1954, 1955; FDER 1981)
- faunal similarity (Boesch 1977, Southwood 1978).

Comparisons were made between stations and sampling periods. Community structure of benthic populations was evaluated in relation to environmental factors such as stream water quality. Recent collections were compared to historical collections (EPA 1978a, Figure 3.3-41) for documentation of temporal changes in benthic communities.

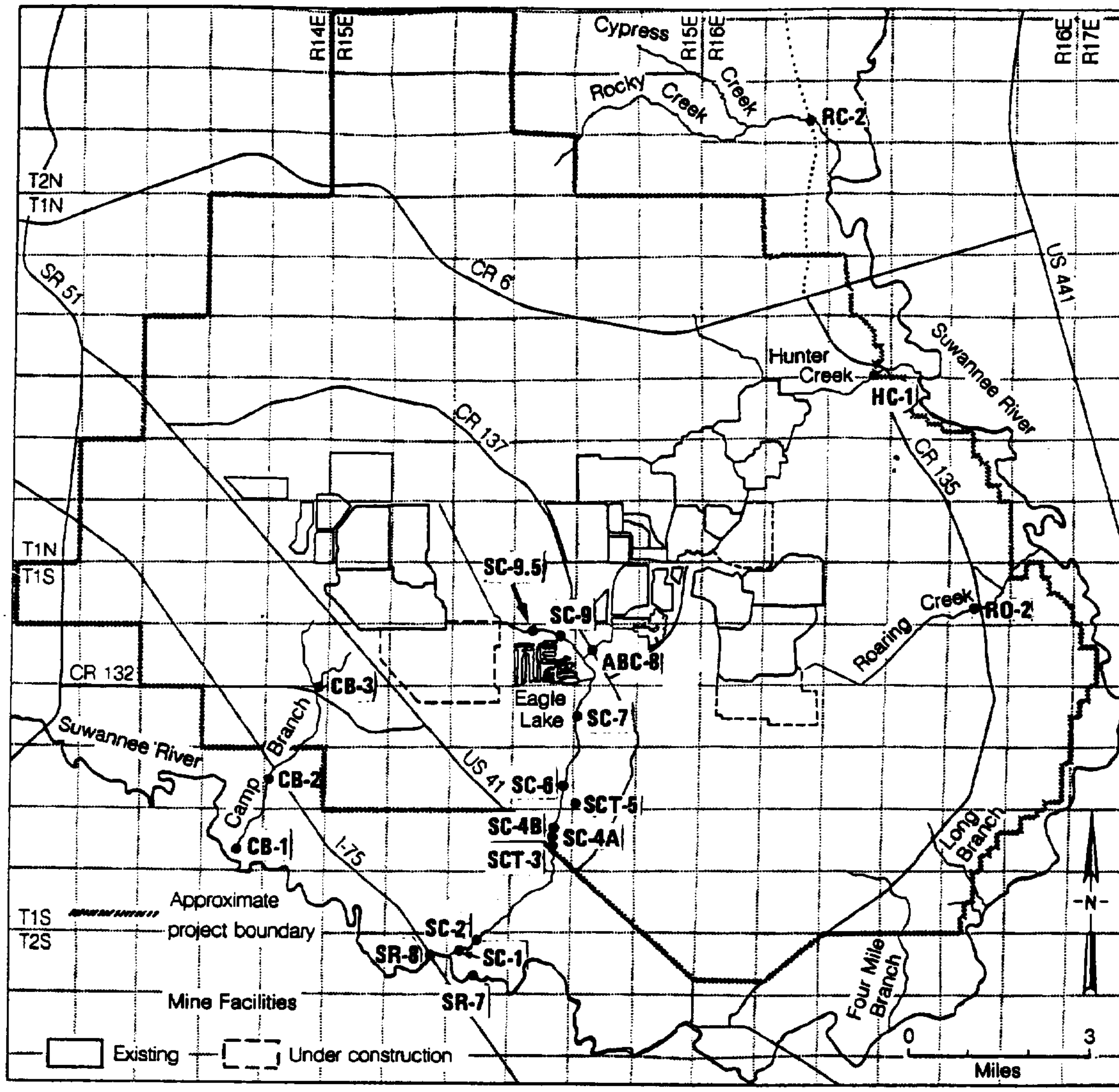
Sample order for the species area curve samples was randomized ten times using a table of random numbers (Sokal and Rohlf 1969). The average number of species added with each successive sample was calculated and plotted to determine how many samples were necessary to produce a $\leq 10\%$ increase in new species collected with successive sampling efforts.

Drift Nets. The weights of macroinvertebrate species and detrital material contributed to the Suwannee River by tributaries were determined. Density (number of individuals per ft^3) and weight (mg/ft^3) estimates were made on material passing each station. Drift was compared among stations using graphical analysis.

Fish. Data were reduced to tabular format for species occurrence at each station. Analysis included evaluating the ecological condition of fish populations at each station and environmental conditions regulating fish populations. Between-station comparisons were made using the Czekanowski/Sorensen similarity index:

$$C_s = 2j/(a+b)$$

where C_s = percent similarity, a = number of species collected at Station a, b = number of species collected at Station b, and j = number



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

• Aquatic sampling station

Figure 3.3-41. Aquatic Sampling Sites for Swift Creek Chemical Complex EIS (EPA 1978a).

of species common to the two stations (Southwood 1978). These data were compared to historical data (EPA 1978a, Figure 3.3-41) to determine temporal changes in the fish community in the upper Suwannee River basin.

Aquatic Macrophytes. Species lists were generated for the project area.

3.3.11.4 Upland Habitat Evaluation

Representative uplands in the project area were evaluated using a habitat evaluation system (ACOE 1980) modified for habitats present in north Florida. The system evaluates habitat quality and has the potential to numerically compare impacts of various activities on a habitat. Readily quantifiable biotic and abiotic habitat characteristics are used in the evaluation.

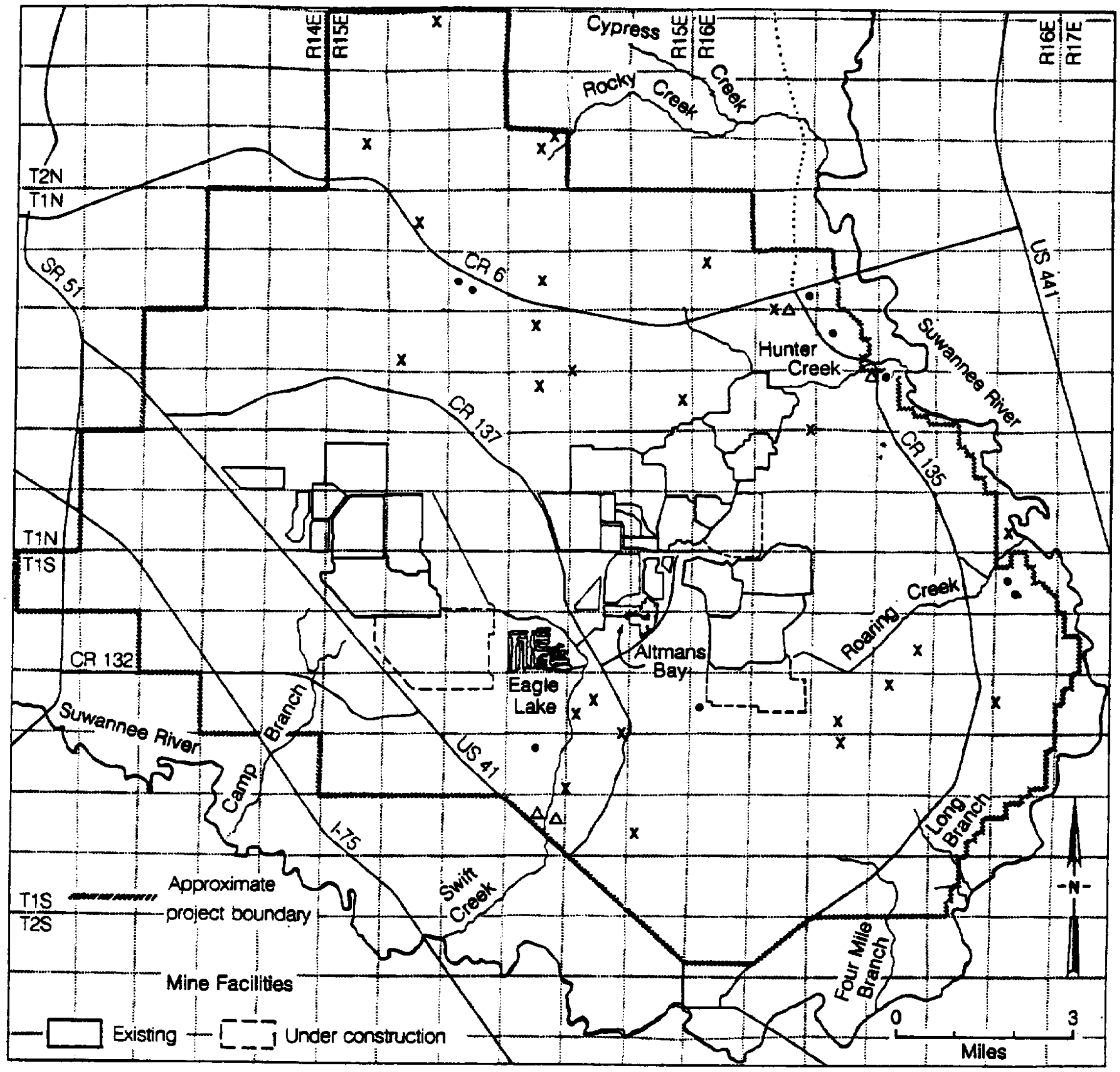
Three upland habitat types were evaluated: upland forest (pine plantation, pine flatwoods, upland hardwoods), bottomland hardwoods (mixed forest sites near streams), and open lands (agricultural). Curves relating biotic and abiotic factors to habitat quality were used to determine a habitat quality index (HQI) factor for each habitat type. Factors were weighted to reflect their contribution to habitat quality.

Photointerpretation and Mapping. Upland forest, bottomland hardwoods, and open lands were mapped, according to the Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976), by photointerpretation of 1979 false color infrared photography and 1981 aerial bluelines and by ground-truthing. Acreages were broken out by drainage basin to permit basin by basin evaluation. Basin totals were summed for a comprehensive evaluation of the study area.

Selection of Representative Habitat Sites and Key Variables. Tracts of each habitat in a drainage basin were selected from 1979 false color infrared aerial photographs and 1981 aerial bluelines. At least two sampling sites were selected for each major basin (Figure 3.3-42). Sites were selected to encompass variations found within a habitat type. Key variables were determined and assigned weights (Table 3.3-102). Weights reflect values used by the ACOE (1980) except for the open lands parameters, where weights were modified because of the deletion of a flooding frequency curve which did not apply to north Florida.

Modification of Habitat Quality Index Curves. Values for each key variable were converted into HQI scores using a specific functional curve for that key variable and habitat type. The HQI is a function of the general value of a habitat for wildlife populations. A scale of 0 to 1.0 is used for the HQI, with 1.0 being the maximum HQI. Habitat quality index curves were derived from those in A Habitat Evaluation System for Water Resources Planning (ACOE 1980). Curves for upland forests (Figures 3.3-43 through 3.3-49), bottomland hardwoods (Figures 3.3-50 through 3.3-56), and open lands (Figures 3.3-57 through 3.3-62) were modified to reflect species associations found in north Florida. Curve slopes and values were not modified.

Field Sampling. Transects were established in each habitat type to verify mapping efforts and to obtain HQI scores. Transect sampling points



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

Δ Bottomland hardwoods
x Upland forest
• Open lands

Figure 3.3-42. Transect Locations for Upland Habitat Evaluations.

