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A SURVEY OF WETLAND RECLAMATION PROJECTS IN THE FLORIDA PHOSPHATE INDUSTRY

Prepared by Dames & Moore

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FLORIDA INSTITUTE OF PHOSPHATE RESEARCH

A SURVEY OF WETLAND RECLAMATION PROJECTS IN THE FLORIDA PHOSPHATE INDUSTRY

FINAL REPORT

By

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SUMMARY

This study identifies and summarizes 35 wetland reclamation projects in the Florida phosphate industry. In Spring 1983, 20 of these projects were completed, 10 were in various stages of construction and plans had been completed for 5 others. Information provided for each project site includes its size, location, goal of the project, revegetation methods, plant survival, monitoring studies; and techniques that failed or that were particularly successful. Many of the wetland projects lacked quantitative monitoring and the success of several techniques are not well documented. One successful technique that was frequently used was spreading a layer of organic soil borrowed from another wetland to encourage the establishment of wetland vegetation.

This study also summarizes the opinions of personnel from the phosphate industry, government agencies, universities and interested citizen groups about wetland reclamation efforts to date. These opinions include comments about existing projects, suggested criteria for judging the success of wetland reclamation projects and recommendations for long term monitoring.

The project descriptions and opinions were obtained through 51 questionnaires that were mailed to individuals or organizations which were interested in or working on wetland reclamation projects in the Florida phosphate industry. The majority of the projects were also inspected in the field.

1.0 INTRODUCTION

1.1 STATEMENT OF PROBLEM AND GOALS

A significant percentage of Florida's phosphate reserves are located beneath wetlands. When mining of these wetlands is permitted by the regulatory agencies, mining companies are required by state laws (Rules of the Department of Natural Resources, Chapter 16C-16) to reclaim these wetlands acre-for-acre. Wetland reclamation is a relatively new science with few well documented demonstration projects or published references describing proven wetland reclamation techniques. Several phosphate companies are conducting wetland reclamation projects but most are in-house company projects and the results are not published. As a result, mining companies are often preparing wetland reclamation plans without the benefit of knowing what techniques work best or whether a particular technique has been tried before.

The goal of the project was, therefore, to conduct a survey of wetland reclamation projects in the Florida phosphate industry and identify those reclamation techniques currently being used. An important part of this work also included cataloging the attitudes and opinions of agencies, industry and university personnel regarding wetland reclamation efforts.

1.2 SPECIFIC OBJECTIVES

The specific objectives of the project were as follows:

To identify and locate existing and planned wetland reclamation projects in the Florida phosphate industry

To identify specific reclamation techniques that have failed or that have been successful

To identify perceived research needs in wetland reclamation

To catalog the opinion's of interested individuals and organizations about wetland reclamation efforts to date.

1.3 PREVIOUS WORK BY OTHERS

The Florida Phosphate Council (1982) and the U.S. Environmental Protection Agency (1981) have both prepared descriptions of wetland reclamation projects in the Florida phosphate region. The primary difference of this study is that 1) it includes additional site-specific information about each wetland project, 2) it includes several new wetland projects, 3) it includes opinions regarding reclamation efforts to date, and 4) it includes suggested criteria for judging the success of wetland reclamation projects.

2.0 METHODS

The information gathered in the survey was obtained through a mail questionnaire and a brief field visit to the project sites. The mailing list for the questionnaire was prepared primarily from the following sources:

1) A list of phosphate companies in Florida, prepared by the Florida Phosphate Council (1982).

2) A list of members serving on the Florida Institute of Phosphate Research (FIPR) Reclamation Research Committee (FIPR, 1982).

3) A list of members serving on the Florida Department of Natural Resources (DNR) Reclamation Advisory Committee (DNR, 1982).

4) A list of organizations, agencies, officials and citizen groups in Florida concerned with natural resource use and management (National Wildlife Federation, 1982).

5) Personal knowledge of others working in or interested in wetland reclamation for the Florida phosphate industry.

The complete mailing list for the questionnaire is given in Appendix A.

A sample questionnaire was prepared and sent to seven individuals on the mailing list for suggestions and comments. Based on those comments, a final questionnaire was prepared and mailed in December, 1982. The final questionnaire was divided into two parts. The first part was designed to gather specific data on each project, such as size, location, soil type, revegetation methods, etc., and was completed by those individuals who were planning or constructing a wetland reclamation project. The second part was designed to obtain the opinions regarding wetland reclamation efforts from a variety of people, including the mining industry. The complete questionnaire and cover letter that were mailed to each individual are attached in Appendix B. Those individuals who did not respond within two to three weeks were contacted by telephone in an attempt to achieve a 100 percent response.

All but five of the reclamation project sites were visited in the field. Those five sites were either unmined or visitation arrangements could not be obtained at the time of the survey.

3.0 RESULTS

A total of 40 (78 percent) of the 51 questionnaires were returned. Only one of the mining companies contacted did not respond. The total number of wetland reclamation projects reported was 35.‘ Of these 35 wetland projects, 20 were completed, 10 were in various stages of construction, and plans had been completed for 5 others. Table 1 presents a summary of the wetland projects, including the company name, mine name, project name, wetland acreage and project age. Locations of the wetland projects are shown on Figures 1 through 4. USS Agri-Chemicals' proposed wetland reclamation methods are described in Table 1 and in the following text but are not shown on the following figures since they are general methodologies that will be applied to many proposed mining sites. It should be noted that many other wetlands in the Florida phosphate region will be mined and reclaimed in the future but are not listed in this report because of the tentative plans for mining and reclamation.

The following three sections provide descriptions of the wetland projects, comments from reclamation managers regarding their projects, and comments by the mining industry, regulatory agencies, consultants, universities and citizen groups regarding wetland reclamation efforts.

3.1 WETLAND PROJECT DESCRIPTIONS

The following text presents descriptive information for each of the 35 wetland projects listed in Table 1. Any published reports that may provide additional data on each project are also referenced. It should be noted that the survival rates for revegetation are often reported as a percentage range and reflect the lack of quantitative monitoring on many of the project sites.

TABLE 1

WETLAND RECLAMATION PROJECTS IN THE FLORIDA PHOSPHATE INDUSTRY, 1983

COMPANY[a]	MINE NAME	PROJECT NAME OR IDENTIFICATION CODE[b]	WETLAND ACREAGE	PROJECT STATUS	COMMENTS
1. Agrico	Payne Creek	AGR-PC-9A	20	Revegetation completed, 1980	Adjacent to Little Payne Creek
2. Agrico	Payne Creek	AGR-PC-16	120	Revegetation partially completed in mid-1982	Floodplain is being replaced adjacent to Little Payne Creek
3. Agrico	Fort Green	AGR-FG-13	126	Revegetation completed May, 1982	Large experimental project adjacent to Payne Creek
4. Amax	Big Four	AMX-BF-5	16	Revegetation completed March, 1982	Adjacent to Gully Branch
5. Amax	Big Four	2-acre Test Plot	2	Revegetation completed, 1976	Unmined plot adjacent to Boggy Branch
6. Amax	Big Four	AMX-BF-1	31	Revegetation completed January, 1980	Adjacent to Boggy Branch
7. Amax	Big Four	Lake Branch Tributary AMX-BF-10	16	Revegetation to be completed in April, 1986	Swamp and stream restoration
8. Amax	Pine Level	Litter Test Plot	0.1	Revegetation completed February, 1980	Small revegetation test plot
9. Amax	Pine Level	Marsh and Lake Site	0.2	Revegetation completed February, 1980	Small unmined pond with marsh border
10. Amax	Pine Level	Floodplain Site	0.5	Revegetation completed April, 1980	Floodplain and stream channel test area
11. Brewster	Haynsworth	Wetlands West Experimental Plots	2-100'x100' plots 2-50'x50' plots 1-125'x250' plot	Revegetation completed, 1979	5 plots in a seepage zone of a clay settling area
12. CF Mining Corp.	Hardee Phosphate Complex	CFM-HC-SP3	15	Revegetation to be completed in December, 1983	Sand/clay mix test plots
13. Estech	Watson	None	8	Revegetation completed, 1981	Part of a capped settling area adjacent to Whidden Creek
14. Farmland	Hickory Creek	Hickory Creek Sand/Clay Mix Area	22.4	Schedule Unknown	Proposed mine
15. Farmland	Hickory Creek	Oak Creek Overburden	20	Schedule Unknown	Proposed mine
16. Gardinier	Fort Meade	GAR-FM-SP(6)	10.6	Revegetation to be completed in December, 1983	Extension of Whidden Creek floodplain swamp
17. W.R. Grace	Four Corners	Demonstration Project	3-0.4 ac. plots 1-0.5 ac. plot	Revegetation completed July, 1978	Four small revegetation test plots
18. W.R. Grace	Bonny Lake	WRG-BL-SP(5)	4.5	Revegetation completed, 1982	In-line wetland connected to Bear Branch
19. W.R. Grace	Hooker's Prairie	WRG-HP-SP(2)	180	Revegetation to be completed in May, 1985	Three adjacent cells with different reclamation configurations
20. IMC	Clear Springs	Homeland - 9, IMC-CS-9A	23	Revegetation completed June, 1981	Part of a reclaimed settling pond

[a] See Appendix A for complete company name and address.
[b] See Figures 1-4 for location of projects.

TABLE 1 (Continued)

	COMPANY[a]	MINE NAME	PROJECT NAME OR IDENTIFICATION CODE[b]	WETLAND ACREAGE	PROJECT STATUS	COMMENTS
21.	IMC	Clear Springs	North 640 Flood Plain, IMC-CS-19	8	Revegetation to be completed in December, 1984	Extension of Peace River floodplain swamp
22.	IMC	Clear Springs	Florida Game and Fresh Water Fish Commission Test Site, Parcel B	20.2	Revegetation completed November, 1978	49 acre experimental area adjacent to Peace River
23.	IMC	Noralyn	South Tiger Bay, IMC-NP-SP(1)	260	Revegetation to be completed in December, 1983	Large project connected to Camp Meeting Ground Creek
24.	IMC	Kingsford	South of K-6, IMC-K-SP(1)	20	Revegetation to be completed in August, 1984	Plan to restore headwaters and channel of Lake Branch
25.	IMC	Kingsford	West of K-6, IMC-K-10	6	Revegetation completed June, 1982	Combination lake and wetland in Halls Branch watershed
26.	Mobil	Fort Meade	Sink Branch	0.5	Revegetation completed March, 1980	Reclamation of small creek channel
27.	Mobil	Fort Meade	Myers Branch, MCC-FM-22A	8	Revegetation to be pleted in July, 1984	Reclamation of stream channel and floodplain
28.	Mobil	Fort Meade	McCullough Creek	21	Revegetation to be pleted in April, 1985	Reclamation of stream channel
29.	Mobil	Nichols	George Allen Creek	3	Revegetation completed September,1982	Reclamation of stream channel
30.	Occidental	Suwannee River	Altman Bay Lake	5	Revegetation completed March, 1975	Swamp reclamation on unmined land adjacent to lake
31.	Occidental	Suwannee River	OCC-SR-2 and OCC-SR-3	3	Revegetation completed January, 1981	Swamp and marsh reclamation in land and lake area
32.	Occidental	Suwannee River	OCC-SR-8	43	Revegetation 95% completed December, 1982	Swamp reclamation, includes University experimental 10 acre area
33.	Occidental	Swift Creek	Eagle Lake OCC-SC-1 & 2	15	Revegetation completed November, 1979	Deep water marsh along Eagle Lake shoreline
34.	USSAC	Rockland	General Methods for Wetlands	248.9	To be mined in Year 2002	Proposed Mine
35.	USSAC	Rockland	General Methods for Stream Restoration	40	To be mined in 1992	Proposed mining of McCullough and Whidden Creeks

1. AGRICO, AGR-PC-9A

Objective and Goal - The objective was to test muck utilization and observe different planting methods (tree spading, ball and burlap trees, broadcast seeding). The total wetland area is 20 acres, consisting primarily of marsh.

Reclamation Schedule - Grading and contouring completed in December, 1979; revegetation completed in January, 1980.

Soil Types and Treatments - The subsurface soil type is overburden. The surface soil on approximately 80% of the wetland area is graded overburden; approximately- 20% contains a six inch layer of organic soil borrowed from a marsh. The area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland is discharge from a lake adjacent to the east. The size of the wetland watershed is approximately 500 acres. Water levels are not being artifically regulated. There is a spillway at the south end of the wetland that discharges to Little. Payne Creek.

Revegetation Methods - The following tree species were planted in the wetland area: sweetgum, red maple, live oak, laurel oak, and wax myrtle. A total of 100 saplings were tree-spaded and 5000 bareroot seedlings were planted. The tree-spaded saplings had a survival rate of greater than 80 percent. The seedlings had a survival rate of 50 to 80 percent.

No herbaceous species or grasses were planted in the wetland area. The spreading of an organic mulch layer was successful in establishing wetland herbaceous species.

Monitoring Program - None.

2. AGRICO, AGR-PC-16

Objective and Goal - The objective is to reclaim a floodplain hardwood swamp-along Little Payne Creek. Part of the area adjacent to the creek is unmined. A portion of the stream channel is being reconstructed. The total area of wetland is 120 acres, approximately 17% is marsh and approximately 83% is planned to be floodplain-hardwood swamp.

Reclamation Schedule - Mining was completed prior to July, 1975. Grading and contouring was partially completed by mid-1982. Revegetation was partially completed by Fall, 1982.

Soil Types and Treatments - The subsurface soil type consists primarily of sand tailings, capped with one foot of overburden. Portions of the area are also unmined. The surface soil type throughout the wetland area is graded overburden. The wetland area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland is stream flow or flooding. The size of the wetland watershed is approximately 300 acres. Water levels in the stream are controlled downstream of the project. The portion of the stream and floodplain that is being reclaimed is approximately 500 feet long, 141 feet wide and three feet deep.

Revegetation Methods - The following tree species were planted in the wetland area: 1600 bareroot sweetgum--seedlings and 1600 bareroot ash seedlings. It is too early to make any statements about planting success.

No herbaceous species or grasses were planted in the wetland area.

Monitoring Program - None.

3. AGRICO, AGR-FG-13

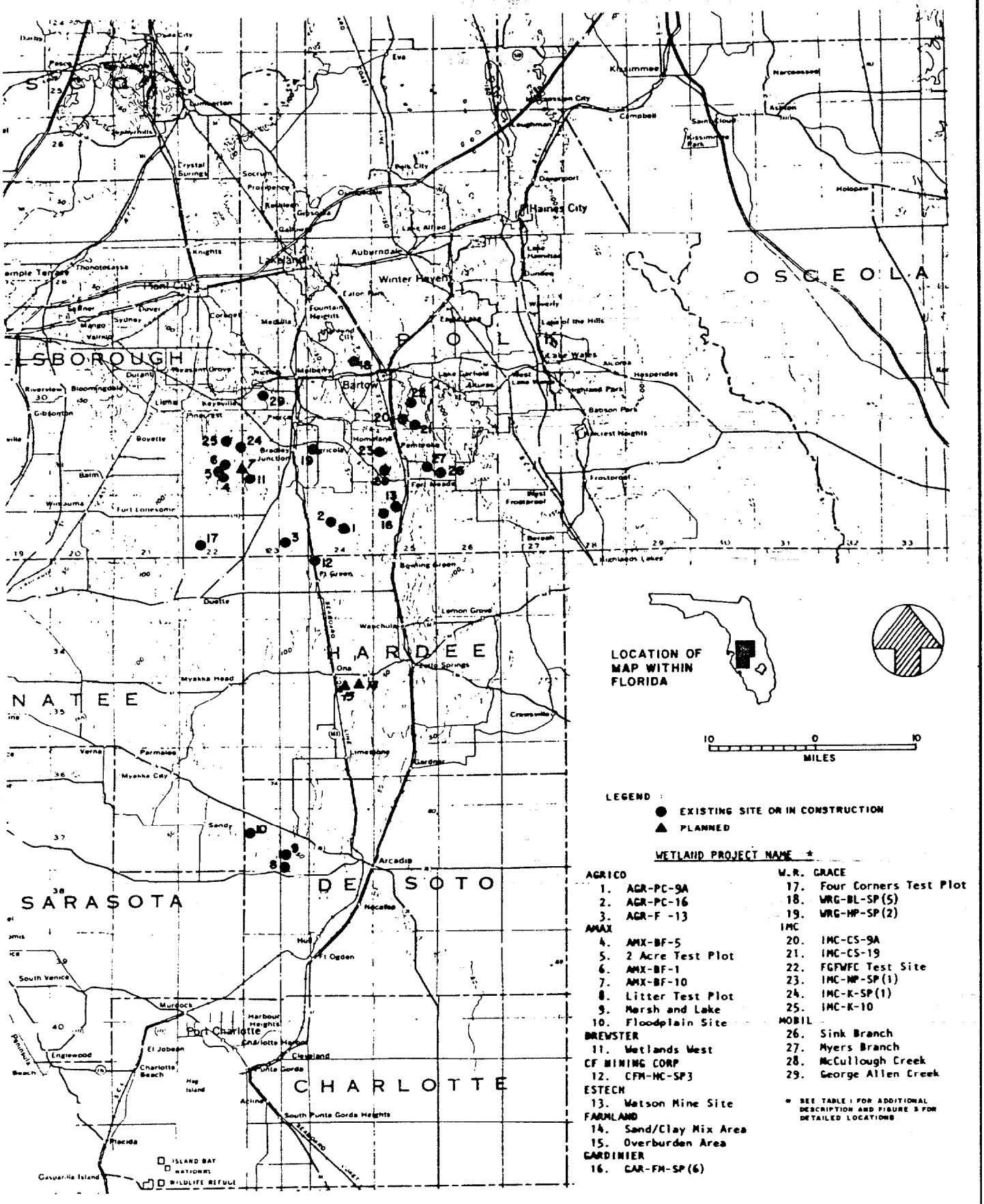
Objective and Goal - The original project approved by DNR was designed as an experiment to provide a wide diversity of habitats complying-with the DNR-rules. The project objectives were expanded to monitor tree planting, organic mulch thickness, natural invasion by wetland species, hydroperiod, fertilization, soil parameters, ground water levels and water budget. The total project area is 366 acres. The total wetland area is approximately 126 acres: consisting of 75 acres of marsh, one acre of bayhead, and 50 acres of floodplain hardwood swamp.

Reclamation Schedule - Mining was completed in August, 1979; grading and contouring was completed in May, 1982; revegetation was completed in May, 1982.

Soil Types and Treatments - The subsurface soil type is sand tailings capped with one foot of overburden. The surface soil on approximately 75% of the wetland area -is graded overburden; approximately 25% contains a zero to one foot layer of organic soils- borrowed from a marsh.- The wetland area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland is surface water runoff The size of the wetland watershed is approximately 366 acres. Water levels-are not artifically regulated. There are outlet swales on the eastern portion of the area to Payne Creek.

Revegetation Methods - Given below is a list of the trees that were planted in the wetland area.

