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EVALUATING DESIGN AND VERIFYING COMPLIANCE OF CREATED WETLANDS IN THE VICINITY OF TAMPA, FLORIDA

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EVALUATING DESIGN AND VERIFYING COMPLIANCE OF CREATED WETLANDS IN THE VICINITY OF TAMPA, FLORIDA

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DISCLAIMER

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ABSTRACT

Permit specifications, construction plans, and field measurements were used to examine the correlation between permit specifications, project design and conditions "as-built" in nine palustrine open water and emergent marsh wetlands created in the metropolitan area of Tampa, Florida between 1979-1987. This study was part of a series of pilot studies being conducted by the Environmental Protection Agency's (EPA) Wetlands Research Program to determine how well compensatory mitigation under Section 404 is working, and how the process could be improved. Data on planned and existing hydrology, wetland area, wetland shape, slopes of banks, and vegetation were collected. Information on the plans for each wetland was gathered from the permit files of the Hillsborough County Environmental Protection Commission (EPC).

Differences between design and conditions as-built were found, however a complete analysis could not be performed in many instances due to inadequate information in the permit files, e.g., hydrological aspects of wetland design could not be evaluated. Correlations between areal requirements and area as-built could not be made for 66% (6/9) of the created wetlands due to inadequate information in the project specifications or construction plans. Four of the created wetlands had irregular shapes, five had either rectangular shapes or at least one long, straight shoreline with otherwise irregular shapes. The predominant as-built slopes approximated the slopes indicated in the project specifications and construction plans for five sites, and one wetland was built with slopes more gentle than intended. Comparisons of predominant slopes could not be made for the remaining three sites due to insufficient information in the project files. Vegetation occurring on the created wetlands consisted primarily of species that had volunteered. Planted species accounted for 0% to 15% of the total number of species found at each site, and 0% to 29% of the percent cover on each created wetland.

The differences between the construction plans, specifications in the project files and the as-built conditions, and the instances where the permit files were inadequate or lacked information, point to the need for verification of projects in both the planning and construction phases of the permitting process. These differences also indicate that the planning phase should focus on the development of an approach that uses information from the scientific literature, experience from past projects, and the history of the surrounding landscape of the site of the planned created wetland. Planning should also involve a professional ecologist to evaluate species mix, elevations and contours, hydrology, and substrate type planned for the created wetland, because most other professionals lack adequate ecological knowledge to evaluate these elements. In addition, the construction phase should culminate in the production of an as-built plan. This would allow immediate checks to ensure that critical features have been included as intended, e.g., wetland area, vegetation type. It would also document any corrective measures that were taken due to unanticipated events during construction. As-built plans of the project would ensure that the details of the actual wetland created were available for future reference.

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SECTION I

INTRODUCTION

The growing body of information on both the ecological values of wetlands and the documentation of the historic losses of these systems has generated concern about the status of the resource. Reflecting this concern, the U.S. Environmental Protection Agency (EPA) initiated a Wetlands Research Program (Zedler and Kentula 1986) to assist the Agency in implementing its responsibilities to protect the Nation's wetlands. The research program was designed to support the Agency in the administration of Section 404 of the Clean Water Act (CWA). One component of this research is to determine how well compensatory mitigation under Section 404 is working, and how the process could be improved.

Completed mitigation projects are being studied by the Wetlands Research Program nationwide to identify critical design features, develop methods for evaluating projects, determine the functions they perform, and describe how they change with time. To date, pilot studies have been conducted in Portland and Seaside, Oregon; Connecticut; and Hillsborough County, Florida. This report is the second in a series designed to evaluate the physical adequacy of created wetlands by comparing field measurements of wetlands created as compensatory mitigation with their construction plans and permit conditions. Because the information contained in the project files was limited to hydrology, wetland area, wetland shape, slopes of banks, and vegetation, our evaluation was also limited to these elements. Wetland hydrology and vegetation are important to study on their own merit because they are two of the factors required to indicate a wetland exists (Federal Interagency Committee for Wetland Delineation 1989). It is important to examine wetland area created to ensure that losses in area do not occur as a result of compensatory mitigation, and wetland shape and slopes of banks are structural features which influence wetland type and wildlife habitat. In light of the above, quantitative measurements were taken to 1) determine if the wetland creation projects conformed to their permit specifications, 2) verify that the wetlands were created according to their construction plans, and 3) evaluate the design of those projects in terms of their resemblance to natural wetlands and their attributes as discussed in the literature. The first report in the series evaluated the design of mitigation projects in Portland, Oregon (Gwin & Kentula 1990). Other aspects of the research conducted near Tampa, Florida are reported in Brown (1991), in which the created wetlands were compared with their natural analogs.

OVERVIEW OF WETLAND REGULATION

The CWA was passed in 1972 to restore and maintain the chemical, physical, and biological integrity of the Nation's waters by regulating the discharge of dredge and

fill materials. In 1977, the legislation was strengthened to give additional protection to wetlands. The U.S. Army Corps of Engineers (COE) and EPA jointly administer the Section 404 permit program. In brief, the COE is the permitting authority, while EPA is responsible for issuing the environmental criteria for permit review, taking the lead in enforcement against unauthorized discharges, and overseeing state assumption of the program. EPA also has the authority to prohibit or restrict discharges that would have unacceptable adverse effects on certain resource values.

Applicants for 404 permits can be required to mitigate any adverse impacts to the aquatic environment caused by the proposed project. The EPA and COE use a three step process to evaluate Section 404 permit applications. The steps are to (1) avoid impacts by exploring alternatives; (2) minimize potential impacts through project modifications; and (3) compensate for any unavoidable impacts which remain. Compensatory mitigation includes either the restoration of existing degraded wetlands or the creation of man-made wetlands (Memorandum of Agreement 1990).

In addition to the federal regulations, in 1984 the state of Florida passed the Henderson Wetlands Act, which requires the Florida Department of Environmental Regulation (FDER) to evaluate proposals to mitigate the adverse impacts of dredging and filling in waters of the state before granting permits for such actions. Mitigation is required when negative aspects of a proposed dredging and filling project have been identified that would result in the loss of wetland functions (FDER Rule 17-312.330).

THE STATUS OF WETLAND CREATION AND RESTORATION

Interest in compensatory mitigation has generated a number of reports on wetland creation and restoration. In summarizing the results of a recent review of wetland creation and restoration in the United States, Kusler and Kentula (1990) state that the overall status of the literature on wetland creation and restoration varies by region, wetland type, and wetland function. Specific findings include:

- Practical experience and the available scientific knowledge on restoration and creation are limited for most types of wetlands. The amount of information varies regionally and with the wetlands function of interest. The most is known about the creation and restoration of the cordgrass (**Spartina alterniflora**) marshes of the low intertidal regions of the Atlantic coast. Much less success has been achieved with the high intertidal marshes and the seagrasses that occur in the same region. Even less is known about creating and restoring wetlands on the Gulf and Pacific coasts, and in general, the least is known about restoring and creating inland, freshwater wetlands.

- Most wetland restoration and creation projects do not have specified goals, which complicates efforts to evaluate "success".