Table 3.3-102. Weights Assigned to Key Variables of Upland Ecosystems.

Key Variable	Upland Forests	Bottomland Hardwood Forests	Open Lands
Species association	17	17	
Number of mast trees	16	16	
Percent understory coverage	14	14	
Percent ground cover	15	14	
Number of large trees	14	14	
Number of snags	11	11	
Tract size	13	14	13
Land use type			18
Land use diversity			18
Distance to cover			18
Distance to woods			16
Perimeter development index			17
	100	100	100

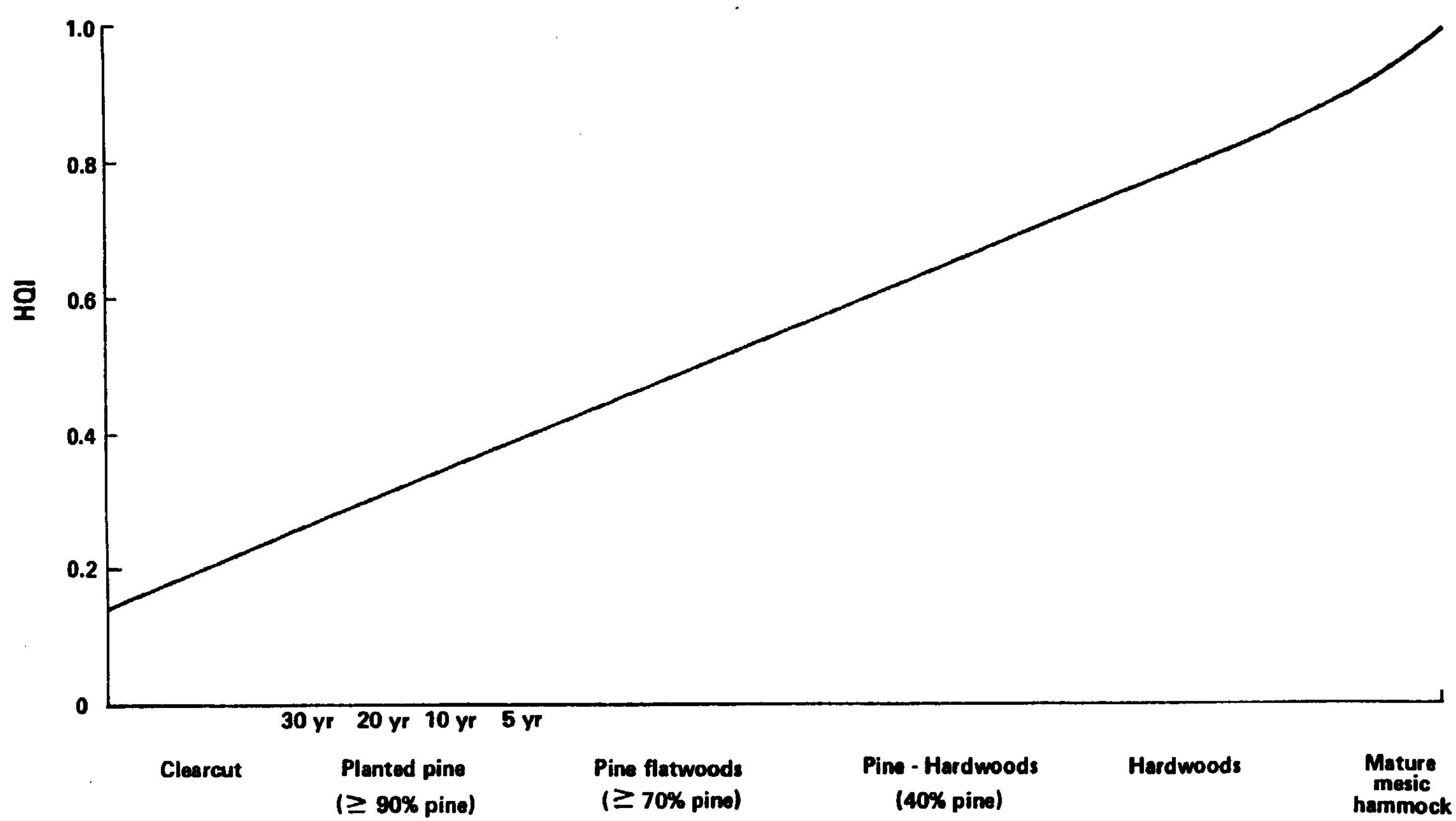


Figure 3.3-43. Habitat Quality Index (HQI) Curve for Species Association, Upland Forest.
(Source: ACOE 1980)

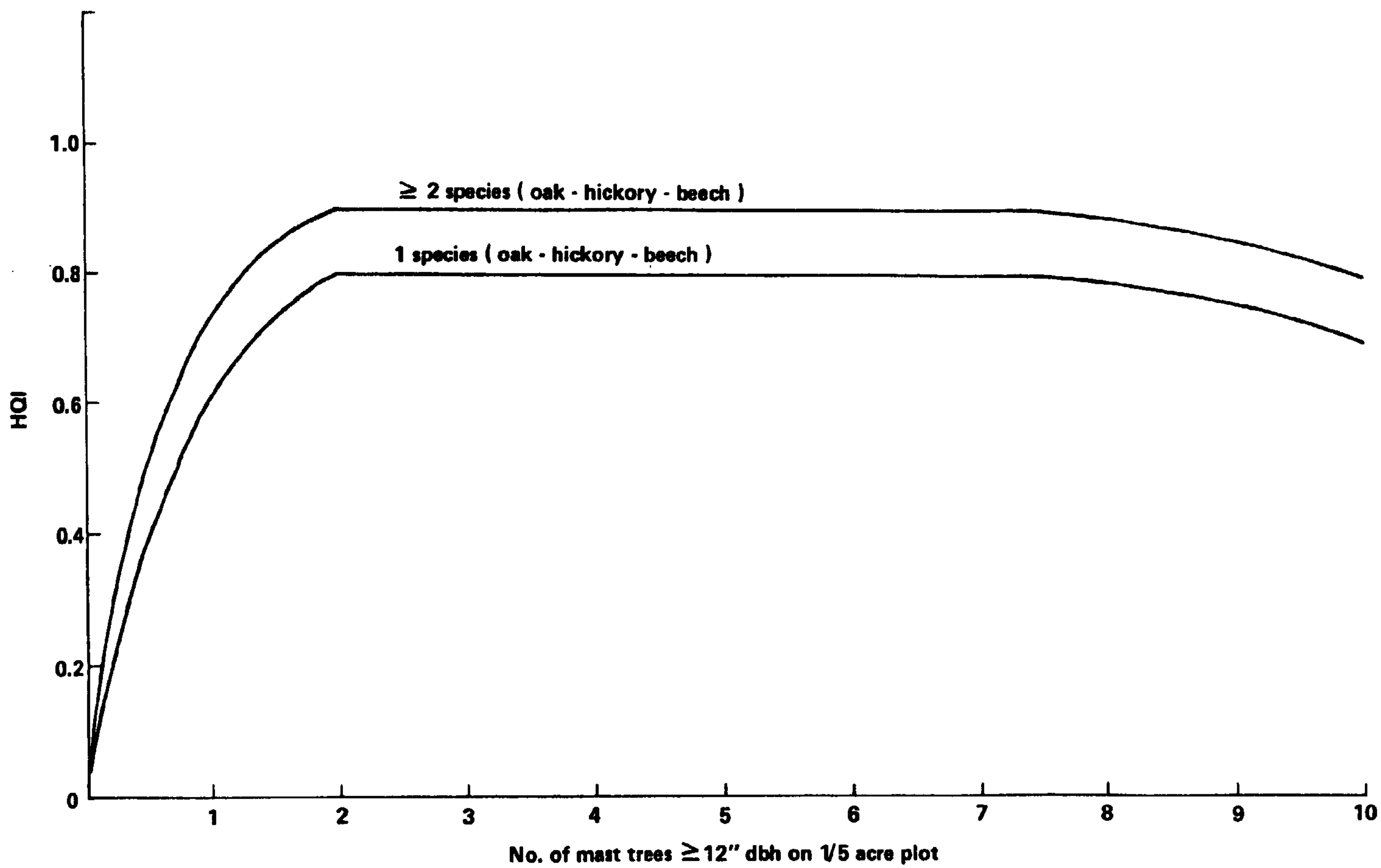


Figure 3.3-44. Habitat Quality Index (HQI) Curve for Number of Mast Trees, Upland Forest.
(Source: ACOE 1980)

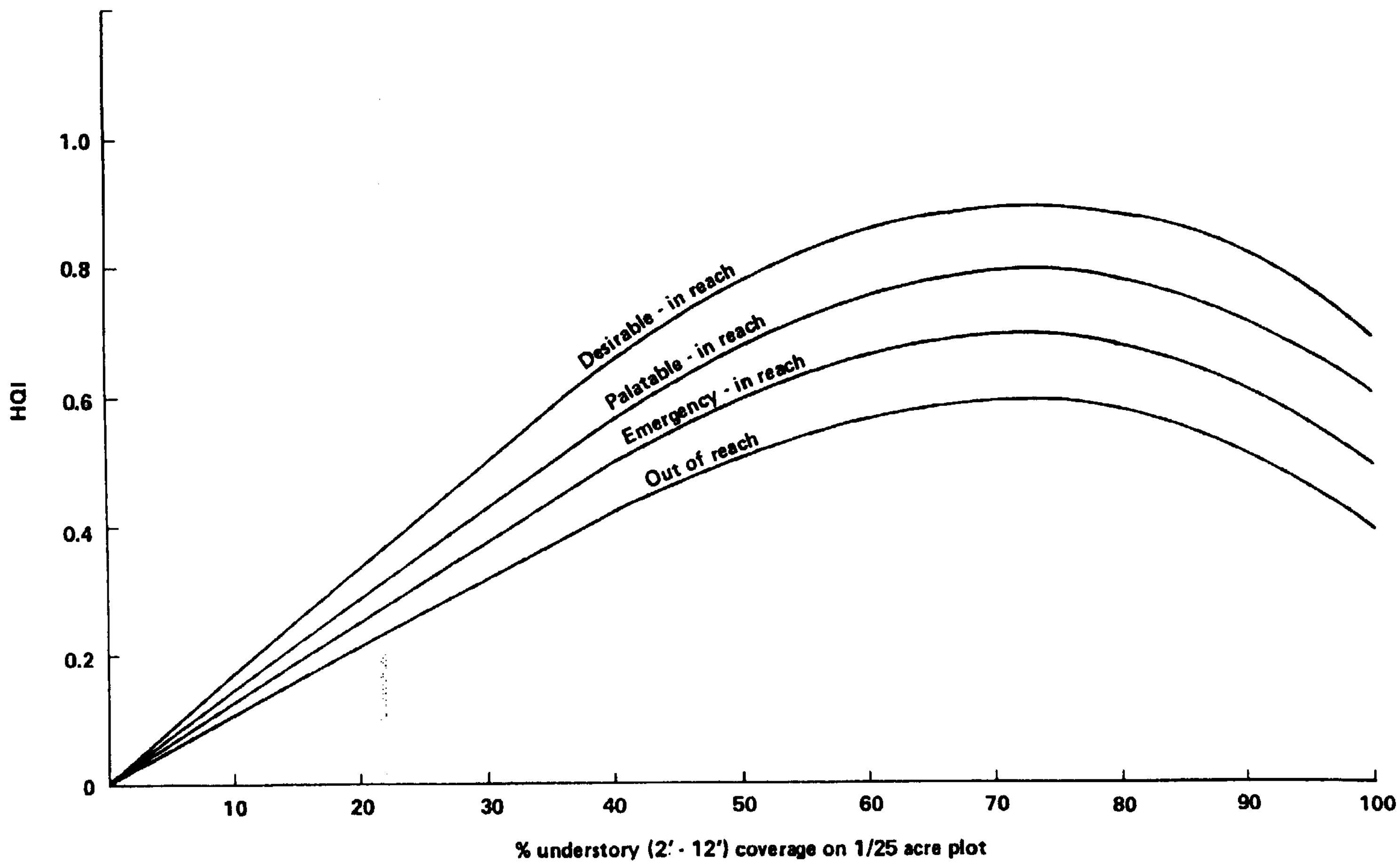


Figure 3.3-45. Habitat Quality Index (HQI) Curve for Percent Understory Coverage, Upland Forest.
(Source: ACOE 1980)