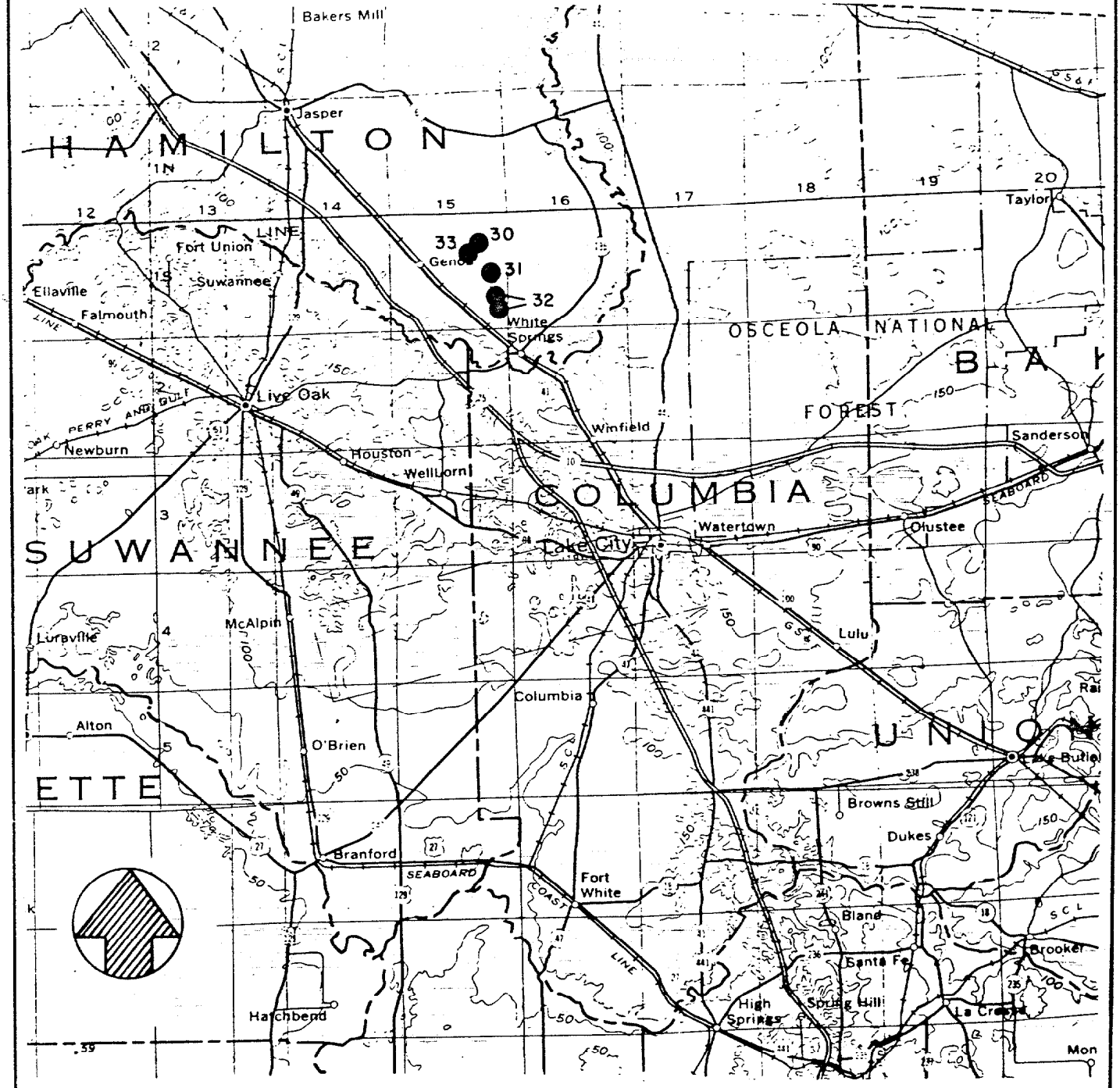


GENERAL LOCATION MAP
CENTRAL FLORIDA

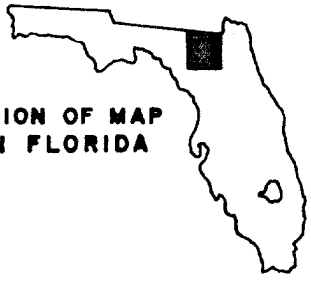
BASE MAP REFERENCE

U S GEOLOGICAL SURVEY, 1967 STATE MAP OF FLORIDA
SCALE 1 500,000.

FIGURE 1



LEGEND : ● EXISTING SITE OR IN CONSTRUCTION



WETLAND PROJECT NAME *

OCCIDENTAL

30. Altman Bay Lake
31. OCC-SR-2 and 3
32. OCC-SR-8
33. OCC-SC-1 and 2

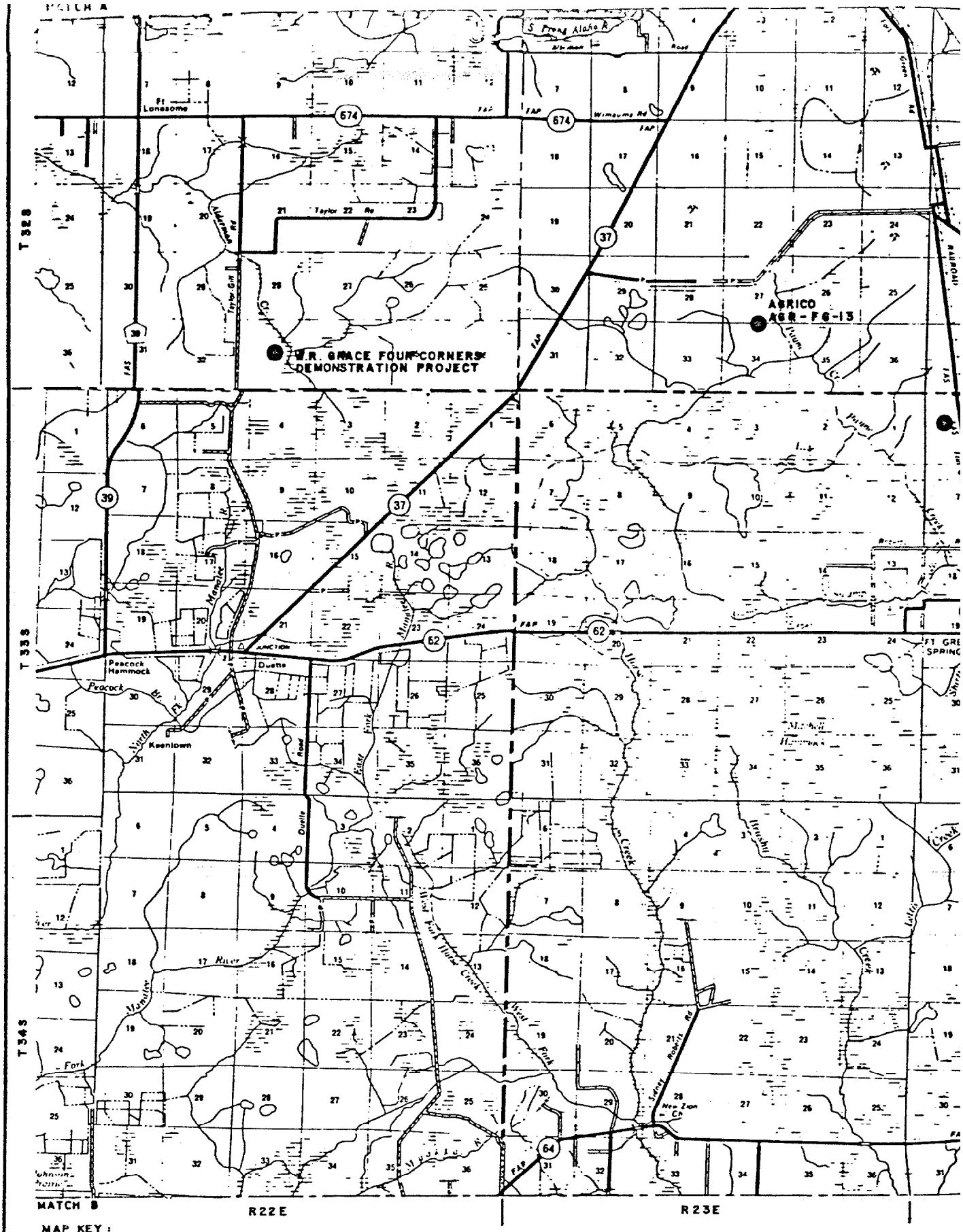
* SEE TABLE 1 FOR ADDITIONAL DESCRIPTION AND FIGURE 4 FOR DETAILED LOCATIONS.

10 0 10
MILES

BASE MAP REFERENCE :
U.S. GEOLOGICAL SURVEY, 1967. STATE MAP OF FLORIDA. SCALE 1 : 500,000

GENERAL LOCATION MAP NORTHERN FLORIDA

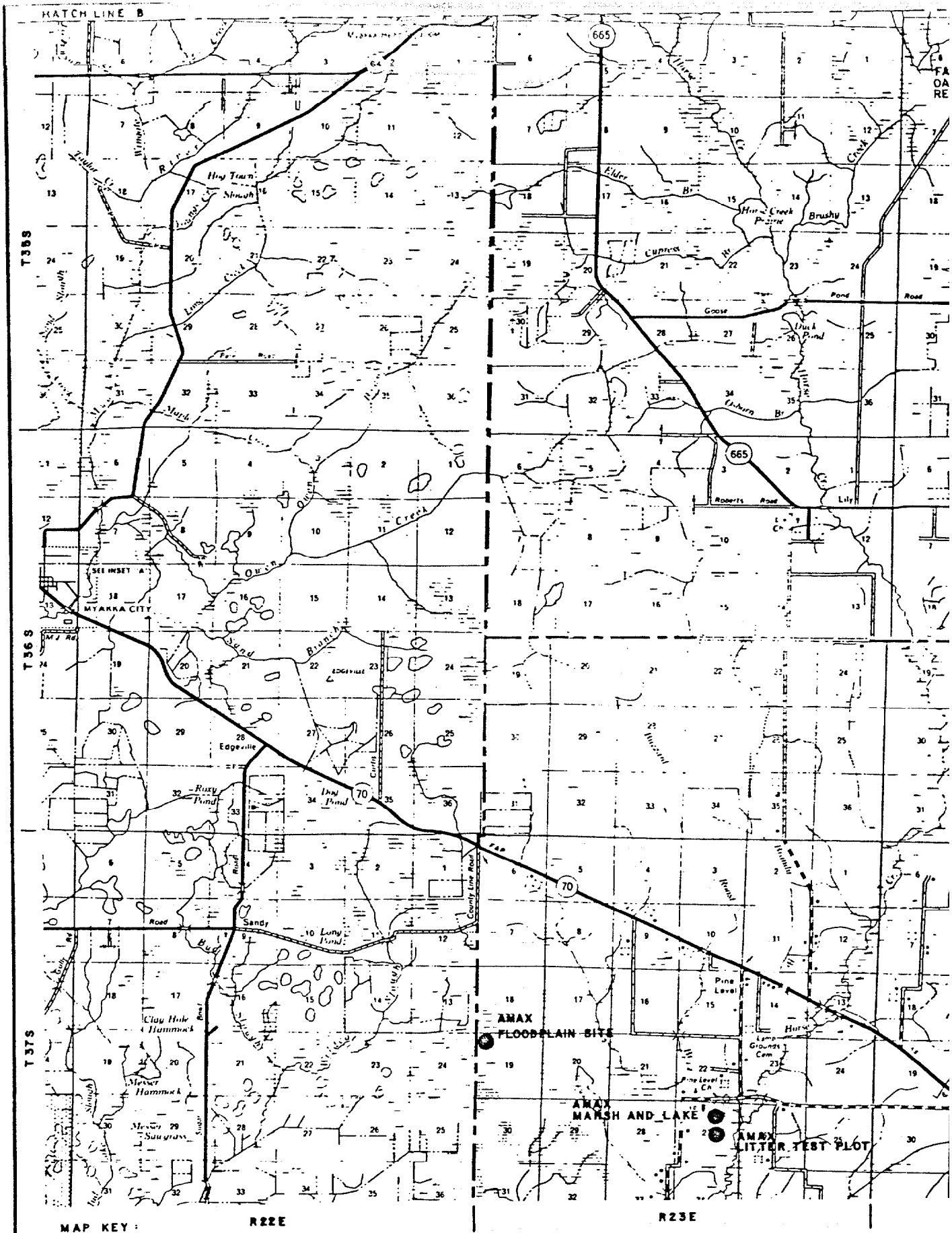
FIGURE 2

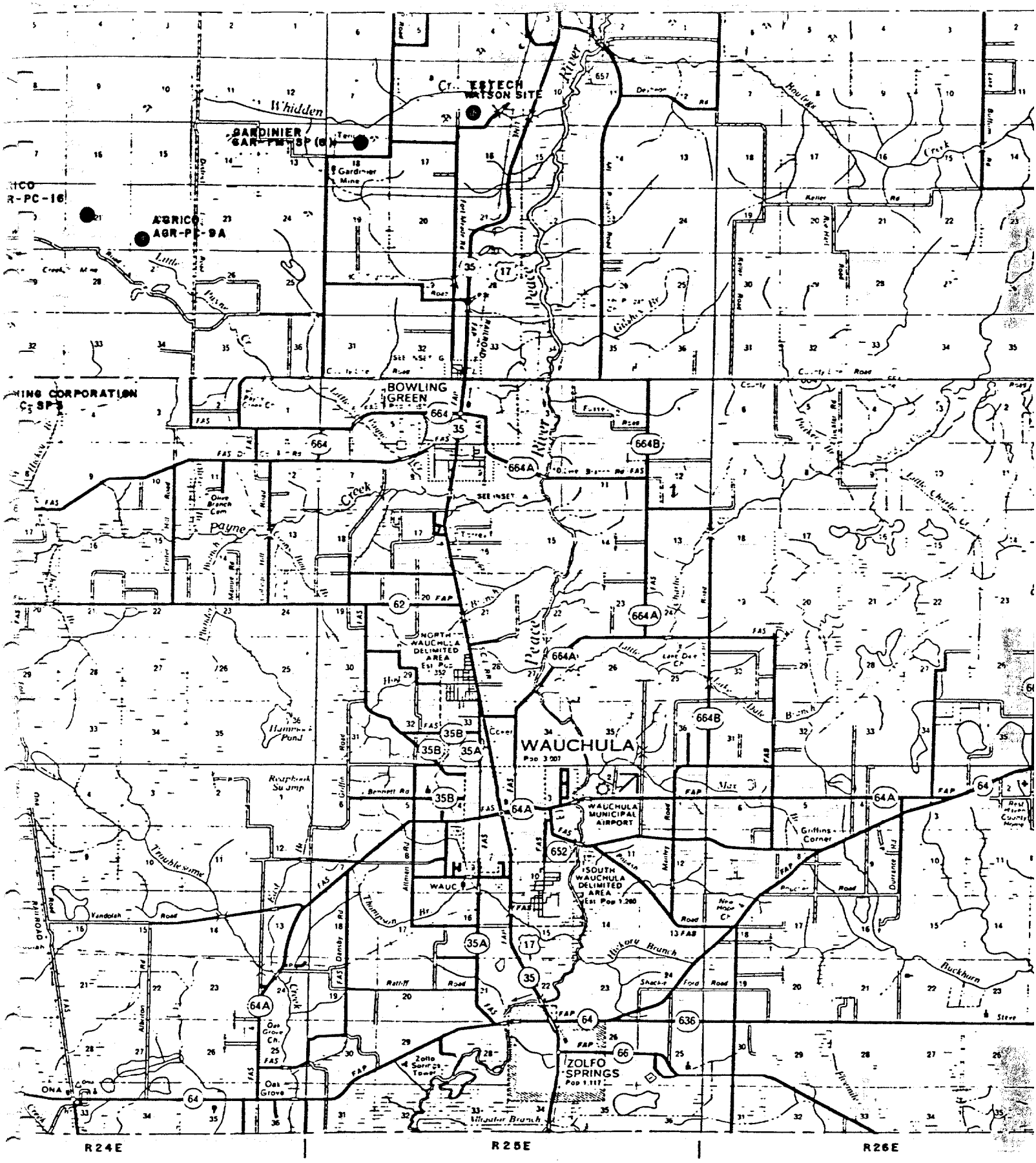


MAP KEY :

SHEET 1
SHEET 2
SHEET 3

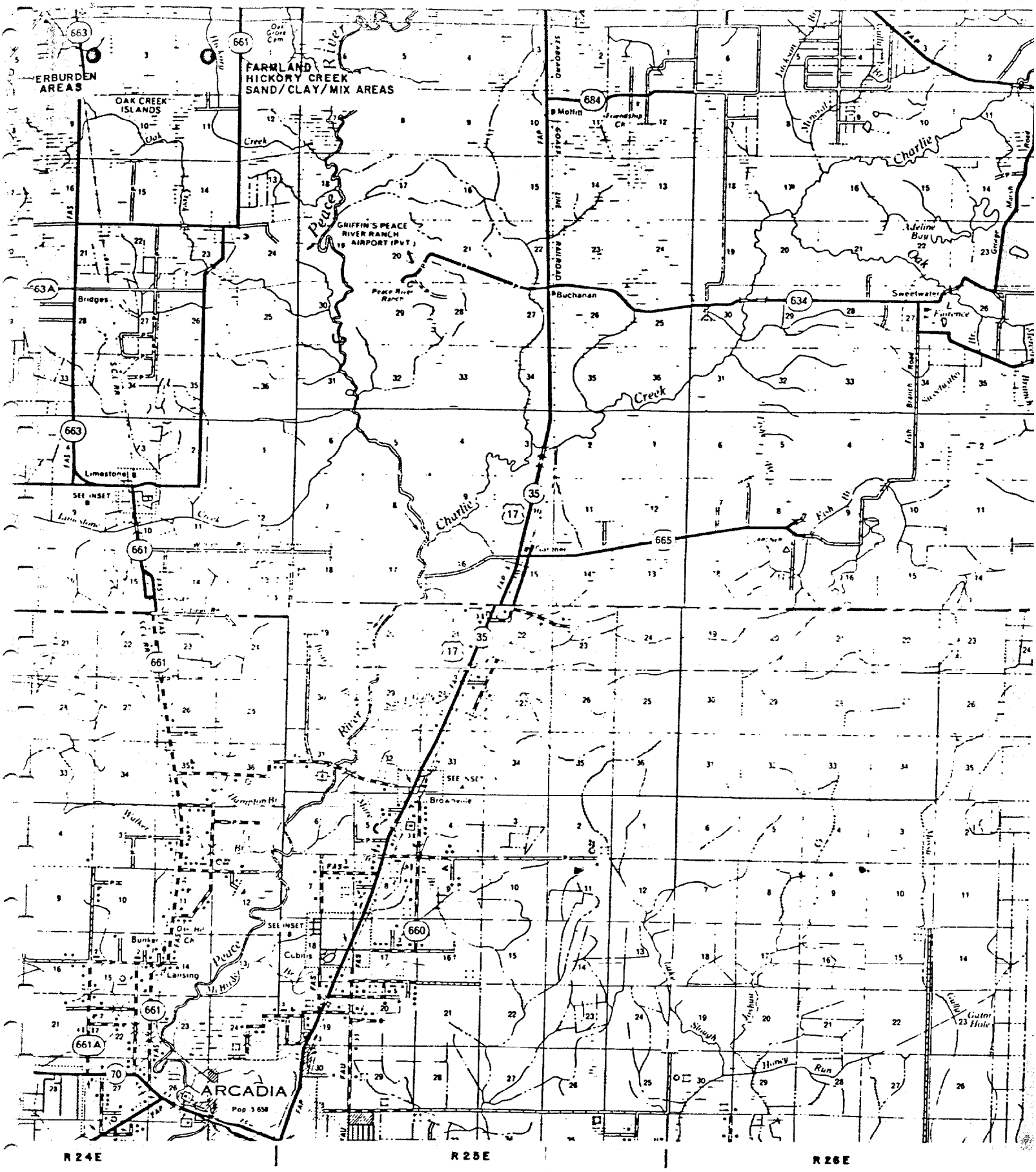
REFERENCE :
GENERAL MAP OF HILLSBOROUGH CO.,(1978), POLK CO.,(1981), HARDEE CO.,(1981), AND MANATEE CO.,(1982). FLORIDA DOT.


MATCH LINE B
T35S
T36S
T37S
R22E
R23E
MYAKKA CITY
SEE INSET A
Edgeville
Sandy
Pine Level
AMAX
FLOODPLAIN SITE
AMAX
MARSH AND LAKE
AMAX
LITTER TEST PLOT
665
70
MAP KEY:
SHEET 1
SHEET 2
REFERENCE:
GENERAL MAP OF HARDEE CO.,(1981),
MANATEE CO.,(1982) AND DE SOTO CO.,
(1981). FLORIDA DOT.