- Monitoring of wetland restoration and creation projects has been uncommon. Most of the studies of mitigation projects have been qualitative case studies (e.g., Baker 1984, Reimold and Cobler 1986, Fishman et al. 1987, Good 1987, Mason and Slocum 1987, and Reiner 1989). Furthermore, most are site-specific and do not use reference sites as a standard for evaluation (Quammen 1986). Therefore, this pilot study looked to begin filling this gap by quantitatively evaluating wetlands created as compensatory mitigation, and by testing an approach for evaluating the design and construction of these wetlands.

SECTION II

METHODS

The design and construction of nine freshwater wetlands created in the Tampa urban area as requirements of the FDER and the Hillsborough County Environmental Protection Commission (EPC) were examined. Briefly, this involved the comparison of the as-built characteristics of the created wetlands measured in the field with the written permit specifications and construction plans found in the official records. In addition, project design and as-built features were compared to design guidelines found in the current literature on wetland creation and restoration.

SITE SELECTION

The specific details of the selection of created and natural wetlands are presented in Brown (1991). For the benefit of the reader, a brief overview of the procedure used for selection of the created wetlands is presented below since the focus of this report is to examine the design of the created wetlands. Data from the natural wetlands are used only to amplify the interpretation of the results from the vegetation analysis.

The regions with the largest numbers of created wetlands were identified using a permit database provided by FDER. Upon further examination of the database and consultation with FDER personnel, the Tampa urban area, specifically Hillsborough County, was selected because of the extensive database kept by the county's EPC on all created wetland projects permitted over the preceding nine years. The EPC files contained records of species planted, year of planting, site conditions, and follow-up site visits. The EPC database was found to be far superior to any other surveyed.

A total of 64 created wetlands in 31 developments throughout the county were identified. The largest concentration was in the recently expanding Tampa urban area. Candidate wetlands were evaluated relative to the following criteria: 1) size--must be less than or equivalent to 1 hectare, the most common size class regionally and probably, nationally; 2) type--herbaceous vegetation; 3) age--at least 1 year old; 4) intensity of maintenance performed since creation of the site--the less maintenance, the more desirable the site. This selection procedure narrowed the number of candidate created wetlands to 20. Final selection of the created wetlands then required site visits to determine which sites: 1) approximated the most commonly found natural freshwater marsh systems of the eco-region, i.e., isolated, fully vegetated marshes were most desirable; 2) located in an urban setting; and 3) accessible. The final selection process yielded nine created wetlands between one and nine years old (Table 1).

TABLE 1. Approximate dates when construction and field sampling was completed for the created wetlands. Dashes (--) indicate no information available.

SITE	CONSTRUCTION COMPLETED	SAMPLED IN THE FIELD
101	Spring 1985	May 1988
102	March 1987	May 1988
103	1985	May 1988
104	1979	May 1988
105	--	May 1988
106	--	May 1988
204	1985	July 1988
205	Spring 1986	July 1988
208	Before June 1985	July 1988

DATA COLLECTION

Data on planned and existing hydrology, wetland area, wetland shape, slopes of banks, and vegetation were collected in the field and in the office, for each site. The general approach is presented below; details are given when each item is discussed in the subsections that follow.

Information on the plans for each site was obtained from the Hillsborough County EPC office. Project descriptions, blueprints, conceptual drawings, and lists of species to be planted were used, as well as EPC "Created Wetlands Assessment Project Candidate Wetlands Data Sheets", when available. Information on the existing conditions on the sites was gathered in the field. Water levels, wetland area, wetland shape, slopes of banks, soil characteristics, and vegetation composition were sampled during May and July of 1988. Sampling methods used and the associated quality assurance procedures are documented in Sherman et al. (1991), and evaluated in Sherman and Gwin (1991).

Evaluating the Hydrology to be Created and As-Built

Hillsborough County EPC files were examined for information on the intended hydrologic regime, water levels, and area of the site to be inundated, and for descriptions of water sources, inlets, outlets, and water control structures.

Sites were evaluated in the field for indicators of wetland hydrology. Evidence that saturation occurred for a time sufficient to support hydrophytic vegetation and create hydric soils was documented according to the criteria listed in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (1989). The presence of a hydrophytic plant community was determined by the presence and degree of dominance of obligate, facultative wetland, and facultative vegetation as defined by Reed (1988). Presence of water above the surface of the substrate, presence of water in soil pits, evidence of soil saturation (glistening), and presence of mottles in the soil were used as evidence of wetland hydrology. In addition, presence of hydric soil was determined on the basis of soil chroma and percent organic carbon content. Soil chroma was determined using a Munsell Color Book. Percent organic matter was expressed as ash free dry weight. In addition, water sources, inlets, and outlets were located and described and their location documented. Water levels on site relative to the soil surface were measured in each plot sampled and recorded. Percent of the site inundated was estimated and recorded.

Evaluating the Area to be Created and As-Built

Three types of information were used to determine how the wetland area in the plans and as-built compared with that listed in the EPC files--the written record, permit maps, and field maps. Paired permit and field maps for each site were drawn at the

same scale so that each map fit on an 8 1/2 x 11 inch piece of paper. Permit maps were drawn from blueprints and conceptual drawings from the Hillsborough County EPC files. Field maps were computer generated from sketches and measurements made in the field with a transit and stadia rod (Lounsbury and Aldrich 1986). The field maps represent the boundary of the wetland as determined from changes in vegetation and slope.

A second member of the field crew checked the accuracy of the measurements made using the transit by duplicating the measurements. The sketches were drawn back at the office using the compass directions and distances determined in the field. The accuracy of the sketches was subsequently checked and verified by a member of the field crew.

A planimeter (Numonics model #1250-1) was used to measure the area of each wetland in acres from the maps. Each map was traced three times and the resulting areas were averaged. A dot grid was used to check the accuracy of the planimetry on three pairs (33%) of the maps. The relative percent difference between the areas derived from planimetry and those calculated by the grid was less than 6%, demonstrating the accuracy of the areal calculations done with the planimeter. The data were converted from acres to hectares by multiplying by 0.4047.

Evaluating the Shape to be Created and As-Built

The shape of each wetland as-built was checked against the shape indicated by the construction plans by visually comparing the permit and field maps. Notes on the observations were made. In addition, the literature was searched for information relating wetland shape to ecological function to evaluate the shapes designed and constructed.

Evaluating Slopes to be Created and As-Built

The Hillsborough County EPC files were searched for specifications for the slopes of the banks of the wetlands. Statements within the files, as well as contour lines on the blueprints and conceptual drawings were used.

The slopes of banks leading into the wetland from upland areas were determined in the field by measuring elevation changes with a transit and stadia rod along transects placed on banks that were characteristic of the site (Lounsbury and Aldrich 1986). Elevation measurements were first made at the top of the bank and then at regular intervals determined by the spacing of the vegetation plots across the wetland. Additional readings were taken at one meter intervals where the microtopography of the wetland was irregular or where gradients appeared steep. Another member of the field team checked the accuracy of the measurements by repeating the procedure at 6% of the data points. The mean difference between the original and duplicate readings

was less than 2%, demonstrating the comparability of the field crew personnel and accuracy of the readings.

Elevations measured in the field were calculated relative to the lowest point in the wetland. Calculations were checked and entered into a computer database. Double entry was used to ensure that errors did not occur in transferring the data from the field sheets into the computer. After entry, the two data sets were electronically compared. Discrepancies were corrected by referring to the field sheets.