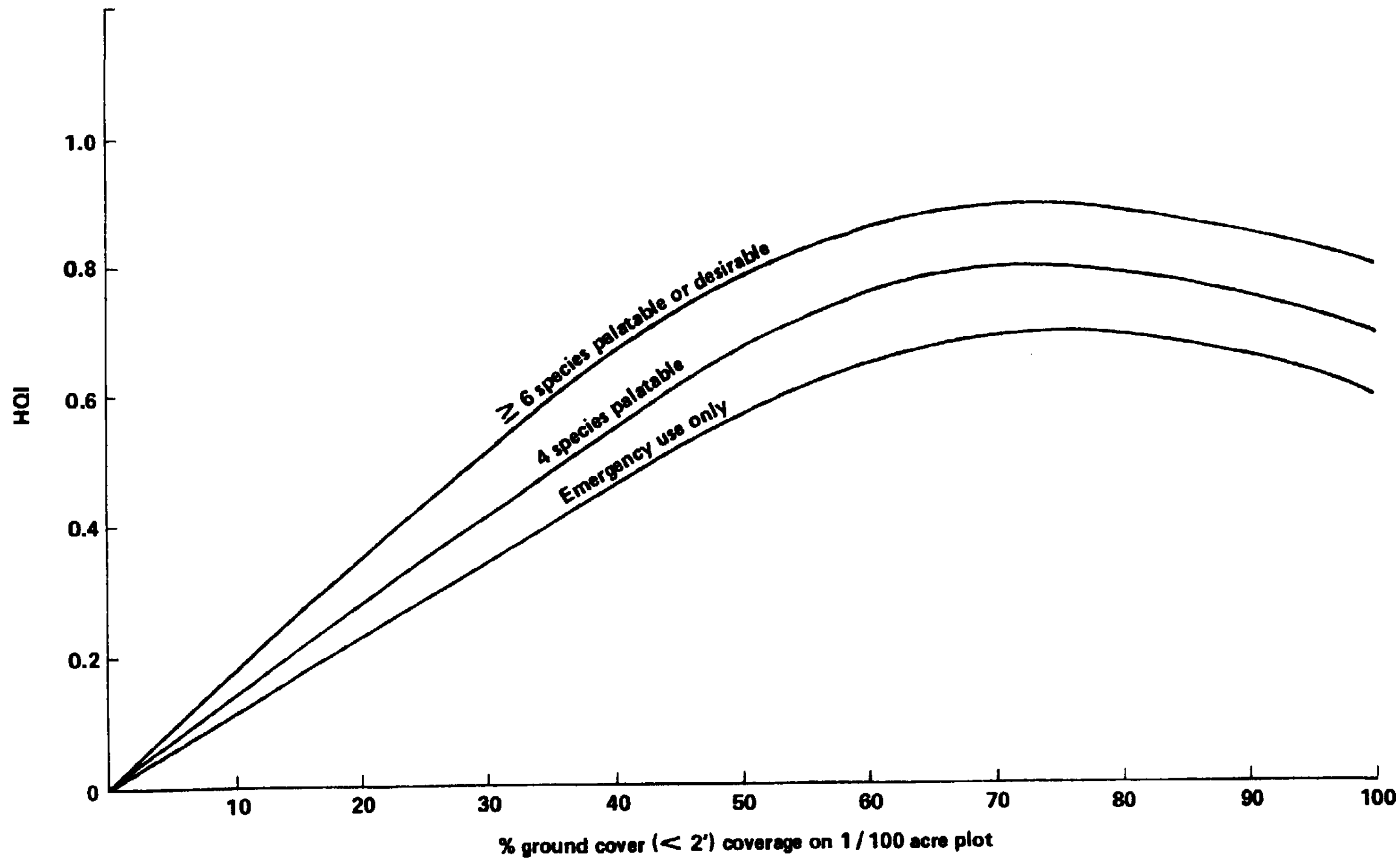


Figure 3.3-46. Habitat Quality Index (HQI) Curve for Percent Coverage of Ground Cover, Upland Forest.
(Source: ACOE 1980)

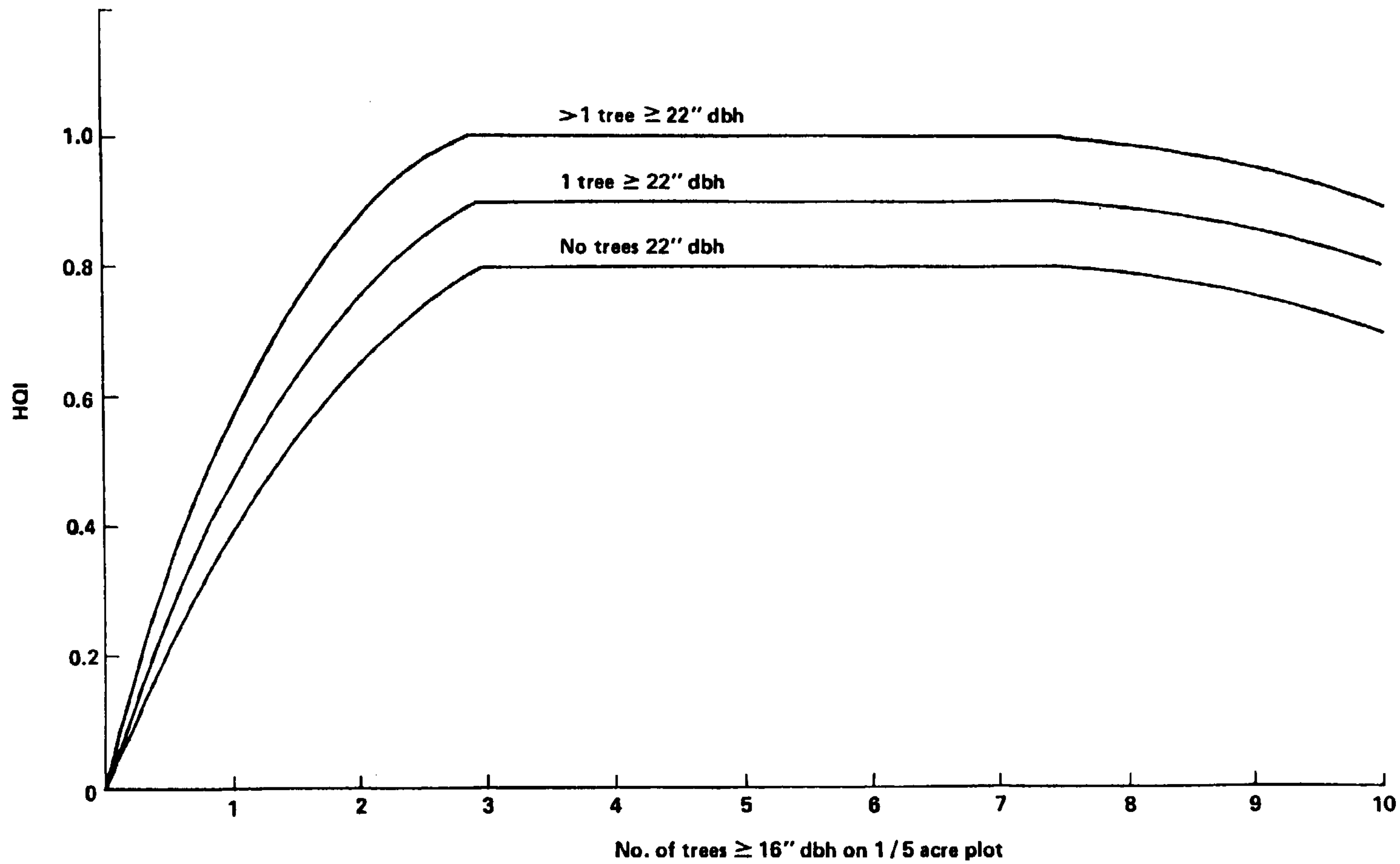


Figure 3.3-47. Habitat Quality Index (HQI) Curve for Large Trees, Upland Forest.
(Source: ACOE 1980)

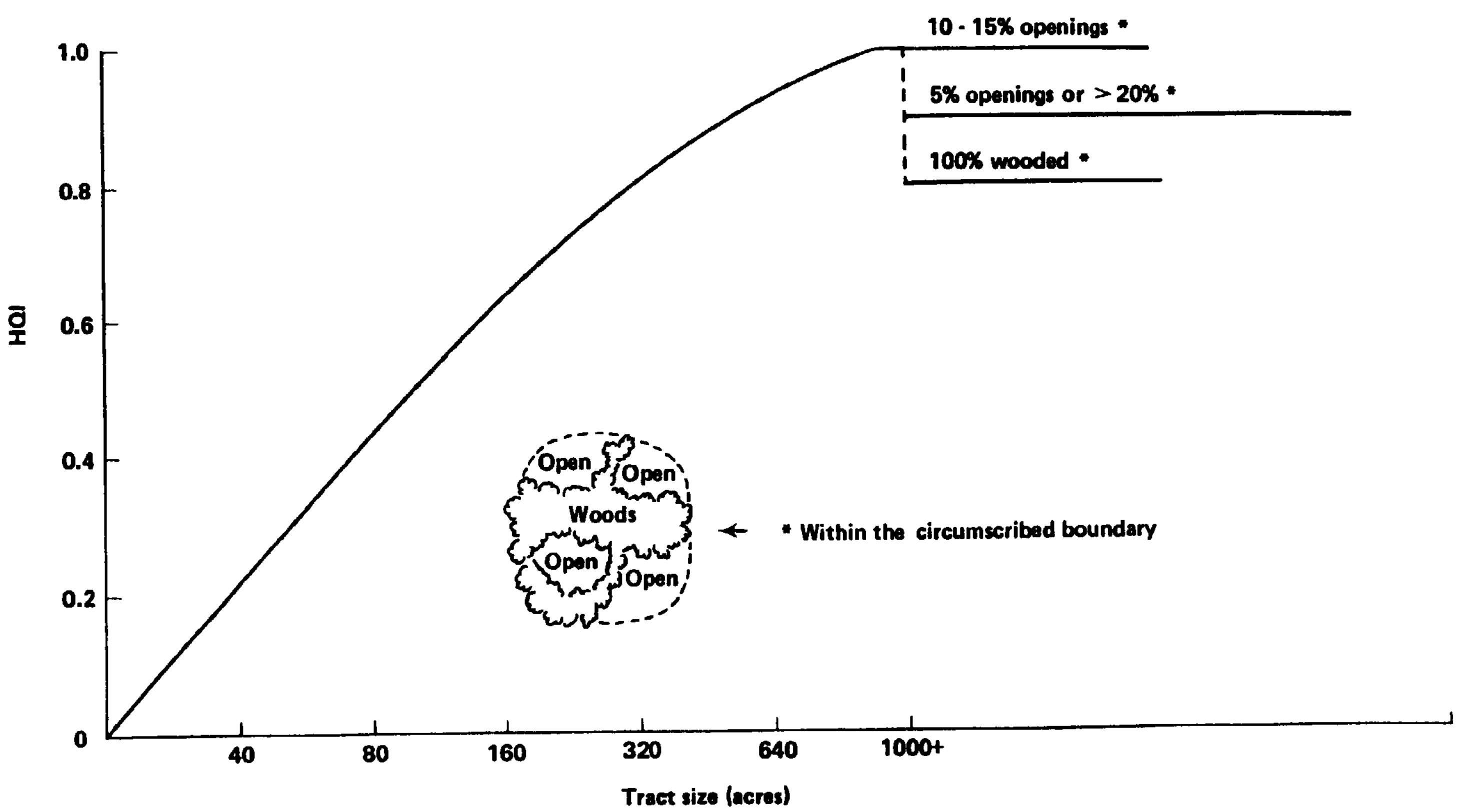


Figure 3.3-48. Habitat Quality Index (HQI) Curve for Tract Size, Upland Forest.
(Source: ACOE 1980)