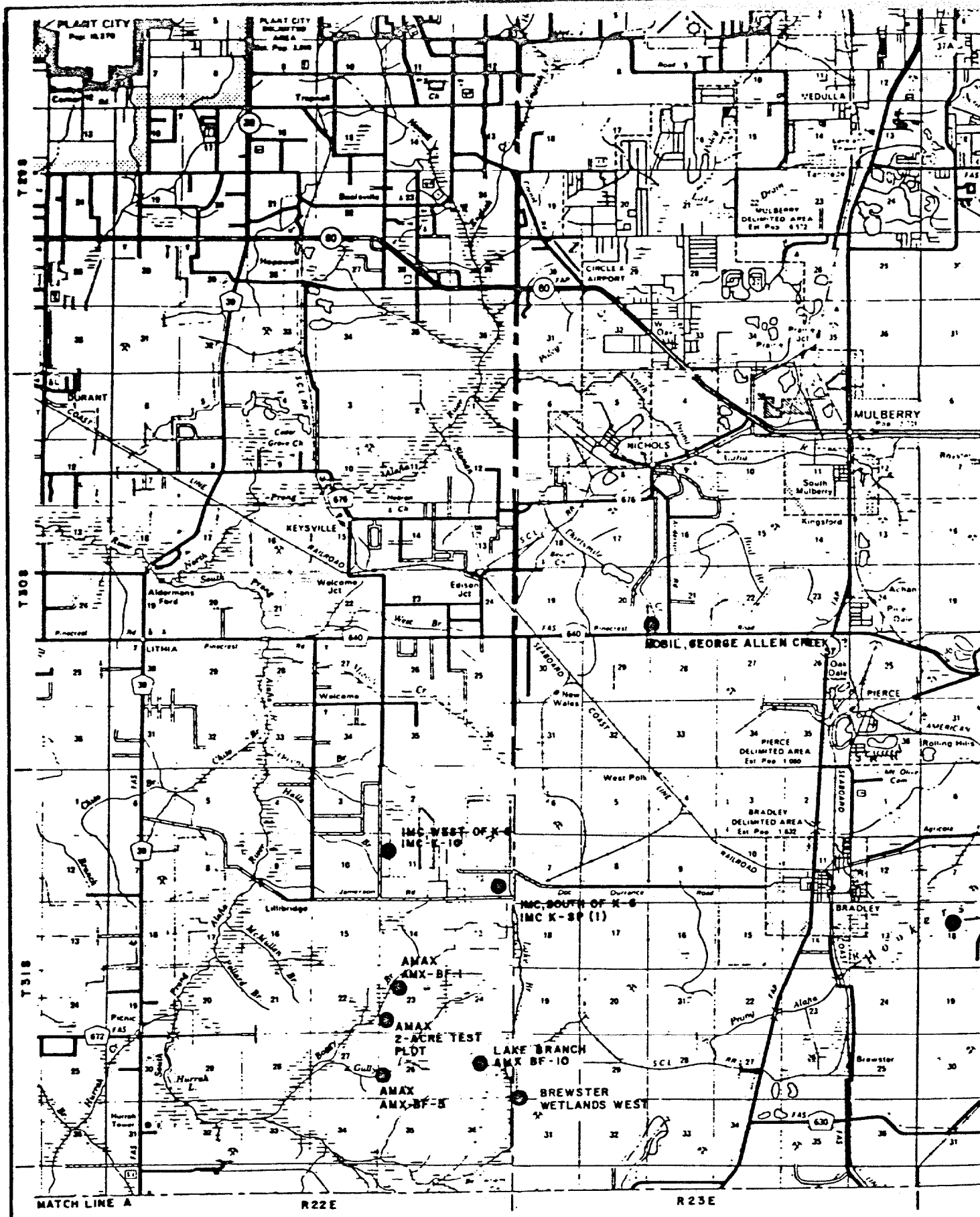
WETLAND RECLAMATION SITES, CENTRAL FLORIDA (SHEET 2 OF 3)

FIGURE 3



WETLAND RECLAMATION SITES, CENTRAL FLORIDA (SHEET 3 OF 3)

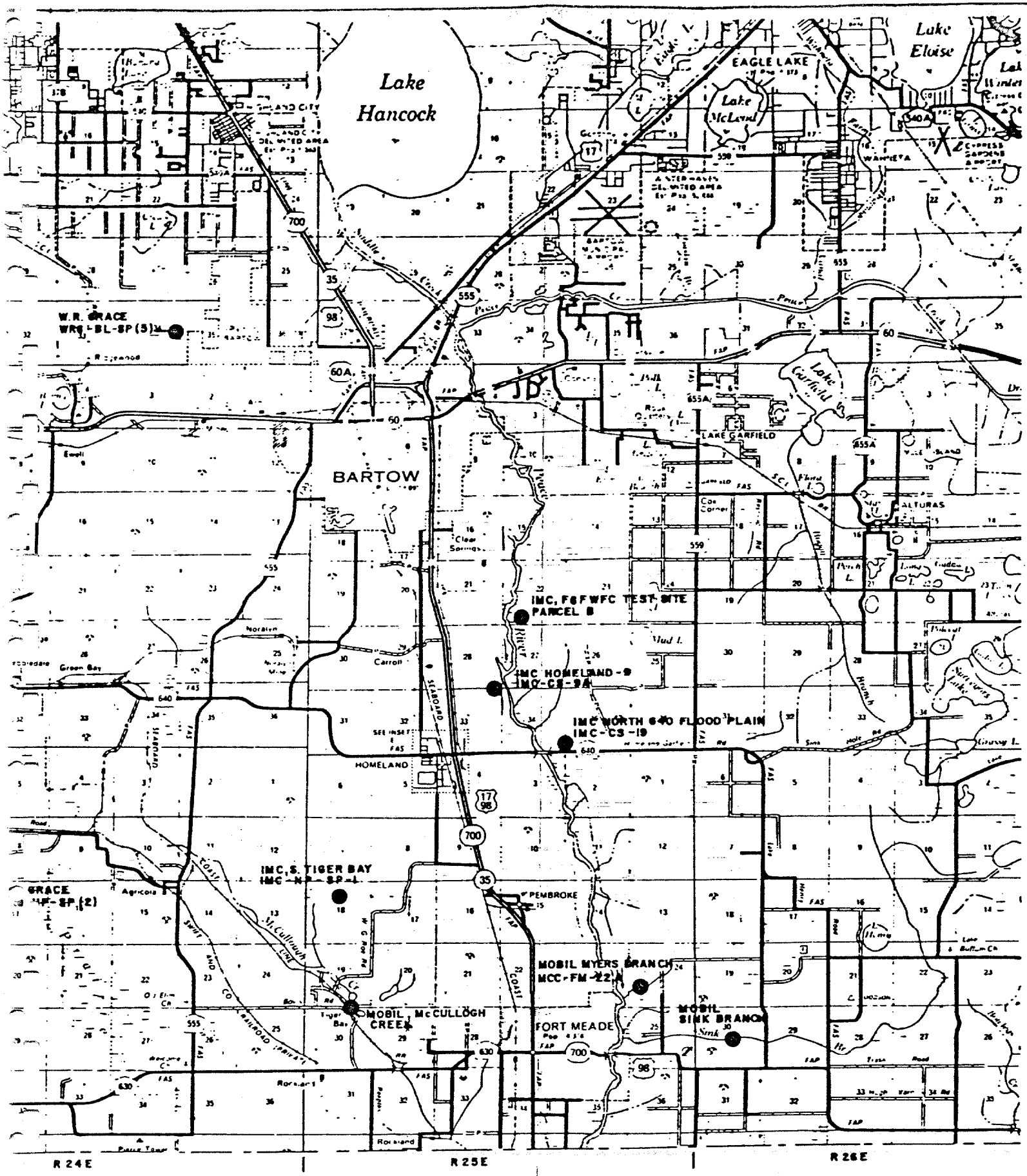
FIGURE 3



MAP KEY:

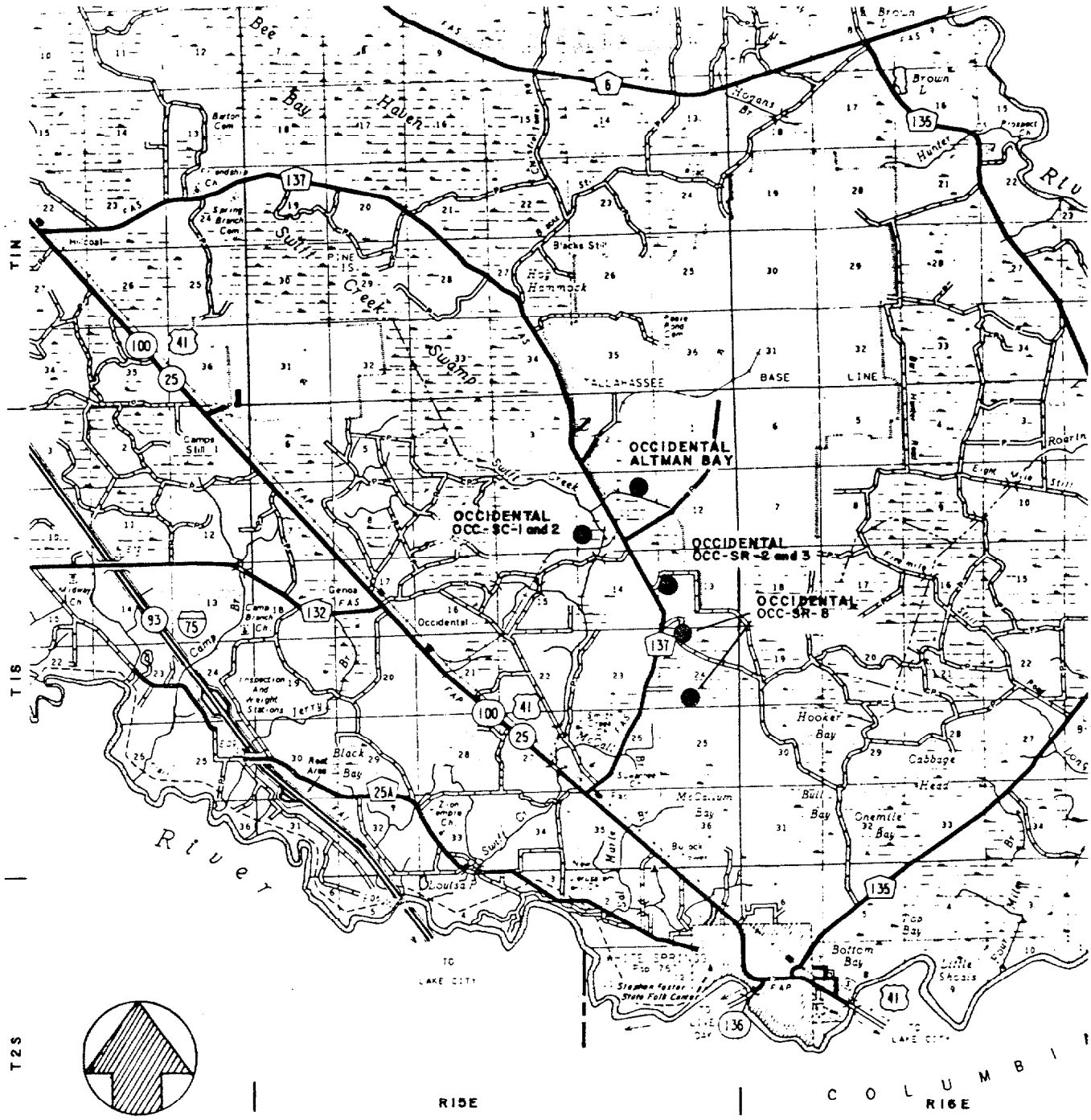
SHEET 2
SHEET 4

REFERENCE:
GENERAL MAP OF POLK CO., (1981) AND HILLSBOROUGH CO., (1978), FLORIDA DOT.



WETLAND RECLAMATION SITES, CENTRAL FLORIDA (SHEET 1 OF 3)

FIGURE 3



WETLAND RECLAMATION SITES
NORTHERN FLORIDA

REFERENCE :
GENERAL HIGHWAY MAP OF HAMILTON CO., FLA.
FLORIDA DOT REVISED 1981.

FIGURE 4

Tree Species	Number Planted	Planting Stock	Survival
Improved Slash Pine	2,300	Bareroot	50 - 80%
Laurel/Live Oak	1,800	Bareroot	50 - 80%
Laurel/Live Oak	92	B&B	50 - 80%
Laurel/Live Oak	740	Tubelings	Greater than 80%
Sycamore	8,500	Bareroot	Greater than 80%
Bald Cypress	100	5-6', Potted	Greater than 80%
Cottonwoods	1,000	Cuttings	Failed
Maple	7,650	Bareroot	50 - 80%
Misc. Hardwoods	1,000	Hand-dug	Less than 50%
Blackgums	3,275	Tubelings	Greater than 80%
Green Ash	2,221	Tubelings	Greater than 80%
Green Ash	1,200	Bareroot	Greater than 80%
Sweetgum	4,704	Tubelings	Greater than 80%
Sweetgum	1,500	Bareroot	Greater than 80%
Bays	834	Tubelings	50 to 80%
Bays	3,600	Bareroot	50 to 80%
Cypress	375	Hand-dug & Potted	50 to 80%
Cypress	20,400	Bareroot	Varied
Cypress	519	Tubelings	Greater than 80%
Elm	65	Hand-dug & Potted	50 - 80%
Elm	540	Tubelings	Greater than 80%
Dahoon Holly	250	Tubelings	Greater than 80%

Herbaceous species that were planted in the wetland area were 50 root sections of bulrush with two to three stems each. These random plantings had a survival rate of 100%. No grasses were planted in the wetland area.

A sparse spreading of an organic soil from donor wetland sites that contained desirable vegetation was very beneficial in inoculating the site with seeds and roots of wetland species.

Monitoring Program - The following parameters are being monitored: water quality and quantity, surface and groundwater fluctuations, floral communities, hydroperiod, elevation, diversity, presence of muck, survival, planting methods, spacing, soils, and wildlife observations. Progress reports on the project have been prepared by Agrico (Carson, 1983a and 1983b).

4. AMAX, AMX-BF-5

Objective and Goal - The objective of this project was to create a hardwood forest and marsh suitable for use as a wildlife habitat. Mulching techniques for marsh revegetation were also tested. The total wetland area is

approximately 16 acres; approximately 11 acres are marsh, and five acres are planned as swamp.

Reclamation Schedule - Mining was completed in March, 1980; grading and contouring was completed in March, 1981; revegetation was completed in March, 1982.

Soil Types and Treatments - The subsurface soil type is overburden. The surface soil on approximately 65% of the wetland area is graded overburden; approximately 35% contains a one foot layer of organic soils borrowed from a marsh. The area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland is surface water runoff. The size of the wetland watershed is approximately 25 - acres. Water levels are being regulated by an overflow channel on the north end of the area. Water draining from the site flows to Gully Branch.

Revegetation Methods - The trees planted in the wetland area are given below.

Species	Number Planted	Planting Stock	Survival
Slash Pine	2,500	Bareroot	30 - 70%
Red Maple	1,100	Bareroot	Less than 30%
Laurel Oak	700	Bareroot	Less than 30%
Sweetgum	100	Potted	Greater than 70%
Cypress	30	Potted	Greater than 70%
Various Hardwoods	42	Tree-spaded	Greater than 70%

No herbaceous species or grasses were planted in the wetland area. The use of mulch from another wetland was successful in establishing marsh vegetation.

Monitoring Program - Monthly water quality for pH, gross alpha, conductivity and fecal coliform. Annual vegetation quadrats for species list; 252 meter transect with 250 quadrats.

5. AMAX, Z-ACRE TEST PLOT

Objective and Goal - The objective of this experiment was to determine the tree species that could be successfully transplanted to reclaimed land. One-half of the area was overturned with a backhoe to simulate mining conditions. The total wetland area is two acres.

Reclamation Schedule - Grading and contouring was completed in 1976; revegetation was also completed in 1976.

Species	Number Planted	Planting Stock	Survival
Cypress	1,400	Potted	Greater than 70%
Red Maple	500	Potted	Less than 30%
Sabal Palm	100	Potted	Less than 30%
Sweetgum	3,000	Bareroot	Less than 30%
Laurel Oak	2,500	Bareroot	Less than 30%
Slash Pine	2,000	Bareroot	Greater than 70%
Loblolly Pine	1,000	Bareroot	Greater than 70%
Various Species	62	Tree-spaded	Greater than 70%

No herbaceous species or-grasses were planted in the wetland area. The spreading of an organic mulch was successful in establishing wetland herbaceous species.

Monitoring Program - None.

7. AMAX, LAKE BRANCH TRIBUTARY, AMX-BF-10

Objective and Goal - The objectives of the project include the following: test various tree planting methods (potted, bareroot, tree-spading); organic mulch versus no mulch; establishment of native vegetative "islands"; re-establishment of hydrologic conditions. The project area will be graded to approximate pre-mining contours. The total project area is 37 acres. The total wetland area is 16 acres; 15.5 acres will be a floodplain hardwood swamp and 0.5 acres will be a stream restoration effort. The reclaimed stream will be approximately 2,500 feet in length, one to three feet in width, and one to three feet in depth. This stream is an unnamed tributary to Lake Branch.

Reclamation Schedule - Mining to be completed, tentatively, in October, 1985; grading and contouring to be completed in January, 1986; revegetation to be completed-in April, 1986:

Soil Types and Treatments - The subsurface soil type will be overburden. The surface soils will consist of graded overburden with a layer of mulch borrowed from other wetlands. Area to be treated and depth of mulch is unknown at this time. There are no plans to fertilize the area.

Hydrology Characteristics - The primary water sources to the wetland area will be surface water runoff, stream flow and some settling area seepage. The original size of the wetland watershed was approximately 400 acres. Current size of the watershed is now 150 acres. After reclamation is complete the watershed will eventually be 400 acres.

Revegetation Methods - The following tree species are planned to be planted in the wetland: sweetgum, various bay species, swamp tupelo, laurel

Soil Types and Treatments - The subsurface soil type is unmined land. The surface soils were overturned and regraded. The area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland area is surface water runoff. The size of the wetland watershed is approximately ten acres. Water levels are not being artificially regulated. The area is located adjacent to Boggy Branch.

Revegetation Methods - Approximately 80 saplings were tree-spaded into the area with approximately 90% survival. The species transplanted were slash pine, bays, red maple, and sabal palm.

No herbaceous species or grasses were planted in the wetland area. Natural reseeding of trees has been very good because of the adjacent forested floodplain.

Monitoring Program - None.

6. AMAX, AMX-BF-1

Objective and Goal - The main objective of this project was to create a hardwood forest suitable for use as a wildlife habitat, as well as creating a cypress pond and marsh. The total wetland area is 31 acres; approximately 50% is planned as a floodplain hardwood swamp, 25% is a marsh and 25% is a cypress swamp.

Reclamation Schedule - Mining was completed in July, 1978; grading and contouring was completed in November, 1979; revegetation was completed in January, 1980.

Soil Types and Treatments - The subsurface soil type is overburden. The surface soil on approximately 30% of the wetland area is graded overburden; approximately 70% contains an eight inch layer of organic soils borrowed from a swamp. The area was not fertilized.

Hydrology Characteristics - The primary water sources to the wetland are surface water runoff and seepage from a nearby settling area. The size of the wetland watershed is approximately 60 acres. Water levels are not being artificially regulated, however, there is a berm with an overflow channel at the pond on the south end of the area. Water from the area drains to Boggy Branch.

Revegetation Methods - Given below are the tree species that were planted in the wetland area.

oak, red maple, and water oak. Planting methods, density, and plant stock are not-known at this time.