Cross-sections of the topography of each wetland were then computer generated using the corrected elevation data. The top and bottom of each bank were located on each cross-section. The top of the bank was defined as the uppermost point on each cross-section. The bottom of the bank was defined as either the first point of inflection on the cross-section, or the point where the profile obviously started to flatten out across the bottom of the basin. The slope of each bank was then calculated.

Slopes specified in the permit plans and construction plans were compared to the as-built condition. To evaluate the design of each created wetland, the available literature on wetland creation was searched for recommendations on slopes appropriate for different types of wetlands, soil stabilization, and the establishment of vegetation and wildlife communities. The recommendations were compared to the slopes contained in the permit plans, construction plans, and the as-built conditions.

The evaluations described above were made first with reference to the predominant slopes on the site. In addition, since the information in the EPC files was often limited, each slope listed in the files and measured in the field was compared to the recommended slopes from the literature.

Evaluating the Vegetation to be Established and Actually Found on Site

Hillsborough County EPC files were searched for revegetation strategies specified as conditions for construction and for lists of vegetation to be planted on the site. When the planting lists contained common names, scientific names were assigned from the Regional Lists of Plant Species that Occur in Wetlands (Reed 1988).

The same field procedures were used in both the created wetlands and their natural analogs (Brown 1991). Transects were placed to obtain a representative sample of the vegetation community of the wetland. This was accomplished by establishing vegetation transects that followed basin morphology, i.e., downgradient through the deepest portions of the habitat, and back up to the opposite edge of the wetland. The number of transects placed in each wetland depended upon the shape of the wetland. For example, in a circularly shaped wetland, two transects would be placed at right angles to each other. In an elongated, oval or rectangularly shaped wetland, three transects might be used--one long transect placed lengthwise in the wetland and two

shorter transects at right angles to the long transect. All species present in forty 1-m^2 quadrats placed at equal intervals along the transects were identified, the percent of the total cover represented was estimated, and species lists were generated. The accuracy of species identification was checked by a second botanist who resampled 25% of the quadrats. Overall, the same species were identified in the same quadrat an average of 84% of the time, demonstrating comparability between the botanists (Sherman and Gwin 1991).

Each species was assigned to one of the U.S. Fish and Wildlife Service's (USFWS) wetland indicator categories (Reed 1988). This resource was also used to determine if species were native to the southeastern United States or exotic. Table 2 lists the wetland indicator codes used. All code assignments were verified by a second person. Any species whose code could not be determined from Reed (1988) was assigned a wetland indicator code by Dr. David Hall and Ms. Christina Raymond of the University of Florida Herbarium and Center for Wetlands, both experts in the taxonomy of Florida wetland plants.

A combined list of all species contained in the planting lists was generated by merging the planting lists from all sites. A combined list of all species actually found on the nine created wetlands was also produced. The lists were compared as to the proportion of 1) native and exotic species, 2) wetland and upland species, and 3) species found on the site that were listed for planting. In addition, the same comparisons were made for the species to be planted and found on all sites.

TABLE 2. Wetland indicator codes assigned to all species found on the created wetlands and on the planting lists. Codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988).

INDICATOR CATEGORY		POSITION IN CATEGORY	NATIVE/EXOTIC
ABS =	Absent from the list	+ = Frequency is toward high end of the category (more frequently found in wetlands).	NAT = Native Species.
FAC =	Facultative. Sometimes found on wetlands (34%--66% estimated frequency), also occurs in nonwetlands.	- = Frequency is toward lower end of the category (less frequently found in wetlands).	EXO = Exotic Species, i.e., species introduced into the region.
NO =	No Agreement, Not Considered, or No Review. No agreement was applied when a regional panel was unable to reach a unanimous decision, not considered was applied to plants recently added to the list, and no review was applied to species that have not received regional review.	\ = Intermediacy within the category.	*** = No information available.
OBL =	Obligate Wetland Species. Always found in wetlands under natural conditions (frequency greater than 99%), but may persist in nonwetlands.		
UPL =	Upland. Occurs in wetlands in another region, but not found (<1% frequency) in wetlands in the region specified.		
FACU =	Facultative Upland. Seldom found in wetlands (1%--33% frequency) and usually occurs in nonwetlands.		
FACW =	Facultative Wetland. Usually found in wetlands (67%--99% frequency), but occasionally found in nonwetlands.		
*** =	No information available.		

SECTION III

RESULTS

Data on planned and existing hydrology, wetland area, wetland shape, slopes of banks, and vegetation were evaluated for each site. The results are presented in the subsections that follow. Appendix I contains a narrative description and a catalog of all the information gathered on each created wetland from field sampling, and from construction plans and permit specifications found in the Hillsborough County EPC files.

EVALUATING THE HYDROLOGY TO BE CREATED AND AS-BUILT

The hydrologic information contained in the project files was inadequate to use in the comparison of the created wetlands with their project specifications and construction plans. A summary of the information found is presented in Table 3. The proportion of the created wetlands inundated by open water ranged from 0.51% to 3.03%. This range was similar to that of the natural wetlands sampled, and suggests little difference between the two populations (Brown 1991).

EVALUATING THE AREA TO BE CREATED AND AS-BUILT

Permit specifications, construction plans, and as-built conditions were compared to evaluate the area of each created wetland. For 44% (4/9) of the created wetlands (sites 101, 102, 105, 106), permit specifications did not indicate area to be created. In addition, construction plans for 44% (4/9) of the created wetlands (sites 103, 104, 105, and 106) did not indicate the scale used in the drawings. Therefore, scale was calculated from distances marked between contour lines or landmarks on drawings, and each wetland's intended area was then estimated using the calculated scale.

Permit Specifications Compared to Field Measurements

Areas specified in the five permits that contained written areal specifications (sites 103, 104, 204, 205, and 208) ranged from 0.25 ha (0.63 acres) to 1.28 ha (3.16 acres) (Table 4). For these five wetlands, the area measured in the field ranged from 0.34 ha (0.84 acres) to 0.88 ha (2.18 acres). Comparisons of the areas specified in the permits with the field measurements showed a cumulative loss of 0.78 ha (1.91 ac) of the 3.58 ha (8.84 ac) intended to be built, although two projects were built larger than specified.

TABLE 3. The hydrology planned for each created wetland studied. Information was taken from the Hillsborough County Environmental Protection Commission (EPC) permit files.

SITE	HYDROLOGY INTENDED AT CREATED WETLAND
101	Letter from the property owner's attorneys to EPC states that the wetland was designed as a detention system and would receive stormwater runoff from discharge generated by the development.
102	Construction plans included planned high and low water levels. Monitoring report states that "a wide range of water level fluctuation" exists and that partial construction of the wetland had resulted in "the pond [being] short on expected volume". An irrigation system was to be installed to provide water until the summer rains began.
103	Design plans indicate that water levels on the site would be determined by water levels in a "connecting swale".
104	No information.
105	No information.
106	No information.
204	Typical high and low water were marked on the construction plans. Sketch of site also stated that the purpose of the project was to provide "drainage structures".
205	Created site would receive overflow of stormwater and runoff flowing through the cypress dome from commercial development via a V-notched weir.
208	No information.

TABLE 4. Comparisons of wetland area required in the permit specifications (PERMIT) with the area indicated by construction plans (PLANS) and with the area of wetland measured from each field map of as-built conditions (AS-BUILT). Area is expressed in hectares. Values in brackets [ac] are the corresponding data expressed in acres, which was converted to hectares by multiplying by 0.4047. Parentheses (%) indicate the percentage of area gained or lost. Dashes (--) indicate no information. Areal measurements followed by an asterisk (*) are estimates, because scale information was lacking from construction plans.