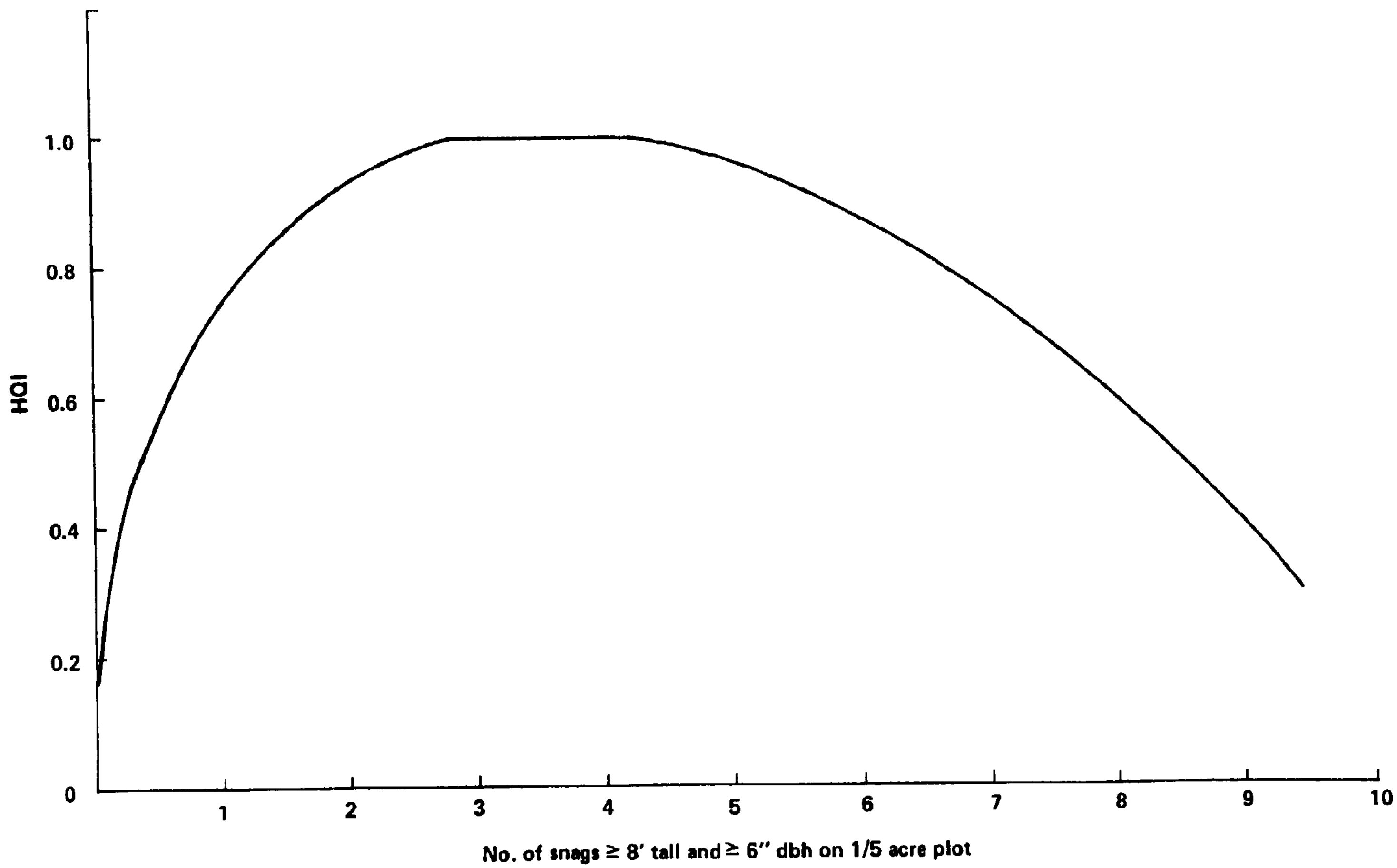


Figure 3.3-49. Habitat Quality Index (HQI) Curve for Number of Snags, Upland Forest.
(Source: ACOE 1980)

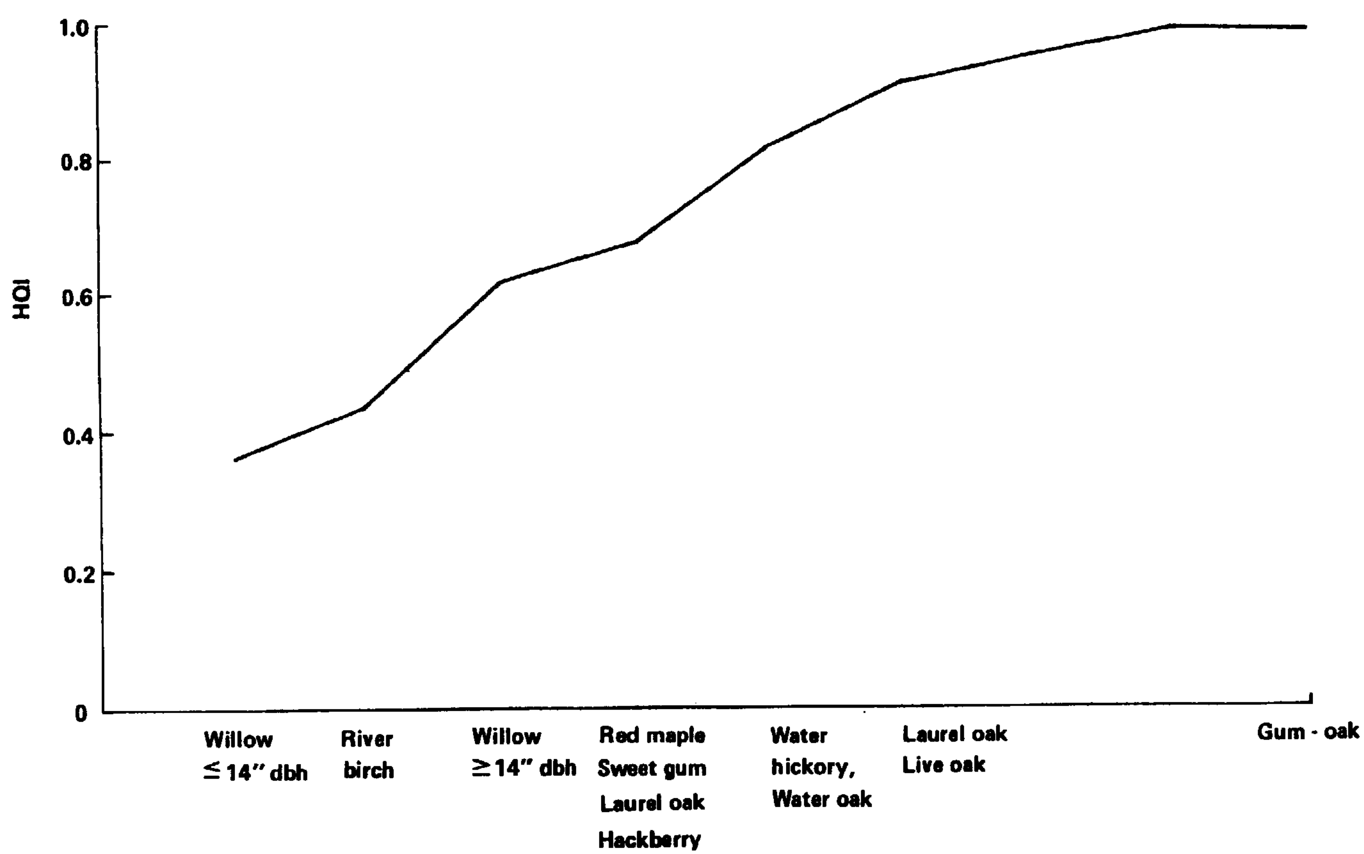


Figure 3.3-50. Habitat Quality Index (HQI) Curve for Species Association, Bottomland Hardwood Forest.
(Source: ACOE 1980)

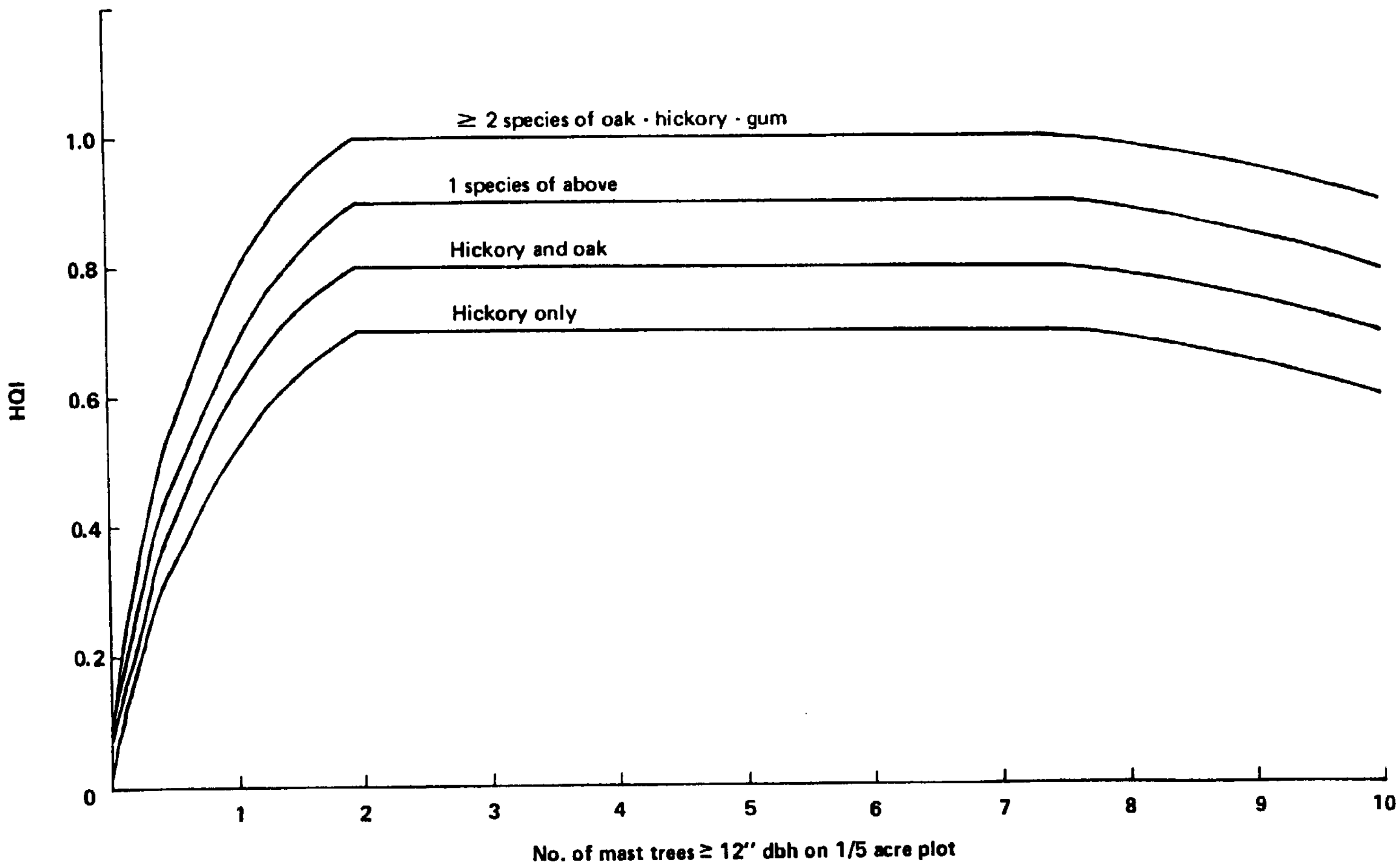


Figure 3.3-51. Habitat Quality Index (HQI) Curve for Number of Mast Trees, Bottomland Hardwood Forest.
(Source: ACOE 1980)