No herbaceous species or grasses are planned to be planted in the wetland area. However; spreading a layer of organic soils borrowed from other wetlands will include transferring of whole plants.

Monitoring Program - Tentative plans are to monitor post-reclamation hydrology, water quality, vegetation survival and succession, wildlife use, and aquatic biota in the stream. Frequency and parameters not known. The design and monitoring of this project will be a cooperative venture between Amax, the U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. Bureau of Mines, Florida Institute of Phosphate Research, Florida Department of Environmental Regulation, Hillsborough County, and the Florida Game and Fresh Water Fish Commission (FGFWFC).

8. AMAX, LITTER TEST PLOT

Objective and Goal - The objective of this study was to develop methodologies of applying topsoil/litter from natural plant communities on reclaimed mine sites, with the hope that seeds and other propagules of native species in that topsoil would colonize those sites. The total wetland area is approximately 0.10 acres, consisting of long retangular test plots.

Reclamation Schedule - Grading and contouring was completed in January, 1980; revegetation was completed in February, 1980.

Soil Types and Treatments - The test plot is an unmined site, but all of the topsoil (A horizon) had been stripped. A layer of organic soil from a bayhead was spread over the wetland test plots at two different thicknesses; 7-2 inches and 4-6 inches. One-half of the area was fertilized with 10-10-10.

Hydrology Characteristics - The primary water source to the wetland plots is ground water. Surface water drainage to the plot area is intercepted by a small drainage canal on the western side of the plot.

Revegetation Methods - No trees, herbaceous plants or grasses were planted in the wetland area.

Monitoring Program - It is planned to monitor vegetation succession in each wetland plot.

9. AMAX, MARSH AND LAKE SITE

Objective and Goal - The objective of this study was to create a marsh in the littoral zone of a 0.4 acre pit lake. The total wetland area is 0.2 acres of marsh.

Reclamation Schedule - Grading and contouring was completed in January, 1980; revegetation was completed in February, 1980.

Soil Types and Treatments - This test area was constructed on an excavated depression. The topsoil was stripped to the subsoil (B horizon). The surface soil was mulched with a layer of organic soil borrowed from another wetland. The area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland is ground water. Water levels are not artificially regulated.

Revegetation Methods - No trees, herbaceous species or grasses were planted in the wetland area. The use of mulch from another wetland was successful in introducing wetland species.

Monitoring Program - None.

10. AMAX, FLOODPLAIN SITE

Objective and Goal - The objective of this project was to create a stream channel and adjacent floodplain. Revegetation techniques tested included the use of litter/topsoil from other wetland areas. The topographic design of the area was tied to the surface and ground water baseline data. The total wetland area is approximately 0.55 acres; 50% is planned as a bayhead and 50% is planned to be a floodplain hardwood swamp. The stream channel is approximately 300 feet long, less than one foot deep, and one to two feet wide.

Reclamation Schedule - Grading and contouring was completed in January, 1980; mulching was completed in April, 1980.

Soil Types and Treatments - The area is constructed on unmined, excavated surface soils. A layer of organic soil from a swamp was spread over the area at a depth of four to six inches. The southern one-half of the area was fertilized with 10-10-10 in attempt to reduce competition from weedy species.

Hydrology Characteristics - The primary water source to the wetland is planned to be stream flow. The site was constructed adjacent to an unnamed tributary. Stream flow from that tributary has not yet been diverted into the new channel. The size of the wetland watershed is approximately 525 acres. Water levels will not be regulated into the area.

Revegetation Methods - No trees, herbaceous plants or grasses were planted in the wetland area. An organic mulch was spread over the area to encourage revegetation of wetland species. Fertilization did not reduce competition from weedy species.

Monitoring Program - Periodic vegetative species inventory and successional trends.

11. BREWSTER, WETLANDS WEST EXPERIMENTAL PLOTS

Objective and Goal - Five plots were located in a seepage zone near the base of a clay settling area. One plot was scraped and planted with trees. Two plots were treated with different thicknesses of mulch from a swamp donor site. One plot was treated with mulch from a marsh donor site. The last plot was untreated. The total wetland area is approximately 1.3 acres. Plot sizes range from 50x50-feet to l25x250 feet.

Reclamation Schedule - Mining was completed by 1975; grading and contouring was completed in August, 1979; revegetation was completed in August, 1979.

Soil Types and Treatments -- The wetland plots are constructed on dike material within a seepage zone of a clay settling area. Of the five wetland plots, three were treated with a mulch borrowed from another wetland. Two of the plots had a mulch spread evenly six inches deep. One plot contained a windrow of mulch two feet-deep.

Hydrology Characteristics - The primary water source to the area is settling area seepage. The site is located just east of Lake Branch.

Revegetation Methods. - One plot was planted with trees. Species planted were sweetgum, slash pine and red maple.

No herbaceous species were planted. Some of the plots had established grass cover prior to mulching.

Monitoring Program - Vegetation was monitored December 1979, March and April 1980, and August and September 1980. Results of the work have been summarized by Clewell (1981).

1 2 . CF MINING CORP., CFM-HC-SP3

Objective and Goal - The objectives for this planned hardwood swamp are: 1) test success of various combinations of species diversity, 2) test effectiveness of an artificial hardpan to perch water, 3) test benefit of various topsoil applications, and 4) test water control. The total wetland area is 15 acres.

Reclamation Schedule - Mining was completed in February, 1981, consolidation was completed in March, 1983; grading and contouring was completed in April, 1983; revegetation to be completed in December, 1983.

Soil Types and Treatments - The subsurface soil type is sand tailings and overburden fill capped with one foot of sand/clay mix (a mix of sand tailings and waste clays) and additional overburden. The total area will be divided into five plots. Soil treatments on the five plots will be as follows: 1) graded overburden only, 2) an eight inch layer of upland top soil taken from

pine flatwoods, 3) an eight inch layer of organic soils borrowed from a marsh, 4) an eight inch layer of organic soils borrowed from a swamp, and 5) a layer of sand/clay mix. Some fertilizer ammendments may be made prior to planting. Soil tests will be made to assess fertilizer needs.

Hydrology Characteristics - The primary water source to the wetland will be surface water runoff. The size of the wetland watershed will be approximately 120 acres. Secondary water source will be mine water discharge. Water draining from the area will enter the plant water recirculation ditch.

Revegetation Methods - The following tree species will be planted in the wetland area: red maple, loblolly bay, sweet bay, swamp tupelo, sweetgum, dahoon, laurel oak, and water oak. A total of 625 tubule seedlings of each species will be planted. A combination of grasses and herbaceous species are planned to be seeded in. The decision on species has not been made at this time.

Monitoring Program - Planned monitoring includes: surface and ground water levels - weekly; water quality - spot check; vegetation survival and succession - quarterly.

13. ESTECH, WATSON MINE SITE

Objective and Goal - The objectives for this marsh will be to evaluate the effectiveness of natural restoration/creation where suitable soil and hydrology parameters are established. The total wetland area is eight acres of marsh.

Reclamation Schedule - Mining was completed in 1948; clay consolidation was completed in 1965; tailings were placed in 1979; grading and contouring was completed in 1979; revegetation was completed in 1981.

Soil Types and Treatments - This project has been constructed in a waste clay settling area which has been capped with zero to ten feet of tailings sand. The surface soils of the marsh consist of approximately 80% waste clays and 20% sand tailings. The wetland area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland is ground water and rainfall. The size of the wetland watershed is approximately 40 acres. Water levels are not artificially regulated. The site lies adjacent to Whidden Creek but there is no connection to the creek from the wetland.

Revegetation Methods - The following trees were planted in the wetland area.

Species	Number Planted	Planting Stock	Survival
Bald cypress	100	Potted	15%
Sweetgum	100	Potted	15%
Loblolly bay	75	Potted	20%
Sweet bay	3	Tree-spaded	67%
Red maple	2	Tree-spaded	100%
Laurel oak	5	Tree-spaded	40%

No herbaceous species were planted in the wetland area. The area was seeded with common bermuda and Argentine bahia grass at a rate of ten pounds per acre.

Monitoring Program

14. FARMLAND, HICKORY CREEK SAND/CLAY MIX AREA

Objective and Goal - The objectives of this project will be to evaluate the establishment of both wooded and herbaceous wetlands on sand/clay mix soils. The total wetland area will be 22.4 acres, consisting of 3.7 acres marsh, 13.8 acres floodplain hardwood swamp and 4.9 acres buffer zone.

Reclamation Schedule - Proposed 'mine, schedule unknown.

Soil Types and Treatments - The subsurface soil type will be sand tailings capped with ten feet of sand/clay mix. Approximately 46% of the surface soil will consist of sand/clay mix, and approximately 54% of the area will contain a one foot thick layer of sand/clay/muck mix. The area will be fertilized based on the results of soil analyses.

Hydrology Characteristics - The primary water source to the wetland will be surface water runoff--and -stream flow. The size of-the wetland watershed is approximately 3,500 acres. Water levels may be artificially regulated by outfalls (pumping station) for manipulation of hydroperiods to control establishment of undesirable species.

Revegetation Methods - Given below is a list of proposed tree planting in the wetland area.

Species	Number To Be Planted	Acreage To Be Planted	Planting Stock
Bald cypress	4,500	2.6	Bareroot
Tupelo gum	4,800	2.8	Bareroot
Pop ash	2,400	1.4	Bareroot
Red maple	4,800	2.8	Bareroot
Sweetgum	2,400	1.4	Bareroot

Species	Number To Be Planted	Acreage To Be Planted	Planting Stock
Laurel oak	1,800	1.0	Bareroot
Live oak	600	0.3	Bareroot
Slash pine	600	0.3	Bareroot
Southern red cedar	600	0.3	Bareroot
Bald cypress	360	0.2	Potted
Loblolly bay	600	0.3	Potted
Sweetgum	180	0.1	Potted
American elm	180	0.1	Potted
Sabal palm	180	0.1	Potted
Total	24,000	13.8	

It is proposed to plant the following wetland herbaceous species on approximately 3.7 acres: sawgrass (Cladium jamaicense), maidencane (Panicum hemitomon), smartweed (Polgonum spp.), arrowhead (Sagittaria spp.), spikerush (Eleocharis acicularis , pickerelweed (Pontedaria cordata), lizard's tail (Saururus cernuus). arrow-arum (Peltandra virginica), smartweed (Polygonum hydropiperoides), and 17 varied species. Planting will include seeds, whole plants and other propagules within mulch added to site. No grasses will be planted in the wetland area.

Monitoring Program - It is planned that vegetation in swamp test plots will be monitored for tree survival, tree height, tree diameter breast height (dbh), and herb cover. Vegetation in marsh test plots will be monitored for clump survival and herb cover. Substrate and invertebrate community monitoring will include soils, benthic cores and benthic net. Hydrologic monitoring will include surface water depth, water table elevations and surface water pH.

15. FARMLAND, OAK CREEK OVERBURDEN

Objective and Goal - The objectives will be to 1) determine the conditions conducive to replacement of a natural diverse drainage system similar to that currently existing on site; 2) provide rapid establishment of vegetative cover and stream flow characteristics, and 3) monitor success and rate of vegetation establishment and suitability. The total wetland area will be 20 acres, consisting of 10 acres of marsh, 4 acres of cypress swamp, 5 acres floodplain hardwood swamp and 1 acre stream restoration. The proposed reclaimed stream will be approximately 5,000 feet long, 25 feet wide and four feet deep.

Reclamation Schedule - Proposed mine, schedule unknown.

Soil Types and Treatments - The subsurface soil type will consist of sand tailings capped with four feet of overburden and organic soils. The surface

soil treatments in the wetland area will consist of 27% graded overburden, 58% organic soils from a marsh spread to a depth of one foot, and 15% organic soils from a swamp spread to a depth of one foot. It is proposed to fertilize the area based on the results of future soil analyses.

Hydrology Characteristics - The primary water sources to the wetland will be ground water, surface water runoff, and settling area seepage. The size of the-wetland watershed is approximately 700 acres.- Control of-water levels in the channel can be accomplished by a nearby ditch surrounding a clay settling area. The channel that, will be reclaimed is an unnamed tributary of Oak Creek.

Revegetation Methods - This proposed reclamation-area will be divided into seven plots labelled "Sites A through G" which will include shallow water marshes, transitional marsh zones, mixed hardwood swamp, mesic stream-side hammock, deep marsh, and hardwood swamp. Farmland has prepared a detailed revegetation plan for each of these sites. Because of the length and detail of this revegetation plan, it has been attached and is included in Appendix C. This revegetation plan was, by far, the most detailed received from any of the respondents.

Monitoring Program - It is planned that the vegetation in the hardwoods area will be monitored for tree survival, tree height, tree dbh, and herbaceous cover. Vegetation in marsh test plots will be monitored for clump survival and herbaceous cover. Substrate and invertebrate community monitoring will include soils, benthic cores and benthic net. Hydrologic monitoring will include surface water depth, water table elevations, and surface water quality.

16. GARDINIER, GAR-FM-SP(6)

Objective and Goal - Specific objectives of this project will be testing the feasibility of perched wetlands, comparisons between clay and peat seals for wetlands, and the testing of various proven and experimental revegetation techniques. However, the major objective of this project will be to design and construct the wetland system as a complete hydrologic unit. The total wetland area will be 10.6 acres; consisting of 0.7 acres marsh, 0.7 acres cypress swamp, 1.2. acres bayhead, 6.6 acres floodplainhardwood swamp, and 1.4 acres of lake border and swales.

Reclamation Schedule - Mining was completed in March, 1981; grading and contouring to be completed in December, 1983; revegetation to be completed in July, 1984.

Soil Types and Treatments - The subsurface soil type will consist of overburden. The surface soil treatments will consist of 72% graded overburden, 13.2% organic soils from a swamp spread at a depth of two feet, and 14.8% of a clay seal derived from reject material from the plant washer.

Fertilizers may be applied. The analyses and application rate will be determined according to specific soil types and vegetation.

Hydrology Characteristics - The primary water source will be surface water runoff. The size of the wetland watershed is approximately 153 acres. Water levels in the perched wetland areas will be artificially regulated somewhat above ground water levels. Swales and channels will be constructed between test areas within the project site. The site is located adjacent to Whidden Creek.

Revegetation Methods - Trees, herbaceous plants and grasses will be planted. Species and quantity information is not available at this time.

Monitoring Program - To be planned and conducted by the University of Florida, Center for Wetlands.

17. W.R. GRACE, FOUR CORNERS DEMONSTRATION PROJECT

Objective and Goal - The objective of this project was to develop methodologies for establishing marsh and swamp vegetation on reclaimed lands. Three artificial marshes and one swamp were created. Techniques included transplanting whole plants, mulching with soil from another marsh, and tree-spading. The total wetland area is approximately 1.7 acres, consisting of three circular marsh areas of 0.4 acres each, and one oblong swamp plot of approximately 0.5 acres.

Reclamation Schedule - Unmined site; grading and contouring completed in June, 1978.

Soil Types and Treatments - The project area is an unmined site but the surface was disturbed to a depth of two feet to simulate mining and reclamation. A one foot layer of organic soils borrowed from a marsh was spread over one of the four plots. The other three plots had no mulch treatment. The plots were fertilized in June, 1978 with 800 pounds per acre of 10-10-10. In September, 1978, the area was again fertilized with 2000 pounds per acres of dolomite and 400 pounds per acre of fertilizer.

Hydrology Characteristics - The primary water source to the wetland is ground water and surface water runoff. The project area is adjacent to Alderman Creek.

Revegetation Methods - Revegetation methods for the four test plots are as follows:

Plot 1 - Control plot, graded and left for natural revegetation.

Plot 2 - Hand planted with plant material taken from a nearby natural marsh; plants included maidencane, pickerelweed and soft rush.

Plot 3 - Mulched 30 cm. deep with mucky substrate from nearby natural marsh.

Plot 4 - Tree plot, 95 trees comprising 16 species were transplanted from a donor site on Alderman Creek. Listed below are those tree species planted:

Species	Number Planted	Planting Stock
Styrax	1	6' to 10' saplings
Red maple	6	6' to 10' saplings
Pop ash	4	6' to 10' saplings
Dahoon holly	4	6' to 10' saplings
Laurel oak	10	6' to 10' saplings
Florida elm	3	6' to 10' saplings
Wax myrtle	4	6' to 10' saplings
Blue dogwood	35	6' to 10' saplings
Swamp tupelo	3	6' to 10' saplings
Sweetgum	5	6' to 10' saplings
Walter's viburnum	5	6' to 10' saplings
Sweet bay	8	6' to 10' saplings
Buckthorn	3	6' to 10' saplings
Red mulberry	1	6' to 10' saplings
Swamp red bay	1	6' to 10' saplings
Witherod viburnum	2	6' to 10' saplings
Total	95	

Fifty seedlings of red maple, cypress and slash pine were also planted.

Monitoring Program - Water levels were recorded monthly. Water quality samples were taken quarterly (pH and turbidity were measured monthly). Vegetation zonation was. sampled with 1 m quadrats. Fauna was sampled with petite ponar grab, seine and dip net. Periphyton was also sampled.

Monitoring results for this project site have been reported by Shuey and Swanson (1979), Swanson and Shuey (1980), Conservation Consultants (1979, 1980 and 1981), and Ford (1983).

18. W.R. GRACE, WRG-BL-SP(5)

Objective and Goal - The objective of this project was to restore wetlands that were mined, according to DNR reclamation rules. The total wetland area is 4.5 acres, consisting of combination hardwood swamp and marsh.

Reclamation Schedule - Mining was completed at the end of 1980; grading and contouring was completed in the winter of 1982; revegetation was completed in the winter of 1982.

Soil Types and Treatments - The subsurface and surface soil type is overburden. The area was fertilized with 600 pounds per acre of 6-6-6.

Hydrology Characteristics - The primary water source into the wetland area is surface water runoff. Water levels are being regulated by a spillway on the east end of the project area. Water from the spillway flows. to Bear Branch.

Revegetation Methods - Three species of trees were planted in the wetland area: sweetgum (bareroot stock), red bay (transplants), and bald cypress (potted stock). Survival for all trees was approximately 80%. No herbaceous plants or grasses were planted in the wetland area.

Monitoring Program - None.

19. W.R. GRACE, WRG-HP-SP(2)

Objective and Goal - The objective of this project will be to establish three large independent experimental cells. The cells will be approximately 60 acres each. The type of wetland that is being planned is marsh. The three reclamation configurations will be compared as to their ability to affect water quality. Twelve experimental revegetation plots will also be established in two of the cells. One of the cells will contain a small island of approximately two acres. The other two cells will each contain a deep water area; one will be approximately 11 acres, the other will be approximately 4.4 acres.

Reclamation Schedule - Mining to be completed in January, 1984; grading and contouring to be completed in September, 1983 to April, 1985; revegetation to be completed in November, 1984 to May, 1985.

Soil Types and Treatments - All three cells will be constructed from mine cuts filled with waste clays. The area will then be capped with sand tailings and covered with overburden mixed with the organic muck which originally occurred over the area. The shallow water habitat in one of the cells will be covered with organic muck from Hooker's Prairie.

Hydrology Characteristics - The primary water source to the wetland will be ground water, and an artificial water source provided by a header ditch at one end of the three cells. Water levels will be artificially regulated by the header ditch and adjustable weirs.

Revegetation Methods - The majority of the project area will be allowed to revegetate naturally. Sufficient seed sources are expected to be provided by wind and by water from the eastern side of Hooker's Prairie. Wetland tree species will be planted only on the small island within one of the cells. The species planted will include cypress, gum, sweetbay, redbay, ash, red maple and sweetgum. Sixty seedlings of each species will be planted.