				DIFFERENCES		
SITE	PERMIT	PLANS	AS-BUILT	PERMIT vs AS-BUILT	PLANS vs AS-BUILT	PERMIT vs PLANS
101	--	0.19 ha [0.48 ac]	0.10 ha [0.25 ac]	--	-0.09 (-47%)	--
102	--	0.21 ha [0.51 ac]	0.21 ha [0.51 ac]	--	0.00 (0%)	--
103	1.13 ha [2.80 ac]	0.75 ha [1.86 ac]*	0.78 ha [1.92 ac]	-0.35 (-31%)	+0.03* (+ 4%)	-0.38 (-34%)
104	1.28 ha [3.16 ac]	1.04 ha [2.56 ac]*	0.88 ha [2.18 ac]	-0.40 (-31%)	-0.16* (-15%)	-0.24 (-19%)
105	--	0.03 ha [0.08 ac]*	0.07 ha [0.18 ac]	--	+0.04* (+133%)	--
106	--	0.03 ha [0.07 ac]*	0.05 ha [0.13 ac]	--	+0.02* (+67%)	--
204	0.53 ha [1.30 ac]	0.28 ha [0.70 ac]	0.34 ha [0.84 ac]	-0.19 (-36%)	+0.06 (+21%)	-0.25 (-47%)
205	0.25 ha [0.63 ac]	0.36 ha [0.88 ac]	0.38 ha [0.95 ac]	+0.13 (+52%)	+0.02 (+ 6%)	+0.11 (+44%)
208	0.39 ha [0.95 ac]	0.29 ha [0.71 ac]	0.42 ha [1.04 ac]	+0.03 (+ 8%)	+0.13 (+45%)	-0.10 (-26%)

Construction Plans Compared to Field Conditions

Areas determined from construction plans ranged from 0.03 ha (0.07 acres) to 1.04 ha (2.56 acres) (Table 4). However, the areas determined for 44% (4/9) of the construction plans (sites 103, 104, 105, and 106) are estimates because scale was not included on the drawings for the site. The area measured in the field for all nine created wetlands ranged from 0.05 ha (0.13 acres) to 0.88 ha (2.18 acres). Although two wetlands were created smaller than their construction plans indicated, comparison of the total area determined from the construction plans with the total area as-built showed a slight increase in the area of wetlands constructed over that intended (approximately 0.06 ha). However, considering that the area intended for four of the nine wetlands were estimates, the total area created and the total area indicated by the construction plans should be regarded as the same.

EVALUATING THE SHAPE TO BE CREATED AND AS-BUILT

Six of the permit maps indicate that the wetlands were designed to have primarily straight, regular boundaries and geometric shapes (e.g., rectangular, circular). The field maps for these wetlands show that two are rectangular, three have at least one long, straight boundary with an otherwise irregular shape, and one is completely irregular. The remaining three permit maps indicate that the wetlands were designed to have irregular shapes and the field maps indicate that they were constructed as designed. To summarize, the field maps for the wetlands studied indicated that all were built with shapes similar to that intended.

EVALUATING SLOPES TO BE CREATED AND AS-BUILT

Slopes to be constructed were evaluated in two ways. The field measurements of as-built slopes were compared with the intended slopes as determined from project specifications or construction plans to ascertain if the banks were graded as specified. Then, the as-built slopes were compared with slopes recommended in the current literature on wetland creation.

Since any one wetland could contain banks with several different slopes, the comparisons between as-built and intended slopes were made with reference to the predominant as-built slopes on the site. In addition, each slope listed and each measured in the field was compared to the recommended slopes from the literature.

As-Built Conditions Compared to Construction Plans and Project Specifications

The predominant as-built slopes approximated the slopes indicated in the project specifications and construction plans for five of the nine sites. One site was built with slopes more gentle than specified. Comparisons of predominant slopes were not made for three sites due to insufficient information in the project specifications and construction plans.

Forty-eight individual slopes were measured of as-built conditions for the nine created wetlands. Of these, 44% (21/48) were more gentle than their respective project specifications or construction plans. Twenty-three percent (11/48) were built as planned and 8% (4/48) were steeper than stipulated. Twenty-five percent of the as-built slopes (12/48) could not be compared to their project specifications and construction plans due to insufficient information in the permit files.

Comparisons with Recommendations in the Literature

The current literature on wetland creation was reviewed to determine if slopes intended for construction and as-built were appropriate for palustrine emergent marshes. The literature recommended that the banks of created wetlands should be graded between 5:1 and 15:1 (horizontal:vertical) to facilitate vegetation establishment and soil stability (Reimold and Cobler 1986, Kruczynski 1990).

The predominant slope to be built for each site as determined from the construction plans and project specifications was compared with the recommended range for slopes from the literature. The results indicated that: 33% (3/9) were steeper than 5:1; 33% (3/9) were within the range of 5:1 to 15:1; and 33% (3/9) could not be evaluated because the predominant slope intended could not be determined.

The predominant slope as determined from the as-built conditions measured at each site was compared with the recommended range for slopes from the literature. The results were: 33% (3/9) were steeper than 5:1; 56% (5/9) were within the 5:1 to 15:1 range; and 11% (1/9) were gentler than 15:1.

The individual slope measurements of as-built conditions were also compared with the recommended slopes from the literature. The results indicated that: 27% (13/48) were steeper than 5:1; 56% (27/48) were within the 5:1 to 15:1 range; and 17% (8/48) were gentler than 15:1.

EVALUATING THE VEGETATION TO BE ESTABLISHED AND ACTUALLY ESTABLISHED

Eight of the nine (89%) project specifications indicated that the wetlands were to be planted. Project specifications for site 104 did not include a planting list.

Evaluation of Planting Lists

Seven of the planting lists used scientific names. Of those seven, one listed genera only, and six listed genus and species for some plants and genus only for others. In addition, one planting list used only common names. Scientific names should be used to designate species for planting because common names can apply to more than one species. The number of species found on the planting lists ranged from three to twenty, with an average of eight species per list (S.E. = $\pm$ 2.0).

The planting lists which specified both the genus and specific epithet for each plant allowed determination of whether or not the species included were native or exotic. All included only native species, and none included exotics (Table 5). However, determination of whether a species was native or exotic could not be made when only the genus was specified.

The majority of the planting lists (5/8) were composed primarily of obligate wetland species (Table 5). Four planting lists included facultative wetland species and two included facultative species. Five planting lists contained species for which the indicator status could not be determined.

Combining the planting lists produced a total of 35 unique species (Table 5). Of these, 29 were native to the Southeast, while the origins of six could not be determined. In addition, 46% (16/35) of the species on the combined list were obligate wetland species. Of the 35 species on the combined planting list, 21 (60%) were found on at least one created wetland, although not necessarily the wetland on which they were to be planted.