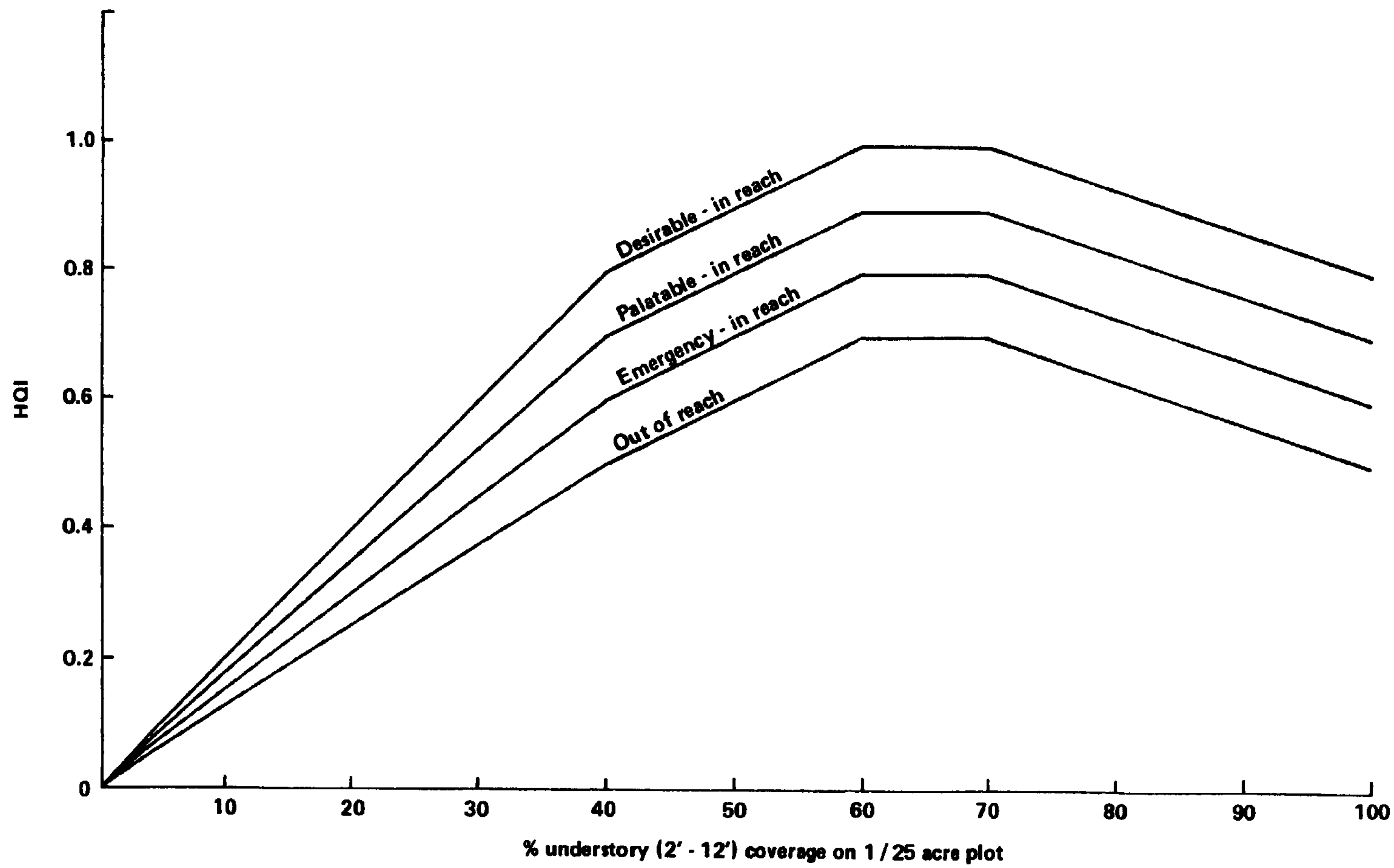


Figure 3.3-52. Habitat Quality Index (HQI) Curve for Percent Understory Coverage, Bottomland Hardwood Forest.
(Source: ACOE 1980)

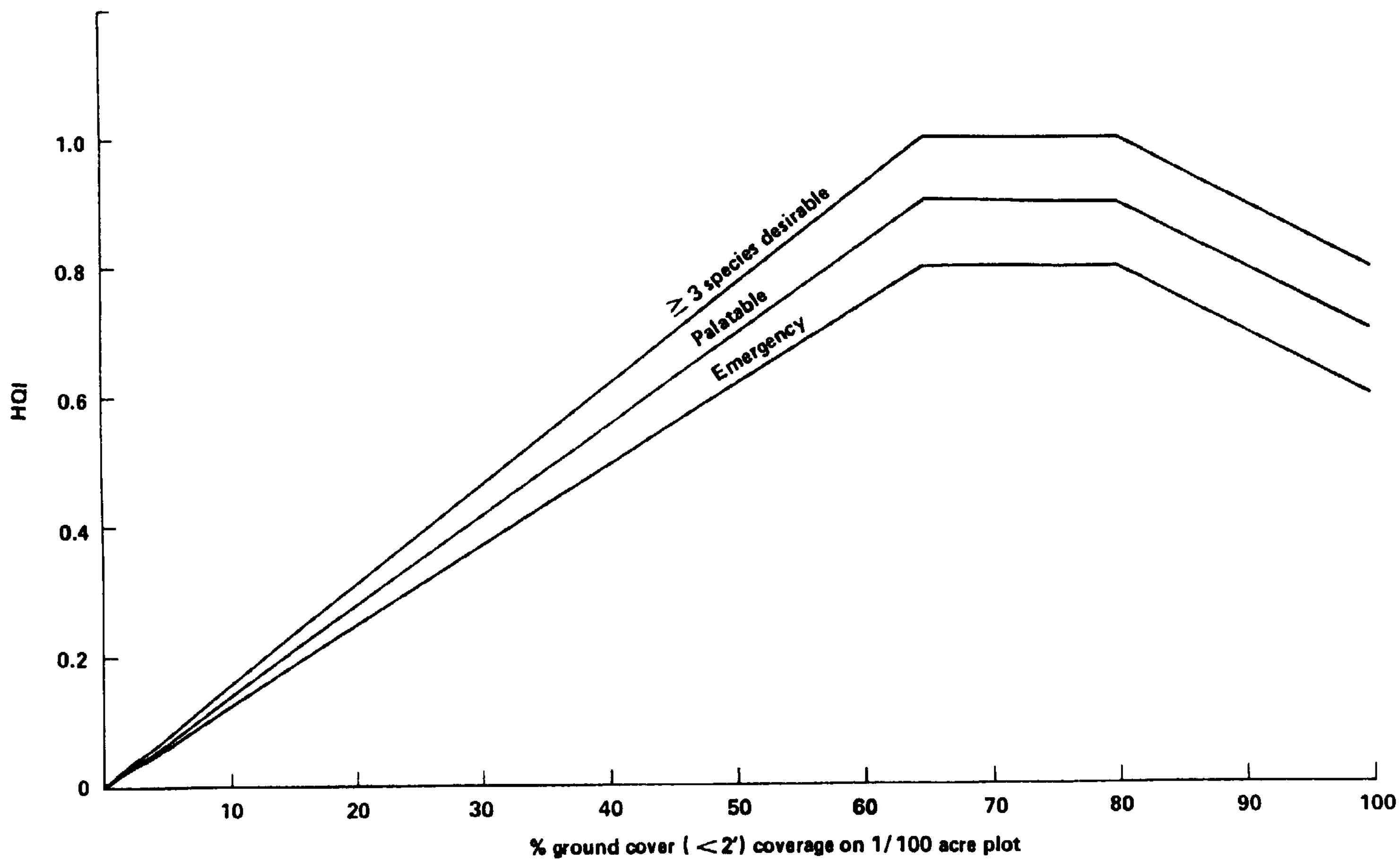


Figure 3.3-53. Habitat Quality Index (HQI) Curve for Percent Coverage of Ground Cover, Bottomland Hardwood Forest.
(Source: ACOE 1980)

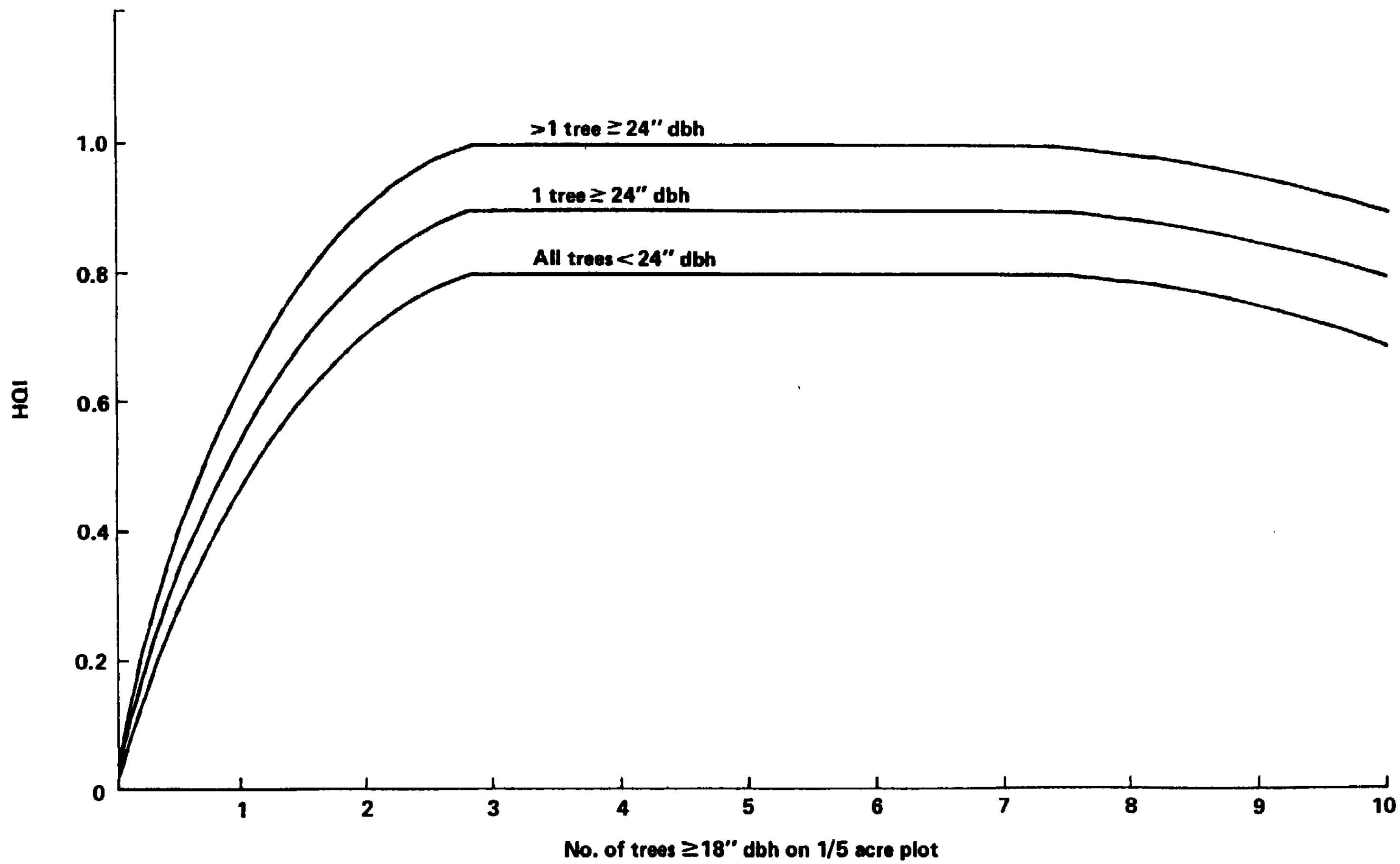


Figure 3.3-54. Habitat Quality Index (HQI) Curve for Large Trees, Bottomland Hardwood Forest.
(Source: ACOE 1980)