A minimum of 12 experimental plots will be established in two of the three cells. The plots will consist of the following four community types: sawgrass, maidencane, a mixture of pickerelweed and arrowhead, and cattail. Three plots of each community type will be established by:

A) Sown seeds (l00'x100' plots)

B) Sprigging or use of reproductive tubers, etc., on:

i) four foot centers (l00'x50' plots)
ii) ten foot centers (100'xl00' plots)

An additional four or more plots will be established in one of the cells to determine if the- community types listed above can re-establish themselves naturally. At least four control plots will be located in Hooker's Prairie to establish baseline standing crops of the community types established in the experimental cells.

Monitoring Program - Water quality entering and leaving each cell will be monitored quarterly. Water quantity will be monitored in each cell with a water level recorder and staff gauges. Fish will be sampled by the FGFWFC. Macroinvertebrates will be sampled semi-annually. Vegetation in plots will be analyzed for density, diversity, and dry-weight.

20. IMC, HOMELAND-9, IMC-CS-9A

Objective and Goal - The objective of this wetland project is to reclaim - a functional wetland inside a settling pond. Total wetland area is approximately 23 acres , consisting primarily of marsh. An additional stream restoration (outfall) of less than one acre has also been constructed.

Reclamation Schedule - Clay consolidation was completed in December, 1980; grading and contouring was completed in December, 1980; revegetation was completed in June, 1981.

Soil Types--and Treatments - The subsurface and surface-soil types in the wetland area are consolidated clays. The area was not fertilized.

Hydrology Characteristics - The primary water source to. the wetland is surface water runoff. The size of the wetland watershed is approximately 400 acres. Water levels are not being artificially regulated. The outfall channel from the wetland is approximately 800 feet in length,. five feet in width, and five feet in depth. Water from this outfall flows to Barber Branch water return pool (tributary to Peace River).

Revegetation Methods - The following tree species were planted in the wetland area:

Species	Number Planted	Acreage Planted	Planting Stock	Survival
Bald cypress	400	5	Bareroot	Greater than 60%
Dahoon holly	40	2	Tubules	Less than 40%
Swamp chestnut oak	50	2	Tubules	40 - 60%
Red maple	400	5	Bareroot	40 - 60%
Loblolly bay	600	5	Bareroot	40 - 60%
Pop ash	20	1	Potted	Less than 40%
River birch	30	2	Tubules	40 - 60%
Sweetgum	20	2	Potted	40 - 60%

The following herbaceous species were planted in the wetland area:

Species	Planting Rate	Acreage Planted	Planting Stock	Survival
Spikerush	3 plants/ac	3	Whole	90%
Bulrush	3 plants/ac	3	Whole	90%
Alligator weed	3 plants/ac	3	Whole	90%
Wapato-duck potato	3 plants/ac	3	Seeds	90%
Pickerelweed	3 plants/ac	3	Whole	90%

The following grasses were planted in the wetland area:

Species	Planting Rate	Acreage Planted	Planting Method	Survival
Switchgrass	3 plants/ac	3	Whole	90%
Wild millet	3 plants/ac	3	Whole	90%

Monitoring Program - Monthly rainfall and water level readings. General wildlife usage and tree survival observations. Monitoring results for this project have been reported by IMC (Goodrich, 1983).

21. IMC, NORTH 640 FLOOD PLAIN, IMC-CS-19

Objective and Goal - The objective of this project was to reclaim a floodplain hardwood swamp. The total wetland area is eight acres, There are also approximately seven acres of deep water habitat and 15 acres of upland in the project area.

Reclamation Schedule - Mining was completed in July, 1978; grading and contouring was completed in November, 1982; revegetation to be completed in December, 1984.

Soil Types and Treatments - The subsurface soil' type is overburden. Approximately 75% of the surface soil also consists of graded overburden. The remaining 25% of the surface soil contains a three to six inch layer of organic soil borrowed from a marsh. The area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland is surface water runoff, a secondary source is ground water, and a tertiary source is stream flow and flooding from the Peace River. The size of the wetland watershed is approximately 400 acres. Water levels are not being artificially regulated. The outfall channel to the Peace River is approximately 50 feet in length, 25 feet in width and six inches deep.

Revegetation Methods - Trees were planted on approximately two acres of the project area. The tree species planted were bald cypress, red maple and dahoon holly. A total of 70 bareroot seedlings were planted. Survival was moderate.

No herbaceous species or grasses were planted in the wetland area. An organic mulch was spread over portions of the site to encourage revegetation of wetland species.

Monitoring Program - Monthly rainfall and water level readings. General wildlife usage and tree survival observations.

22. IMC, FLORIDA GAME AND FRESH WATER FISH COMMISSION TEST SITE, PARCEL B

Objective and Goal- The objective of this project was to establish physical site characteristics similar to -those which produce and maintain native wetlands. Basins were created to encourage emergent plant growth, store water from an onsite drainage area, and provide habitat for fish and aquatic life. The total project area is approximately 49 acres, of which 9.8 acres is wetland, and 9.4 acres is transitional. The remaining area is open water or upland,

Reclamation Schedule - Mining was completed in March, 1968; grading and contouring was completed in November, 1978; revegetation was completed in May, 1979.

Soil Types and Treatments - The subsurface and surface soil types in the project area are overburden. No fertilizer was applied in the wetland area.

Hydrology Characteristics - The primary water source to the wetland is ground water, surface water runoff, and minor amounts of flooding from the Peace River. The size of the wetland watershed is approximately 200 acres.

Water levels are not artificially regulated, however, there is a berm/access road around the lower portion of the area, and there is one outfall on the south end.

Revegetation Methods - The following tree species were planted in the wetland area:

Species	Number Planted	Planting Stock	Survival
North Florida slash pine	600	Seedlings	55.4%
South Florida slash pine	602	Seedlings	27.4%
Sand pine	450	Seedlings	48.7%
Loblolly pine	500	Seedlings	41.1%
Longleaf pine	650	Seedlings	2.0%
Spruce pine	650	Seedlings	59.2%
Cottonwood	700	Seedlings	7.8%
Bald cypress	1,488	Seedlings	82.4%
Catalpa	675	Seedlings	69.1%
Green ash	1,165	Seedlings	69.3%
Live oak	580	Seedlings	24.8%
Red cedar	620	Seedlings	72.1%
Red maple	1,400	Seedlings	51.8%
Sweetgum	1,252	Seedlings	56.8%
Sycamore	525	Seedlings	63.8%
Tupelo gum	964	Seedlings	25.2%
Total	12,820		

Species	Number Planted	Planting Stock
Bald cypress	12	Tree-spaded
Cabbage palm	8	Tree-spaded
Florida elm	12	Tree-spaded
Laurel oak	6	Tree-spaded
Red maple	8	Tree-spaded
Sweetgum	17	Tree-spaded
Pop ash	21	Tree-spaded
Water oak	11	Tree-spaded
Sugarberry	3	Tree-spaded
Black cherry	1	Tree-spaded
Ironwood	1	Tree-spaded
Persimmon	2	Tree-spaded
Pignut hickory	2	Tree-spaded
Total	104	

Average survival rate of tree-spaded stock was 78.8%.

Herbaceous species that were planted include:

Species	Number Planted	Acreage Planted	Planting Stock
Arrowhead	52	4 (20'x 20') plots	Whole
Pickerel-weed	57	4 (20'x20') plots	Whole
Soft rush	23	4 (20'x20') plots	Whole
Maiden-cane	42	4 (20'x20') plots	Whole
Maiden-cane	5000	20'x100' plot	Rhizomes

Virtually all of the herbaceous plantings had persisted through. their second growing season.

Monitoring Program Monthly studies were conducted in 1979 and 1980 for soils, rainfall events, ground and surface water fluctuations, water quality, vegetation survival and zonation, wildlife use and aquatic life, Monitoring results of this project have been published (Gilbert, et al., 1979, 1980 and 1981).

23. IMC, SOUTH TIGER BAY, IMC-NP-SP(1)

Objective and Goal - The objective of this project was to reclaim a 260 acre area and create the following wetland type communities: marsh - 149 acres, cypress swamp - 50 acres, bayhead - 10 acres, floodplain-hardwood swamp - 10 acres, outfall stream channel - 1 acre, and other swamp hardwoods - 40 acres. The outfall stream channel is approximately 1000 feet in length, 50 feet in width and ten feet deep with a discharge of approximately 2000 gpm (base flow estimated/rainy season). This outfall discharges to Camp Meeting Ground Creek.

Reclamation Schedule - Mining was completed in July, 1978; grading and contouring was completed in June, 1982; revegetation to be completed in December, 1983.

Soil Types and Treatments - The subsurface and surface soil type within this project area consists of overburden soils. The area was not fertilized.

Hydrology Characteristics - The primary water sources to the wetland area are ground water, surface water runoff and rainfall. The size of the wetland watershed is approximately 435 acres. Water levels are not artificially

regulated. The outfall is located on the east side of the wetland.

Revegetation Methods - A total of 35 cabbage palm tubule seedlings were planted on ten acres of the wetland area. Survival was greater than 60 percent. Additionally, approximately 40 species of trees are planned to be planted in the various wetland communities.

The following herbaceous species were planted within the wetland area: spike rush, pickerelweed, soft rush, smartweed, and maidencane. Planting rate was ten whole plants per acre. Total area planted was 20 acres. Survival rate was approximately 90 percent for all species. No grasses were planted within the wetland area.

Monitoring Program - Monthly rainfall and water level readings. General - wildlife usage and tree survival observations.

24. IMC, SOUTH OF K-6, IMC-K-SP(1)

Objective and Goal - The objectives of this project are to restore portions of the Lake Branch stream channel and reclaim the headwaters consisting of a bayhead/swamp. The total wetland area will be approximately ten acres of cypress swamp and bayhead. Approximately 0.2 acres of stream channel will be reclaimed. The reclaimed stream channel will have a length of approximately 300 feet, a depth of approximately three feet, and a width of approximately 25 feet. Discharge will be approximately 1 cfs (base flow).

Reclamation Schedule - Mining was completed in November, 1981; grading and contouring to be completed in June, 1984; revegetation to be completed in August, 7984.

Soil Types and Treatments - The subsurface soil type will be sand tailings capped with one to four feet of overburden. The surface soil will consist of graded overburden. No fertilization of the area is anticipated.

Hydrology Characteristics - The primary water source to the wetland will be surface water runoff, a secondary source will be ground water, and a tertiary source will be mine water discharge. The size of the wetland watershed will be approximately 100 acres. Water levels will not be artificially regulated.

Revegetation Methods - This project is under construction and revegetation plans are not complete.

Monitoring Program - None, project not complete.

25. IMC, WEST OF K-6, IMC-K-10

Objective and Goal - The objectives of this project are to: 1) test tree growth on various reclaimed soils and soil combinations, 2) reclaim various functional natural systems, and 3) reclaim and improve Halls Branch watershed conditions. This six acre marsh is located along an eight acre lake.

Reclamation Schedule - Mining was completed in September, 1981; grading and contouring was completed in June, 1982; revegetation was completed in June, 1982.

Soil Types and Treatments - The soil type consists of overburden and sand tailings capped with 0.5 - 2.5 feet of overburden. The area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland area is ground water, secondary water source is surface water runoff. The size of the wetland watershed is approximately 150 acres. Water levels are not being artificially regulated. There is an outfall channel from the wetland area draining to Halls Branch. This outfall channel is 50 feet in length, 30 feet in width, and one foot in depth. Discharge is approximately 100 gpm (minimum flow).

Revegetation Methods - Approximately four acres of the wetland area were planted with trees. Given below are the trees planted:

Species	Number Planted	Planting Stock	Survival
Bald cypress	125	Tubules	Greater than 60%
Sweetgum	140	Tubules	Greater than 60%
Red maple	47	Tubules	Greater than 60%
Red bay	50	Tubules	40 - 60%
Sweet bay	75	Tubules	40 - 60%
Loblolly bay	60	Tubules	40 - 60%
Swamp tupelo	60	Tubules	40 - 60%
Carolina ash	70	Tubules	40 - 60%
Dahoon holly	55	Tubules	40 - 60%
Blue beech	83	Tubules	40 - 60%
Water oak	60	Tubules	Less than 40%

The following herbaceous species were planted in approximately four acres of the wetland:

Species	Number Planted	Planting Stock	Survival
Soft rush	10 plants/ac	Whole	Greater than 60%
Maidencane	10 plants/ac	Whole	40 - 60%
Spike rush	10 plants/ac	Whole	Greater than 60%
Sedges	10 plants/ac	Whole	Greater than 60%
Pickerelweed	10 plants/ac	Whole	Greater than 60%
Smartweed	10 plants/ac	Whole	Greater than 60%
Water lily	40 plants/ac	Seed	Premature

No grasses were planted in the wetland area.

Monitoring Program - Rainfall and water level readings. General wildlife usage and vegetation survival. Water quality and quantity.

26. MOBIL, SINK BRANCH

Objective and Goal - The primary objective of the project was to demonstrate the feasibility of reclaiming a small creek channel and associated vegetative cover. The project included evaluation of surface soil treatment and tree transplanting on the development of the vegetative cover. The project area is approximately two acres; 0.5 acres are wetland, and 1.5 acres are upland. The reclaimed stream is approximately 1000 feet in length, 40 feet in width at high water, and 2.5 feet in depth at high water.

Reclamation Schedule - Mining was completed in 1975; grading and contouring was completed in January, 1980; revegetation was completed in March, 1980; stream rerouted in September, 1980.

Soil Types and Treatments - The subsurface soil type consists primarily of overburden. Smaller areas of waste clay pockets and sand tailings are also present. The excavated area for the new channel was divided into four plots, each were 200 feet in width and each received a different surface soil treatment. Plot 1 was treated with a one foot layer of organic soil borrowed from a swamp. Plot 2 was treated with a 0.5 foot layer of organic soil borrowed from a swamp. Plot 3 received no organic soil ammendments but was fertilized. Plot 4 received no organic soil amendments or fertilizer and was a control plot.

Hydrology Characteristics - The primary water source to the wetland is stream flow from Sink Branch. The size of the watershed is approximately 2000 acres. Water levels are not artificially regulated.

Revegetation Methods - The following tree species were planted in the wetland area:

Species	Number Planted	Planting Stock	Survival
Sweetgum	29	Tree-spaded	79%
Oak	63	Tree-spaded	73%
Florida elm	16	Tree-spaded	69%
Slash pine	2	Tree-spaded	0%
Sweetbay	16	Tree-spaded	31%
Red maple	3	Tree-spaded	100%
Other	11	Tree-spaded	100%
Bald cypress	45	Potted	93%
Green ash	50	Potted	94%
Sweet gum	100	Potted	84%
Red maple	100	Potted	65%
Slash pine	150	Potted	55%
Sweetgum	400	Bareroot	25%
Live oak	150	Bareroot	11%
Dogwood	100	Bareroot	10%
Slash pine	300	Bareroot	1%

The project area was seeded with a grass seed mixture of bahia grass (40 lbs./acre), common bermuda grass (10 lbs./ acre), and rye grass (30 lbs./acre).

Monitoring Program - Survival counts were made for transplanted trees at periodic intervals for 18 months after planting. In addition, water quality samples were collected and analyzed on a monthly basis nine months prior and six months after diversion. Progress reports on this project have been prepared by Zellars-Williams, Inc. (1980 and 1981).

27. MOBIL, MYERS BRANCH, MCC-FM-22A

Objective and Goal - The objective of this project will be to construct a field-scale reclamation project of a small tributary stream channel, floodplain and the associated vegetative cover. The total wetland area will be eight acres of floodplain hardwood swamp. The reclaimed stream channel will be approximately 1400 feet in length, 50 feet in width and will have a variable depth. The name of the stream that is being reclaimed is Myers Branch, a tributary of the Peace River.

Reclamation Schedule - Mining was completed in July, 1980; grading and contouring to be completed in June, 1983; revegetation to be completed in July, 1984.

Soil Types and Treatments - The primary subsurface soil type will be sand tailings capped with one foot of overburden. Smaller portions of the project area will contain mined overburden. Approximately 80% of the wetland area will contain a 0.5 foot layer of upland top soil borrowed from a

transitional mesic forest. Approximately 20% of the wetland area will contain a 0.5 foot layer of organic soil borrowed from a bayhead swamp. It is planned to fertilize the area with approximately 300 pounds per acre of 20-4-10.

Hydrology Characteristics - Primary water source to the wetland will be surface water runoff. The size of the watershed is approximately 400 acres. Water levels will not be artificially regulated.

Revegetation Methods - The wetland area will be planted with trees at a density of 400 trees per acre. Species to be planted include bald cypress, blackgum, Carolina ash, sweetgum, red maple, and laurel oak.

No wetland herbaceous species will be planted. It is planned to seed the area with rye grass or millet at a rate of 30 pounds per acre.

Monitoring Program - None, project not complete.

28. MOBIL, McCULLOUGH CREEK

Objective and Goal - This project is a field -scale reclamation project which has the objective of reclaiming a small stream and its associated vegetative cover. Total wetland area will be 21 acres, consisting of two acres of marsh and 19 acres of floodplain hardwood swamp. The reclaimed floodplain will be approximately 3500 feet in length, 200 feet in width and the depth will be variable.

Reclamation Schedule - Mining was completed in February, 1981; grading and contouring to be completed in April, 1985; revegetation to be completed in June, 1986.

Soil Types and Treatments - The primary subsurface soil type will be sand tailings capped with one foot of overburden. Some smaller areas will contain overburden alone. It is planned to spread a 0.5 foot layer of stockpiled upland topsoil from a mesic forest over the entire area. It is planned to fertilize the area with 20-4-10 at a rate of approximately 300 pounds per acre.

Hydrology Characteristics - The primary water source to the reclaimed stream and floodplain will be surface water runoff. The size of the watershed is approximately 1040 acres. Water levels are not planned to be artificially regulated. McCullough Creek eventually discharges into the Peace River.

Revegetation Methods - Trees will be planted throughout the floodplain area at a density of 400 trees per acre. Species to be planted include bald cypress, blackgum, laurel oak, red maple, sweetgum and Carolina ash.

Wetland herbaceous species will be planted in the shallow ponds along the reclaimed stream channel. Planting density will be 500 plants per acre. Species to be planted will be pickerelweed, maidencane, smartweed, arrowhead,

and yellow water lily. The floodplain will also be seeded with rye grass or millet at a rate of 30 pounds per acre.

Monitoring Program - Monitoring of growth and survival of planted vegetation is planned.

29. MOBIL, GEORGE ALLEN CREEK

Objective and Goal - The objective of this project is to reclaim a stream channel and its associated vegetative cover. The total area of the stream restoration project will be eight acres. Approximately three acres are wetland and approximately five acres are deep water habitat. The total length of the stream is 6000 feet. Width and depth of the stream is variable.

Reclamation Schedule - Mining was completed in 1980; grading and contouring was completed in October, 1981; revegetation was completed in September, 1982.

Soil Types and Treatments - The surface and subsurface soils in the reclamation area consist of overburden material. The project area was fertilized with 300 pounds per acre of 20-4-10.

Hydrology Characteristics - The primary water source during high water flow is surface water runoff. Seepage from a nearby settling area provides low water flow. The size of the watershed is approximately 600 acres. Water levels are not artificially regulated. George Allen Creek is a tributary to Guy Branch.

Revegetation Methods - The following tree species were planted in the wetland area:

Species	Number Planted	Acreage Planted	Planting Stock	Survival
Longleaf pine	1000	2	Bareroot	Less than 40%
Loblolly pine	4000	6	Bareroot	40 - 70%
Slash pine	5000	7	Bareroot	40 - 70%
Bald cypress	500	3	Potted	40 - 70%
Sweetgum	500	3	Potted	40 - 70%
Red maple	500	3	Potted	40 - 70%
Blackgum	865	3	Tree-spaded	Greater than 70%
Carolina ash	1200	3	Tree-spaded	Greater than 70%
Laurel oak	200	3	Tree-spaded	Greater than 70%
Slash pine	100	3	Potted	40 - 70%

The following herbaceous species were planted in the wetland area:

Species	Planting Rate	Acreage Planted	Planting Stock	Survival
Pickerelweed	250/ac	2	Whole	40 - 70%
Arrowhead	250/ac	2	Whole	40 - 70%
Yellow water lily	200/ac	0.5	Whole	40 - 70%
Maidencane	500/ac	2	Sprigs	Less than 40%

The following grasses were planted in the wetland area:

Species	Planting Rate	Acreage Planted	Survival
Bahia grass	40 lbs/ac	25	40 - 70%
Common Bermuda grass	10 lbs/ac	25	40 - 70%
Rye grass	30 lbs/ac	25	Greater than 70%

Monitoring Program - None.