Evaluation of the Vegetation Found On-Site

The number of species found on each site was much greater than the number of species contained on each planting list. The average number of species found on a created wetland was 50 (S.E. = $\pm$ 8.4). Vegetation communities at three of the nine wetlands (33%) were composed completely of volunteer species. For the remaining six created wetlands, between 84.6% and 98.0% of the species found were volunteers (Table 6). The species that volunteered on the created wetlands were compared with the species that were found on the natural wetlands sampled (Brown 1991). This

TABLE 5. Composition of planting lists. # SPECIES is the total number of species listed to be planted on each wetland. # NAT is the number of species indigenous to the southeastern United States listed. The species were counted in the Unknown (UNK) category if only the genus was given. Also listed are the numbers of species found on each planting list which fell into the categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Plants were assigned to categories in consultation with Dr. David Hall and Ms. Christina Raymond of the University of Florida Herbarium. The categories are: OBL--obligate wetland species; FACW--facultative wetlands species; FAC--facultative species, FACU--facultative upland species, and UPL--upland species. The combined list (Comb List) is composed of all unique species on the planting lists. No species was counted more than once, though species may have occurred on more than one planting list. NP indicates the created wetland was not planted.

SITE	# SPECIES	# NAT	# UNK	# OBL	# FACW	# FAC	# FACU/UPL
101	3	3	0	3	0	0	0
102	9	9	0	6	3	0	0
103	5	3	2	0	3	0	0
104	NP	NP	NP	NP	NP	NP	NP
105	6	3	3	3	0	0	0
106	6	3	3	3	0	0	0
204	20	17	3	7	7	3	0
205	3	0	3	0	0	0	0
208	12	12	0	6	4	2	0
Comb List	35	29	6	16	10	3	0

TABLE 6. Species found on the sites that were to be planted, volunteered, and that occurred on the natural wetlands sampled. NA indicates planting information available was inadequate, therefore, all species found on the site were assumed to be volunteers. NP indicates the wetland was not planted. The combined list (Comb List) was created by merging all the individual planting lists and lists of species found on the sites. Species were only counted once, though they may have occurred on more than one planting list and may have been found at more than one site. # SPECIES FOUND is the total number of species found on the created wetland. % PLANTED SPECIES FOUND is the proportion of species found on the site that were on the planting list. % VOLS FOUND is the proportion of the total number of species found on the site that were volunteers (not on the planting list). % ON NATURAL WETLANDS is the proportion of the species on the created wetland that also occurred on the natural wetlands. Actual numbers of species found in each category are in parentheses.

SITE	# SPECIES FOUND	% PLANTED FOUND	% VOLS FOUND	% ON NATURAL WETLANDS
101	50	0.0 (0)	100.0 (50)	58.0 (29/50)
102	79	6.3 (5)	93.7 (74)	38.0 (30/79)
103	49	2.0 (1)	98.0 (48)	61.2 (30/49)
104	38	0.0 (NP)	100.0 (38)	55.3 (21/38)
105	13	15.4 (2)	84.6 (11)	53.8 (7/13)
106	35	5.7 (2)	94.3 (33)	54.3 (19/35)
204	96	11.5 (11)	88.5 (85)	59.4 (57/96)
205	34	0.0 (NA)	100.0 (34)	52.9 (18/34)
208	59	8.5 (5)	91.5 (54)	61.0 (36/59)
Comb List	207	10.1 (21)	89.9 (186)	44.0 (91/207)

comparison showed that the proportion of volunteer species on the created wetlands that also occurred on the natural wetlands ranged from 38.0% to 61.2%. Overall, an average of 54.9% (S.E. = 2.4%) of the species on the created wetlands also occurred on natural wetlands, and 44.0% of the species on the combined planting list also occurred on the combined list of species found on the natural wetlands.

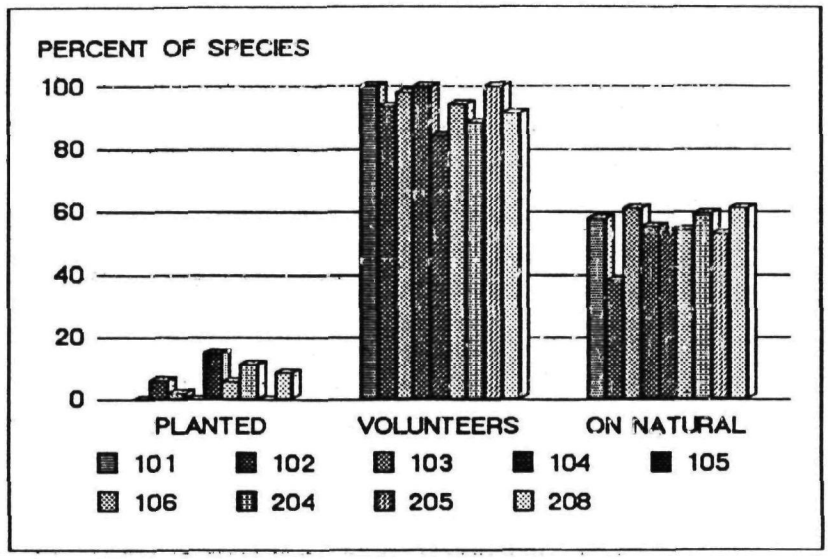
The relative abundance of the species found on the created wetlands followed a pattern similar to that generated by evaluating the number of species found on the sites (Figure 1). For those wetlands that were planted, the proportion of the plant cover composed of species to be planted ranged from 0.0% to 33.4% (Table 7). The proportion of the plant cover on the created wetlands that was composed of volunteers ranged from 66.6% to 100.0%, and the proportion of the plant cover composed of species that also occurred on the natural wetlands sampled ranged from 48.0% to 93.4%.

Plant communities found at the created wetlands were composed of both native and exotic species. However, all sites had a much greater proportion of native than exotic species, with regard to both the numbers of species found and the proportion of the cover composed of those species (Table 8). The proportion of native species found on each site ranged from 79.7% to 96.6%. The proportion of the cover composed of native species on each created wetland ranged from 83.4% to 99.5%. Combining the lists of species found on each created wetland generated a total of 207 unique species. Of these, 174 (84.1%) were native to the southeastern United States.

A majority of both the number of species present and the proportion of the cover was composed of obligate wetland (OBL) and facultative wetland (FACW) species (Figure 2). The proportion of species found on the created wetlands that were OBL ranged from 26.5% to 53.8% (Table 9). The proportion of the cover composed by OBL species was somewhat higher, ranging from 37.4% to 90.2% (Table 10), indicating that species in this category represent a large proportion of the vegetation on these wetlands. The proportion of FACW species found on the created wetlands ranged from 23.1% to 43.0%, and the proportion of the cover composed of FACW species ranged from 4.5% to 51.5%.

Facultative (FAC), facultative upland (FACU), and upland (UPL) species were minor constituents of the vegetation on the created wetlands, in terms of both the species found and the proportion of the cover composed of these species. The proportion of FAC species found on the created wetlands ranged from 3.4% to 26.5%, and the proportion of the cover composed of these species ranged from 0.1% to 12.8%. FACU and UPL species constituted even smaller proportions of the vegetation. The proportion of FACU and UPL species found ranged from 0.0% to 16.0% and 0.0% to 1.0%, respectively. The proportion of the cover composed of these species ranged from 0.0% to 13.2% (FACU) and 0.0% to 0.2% (UPL).

A.



B.