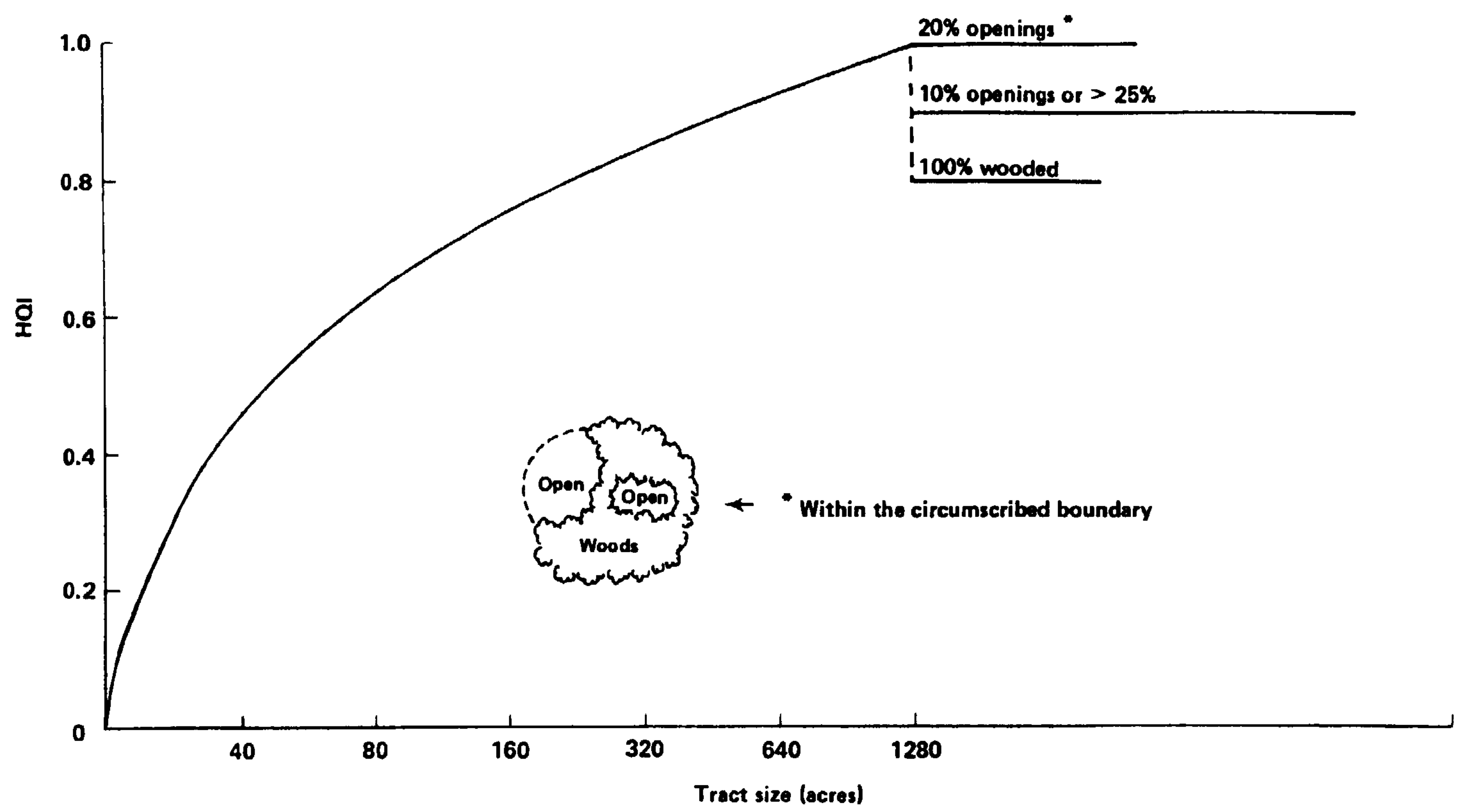


Figure 3.3-55. Habitat Quality Index (HQI) Curve for Tract Size, Bottomland Hardwood Forest.
(Source: ACOE 1980)

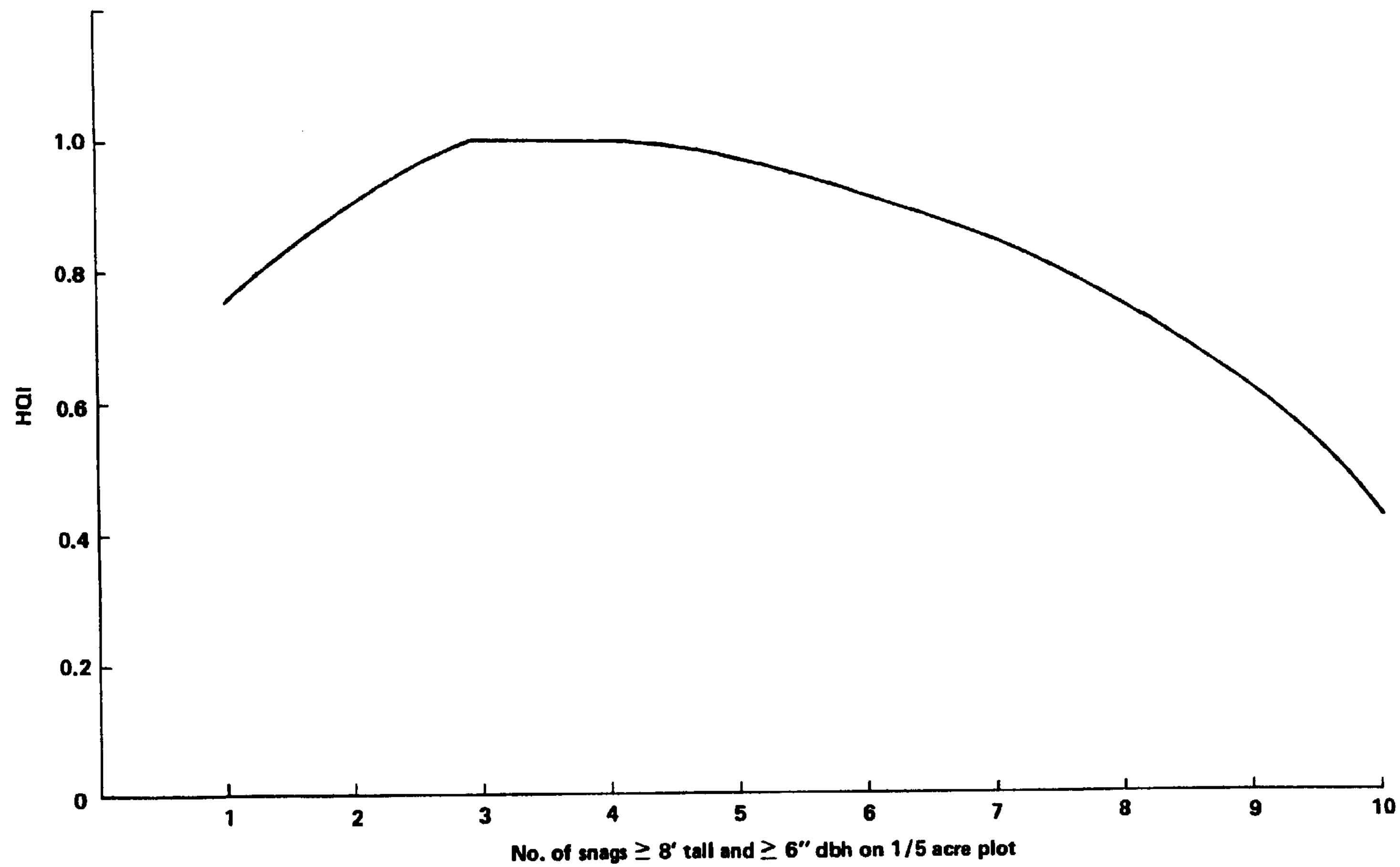


Figure 3.3-56. Habitat Quality Index (HQI) Curve for Number of Snags, Bottomland Hardwood Forest.
(Source: ACOE 1980)

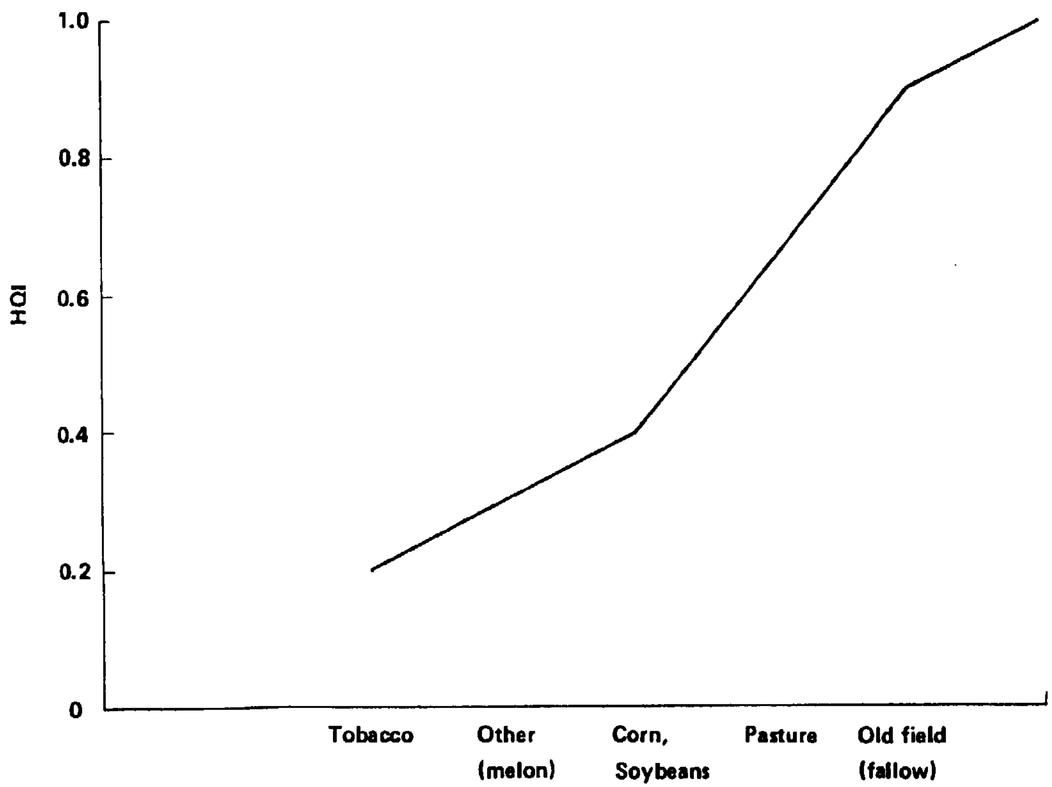


Figure 3.3-57. Habitat Quality Index (HQI) Curve for Land Use, Open Lands.
(Source: ACOE 1980)