30. OCCIDENTAL, ALTMAN BAY LAKE

Objective and Goal - The objective of this project was to reclaim wetlands as part of an approved DNR reclamation program. The total wetland area is approximately five acres, consisting of cypress swamp.

Reclamation Schedule - Mining adjacent to the site was completed in July, 1973; wetland area was unmined; grading and contouring was completed in September, 1974; revegetation was completed in March, 1975.

Soil Types and Treatments - This project site is constructed on cleared, unmined lands. The area was not fertilized.

Hydrology Characteristics - The primary water source to the wetland is surface water runoff. The size of the wetland watershed is approximately 25 acres. Water levels are not artificially regulated. Drainage ditches are located along the south and west side of the project area which flow to Swift Creek.

Revegetation Methods - Approximately two acres of the wetland area were planted with bareroot tree seedlings. A total of 500 cypress and 1000 loblolly pine seedlings were planted. Survival rate for both species was greater than 80 percent.

No herbaceous species or grasses were planted in the wetland area.

Monitoring Program - None.

31. OCCIDENTAL, OCC-SR-2 and 3

Objective and Goal - The goal of the project was to establish wetlands on a reclaimed area. Total wetland area is three acres, consisting of 1.5 acres marsh and 1.5 acres cypress swamp.

Reclamation Schedule - Mining was completed in March, 1976; grading and contouring was completed in December, 1979; revegetation was completed in January, 1981.

Soil Types and Treatments - The subsurface and surface soil type in the wetland area is overburden. The only fertilizer applied was 18-8-2 forestry starter pellets, one with each tubule cypress seedlings.

Hydrology Characteristics - The primary water source to the wetland area is surface water runoff and ground water. Mine drainage is a secondary water source. Water levels are regulated by a spillway in a nearby lake. Drainage from the area flows to Swift Creek.

Revegetation Methods - The following tree species were planted on 1.5 acres of the wetland area:

Species	Number Planted	Planting Stock	Survival
Cypress	50	Tubules	Greater than 80%
Cypress	50	Bareroot	Greater than 80%
Sweetgum	50	Bareroot	Greater than 80%
Red maple	20	Bareroot	30 - 80%

The following wetland herbaceous plants were planted in 1.5 acres of the wetland area; soft rush, smartweed and sedges. Planting stock was whole plants and survival rate was greater than 80 percent for the soft rush and smartweed, and 30 to 80 percent for the sedges. No grasses were planted in the wetland area.

Monitoring Program - Photographic record of the progress of the vegetation is being kept by Occidental.

32. OCCIDENTAL, OCC-SR-8

Objective and Goal - The objective of this project was to establish 33 acres of reclaimed wetlands according to DNR rules, Chapter 16C-16. The

wetland type being planned is cypress swamp. The University of Florida, Center for Wetlands, also has a ten acre experimental wetland area in this project area. The following descriptions pertain to the 33 acre cypress swamp.

Reclamation Schedule - Mining was completed in March, 1981; grading and contouring was completed in December, 1982; revegetation was 95% complete in December, 1982.

Soil Types and Treatments - The subsurface and surface soil types in the wetland area are overburden material. Planted trees in the wetland area were fertilized with forestry starter tablets, one per seedling. Analysis was 18-8-3 and 22-8-2.

Hydrology Characteristics - The primary water source to the wetland is surface water runoff and ground water. Mine drainage is a secondary water source. Water levels are regulated through a spillway at the exit of the reclaimed lake. Water from the area drains to Swift Creek.

Revegetation Methods - The following tree species were planted in the wetland area:

Species	Number Planted	Acreage Planted	Planting Stock	Survival
Bald cypress	5000	20	Bareroot	Greater than 80%
Bald cypress	2500	10	Tubules	Greater than 80%
Blackgum	200	n/a	Seeded	Less than 30%
Cypress	30	n/a	Seeded	30 - 80%

The following herbaceous species were randomly planted on approximately one acre; pickerelweed, soft rush, canna, sedges and lizard tail. Planting stock was whole plants. Survival rate for all species was 30 to 80 percent. No grasses were planted in the wetland area.

Monitoring Program - DNR quarterly inspections for vegetation survival to insure compliance with reclamation requirements.

33. OCCIDENTAL, EAGLE LAKE, OCC-SC-1 and 2

Objective and Goal - The objective of this project was to reclaim wetlands as part of an approved DNR reclamation program. The total wetland area is 15 acres, consisting of 14 acres marsh and one acre cypress swamp.

Reclamation Schedule - Mining was completed in May, 1977; grading and contouring was completed in December, 1977; revegetation was completed in November, 1979.

Soil Types and Treatments - Approximately 34% of the wetland area is constructed on unmined land. The remainder is constructed on graded overburden. The area was not fertilized.

Hydrology Characteristics - The primary water sources to the wetland area are surface water runoff from disturbed areas and a natural swamp, and mine discharge. Water levels are regulated by a spillway at the Eagle Lake drainage exit. Water from the area drains to Swift Creek.

Revegetation Methods - A total of 200 bareroot seedlings of bald cypress were planted on one acre of the wetland area. Survival rate was greater than 80 percent.

Cuttings of maidencane were planted on approximately three acres in the wetland area. Planting rate was three bushels per acre. Survival. rate was 30 to 80 percent.

Monitoring Program - Photographic record of the progress of the vegetation is being kept by Occidental.

34. USSAC, GENERAL METHODS FOR WETLANDS

Objective and Goal - The objective of these planned wetland reclamation projects will be fulfillment of Chapter 211, Part 2, Florida Statutes, and Chapter 16C-16, Florida Administrative Code. A total of 403.1 acres of wetland will be reclaimed, consisting of 156.2 acres marsh, and 246.9 acres floodplain hardwood swamp.

Reclamation Schedule - Mining or clay consolidation to be completed in December, 2002; grading and contouring to be completed in June, 2004; revegetation to be completed in December, 2004.

Soil Types and Treatments-These wetland reclamation projects will be constructed on three types of mined land; overburden, waste clay settling areas, and waste clays capped with two feet of sand tailings. All of the wetland areas will have a surface soil of graded overburden. The need for fertilization will be determined by future soil testing.

Hydrology Characteristics - The primary water source to the wetland areas will be surface water runoff. The size of the wetland watershed compared to the area of wetland will be 3:1 or better. Water levels are not planned to be regulated. Water from these future projects will drain to McCullough Creek, Whidden Creek and Little Payne Creek.

Revegetation Methods - It is planned that the following trees will be planted in the wetland area; pond cypress, bald cypress, red maple, sweet gum, and bay. Planting rate will be 435 trees per acre. Total acreage to be planted and planting stock has not yet been determined.

It is anticipated that white clover and sweet clover will be planted in the wetland area. Planting rate, acreage and planting stock are not yet

determined. The following grasses will also be planted; bahia at 20 to 30 pounds per acre, bermuda at 10 pounds per acre, rye at 55 pounds per acre, and brown top millet at 55 pounds per acre.

Monitoring Program - Routine inspection, sampling of water at discharge points to meet current legal requirements; restoration of biological integrity.

35. USSAC, GENERAL METHODS FOR STREAM RESTORATION

Objective and Goal - The objective of these future projects will be to restore the topography and aquatic biota of streams. Total stream restoration area will be 197.9 acres. Total stream length will be 2 to 2.5 miles, average width will be 30 feet, average depth will be two feet.

Reclamation Schedule - Mining or clay consolidation to be completed in January, 1992; grading and contouring to be completed in June, 1993; revegetation to be completed in December, 1993.

Soil Types and Treatments - The subsurface and surface soil types for the stream restoration projects will be overburden material; It is not planned to fertilize the area.

Hydrology Characteristics - The primary water source will be stream flow. The size of the watershed is approximately 200 acres. Water levels will not be artificially regulated.

Revegetation Methods - Revegetation methods for trees, herbaceous species and grasses in the wetland area have not yet been determined.

Monitoring Program - Testing sufficient to meet legal requirements.

3.2 COMMENTS FROM RECLAMATION MANAGERS REGARDING THEIR PROJECTS

Presented below are Questions 22 through 32 of the Questionnaire and the responses received by the mining companies. These questions were directed to the reclamation managers to learn more about the general reclamation methods used. A summary of the results of each question is provided along with unedited individual responses. A few responses were taken from published reports and are referenced as such.

Question 22: Was there any attempt to control the invasion of weedy species? Yes ____, No ____. If so, briefly describe:

Eighty percent of the people responding indicated they had not used or were not planning any weed control measures. Descriptions of weed control used by the others are given below.

- **Mulching with an organic soil borrowed from another wetland encouraged diversity of native wetland species.**
- **Cattails were sprayed with a herbicide to aid tree planting operations.**
- **Water level control and variable hydroperiod.**
- **Fertilizer applications (unsuccessful).**

Question 23: Was any government agency, university group, citizen group, or consultants significantly involved in the planning or design of the project? Yes ____, No ____. If so, please identify:

The majority of the mining companies received some planning or design assistance. Approximately 40 percent of the projects were completed with in-house staff. Presented below is a list of those groups cooperating with the mining companies.

Government Agencies

- Florida Department of Environmental Regulation
- Florida Department of Natural Resources
- Florida Game and Fresh Water Fish Commission
- Hillsborough County Environmental Protection Commission
- Hillsborough County Planning Department
- U.S. Army Corps of Engineers
- U.S. Bureau of Mines
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Soil Conservation Service in Hillsborough County

Universities

- University of Florida, Center for Wetlands

Consultants[1]

- Breedlove and Associates, Inc.
- Bromwell Engineering, Inc.
- Conservation Consultants, Inc.
- Dames & Moore
- EcoImpact, Inc.
- Environmental Science and Engineering, Inc.
- Lotspeich and Associates, Inc.
- Zellars-Williams, Inc.

Question 24: Is a written report on the project available to interested individuals? Yes ____, No ____. If so, please state the name of the report and ordering information (mailing address and cost).

[1]Mention of any consulting organization does not constitute an endorsement by the Florida Institute of Phosphate Research.

Written reports are available or are in press for only 6 of the 35 projects. This does not include applications for permits or reclamation plans that may have been submitted to the state or federal agencies. Given below is the list of available reports, all of which are in the Florida Institute of Phosphate Research library.

. Carson, J.D., 1983a. Progress report of a reclaimed wetland on phosphate mined land in central Florida. Proc. Reclamation and the Phosphate Industry Symp., Clearwater Beach, Florida, 26-28 January 1983, Florida Institute of Phosphate Research. (in press)

. _____, 1983b. Progress report of a reclaimed wetland on phosphate mined land in central Florida. Proc. Ninth Ann. Conference: Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Florida. (in press)

These two progress reports provide qualitative results on Agrico's largest wetland project (AGR-FG-13).

. Clewell, A.F., 1981. Vegetative restoration techniques on reclaimed phosphate strip mines in Florida. The Journal of the Society of Wetland Scientists. 1:158-170.

This report summarizes some of the efforts on Brewster's and W.R. Grace's experimental plots.

. Conservation Consultants, Inc., 1979. Wetland reclamation pilot study for W.R. Grace & Co., Annual Report for 1978. Prepared by Conservation Consultants, Inc., Palmetto, Florida for W.R. Grace & Co., Bartow, Florida.

. _____, 1980. Wetland reclamation pilot study for W.R. Grace & Co., Annual Report for 1979. Prepared by Conservation Consultants, Inc., Palmetto, Florida for W.R. Grace & Co., Bartow, Florida.

. _____, 1981. Wetland reclamation pilot study for W.R. Grace & Co., Annual Report for 1980. Prepared by Conservation Consultants, Inc., Palmetto, Florida for W.R. Grace & Co., Bartow, Florida.

. Ford, K.V., 1983. Wetlands reclamation at Four Corners Mine. Proc. Reclamation and the Phosphate Industry Symp., Clearwater Beach, Florida, 26-28 January 1983, Florida Institute of Phosphate Research (in press)

. Shuey, A.G. and L.J. Swanson, Jr., 1979. Creation of freshwater marshes in west central Florida. Proc. Sixth Ann. Conference: Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Florida. 6:57-76.

. Swanson, L.J., Jr. and A.G. Shuey, 1980. Freshwater marsh reclamation in west central Florida. Proc. Seventh Ann. Conference: Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Florida. 7:51-61.

These six reports above provide results at W.R. Grace's experimental plots.

. Gilbert, T., T. King, B. Barnett, J. Allen, Jr., and R. Hearon. 1979. Wetlands reclamation technology development and demonstration for Florida phosphate mining. Proc. Sixth Ann. Conference: Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Florida. 6:87-101.

. Gilbert, T., T. King, L. Hord, and J. Allen, Jr., 1980. An assessment of wetlands establishment techniques at a Florida phosphate mine site. Proc. Seventh Ann. Conference: Restoration and Creation of Wetlands. Hillsborough Community College, Tampa, Florida. 7:245-263.

. Gilbert, T., T. King, and B. Barnett, 1981. An assessment of wetland habitat establishment at a central Florida phosphate mine site. The Florida Game and Fresh Water Fish Commission. Performed for the U. S. Fish and Wildlife Service, Atlanta, Georgia. FWS/OBS - 81/45.

The project described in the three references above is the IMC Florida Game and Fresh Water Fish Commission Test Site, Parcel B. The last of the three references (Gilbert et.al., 1981) includes all the information provided in the two earlier reports.

. Goodrich, R., 1983. Reclamation methods for clay settling ponds. Proc. Reclamation and the Phosphate Industry Symp., Clearwater Beach, Florida, 26-28 January 1983, Florida Institute of Phosphate Research. (in press)

This report summarizes the results on IMC's Homeland-9 project (IMC-CS-9A).

. Zellars-Williams, Inc., 1980. Quarterly progress report for Sink Branch reclamation area.

. _____, 1981. Progress report for Sink Branch reclamation area.

Both of the reports referenced above are available at no cost from Mobil Chemical Company, P.O. Box 311, Nichols, Florida 33863.

Question 25: Did you find any reclamation literature or other technical references particularly helpful in designing your project? Yes ____, No ____. If so, please identify.

Very few of those responding (26 percent) mentioned any helpful references. One respondent stated that discussion with other reclamation planners in the mining industry' was helpful. Listed below are the few references that were mentioned.

- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. La Roe, 1979. Classification of wetlands and deepwater habitats of the United States. Fish and Wildlife Service. FWS/OBS-79/31. Washington, D.C.

- Florida Department of Natural Resources,_ 1980. Florida Administrative Code, Chapter 16C-16, Mine Reclamation. Division of Resource Management. Tallahassee, Florida.

- _____ ,1979. Aquatic and wetland plants of Florida. Bureau of Aquatic Plant Research and Control. Tallahassee, Florida.

- U.S. Soil Conservation Service, 1975. Engineering field manual for conservation practices. U.S. Conservation Service. Various paging.

Question 26: Are any monitoring studies being conducted on the project, such as water quality, water quantity, vegetation survival or succession, wildlife usage, aquatic biology, etc.? Yes ____, No_____. If so, please describe briefly, include frequency of sampling and parameters.

Some type of monitoring is being done on most of the wetland projects, although the intensity and duration of the monitoring varied significantly. Only eleven project sites have had no monitoring. Monitoring is being planned for ten other sites. A description of the monitoring is presented at the end of each site description in Section 3.1.

Question 27: An important part of this questionnaire is to help other people who will be conducting wetland reclamation projects. Please identify any reclamation technique or species that failed and/ or that you would not recommend on other projects.

Only eleven responses were received to this question. They are:

- To avoid excessive erosion on stream reclamation projects, particular attention should be given to following engineering designs that call for distributing the vertical fall over as much stream length as possible.

- Design elevation of wetland area was too low. Water level ended up too deep to establish wetland vegetation.

- Permanent grass plantings (e.g. bahia grass or bermuda grass) compete with transplanted trees. Grassing with trees should be avoided unless absolutely necessary for control of erosion on stream side slopes.

- Spreading a six inch layer of organic soil, borrowed from another wetland, appears to be as effective as spreading a one foot layer for revegetation of marshes.

- Tree-spading large saplings appears to be of questionable value since potted seedlings seem to grow more vigorously.

- People should be careful about committing to spreading mulch at a specific depth with large earthmoving machinery. The thickness of the mulch will vary considerably over the site.

- Seepage habitat near clay settling areas is ephemeral and marshes cannot be permanently established on them. Mulching for swamp restoration in open areas appears to be ineffective. A combination of planting tree seedlings and mulching may be successful. It may be advantageous to spread the swamp mulch in strips between the trees after they have reached sapling size. (This response was taken from Clewell (1981)).

- Bare wet soils should be mulched or planted as soon as possible to discourage establishment of invading cattail.

- Prevent excess nutrients within the water.

- Plant trees just prior to the rainy season or during the rainy season; don't plant in the dry season.

- Would not recommend planting tree seedlings. (This response was from one person who had a very poor survival rate with bareroot tree seedlings).

Question 28: Please identify those reclamation techniques that were particularly successful and that you would use on other projects or would recommend to others.

- Five respondents recommended spreading mulch or muck from another donor wetland as a successful revegetation technique for marshes.
- Two respondents stated transplanting of wetland herbaceous plants was successful. Another respondent was more specific and stated good survival rates with transplanted pickerelweed, arrowhead, and yellow water lily.
- Mulching with an organic soil appeared to enhance tree survival and reduce competition from undesirable species. A six inch layer of organic soil appeared to be as effective as a twelve inch layer.
- Stabilize the site to achieve desired parameters. (The apparent implication in this comment is to allow some time period for water levels to become reestablished and for soils to consolidate).
- Plant sufficient stock of desired climax vegetation to insure seed source.
- Planting of trees is successful on soils that consist of a mixture of waste clays and sand tailings.
- The low end of a clay settling area is a recommended location for reclamation of a wetland.
- Fluctuating water levels are important in providing moisture, seeds, nutrients, etc.
- If overburden is high in muck content, use it to your advantage in wetland reclamation, rather than burying it.
- Water control measures can help disperse planted vegetation throughout a lake.
- Cypress can be transplanted or grown from seedlings with good success.

Question 29: State how the water depths and water area within the project compared to your plans or projections. Water depth is ____% of planned. Surface water area is ____% of planned.

Fifteen responses were received on this question, ten of which stated that water depth and water area were 100% of plan. The remaining projects,

except for one, were within 10% of plan. The one exception had water depths 190% of plan. One respondent stated surface water depths and acreage projections were successful primarily because the projects were designed after mining. Such predictions before mining takes place were considered to be much less reliable.

Question 30: Was any lack of information particularly troublesome in the design of your wetland reclamation project? Yes ____, No_____. If so, please identify.

Twenty-nine responses were received, 15 of which stated there was no particular lack of information. Given below is the type of information the other 14 respondents believe is needed.

- Seed propagation information.
- Information on mulching techniques for swamp establishment.
- Type of plants and trees that do best at different soil moisture levels on reclaimed wetlands.
- Distribution of wetland vegetation on reclaimed soil versus water level design and fluctuation.
- Beneficial information would include vegetation-site relationships such as hydroperiod, soil requirements, competitive ability of species, etc.
- The most troublesome lack of information was a set of target parameters which could be considered successful by regulatory agencies.
- Contradicting opinions of regulatory agencies. (Two respondents stated this problem).
- Lack of baseline flow data and drainage basin information is troublesome in stream reclamation.
- Lack of information on volume and location of post-mining materials makes the predictions of final shapes less reliable and the costs of reclamation greater.