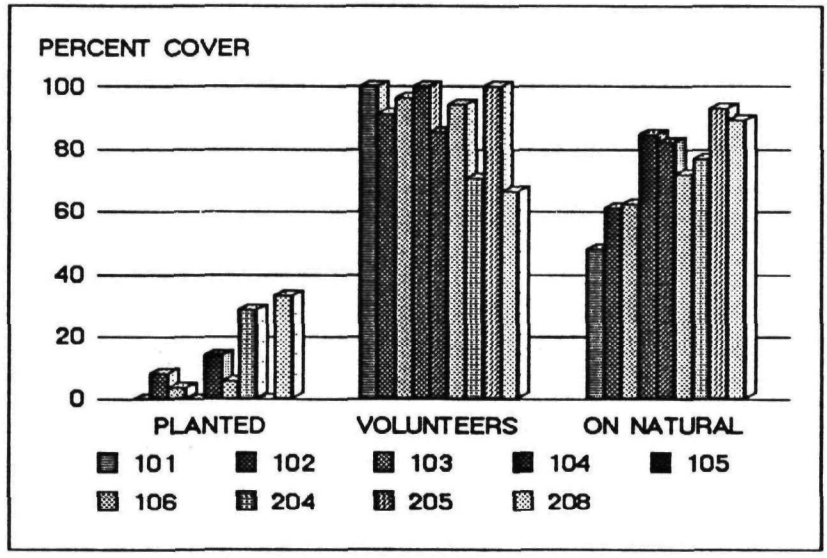


FIGURE 1. A. The proportion of the number of species found on each created wetland that were planted (PLANTED), volunteered (VOLUNTEERS), and that also occurred on the natural wetlands sampled (ON NATURAL). B. The relative abundance (expressed as % cover) of species that were planted (PLANTED) found on each created wetland, volunteered (VOLUNTEERS), and were also found on the natural wetlands (ON NATURAL).

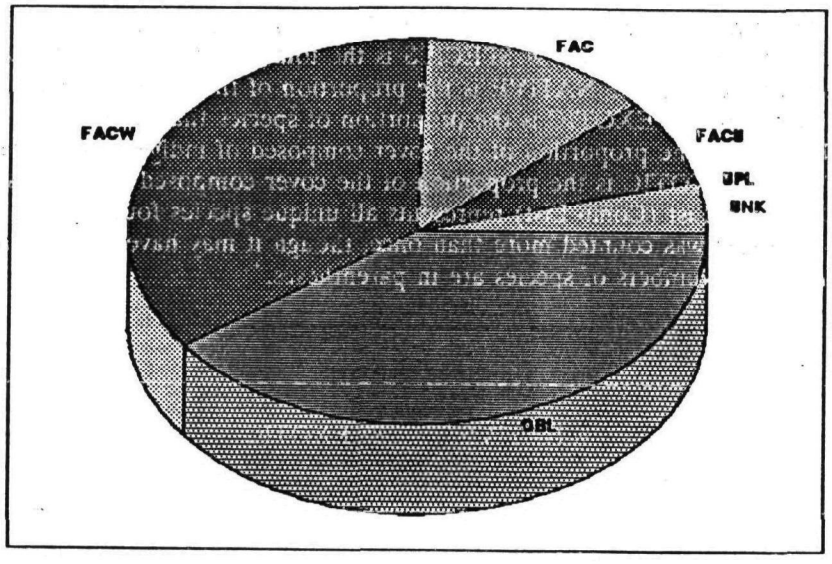
TABLE 7. Proportion of the plant cover found on the created sites composed of species to be planted, volunteers, and that were also found on the natural wetlands sampled. NP indicates the wetland was not planted. NA indicates planting information was inadequate, therefore, all species found on the site were assumed to be volunteers. PLANTED is the proportion of the cover composed of species found on the site that were on the planting list. VOLUNTEERS is the proportion of the cover composed of species found on the site that were volunteers (not on the planting list). NATURAL WETLANDS is the proportion of the cover composed of species that also occurred on the natural wetlands sampled. An asterisk (*) indicates the wetland was mulched during construction.

SITE	PLANTED	VOLUNTEERS	NATURAL WETLANDS
101	0.0%	100.0%	48.0%
102*	8.3%	91.7%	61.3%
103*	3.7%	96.3%	62.5%
104*	NP	100.0%	84.9%
105	14.0%	86.0%	82.4%
106	5.6%	94.4%	72.4%
204*	28.9%	71.1%	77.4%
205*	NA	100.0%	93.4%
208*	33.4%	66.6%	89.4%

TABLE 8. Proportions of the species found on a site that are indigenous to the southeastern United States or exotic. # SPECIES is the total number of species found on each created wetland. % NATIVE is the proportion of the total number of species that were indigenous. % EXOTIC is the proportion of species that were exotic. % COVER NATIVE is the proportion of the cover composed of indigenous species, and % COVER EXOTIC is the proportion of the cover composed of exotic species. The Combined List (Comb List) represents all unique species found on the created wetlands. No species was counted more than once, though it may have been found on more than one site. Numbers of species are in parentheses.

SITE	# SPECIES	% NATIVE	% EXOTIC	% COVER NATIVE	% COVER EXOTIC
101	50	82.0% (41)	14.3% (7)	92.9%	7.0%
102	79	79.7% (63)	12.7% (10)	79.0%	17.7%
103	49	87.8% (43)	4.0% (2)	98.8%	0.7%
104	38	94.7% (36)	5.3% (2)	93.3%	6.7%
105	13	92.3% (12)	0.0% (0)	95.2%	0.0%
106	35	82.9% (29)	11.4% (4)	83.4%	16.1%
204	96	89.6% (86)	9.4% (9)	94.3%	5.7%
205	34	91.2% (31)	2.9% (1)	98.5%	0.6%
208	59	96.6% (57)	1.7% (1)	99.5%	0.4%
Comb List	207	84.1% (174)	9.7% (20)		

A.



B.

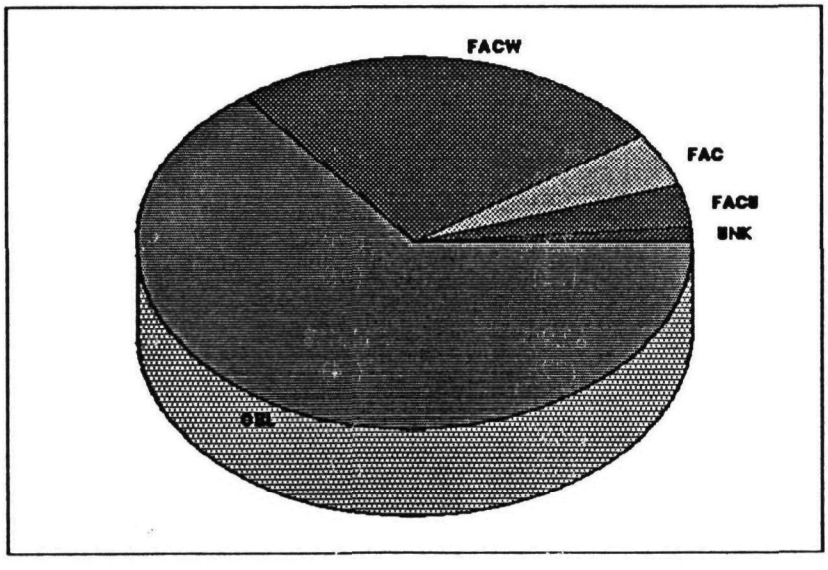


FIGURE 2. A. The proportion of the total number of species found on the created wetlands by wetland indicator category (Reed 1988). B. The proportion of the relative abundances of the species found on the created wetlands by wetland indicator category (Reed 1988) expressed as the proportion of the total cover composed by each.