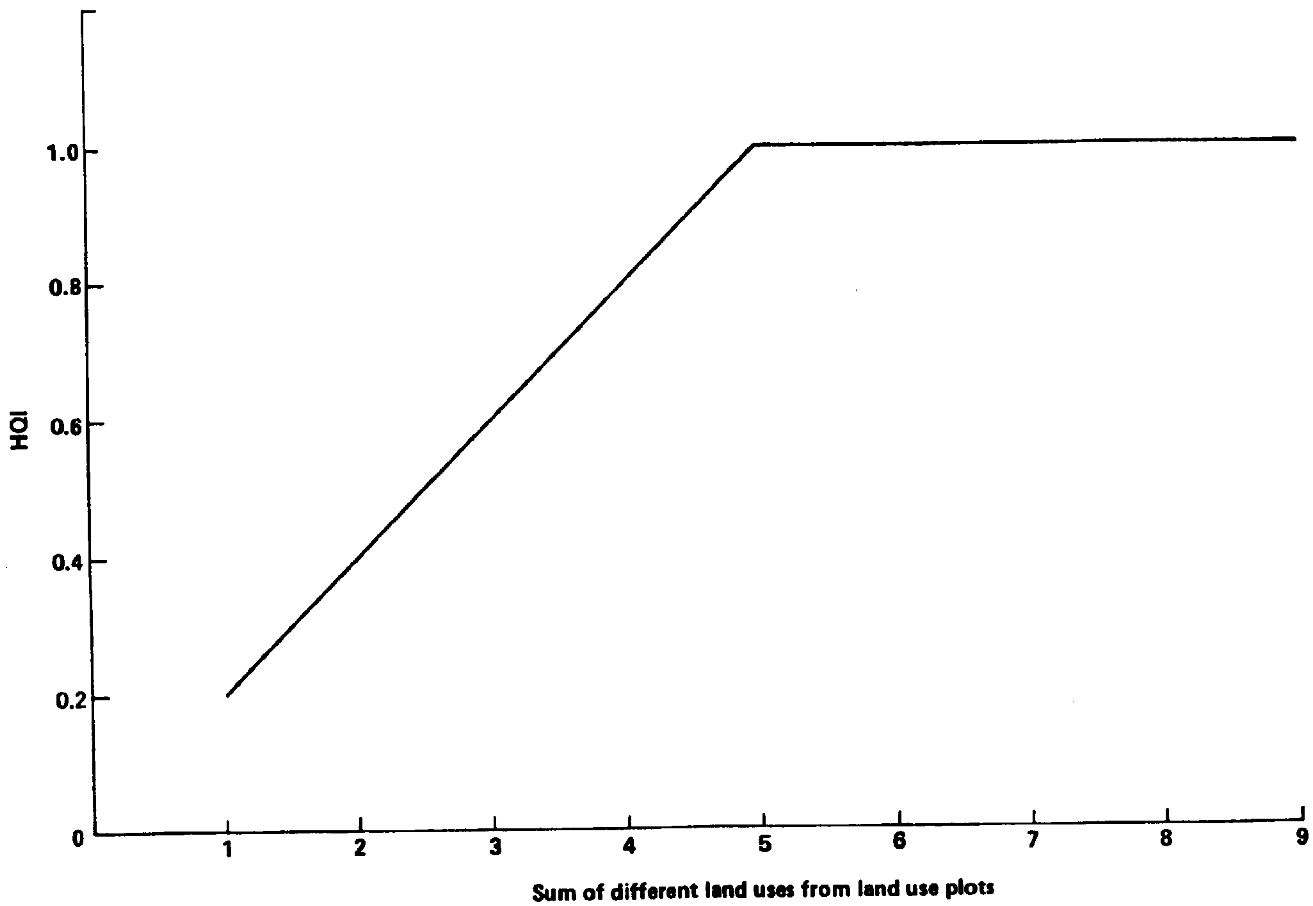


Figure 3.3-58. Habitat Quality Index (HQI) Curve for Diversity of Land Uses, Open Lands.
(Source: ACOE 1980)

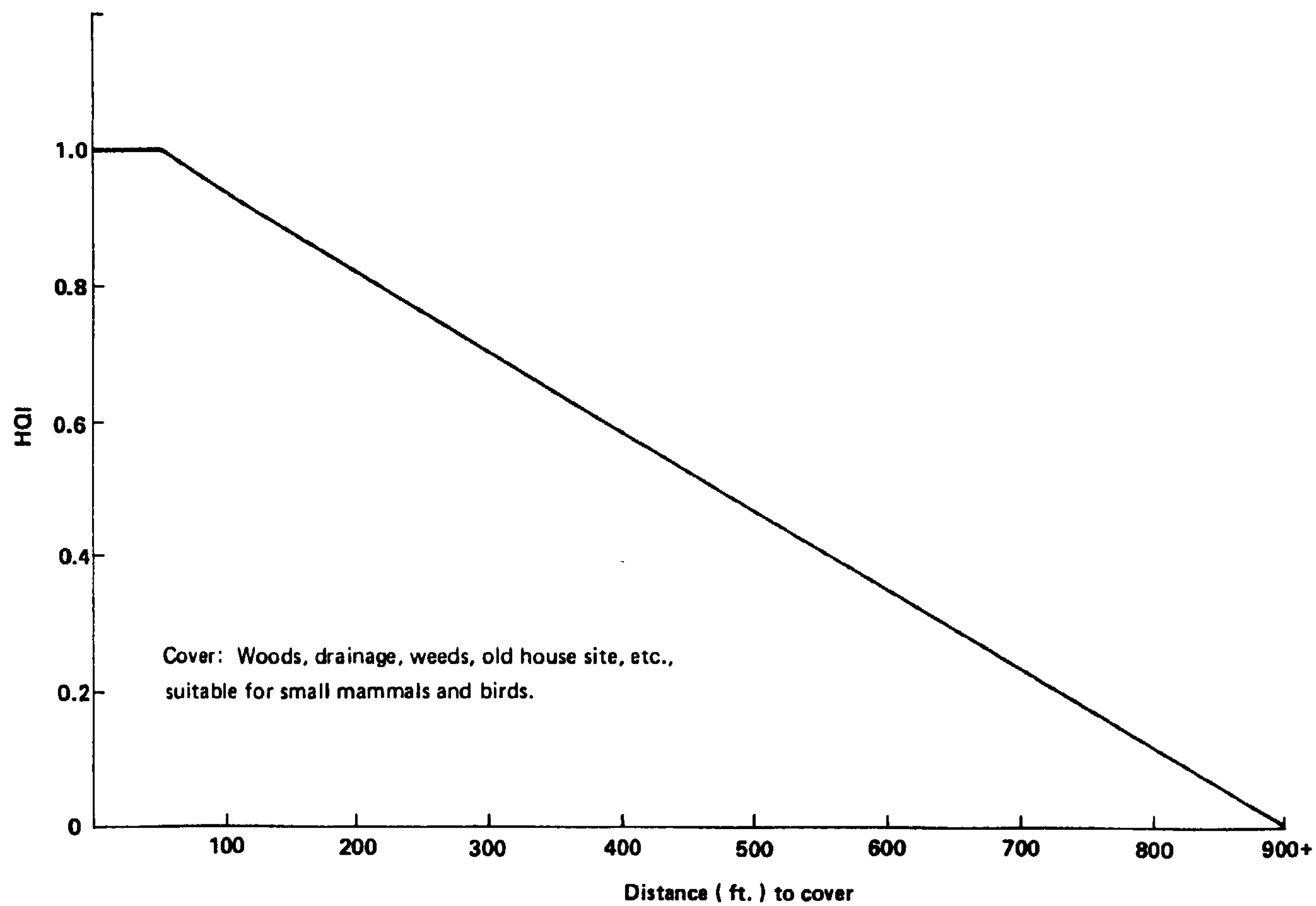


Figure 3.3-59. Habitat Quality Index (HQI) Curve for Distance to Cover, Open Lands.
(Source: ACOE 1980)

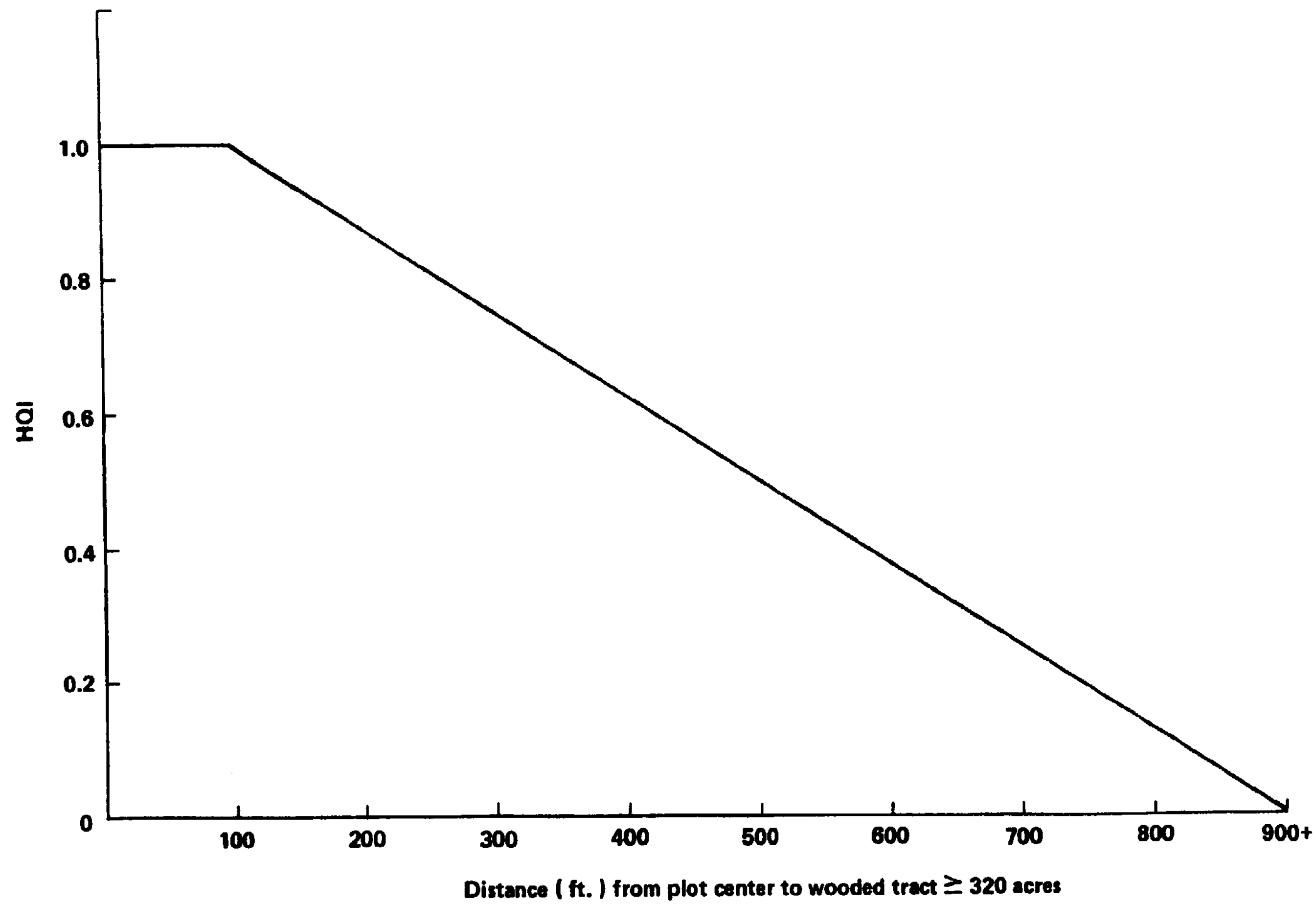


Figure 3.3-60. Habitat Quality Index (HQI) Curve for Distance to Wooded Tract, Open Lands.
(Source: ACOE 1980)