- Prediction of post-reclamation water levels is an important factor in calculation of the lake design criteria for littoral zone and zone of fluctuation.

- The general lack of well documented revegetation techniques.

Question 31: What kinds of information would you like to see developed for wetland reclamation projects? (examples: sources of plant material, planting methods, prediction of post-reclamation ground water levels or surface water runoff, methods to control weedy species, etc.)

Of the twenty-six responses received-on this question, the most repeated request (mentioned eight times) was for information on control of weedy species. Three other respondents requested information on all the examples listed above. Given below are the remainder of the responses.

- Source of plantmaterials. (Requested by three individuals)

- Planting methods. (Requested by two individuals)

- Data regarding ecological validity of subclimax phases.

- Techniques for direct seeding.

- Seed propagation.

- Channel or stream establishment.

- Planting recommendations for different moisture regimes around a wetland. (Requested by two individuals)

- Soil consolidation and bearing capacity vs. time.

- Species that do well in heavy clay.

- Prediction of post-reclamation water levels.

- A point in the desired plant succession process must be determined which is deemed a successful goal for wetland reclamation projects.

Question 32: Would your company object to participating in a simple standardized monitoring program for your wetland project(s).

Of the twelve mining companies listed in Table 1, only one objected to participating in a standardized monitoring program. Two other companies also stated that they would need to review the program prior to making a commitment.

3.3 COMMENTS BY THE MINING INDUSTRY, REGULATORY AGENCIES, UNIVERSITIES AND CITIZEN GROUPS

This section presents the responses received for Questions 1 through 3, Part II of the questionnaire, which was designed to solicit the opinions of a variety of people on the wetland reclamation efforts to date.

Question 1: There are a number of existing wetland projects in the phosphate industry. Please state which of these projects you are familiar with and which of these you believe have shown successful wetland reclamation. Suggested comments might include successful, unsuccessful, premature, or unfamiliar.

The questionnaire listed 17 wetland projects for people to comment on. The most interesting aspect of the results was that 78% of the respondents stated that they were "unfamiliar" with the projects listed. This was somewhat unexpected since the majority of those on the mailing list (Appendix A) were mining companies who were planning wetland reclamation projects, agencies regulating mining activities or environmental groups that were expected to be interested in wetland reclamation. Results of the remaining comments were: 10% "successful", 3% "some success", 3% -"unsuccessful" and 6% "premature". Presented in Table 2 are the responses received for each of the 17 wetland projects plus additional verbal- comments from a variety of respondents.

Question 2: Please state your suggested criteria for judging the success of wetland reclamation projects, regardless of existing regulations. Examples might include planting survival, wildlife usage, vegetation diversity, aquatic biota diversity, water quality, percentage of area with fluctuating shallow water zone, etc.

TABLE 2

OPINIONS BY THE MINING INDUSTRY, REGULATORY AGENCIES, UNIVERSITIES AND CITIZEN GROUPS REGARDING WETLAND RECLAMATION EFFORTS

PROJECT SITE[1]	NUMBER OF RESPONSES					ADDITIONAL COMMENTS RECEIVED
	UNFA-MILIAR	SUCCESS-FUL	SOME SUCCESS	UNSUC-CESSFUL	PRE-MATURE	
1. Agrico, AGR-PC-9A; 20-acre site adjacent to Little Payne Creek	34	3	0	1	2	Not documented. Contains artificially regulated water levels which would be unsatisfactory for long term maintenance.
2. Agrico, AGR-PC-16; 120-acre site adjacent to Little Payne Creek	33	0	0	0	7	Not documented. Unmined portion is not valid.
3. Agrico, AGR-FG-13, 126-acre site adjacent to Payne Creek	25	5	2	0	8	Good trend towards swamp. Good job on water levels, littoral zone and irregular shoreline. Self maintaining water levels is questionable. Vegetation on barren soils appeared poor. Very promising. Fertilization of slopes may have been unnecessary. Distinct algal bloom at time of inspection.
4. Amax, 2-acre experimental plot on unmined land	32	6	0	0	2	None
5. Amax, AMX-BF-1; 31-acre site adjacent to Boggy Branch	30	6	0	1	3	Excellent. Diversity moderately high. No drainage basin. No water level fluctuation. Weed problem.
6. Amax, AMX-BF-5; 16-acre site adjacent to Gulley Branch	28	10	1	0	1	Excellent example of marsh restoration. Herbaceous vegetation was successful. Hardwoods are premature. Possibly more relief should have been incorporated into plan.
7. Amax, small pond and marsh on Buzzard's Roost Ranch	37	2	0	0	1	None
8. Amax, Litter test plots	35	0	0	2	3	Lacks documentation. Too small. Not valid since it is unmined.
9. Brewster, Wetlands West experimental plots	32	1	2	4	1	Too small. Some competition problems using topsoil. Idea of using seepage area of a clay settling area as a wetland is questionable.
10. Estech, Watson Mine site; 8-acres adjacent to Whidden Crk.	38	2	0	0	0	None
11. W.R. Grace, Four Corners test plots (<1 acre each)	26	9	3	2	0	Too small. Not valid since it is unmined. Good documented evidence for the need to mulch; poor diversity and cover in the control plot. Some erosion problems. Elevation controls did not appear adequate, thus hydroperiods may have varied.
12. IMC, IMC-CS-9A; 23-acre site in reclaimed settling pond	26	7	4	1	2	Lacks documentation. Clay is subsiding as water is drawn off. Unnatural. Appears to have been left by default rather than being designed. Good idea to use low area of settling pond as a wetland site. Good example model for settling ponds.

[1]See Table 1 for additional description of project sites. This table includes only those project sites listed in the mailed questionnaire and additional sites provided by the respondents.

TABLE 2 (Continued)

PROJECT SITE[1]	UNFA-MILIAR	NUMBER OF RESPONSES: SUCCESS-FUL	SOME SUCCESS	UNSUC-CESSFUL	PRE-MATURE	ADDITIONAL COMMENTS RECEIVED
13. IMC, FGFWFC test site; 20-acres adjacent to Peace River	22	11	2	2	3	Monitoring needs to be continued on this carefully documented project. Use of nonlocal trees shouldn't have been allowed. Unsuccessful due to poor hydrology and contour design. No watershed. Hydroperiod issue was ignored.
14. Mobil, Sink Branch Branch stream site	26	6	2	2	4	Too small. The stream should have included open water areas. Poor contouring and monitoring. Learned that 0.5 foot of organic soil is as good as one foot, and not to plant grass with trees. Tree spading appears of questionable value.
15. Occidental, Altman Bay Lake; 5-acre unmined area	34	1	0	2	3	High tree mortality.
16. Occidental, OCC-SC-1 and 2; 15-acre marsh on Eagle Lake	36	0	1	1	2	High tree mortality.
17. Occidental, OCC-SR-2 and 3; 3-acre site	37	1	1	0	1	None
Other Sites Mentioned:						
18. Occidental, OCC-SR-8; 43-acre site	0	0	0	0	1	None
19. Mobil, George Allen Creek stream reclamation	0	0	0	1	0	None
20. IMC, IMC-NP-SP(1); 260-acre site, S. Tiger Bay	0	1	0	0	0	None
21. IMC, IMC-CS-19; 8-acre site, North 640 floodplain	0	1	0	0	0	None
22. IMC, IMC-K-10; 6-acre site, west of K-6	0	1	0	0	0	None

A total of 139 suggested criteria were offered as a response to this question. Many of the comments were repetitive or were very similar. The five most frequently suggested criteria were vegetation diversity (18 respondents), water quality (14 respondents), plant survival (9 respondents), wildlife use (8 respondents) and natural water fluctuation (6 respondents). Presented below are all of the suggested criteria received. Similar responses were edited and combined.

Vegetation Criteria (58 Responses)

- Vegetation diversity and similarity to original or natural wetland. One respondent stated similarity should be 75% of original wetland.
- Natural revegetation (germination, fruiting, sprouting) and survival.
- For marshes; greater than 85% plant cover within two years, with insignificant cattails.
- For forested wetlands and streambanks; tree density shall be equal to or greater than premining conditions or a similar nearby control site, within five years. Species composition and community evenness for woody vegetation shall also be at least 95% similar to premining conditions or a nearby control site. The species composition of herbaceous vegetation in the swamp shall be at least 90% similar, and community evenness shall be at least 50% similar to premining conditions or a similar nearby control site within five years.
- For forested wetlands; trees should begin to form a closed canopy above herbaceous flora in five to ten years.
- For marshes and herbaceous streambanks; the site shall support a vegetative cover at least 95% similar to that 1) in the site prior to mining if it was a marsh, or 2) in a similar control site within a limited geographic area. Similarity is defined in terms of species composition, community evenness, and percentage cover. One respondent specified that ground cover vegetation should be self-maintaining.
- For lotic systems (moving water); within five years the aquatic vegetation (submersed, floating, and emersed plants located in the channel) shall be at least 95% similar in species composition and community evenness as the portion of stream immediately upstream from the site. If the stream above the site is heavily infested with noxious or undesirable aquatic weeds, this requirement shall be

waived in favor of a reduction in the number/area1 extent of the undesirable plants.

- Vegetation cover should be sufficiently established to prevent erosion; plant cover should be 100% on grazing land.

- Plant survival.

- Successional trend towards mature marsh or swamp.

- Plant growth.

- Primary productivity.

Hydrology Criteria (34 responses)

- Water quality; within five years of reclamation, the levels of seven water quality parameters (total suspended solids, total dissolved solids, turbidity, chlorophyll a/phaeophytin, orthophosphate, total phosphate, ammonia nitrogen, nitrate/nitrite nitrogen, and total Kjeldahl nitrogen) measured bi-monthly for one year, shall not deviate greater than within one standard deviation from those levels monitored at bi-monthly intervals either 1) prior to mining, or 2) in a similar control site within a limited geographic area. For lotic systems (moving waters) the water quality downstream from site shall be equal to or better than water quality entering site.

- Water quality; should meet DER Class III standards and nutrients should be below midpoint of mesotrophic systems, data should be tied to storm events; wetland should enhance water quality or at least equal premining conditions.

- Hydroperiod; within five years of reclamation the hydroperiod (length of time the area contains standing water vs. length of time dry) shall be the same as hydroperiod measured in a similar control site within a limited geographic area. One respondent specified that hydroperiod should be 75-125% of original wetland.

- Receiving waters should receive 90-110% of premining runoff.

- Wetland should contain a permanent water pool six inches to six feet in depth.

Wildlife Criteria (15 responses)

- Wildlife use; diversity and abundance should be similar to premining conditions.

- Aquatic community of streams; within five years the aquatic macro-invertebrate community in the site shall be at least 95% similar to that immediately upstream from the site. Community similarity is based on species composition and evenness.

- Aquatic biota diversity should be similar to undisturbed systems.
- The wetland should contain a variety of aquatic habitats.
- The wetland should have stable wildlife populations, including invertebrates, fish, herps, birds and mammals.

Topographic Criteria (12 Responses)

- The acreage must at least be equal to the original wetland.
- Wetlands must be at least one acre in size.
- Restoration should include topographic equivalence.
- Reclaimed area should have no unplanned channel development.
- Proper slopes should be constructed.

Soils Criteria (8 responses)

- Proper erosion control measures should be adhered to; there should be no evidence of excessive erosion.
- Soils should be characteristic of wetlands; texture, permeability, horizontal and vertical transmissivities, percent organic matter, and nutrient availability.

Miscellaneous Criteria (12 responses)

- Judgement should be based on site specific characteristics rather than "hard and fast" rules.
- Appearance should be natural.
- The established ecosystem should be self-maintaining.
- The reclaimed wetland should utilize existing natural systems.
- Criteria should be determined by a combination of research, expert advice and successful techniques in the field.
- It is impossible to judge success without clearly defining the objectives to be achieved.
- DNR regulations provide reclamation standards.
- The enthusiasm and support of management in the implementation of the reclamation project should be a criteria for success.

Question 3: If a mining company or research group were to monitor wetland reclamation projects on a regular basis, what types of data would you like to see collected.

A total of 113 responses were received on this question. The monitoring parameters suggested are closely related to the criteria given in the responses to the previous question. The four most frequently suggested parameters were water quality (14 respondents), plant survival (8 respondents), wildlife use (12 respondents), and vegetation diversity and composition (8 respondents). Presented below are all of the suggested monitoring parameters.

Vegetation Parameters (46 Responses)

- Vegetation survival.
- Vegetation succession and natural revegetation.
- Vegetation diversity, composition, and dominance.
- Percent cover.
- Amount of noxious weedy species.
- Primary production.
- Vegetation data should be correlated to soil treatment, hydroperiod, revegetation methods, season of planting, elevation and water depth.
- Recruitment regarding seed sources.
- Forested wetlands; tree density, tree growth, and tree survival.
- Mapping of communities annually.
- Herbaceous transects, sampled semi-annually; species composition in forested wetlands to be done annually.

Hydrology Parameters (33 Responses)

- Water quality: composite list of parameters from respondents are; total suspended solids, total dissolved solids, turbidity, chlorophyll a/phaeophytin, ortho-phosphate, total phosphate, ammonia nitrogen, nitrate/nitrite nitrogen, total Kjeldahl nitrogen, pH, acidity, nutrients, alkalinity, hardness, total organic carbon, and gross alpha.

- Water levels and hydroperiod.
- Runoff coefficients.
- Flood hydrographs and flood discharges.
- Computation of low flows.
- Detailed information regarding water control structures to determine discharge capabilities.
- Water budget, particularly for small watersheds that have been mined.
- Ground water level and quality.
- Water depth profiles along two transects.

Wildlife Parameters (15 Responses)

- Wildlife use; including comparisons of bird and mammal populations to native undistrubed sites.
- Activity of beneficial microorganisms.
- Aquatic macroinvertebrate diversity and recovery; measured semi-annually.
- Terrestrial and aquatic biota diversity.

Topography Parameters (4 Responses)

- Watershed size, for calculating discharges.
- Computation of flood elevations.
- Detailed topographic mapping.

Soil Parameters (9 Responses)

- Soil structure, saturation and percolation.
- Sedimentation data.
- Need for soil ammendments.
- Erosion monitoring.

Miscellaneous Parameters (6 Responses)

- Adequate data to insure compliance with existing regulations.

- Aerial photography; quarterly for first three years, annually up to ten years, every five years thereafter.
- Health and diversity of the re-established ecosystem.
- Consistent standard method analyses for community composition.

4.0 DISCUSSION

The survey revealed a lack of well documented results for most of the existing wetland reclamation projects in central Florida. At least 30 projects have already been completed or are in construction but few mining companies are conducting quantitative testing and monitoring, or publishing results of their findings. Consequently, most people interested in wetland reclamation are unfamiliar with many of the projects.

The lack of documentation on most projects also revealed few wetland reclamation techniques that were particularly successful or unsuccessful. One successful revegetation technique that was well documented was that mulching with soil borrowed from another wetland definitely enhanced the establishment of wetland vegetation.

Many of the respondents to the questionnaire indicated few helpful technical references and listed a need for additional reclamation information. The types of information requested included control of weedy species, sources of plants and seeds, planting recommendations for different moisture regimes, revegetation techniques, stream channel establishment and prediction of post-reclamation water levels.

The survey indicated that judging the success of wetland reclamation projects is difficult because of the lack of agreement on the definition of success. A large number of opinions were received by the respondents regarding suggested "success" criteria . Although the opinions varied widely, most respondents agree on several general categories of "success" criteria; they are vegetation, hydrology, wildlife use, soils and topography. It is apparent that a set of specific criteria that would be acceptable to the

regulatory agencies and mining industry needs to be developed. The specific criteria would help guide future reclamation research efforts and provide target goals for reclamation managers.

The information obtained during this survey should be of value to those people who are interested in keeping up with wetland reclamation efforts and research. A large number of projects are described and references are cited when additional information is available. Depending on the number of new wetland projects constructed each year and the intensity of future monitoring, it would be of value to update this survey on a periodic basis. Future surveys should include the results of some fairly simple but standardized monitoring or evaluation programs.

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APPENDIX A

ADDRESS LIST FOR QUESTIONNAIRE

ADDRESS LIST FOR FIPR QUESTIONNAIRE

SURVEY OF WETLAND RECLAMATION PROJECTS

PHOSPHATE MINING COMPANIES

Agrico Chemical Company
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Attention: Mr. D. R. Morrow, General Manager

Amax Phosphate, Inc.
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Lakeland, Florida 33801

Attention: Mr. R. L. Oliverio, Manager

Becker Phosphate Corporation
P. 0. Box 9034
Bradenton, Florida 33505

Attention: Mr. Gary Montin, Environmental Director

Brewster Phosphates
Bradley, Florida 33835

Attention: Mr. R. A. Leitzman, Manager

CF Industries, Inc.
P. 0. Box 1549
Wauchula, Florida 33873

Attention: Mr. Frank N. Buzzanca, General Manager

Estech, Inc.
P. 0. Box 208
Bartow, Florida 33830

Attention: Mr. John Oskam, Vice President

Farmland Industries, Inc.
P. 0. Box 441
Mulberry, Florida 33860

Attention: Mr. Richard Murphy, Executive Director

Freeport Land Company
P. 0. Box 6717
Lakeland, Florida 33803

Attention: Mr. William B. Huey, Resident Manager

Gardinier, Inc.
P. 0. Box 3269
Tampa , Florida 33601

Attention: Mr. Rudy J. Cabina, Vice President

W. R. Grace & Company
P. 0. Box 471
Bartow, Florida 33830

Attention: Mr. D. S. Sharpe, General Manager

International Minerals & Chemical Corporation
P. 0. Box 7047
Lakeland, Florida 33803

Attention: Mr. C. A. Campbell, Vice President

Mobil Chemical Company
P. 0. Box 311
Nichols, Florida 33863

Attention: Mr. K. D. Fetrow, Manager

Noranda
Hopewell Land Corporation
P. 0. Drawer 159
Lithia, Florida 33547

Attention: Mr. Lonnie Engel, Mine Planner

Occidental Chemical Company
P. 0. Box 300
White Springs, Florida 32096

Attention: Mr. M. P. McArthur, Vice President

USS Agri-Chemicals
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Ft. Meade, Florida 33841

Attention: Mr. G. W. Beck, Manager

GOVERNMENT AGENCIES

Central Florida Regional
Planning Council
515 East Boulevard Street
Bartow, Florida 33830

Attention: Mr. Jeffrey Spence

Division of Veterans and Community Affairs
Bureau of Land and Water Management
2571 Executive Center Circle E.
Tallahassee, Florida 32301

Attention: Mr. Tom Beck, Associate Planner

Florida Department of Agriculture
and Consumer Services
Division of Forestry- --
5745 South Florida Avenue
Lakeland, Florida 33803

Attention: Mr. Mark Hebb, District Forester

Florida Department of Environmental Regulation
7601 Highway 301 North
Tampa , Florida 33610

Attention: Mr. William K. Henessey, District Manager

Florida Department of Natural Resources
3900 Commonwealth Boulevard, Room 607
Tallahassee, Florida 32303

Attention:- Ms. Casey Gluckman, Director
Division of Resource Management

Florida Game and Fresh Water Fish Commission
P. 0. Box 1840
Vero Beach, Florida 32960

Attention: Mr. Terry Gilbert

Hardee County
412 West Orange
Wauchula, Florida 33873

Attention: Mr. Harry Lampe, County Administrator/Engineer

Hillsborough County
Department of Development Coordination
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Attention: Ms. Ethyl Hammer, Principle Planner

Manatee County
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Bradenton, Florida 33506

Attention: Mr. Richard M. Eckenrod, Phosphate Mining Coordinator

North Central Florida Regional Planning Council
2002 N. W. 13th Street
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Attention: Mr. Chuck Kiester

Polk County, Department of Environmental Service
P. 0. Box 39
Bartow, Florida 33830

Attention: Mr. Frank Wilson, Director

Southwest Florida Water Management District
5060 U. S. Highway 41, South
Brooksville, Florida 33512

Attention: Mr. Richard Owen

Suwannee River Water Management District
Post Office Drawer K
White Springs, Florida 32096

Attention: Mr. Don Morgan

Tampa Bay Regional Planning Council
9455 Koger Boulevard
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P. 0. Box 4970
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Attention: Mr. John Adams, Chief of Regulatory Division

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UNIVERSITIES

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ENVIRONMENTAL CITIZEN GROUPS

Environmental Information Center Of The
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Attention: Mr. Kenneth Morrison, Vice--President

Florida Audubon Society
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Maitland, Florida 32751

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626 N. Main Street
Gainesville, Florida 32601

Attention: Ms. Helen Hood

Lake Region Audubon Society
P. 0. Box 2471
Lakeland, Florida 33803

Attention: Mr. Chuck Geanangel

Manasota-88
5314 Bay State Road
Palmetto, Florida 33561

Attention: Ms. Gloria Rains, Chairman

CONSULTING FIRMS

Breedlove & Associates
618 N. W. 13th Avenue
Gainesville, Florida 32601

Attention: Mr. Ben Breedlove

Bromwell Engineering
P. 0. Box 5467
Lakeland, Florida 33803

Attention: Mr. Al Picardi, Environmental Biologist

Conservation Consultants
P. 0. Box 35
Palmetto, Florida 33561

Attention: Mr. Andre Clewell
Director of Environmental and Biology Division

ECO/Interface Evaluations
2918 Walnut Street
Orlando, Florida 32806

Attention: Mr. Hal Scott

Environmental Science and Engineering, Inc.
5406 Hoover Blvd., Suite D
Tampa, Florida 33614. __

Attention: Mr. Ollie Boody, Aquatic Biologist

Zellars-Williiams
4222 S. Florida Avenue
Lakeland, Florida 33803

Attention: Mr. John Bunch, Manager of Geology

OTHERS

Archbold Biological Station
Rt. 2, Box 180
Lake Placid, Florida 33852

Attention: Mr. James Layne

Florida Phosphate Council
P. O. Box 5530
Lakeland, Florida 33803

Attention: Mr. Steven Tubbs

Dr. David J. Robertson
P. 0. Box 554
Bartow, Florida 33830

APPENDIX B

COVER LETTER AND QUESTIONNAIRE

January 11, 1983

Attention:

Gentlemen:

A Survey of Wetland Reclamation Projects
in the Florida Phosphate Mining Industry
For the Florida Institute of Phosphate
Research

Dames & Moore is conducting a survey of wetland reclamation projects for the Florida Institute of Phosphate Research (Project No. 82-03-19). The purpose of this survey is to provide a detailed description of existing and planned wetland reclamation projects to those agencies, companies, and individuals interested in wetland reclamation. To obtain this information, we are asking for your cooperation in completing the attached questionnaire. We are also hoping to visit each project in the next three to five weeks and would appreciate your assistance at that time.