TABLE 9. Proportions of the total number of species found on a site which fell into the categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). # SPP is the total number of species found on each wetland. Plants were assigned to categories in consultation with Dr. David Hall and Ms. Christina Raymond of the University of Florida Herbarium. Categories are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; and UNK--species that could not be identified or for which the wetland indicator could not be determined. The combined list (Comb List) is composed of all unique species found at the created sites. No species was counted more than once, though it may have been found at more than one site. Results are expressed as percentages of the total number of species found on site. Actual numbers of species are in parentheses.

SITE	# SPP.	% OBL	% FACW	% FAC	% FACU	% UPL	% UNK
101	50	26.0% (13)	28.0% (14)	26.0% (13)	16.0% (8)	0.0% (0)	4.0% (2)
102	79	34.2% (27)	43.0% (34)	11.4% (9)	3.8% (3)	0.0% (0)	7.6% (6)
103	49	38.8% (19)	32.7% (16)	14.3% (7)	6.1% (3)	0.0% (0)	8.2% (4)
104	38	44.7% (17)	39.5% (15)	13.2% (5)	2.6% (1)	0.0% (0)	0.0% (0)
105	13	53.8% (7)	23.1% (3)	15.4% (2)	0.0% (0)	0.0% (0)	7.7% (1)
106	35	51.4% (18)	25.7% (9)	8.6% (3)	8.6% (3)	0.0% (0)	5.7% (2)
204	96	41.7% (40)	32.3% (31)	15.6% (15)	8.3% (8)	1.0% (1)	1.0% (1)
205	34	32.4% (11)	35.3% (12)	11.8% (4)	14.7% (5)	0.0% (0)	5.9% (2)
208	59	52.5% (31)	37.3% (22)	3.4% (2)	5.1% (3)	0.0% (0)	1.7% (1)
Comb List	207	36.7% (76)	32.4% (67)	14.5% (30)	9.7% (20)	0.5% (1)	5.8% (13)

TABLE 10. Relative abundances of the species found on a site, expressed as the proportion of the total cover composed by each, which fell into the categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Plants were assigned to categories in consultation with Dr. David Hall and Ms. Christina Raymond of the University of Florida Herbarium. Categories are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; and UNK--species that could not be identified or for which the wetland indicator could not be determined. Results are expressed as percentages of the total vegetation cover of all species sampled on site.

SITE	% OBL	% FACW	% FAC	% FACU	% UPL	% UNK
101	52.6%	23.6%	10.4%	13.2%	0.0%	0.2%
102	45.1%	33.7%	12.8%	5.1%	0.0%	3.3%
103	79.4%	12.8%	6.5%	0.9%	0.0%	0.5%
104	54.2%	38.3%	7.1%	0.4%	0.0%	0.0%
105	90.2%	4.5%	0.4%	0.0%	0.0%	4.8%
106	79.9%	17.5%	0.3%	1.8%	0.0%	0.5%
204	37.4%	51.5%	4.0%	6.9%	0.2%	0.0%
205	76.4%	18.1%	0.5%	4.0%	0.0%	1.0%
208	66.5%	32.5%	0.1%	0.9%	0.0%	0.0%

SECTION IV

DISCUSSION

Wetlands are, and undoubtedly will continue to be, created as compensation for those destroyed by development. Therefore, it is important to ensure that the wetlands created compensate fully for those destroyed, in terms of function as well as acreage. Because measures of wetland structure are more readily available and better understood than are measures of function, we focus on structural measures to determine if wetland replacement has occurred. Although verifying that wetland function exists is the ultimate goal, it is important to establish that a project is, indeed, a wetland. This includes ensuring that the wetland design is appropriate for the type of wetland desired and its location, and that structural elements were constructed correctly. The following discussion examines wetland design and planning in terms of the results of this study, and presents suggestions for improving the process.

DESIGN OF CREATED WETLANDS

Hydrology

Hydrology is one of the most important aspects of wetland establishment (Mitsch and Gosselink 1986). Therefore, the design of a created wetland should include specific statements of the hydrological characteristics intended. Descriptions of planned high and low water levels or requirements that a source of water must (or will) be provided are not sufficient in themselves. The plans must explicitly state at minimum 1) how and from where the water will be supplied to the site, 2) the depths at which water will inundate the site (seasonal high and seasonal low), and 3) the timing and duration of inundation.

Hydrological aspects of the created wetlands were not included in the comparisons of as-built conditions with project specifications and construction plans because information in the project files was inadequate. However, the percent of open water on each created wetland was estimated during field work, and a small proportion of each was found to be open water. This would be appropriate for palustrine emergent wetlands. Because the proportion of open water on each site was similar to that of the natural wetlands sampled (Brown 1991), we can speculate that this was intentional on the part of the wetlands' designers. On the other hand, because a majority of the created wetlands had greater mean and maximum water depths, as well as steep bank slopes and basins that are deeper than the natural wetlands sampled, it is also possible that the designers intended the sites to have greater proportions of open water (i.e., ponds). If the wetlands were intended to be ponds, then the similarities to the natural wetlands occurred because of the low water levels that resulted from the relatively serious drought prior to and during field data collection (Brown 1991). We

recommend continuous or periodic monitoring of water levels and proportion of open water to determine which of the above possibilities is true.

Area of Wetland to be Created

It cannot be determined whether or not there was a net loss of wetland area due to the absence of areal requirements in the project specifications or scale markings on construction plans and conceptual drawings for 66% (6/9) of the created wetlands studied. Without information on what was intended, it cannot be discerned if the area created is correct, and the builder/contractor cannot be held accountable for constructing a wetland of the correct size. When project specifications included area and conceptual drawings included scale, areas actually built tended to be similar to the area intended. In fact, of the three created wetlands whose project files included both written specifications of area to be created and conceptual drawings that included scale, two were constructed with area slightly greater than that specified.

Shape of the Wetland to be Created

The shape of a wetland can influence its function as wildlife habitat. An irregular shoreline with small vegetated fingers and open water bays will provide more edge than will an even-sided shoreline. Greater edge tends to increase waterfowl usage by providing isolated areas for feeding and loafing (Crawford and Rossiter 1982). Two of the created wetlands studied had rectangular shorelines, and three others had one long, straight shoreline with otherwise irregular shapes. The other four wetlands were constructed with irregular shorelines. Therefore, the four created wetlands constructed with irregular shorelines may provide more benefit to wildlife than those constructed with rectangular shapes and straight shorelines.

Slopes

Garbisch (1977) states that slopes are one of the most important factors in preparing a site for marsh establishment. He suggests designing slopes to be as gentle as possible without impounding water. One method of calculating slopes that will be proper for the vegetation type desired, is to determine the slopes of non-eroding, vegetated sections of banks of wetlands contiguous to the site. For example, Shisler and Charette (1984) recommend the grading of slopes and topography to the relative elevations of adjacent natural marshes.

Kruczynski (1990) recommends slopes between 5:1 and 15:1 (horizontal:vertical) to provide maximum flooding of wetland area, to minimize erosion, and to promote the successful establishment of wetland vegetation. He states that many mitigation sites have been unsuccessful because of the steepness of their slopes. In this study 33% (3/9) of the sites both as planned and constructed had slopes steeper than 5:1 predominant on the site, and field sampling showed that 27% (13/48) of all the slope measurements taken within the created wetlands studied were steeper than 5:1.