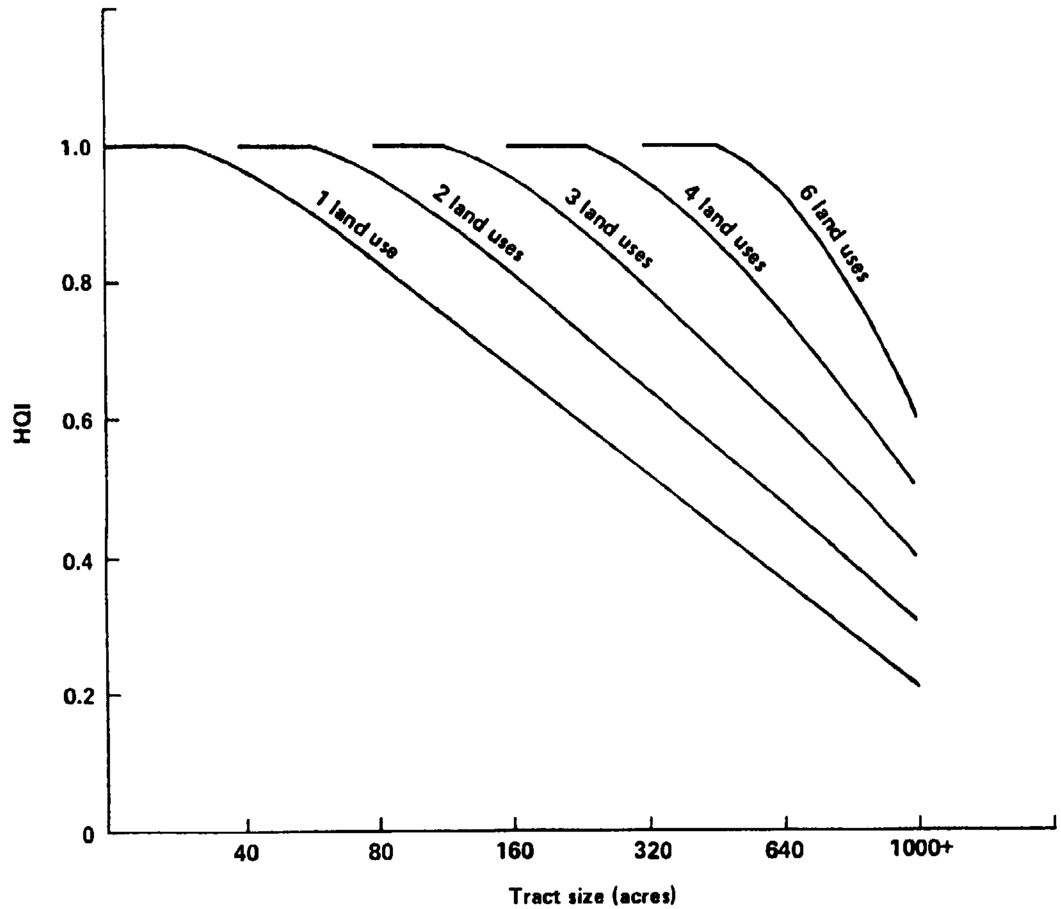


Figure 3.3-61. Habitat Quality Index (HQI) Curve for Tract Size, Open Lands.
(Source: ACOE 1980)

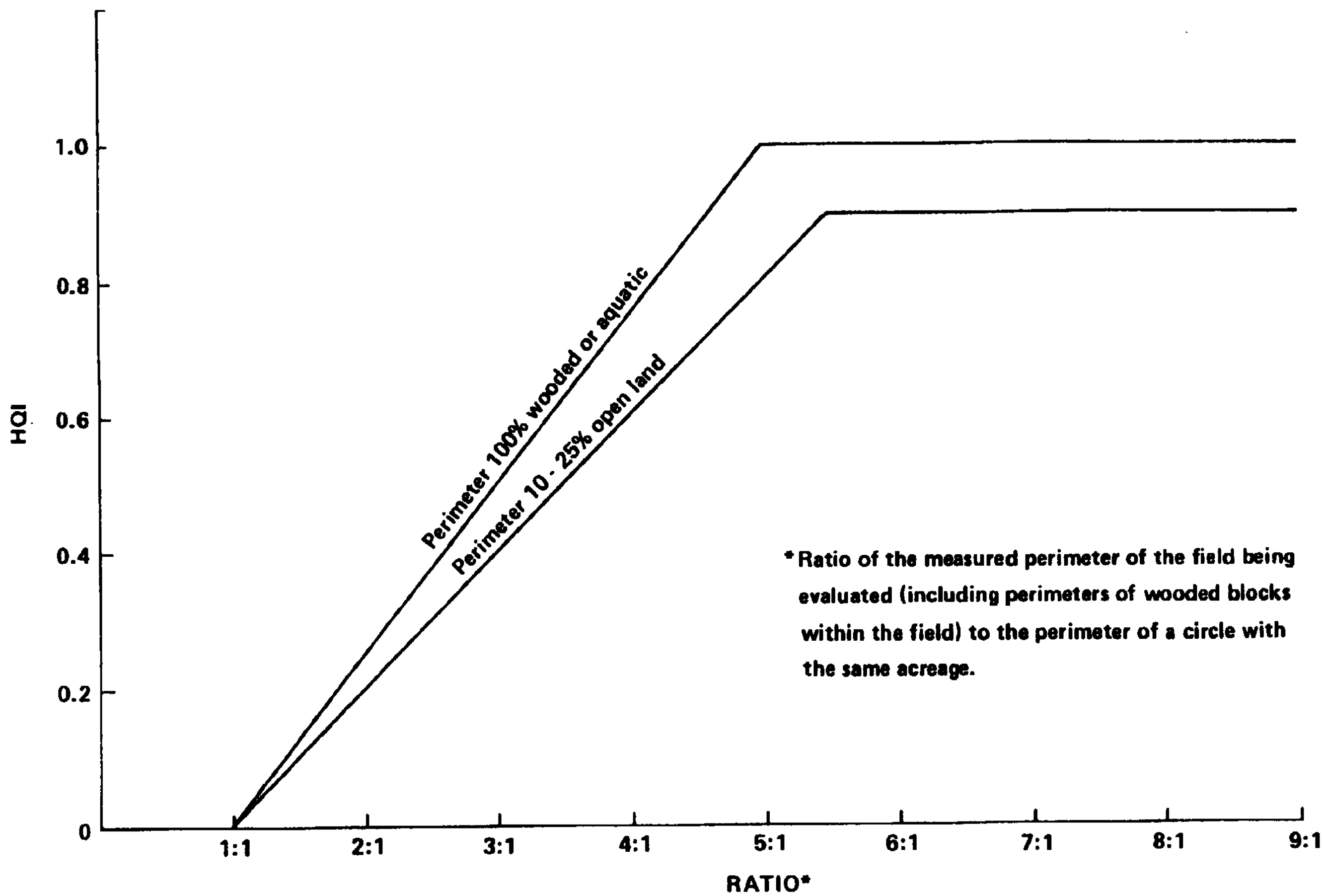


Figure 3.3-62. Habitat Quality Index (HQI) Curve for Perimeter Development/Sinuosity, Open Lands.
(Source: ACOE 1980)

and lengths were determined by the size of the habitat type under study, but no transect had points closer than 150 ft. Transect starting points were selected at random within the systematically selected sampling areas. At each point the habitat was evaluated using a standard form (Tables 3.3-103, 3.3-104, and 3.3-105). Beginning plots were half the distance between points into the habitat, and subsequent plots were paced along a pre-determined compass line. Any plot that had <75% of the species association under study was moved in either direction along the transect until >75% of the species association was present. Plots were not allowed to overlap; when plot locations were adjusted, the next plot was paced from the original plot center. The size of the plot and parameters used for evaluation differed among key variables according to habitat (Table 3.3-106). Parallel transects were at least 110 ft apart, and parallel evaluation areas were not allowed to overlap.

Data Analysis. Data from transect plots were placed on appropriate habitat quality curves, and HQI scores were extrapolated from the curves for each parameter at each plot (Figures 3.3-43 through 3.3-62). A plot HQI score was calculated by multiplying each parameter HQI score by its assigned weight, summing all weighted parameter HQI scores, and dividing by 100. Plot HQI scores were summed and averaged for a habitat, and mean and coefficient of variation of the habitat's HQI score were calculated.

Table 3.3-103.
HES DATA FORM
UPLAND FOREST

Location: ______
Drainage: ______
Personnel: ______
Size: ______

Project: ______
Date: ______
Time: ______
HQI Score: ______

Key Variable	Wt	1			2			3			4			5			6			7			$\bar{x}$ HQI Score
		Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	
1. Species association	17																						
2. Number of mast trees	16																						
3. % understory cover	14																						
4. % ground cover	15																						
5. No. trees ≥ 16" dbh	14																						
6. Tract size	13																						
7. No. of snags	11																						
Total																							

Notes:

Table 3.3-104.
HES DATA FORM
BOTTOMLAND HARDWOOD FOREST

Location: ______
Drainage: ______
Personnel: ______
Size: ______

Project: ______
Date: ______
Time: ______
HQI Score: ______

Key Variable	Wt	1			2			3			4			5			6			7			$\bar{x}$ HQI Score
		Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	
1. Species association	17																						
2. Number of mast trees	16																						
3. % understory cover	14																						
4. % ground cover	14																						
5. No. trees ≥ 18" dbh	14																						
6. Tract size	14																						
7. No. of snags	11																						
Total																							

Notes:

Table 3.3-105.
HES DATA FORM
OPEN (NON-FOREST) LAND

Location: ________
Drainage: ________
Personnel: ________
Size: ________

Project: ________
Date: ________
Time: ________
HQI Score: ________

Key Variable	Wt	1			2			3			4			5			6			7			$\bar{x}$ HQI Score
		Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	Data	HQI	Wt HQI	
1. Land use type	18																						
2. Land use diversity	18																						
3. Distance to cover	18																						
4. Distance to woods	16																						
5. Tract size	13																						
6. Perimeter development index	17																						
Total																							

Notes:

Table 3.3-106. Evaluation Parameters for Key Variables for Upland Forests, Bottomland Hardwood Forests, and Open Lands (plot size in parentheses).

Key Variable	Parameters Evaluated
UPLAND FORESTS AND BOTTOMLAND HARDWOODS	
Species association	Dominant tree species (1/5 acre)
Number of mast trees	Hard mast trees ≥ 12 in dbh (1/5 acre)
Percent understory coverage	Plants 2-12 ft, % cover, % reachable by deer (1/25 acre)
Percent ground cover	Plants <2 ft, % cover (1/100 acre)
Large trees	<u>Upland Forests</u>: trees ≥16 in dbh and 22 in dbh <u>Bottomland Forests</u>: trees ≥18 in dbh and <u>24 in dbh (1/5 acre)</u>
Number of snags	Snags ≥8 ft tall and ≤6 in dbh (1/5 acre)
Tract size	Size of habitat being sampled
OPEN LANDS	
Land use type	(1/5 acre)
Land use diversity	Sum land uses in all plots; count similar land uses separated by ≥0.25 mi as additional use.
Distance to cover	Measure distance to nearest cover.
Distance to woods	Measure distance to nearest woods capable of supporting general wildlife use.
Tract size	Measure tract size from aerial photos.
Perimeter development index (PDI)	Measure total perimeter of area (TP in ft), tract size (A in sq ft), and enclosed woods and wetlands. $PDI = \frac{TP}{3.5449\sqrt{A}}$

3.3.12 Literature Cited

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