Please return the completed questionnaire to Mr. Kevin Ruesch at the above letterhead address within three weeks. Please do not hesitate to call if you have any questions.

Very truly yours,

DAMES & MOORE

T. M. Gurr
Partner

Kevin J. Ruesch
Project Ecologist

TMG/KJR:ap

Attachment

INSTRUCTIONS FOR QUESTIONNAIRE

The questionnaire is divided into two parts. Part I is designed to describe existing and planned wetland reclamation projects. Part I should be filled out by those who have worked on or are planning a wetland reclamation project. Part II (Page 10) is designed to obtain the opinions of the mining industry, agencies, universities, and interested citizens groups about wetland reclamation efforts to-date. Part II should be filled out by those individuals who are familiar with the wetland reclamation efforts of the phosphate industry.

It is likely that project sites may have some important feature that is not covered in the questionnaire or that would be difficult to describe with the format of the questions. Please use attachments if you need additional space to answer a question or if you need to clarify any of your responses. A copy of any report that you may have completed on a project would also be helpful.

Feel free to add any comments regarding the questionnaire's clarity, simplicity, and completeness. FIPR and others have expressed an interest in possibly updating this survey on a periodic basis and your suggestions would be greatly appreciated.

QUESTIONNAIRE

SURVEY OF WETLAND RECLAMATION PROJECTS

IN THE FLORIDA PHOSPHATE MINING INDUSTRY

FOR THE

FLORIDA INSTITUTE OF PHOSPHATE RESEARCH

PART I. Description of Existing or Planned Wetland Reclamation Projects. Please make additional copies of this questionnaire and complete the following for each wetland reclamation project.

1. Company or Organization (Name, address, telephone):

_____

_____

_____

_____

2. Name of Mine: _____

3. Mine Manager: _____

4. Reclamation Manager: _____

5. Name of Project Manager if different than above: _____

_____

6. Name or identification code of project or parcel: _____

_____

7. Location of project: Section _____, Township _____, Range _____.

8. State the actual or anticipated completion dates (month and year) for the project.

Mining or clay consolodation Completed:

_____

Grading and Contouring Completed: _____

Revegetation Completed: _____

DNR Certification: _____

9. State the acreage of the project. Provide separate estimates for upland or deep water habitats within the project area.

Habitat	Acres
Deep Water (≥ 6 feet)	_____
Wetland	_____
Upland	_____

10. State the average channel width, depth, length, and discharge for stream reclamation projects.

Width _____, depth _____, length _____, discharge _____.

Also identify the name of the stream that is being reclaimed, or state that it is unnamed or newly formed stream _____.

11. State the name of the stream or lake directly receiving water discharged from the project site: _____

_____.

12. If available, please provide an aerial photograph and topographic map with the project boundary.

13. State the type of wetland that is being planned.

Wetland Type	Acres	Percent of Wetland Area
Marsh	_____	_____
Cypress Swamp	_____	_____
Bayhead	_____	_____
Floodplain Hardwood Swamp	_____	_____
Stream Restoration	_____	_____
Other: _____	_____	_____
TOTAL:		100%

14. Identify the specific objectives of the project, such as testing different tree planting methods, thicknesses of organic mulch, response to fertilization, restoration of the topography and aquatic biota of a disturbed stream, etc.

_____

_____

_____

_____

_____

15. Identify the subsurface soil type (surface soil types are requested in the next question).

_____ Overburden

_____ Tailings sand capped with ____ feet of overburden

_____ Waste clay settling area

_____ Waste clay capped with ___ feet of tailings sand and ___ feet of overburden

_____ Sand-clay mixture

_____ Sand-clay mixture capped with ___ feet of overburden

_____ Unmined, subsurface undisturbed

_____ Other: _____

16. Identify surface soil treatments and percent of wetland area treated.

Soil Treatment	Percent of Wetland Area
Graded overburden only	_____
Layer of stockpiled upland topsoil (___ feet)	_____
Layer of organic soils from a marsh (___ feet)	_____
Layer of organic soils from a swamp (___ feet). Specify swamp type: _____	_____
Excavated depression in umined land	_____
Other: _____	_____
TOTAL:	100%

17. Was the area fertilized? Yes ____, No ____. If yes, provide approximate analysis and application rate.

_____

_____

18. Identify the primary water source to the wetland area.

_____ Groundwater

_____ Surface water runoff

_____ Normal stream flow or flooding

_____ Artificial source, such as:

____ mine water discharge

____ settling area seepage

_____ Other: _____

19. What is the approximate size of the wetland watershed?

_____ acres.

20. Are water levels being artificially regulated? Yes ____, No _____. If yes, briefly describe: _____

_____

_____.

21. Indicate revegetation methods in the wetland area.

A. Trees. Were trees planted? Yes _____, No _____.

Species (Common Name)	Number Planted	Acreage Planted	Plant Stock*	Survival**

*Indicate whether planting stock was bare rooted (BR), potted seedlings (P), tubules (T), seeded (S) or tree spaded saplings (TS). ** Give percent survival if data is available otherwise provide, qualitative results such as high, moderate, low or failed.

B. Herbaceous species. Were wetland herbaceous species planted? Yes ____, No ____.

Species (Common Name)	Planting Rate	Acreage Planted	Plant Stock*	Survival

* Indicate type of planting stock, such as sprigs, rhizomes, seeds or whole plants.

C. Grasses. Were grasses planted? Yes ___, No ___.

Species (Common Name)	Planting Rate	Acreage Planted	Planting Method	Survival

22. Was there any attempt to control the invasion of weedy species? Yes ____, No ____. If so, briefly describe:

_____

_____

23. Was any government agency, university group, citizen group, or consultants significantly involved in the planning or design of the project? Yes _____, No _____. If so, please identify: _____

_____

_____.

24. Is a written report on the project available to interested invididuals? Yes ____, No ____. If so, please state the name of the report and ordering information (mailing address and cost). _____

_____

_____

_____

_____

25. Did you find any reclamation literature or other technical references particularly helpful in designing your project? Yes _____, No _____. If so, please identify. _____

_____

_____

_____

26. Are any monitoring studies being conducted on the project, such as water quality, water quantity, vegetation survival or succession, wildlife usage, aquatic biology, etc.? Yes ____, No ____. If so, please describe briefly, include frequency of sampling and parameters. _____

_____

_____

_____

_____

_____

27. An important part of this questionnaire is to help other people who will be conducting wetland reclamation projects. Please identify any reclamation technique or species that failed and/or that you would not recommend on other projects. _____

_____

_____

_____

_____

_____

_____

28. Please identify those reclamation techniques that were particularly successful and that you would use on other projects or would recommend to others. _____

_____

29. State how the water depths and water area within the project compared to your plans or projections.

    Water depth is _____% of planned.

    Surface water area is ____% of planned.

30. Was any lack of information particularly troublesome in the design of your wetland reclamation project? Yes ____, No ____. If so, please identify. _____

31. What kinds of information would you like to see developed for wetland reclamation projects? (examples: sources of plant material, planting methods, prediction of post-reclamation ground water levels or surface water runoff, methods to control weedy species, etc.) _____

32. Would your company object to participating in a simple standardized monitoring program for your wetland project(s). Yes _____, No _____.

PART II. Opinions and suggestions regarding wetland reclamation efforts to-date.

1. There are a number of existing wetland projects in the phosphate industry. Please state which of these projects you are familiar with and which of these you believe have shown successful wetland reclamation. Suggested comments might include successful, unsuccessful, premature, or unfamiliar.

   1. Agrico - Payne Creek Mine; 20-acre site adjacent to Little Payne Creek. Comment: _____
   2. Agrico - Payne Creek Mine; 327-acre site (120 acres is wetland) adjacent to Little Payne Creek; mostly unmined. Comment: _____
   3. Agrico - Fort Green Mine; 366-acre site (150 acres is wetland) adjacent to Payne Creek. Comment: _____
   4. Amax - Big Four Mine; 2-acre experimental plot on unmined land. Comment: _____
   5. Amax - Big Four Mine; 31-acre site (AMX-BF-1) adjacent to Boggy Branch. Comment: _____
   6. Amax - Big Four Mine; 21-acre site (AMX-BF-5) adjacent to Gulley Branch. Comment: _____
   7. Amax - Pine Level Mine Site; one-acre pond on Buzzard's Roost Branch. Comment: _____
   8. Amax - Pine Level Mine Site; 80' X 250' excavated plot on unmined land. Comment: _____
   9. Brewster - Haynsworth Mine; five small wetland test plots (< one acre each). Comment: _____
   10. Estech - Watson Mine; 15-acre site adjacent to Whidden Creek. Comment: _____
   11. W. R. Grace - Four Corners Mine; four excavated wetland test plots (< one acre each). Comment: _____

12. I.M.C. - Clear Springs Mine; 23-acre site in a reclaimed settling pond between the Peace River and U. S. Highway 17. Comment: _____

13. I.M.C. - Clear Springs Mine; 49-acre site adjacent to the Peace River. Comment: _____

14. Mobil - Ft. Meade Mine; Sink Branch Stream reclamation project. Comment: _____

15. Occidental - Suwanee River Mine; 5-acre excavated unmined plot adjacent to reclaimed lake. Comment: _____

16. Occidental - Suwanee River; 15-acre site adjacent to stream. Comment: _____

17. Occidental - Suwanee River; 3-acre finger on reclaimed lake. Comment: _____

Others:

_____

_____

_____

_____

_____

2. Please state your suggested criteria for judging the success of wetland reclamation projects, regardless of existing regulations. Examples might include planting survival, wildlife usage, vegetation diversity, aquatic biota diversity, water quality, percentage of area with fluctuating shallow water zone, etc. _____

_____

_____

_____

_____

_____

3. If a mining company or research group were to monitor wetland reclamation projects on a regular basis, what types of data would you like to see collected? _____

APPENDIX C

REVEGETATION PLAN FOR SEVEN WETLAND SITES ON FARMLAND'S PROPOSED HICKORY CREEK MINE

(See Section 3.1 for Additional Site Description)

Sites A and B--Shallow Water Marshes

Sites A and B will be extensions of two shallow marshes which currently exist in the approximate locations of the new marshes. Species selection has been based on the species composition of the existing marshes as found by field sampling. Four species which currently comprise over 50 percent of the vegetative cover of these marshes will be specifically introduced.

Planting Mixture:

Juncus effusus	Seedling transplants (75/acre)
Polygonum spp.	Seed broadcast
Panicum hemitomon .	Sprigging (300/acre)
Sagittaria spp.	Transplants (25/acre)

Other appropriate marsh species (see Table 2-4, Column 1) will be introduced as propagules in the natural organic *soil* and mulch used as soil amendments for these sites.

*Site E--Transitional Marsh Zone

Site E is proposed to be a low area adjacent to the main channel which may occasionally be inundated, and may often be saturated, but often is dry. Transitional species to be planted in this area include those commonly found around margins of shallow marshes or along similar ephemerally flooded overflow areas of creeks in this region. This site is intended to add to the diversity of the area and to provide a transitional wetland fringe to enhance portions of the creek channel and provide a seed source for downstream areas.

Planting Mixture (lower portion):

Juncus effusus	Seedling transplants (l00/acre)
Polygonum spp.	Seed broadcast
Panicum hemitomon	Sprigging (300/acre)
Iris savannarum	Transplants (300/acre)
Eleocharis spp,	Plug transplants (l00/acre)

Acer rubrum	Bare root seedlings (30/acre)
Cyperus spp.	Plug transplants (50/acre)
Nyssa biflora	Bare root seedlings (30/acre)
Commelina diffusa	Sprigging (100/acre)
Myrica cerifera	Seedling transplants (30/acre)

Planting Mixture (upper edge):

Axonopus sp.	Seed broadcast
Spartina bakeri	Transplants (60/acre)
Hypericum spp.	Seed broadcast
Baccharis halimifolia	Seed broadcast
Ilex cassine	Sapling transplants (40/acre)
Myrica cerifera	Sapling transplants (40/acre)
Pinus elliottii	Bare root seedlings (40/acre)
	Sapling transplants
Panicum hemitomon	Sprigging (300/acre)

Site C--Mixed Hardwood Swamp (Backwater Flooding)

Species mixtures will consist of bottomland species commonly found along the Peace River floodplain and along drainages within the Oak Creek Islands area, This area will be planted with a much higher density (about 35 per acre) of transplanted saplings than any other area on the property. For both transplanted and bare root or potted trees, approximately equal numbers of each species in the planting mixture will be planted.

Bare root and potted seedlings will be hand planted at a density of 900 trees per acre. Transplants will be planted randomly. Bare root and potted trees will be planted at 7-ft centers. Fourteen percent of seedlings planted will be potted seedlings.

Shrub and vine species will also be introduced in this area by transplants or nursery stock at a density of 20 to 50 points per acre, Herbaceous ground cover species will be introduced for initial soil

stabilization and erosion control. Organic matter will come from a site surrounded by a hardwoods community so that some additional seed source may be present.

Planting Mixture (trees):

Transplants (35/acre)	Bare Root/Potted (900/acre)
Liquidambar styraciflua	Liquidambar styraciflua
Sabal palmetto	Sabal palmetto
Acer rubrum	Acer rubrum
Ulmus americana	Ulmus americana
Nyssa spp.	Nyssa spp.
Quercus laurifolia	Quercus laurifolia
Q. nigra	Q. virginiana
Fraxinus caroliniana	Taxodium distichum
Magnolia virginiana	Gordonia lasianthus
Carpinus caroliniana	Platanus occidentalis
Pinus elliottii	Pinus elliottii
Ilex cassine	
Diospyros virginiana	

Planting Mixture (shrubs and vines) (20 to 50/acre):

Callicarpa americana	Myrica cerifera
Vitis spp.	Sambucus canadensis
Ampelopsis arborea	Ludwigia peruviana
Parthenocissus quinquefolia	Smilax spp.
Crataegus spp.	Cornus foemina
Viburnum spp.	Styrax americana
Cephalanthus occidentalis	Vaccinium spp.
Prunus caroliniana	

Planting Mixture (herbs):

Annual rye

Carpet grass

Site D--Mesic Streamside hammock

Along those portions of the creek which have a distinct channel, vegetation will be planted in a 50- to l00-ft band which will be characteristic of mesic or xeric hammocks which have been altered by grazing or fire (similar to existing on-site systems). Within areas contiguous to the channels occasional Nyssa spp., Fraxinus spp., or Cephalanthus occidentalis individuals may be planted. Annual rye grass and carpet grass will be planted as a ground cover.

Planting Mixture (overstory):

Transplants (8/acre)	Bare Root/Potted (400/acre)
Quercus virginiana	Quercus virginiana
Q. laurifolia	Q. laurifolia
Sabal palmetto	Sabal palmetto
Acer rubrum	Acer rubrum
Liquidambar styraciflua	Liquidambar styraciflua
Quercus nigra	Quercus nigra
	Pinus elliottii
	Ulmus americana

Site F--Deep Marsh

Site F will constitute the deepest wetland community in this area. It is intended to replace the area on the original drainage directly adjacent to the railroad spur. The species mixtures will differ between the outer zone and the deeper inner zone which will remain inundated for most of the year. Other species will also be introduced in the organic soil or natural mulch soil amendments.

Planting Mixture (outer zone):

Juncus effusus	Seedling transplants (100/acre)
Panicum hemitomon	Sprigging (300/acre)
Cladium jamaicense	Transplants (30/acre)
Sagittaria spp.	Transplants (50/acre)
Andropogon spp.	Seed broadcast
Polygonum spp.	Seed broadcast

Planting Mixture (deep zone)

Panicum hemitomon	Sprigging (200/acre)
Sagittaria spp.	Transplants (50/acre)
Pontederia cordata	Transplants (50/acre)
Polygonum spp.	Seed broadcast
Cephalanthus occidentalis	Transplants (10/acre)
Thalia geniculata	Transplants (10/acre)
Echinochloa walteri	Seed broadcast
Nymphoides aquatica	Transplants (10/acre)
Utricularia sp.	Transplants (20/acre)
Proserpinacea pectinata	Transplants (20/acre)

Site G--Hardwood Swamp

Overstory species planted in Site G will be those capable of-tolerating periodic inundation. Organic soil material from sites surrounded by hardwoods communities may introduce herb and shrub species. Some herbaceous species may be introduced by transplant or seed to help establish ground cover.

Approximately equal numbers of each transplanted tree species in the mixture will be planted. Transplants will be placed randomly at densities of about 20 tree; per acre.
density of 900 trees per acre at 7-ft centers. Thirty-three percent will be potted seedlings.

Transplants (20/acre)	Bare Root/Potted (900/acre)
Nyssa biflora	Taxodium distichum (20%)
Acer rubrum	Nyssa spp. (20%)
Cephalanthus occidentalis	Platanus occidentalis (10%)
Fraxinus caroliniana	Acer rubrum (15%)
Ulmus americana	Gordonia lasianthus (10%)
Magnolia virginiana	Quercus laurifolia (10%)
Persea palustris	Liquidambar styraciflua (15%)