D'Avanzo (1990) stated that the failure of plantings in created wetlands is often caused by incorrect slope, and the resulting erosion and increased rate of sedimentation. Water fluctuations and the corresponding changes in the duration and frequency of inundation of the site are likely to be greater when slopes are steep than when gradual. Any influx of water into a small area with steep slopes will cause a rapid deepening of the water as it rises up the banks. Influx of the same amount of water will cause a much smaller increase in depth in a site where the water is spread over a greater area because slopes are gentle. These differences in water fluctuations, and hence, the differences in the duration and frequency of inundation, influence the amount, zonation, and form of the vegetation community. Another consequence of steep banks is less area with the appropriate hydrology for wetland vegetation to become established. Thus, we have observed that only a narrow band of vegetation forms at the water's edge in wetlands with steep bank slopes.

Vegetation to be Established and Actually Found on the Site

Planting Lists–

A list of species to be planted should be included in the project plan if planting is to be done. Planting lists were found for eight of the nine created wetlands studied. However, some of these lists were problematic: 1) one listed common names only, 2) several used names of genera only instead of both genus and species, and 3) none specified planting methods. Scientific names, both genus and species, should be used to identify species for planting, and, whenever possible, the native variety should be specified. Common names may be included with the scientific names, but should not be the sole means of species identification because a common name often can apply to more than one species. Overall, however, these planting lists were much less problematic than those included in project plans for wetlands created in Oregon that were examined in a similar study. In addition to the problems listed above, the planting lists for the wetlands created in Oregon included exotic species, upland species, and commercial cultivars (Gwin and Kentula 1990). These problems did not occur on the planting lists examined in this study.

As stated above, none of the projects studied prescribed planting exotic or upland species. Of those planting lists that specified both genus and species, all contained species that were native to the southeast and either obligate wetland, facultative wetland, or facultative species (Reed 1988). In addition, most project specifications stated the wetland should be monitored for one or two years, and required removal by hand of nuisance or invasive species such as **Typha** spp. (Cattails), **Melaleuca quinquenervia** (Melaleuca), and **Schinus terebinthifolius** (Brazilian peppertree) to help ensure the survival of desired species. The survival of planted species constituted the primary evaluation criteria, and the removal of invasive or nuisance species were the principal actions to be taken during monitoring.

None of the project files contained instructions or timing for the actual planting process. The season for planting, type of planting materials, planting density, and required survival rates, should be stated in the project specifications (Kruczynski 1990). When considering type of plant material to use, several factors should be considered. Seeding is the least expensive method, but its success is the least predictable (Garbisch 1986) because seeds may be washed away by fluctuating water levels or consumed by wildlife. Moreover, seed germination and development in shallow water depend upon uncontrollable parameters such as the temperature and turbidity of the water (Garbisch 1986).

Transplanting of peat-potted plants, plugs, sprigs, and dormant underground plant parts (tubers, bulbs, and rhizomes) is both the most successful and most expensive method of revegetating (Garbisch 1986). Generally, in the Southeast, materials should be planted during the wet season, or plans for irrigation should be made (Erwin 1990). The transplants or seeds used should be of local origin, because native wetland plants grown from non-local genetic stock may not be adapted to local climatic conditions. Garbisch (1977) recommends that plant stock used should originate from within a 100-mile radius of its intended destination. However, ensuring that plant stock originates in a climate and ecological setting similar to its intended destination is probably more important than strictly following the 100-mile radius recommendation. Generally, abundant plant material for the revegetation of marsh creation projects can be found in the Southeast (Erwin 1990).

Survival of Species Planted–

Overall, approximately 90% of the species on the created wetlands were volunteers, while about 10% were species found on the planting lists (Table 6). A similar pattern was found when the relative abundances of the species were considered (Figure 1). It is interesting to note however, that approximately 60% of the species to be planted were found on at least one of the created sites, although not necessarily the site they were to be planted on. This poses the question: Why weren't species on the planting lists found in greater numbers on the respective created wetlands? One possibility is that the species on the individual planting lists constitute only a small proportion of the possible number of species capable of growing on these wetlands. Therefore, the small fraction of the vegetation community made up of planted species may merely reflect the large number of species that could be planted and would survive on created wetlands.

However, it is also possible that the planted species did not occur in larger numbers or greater abundances on the created wetlands because the original planting materials were unhealthy or were not handled properly, or that they simply weren't planted. Since none of the project files gave instructions for handling the planting materials, specified types of propagules to use, or where individual species should be planted, these are possibilities.

Lastly, it is possible that environmental conditions at the created wetlands may have been incorrect for the survival of the species planted. Therefore, it may be necessary to change the conditions of the site (hydrology, slopes, location, etc.) to allow the species planted to persist on the created wetlands. Future research might include exploring the type of environmental conditions necessary for the successful establishment of desired species.

Planting vs Natural Revegetation of the Site--

Natural revegetation may be a viable option since over 90% of both the species found on the created sites, and the percent cover occupied by those species, were volunteers. In addition, a large proportion of these volunteers were also found on natural wetlands of the same type in the region (Figure 1). However, both Shisler and Charette (1984) and Erwin (1990) recommend that natural revegetation be allowed only on small wetlands created adjacent to, or within existing marshes, so that the volunteer colonization of the site by desired species does not take too long to meet the desired goals of the project. Erwin (1990) also recommends that natural revegetation not be allowed when problematic exotics such as **Melaleuca quinquenervia** (Melaleuca) and **Schinus terebinthifolius** (Brazilian peppertree) are found within or adjacent to the site. These species are a threat to the colonization of native, non-invasive marsh species because the exposed substrate provides optimal habitat for aggressive colonization by the invasive species. Even without the threat of colonization by invasive exotics, the amount of time required for the site to fully revegetate naturally will probably be longer than if the wetland is planted. Therefore, the time required for the site to fully revegetate through natural means constitutes a wetland loss. Planting lessens this temporal loss because it hastens the establishment of a functional wetland (Kruczynski 1990).

Because a large proportion of the volunteers on the created wetlands also occurred on natural wetlands, it may be expedient to plant these species. An inventory of the desirable species that occur on natural wetlands could be developed and then used as a template for the planting of created wetlands. This might help ensure that the appropriate wetland vegetation communities develop on the created wetlands in the least amount of time possible.

Mulching the created wetland by applying a layer of topsoil removed from the destroyed wetland may enhance and accelerate the revegetation process by providing a supply of propagules, a seedbank, from which the wetland should revegetate. Because the stripping process from the donor wetland thoroughly mixes the soil materials, the vegetation of the created wetland may have a different cover frequency and pattern of distribution than of the donor wetland (Erwin 1990). However, mulching may provide an organic surface horizon and soil microflora (Kruczynski 1990) and helps to reduce evaporation of soil pore water, runoff and soil loss, and surface compaction and crusting (Thornburg 1977). Six of the created wetlands in this study (Sites 102, 103, 104, 204, 205, and 208) were mulched, which may have accelerated the successful establishment

of the wetland vegetation (Brown 1991). The one drawback to mulching is the possible introduction of undesirable exotics or invasive species such as Typha spp. (cattails).

Instances Where Planting May be Advisable--

Although the high proportion and percent cover of volunteer obligate and facultative wetland species that occurred on the created wetlands indicate that appropriate revegetation will occur without planting, it may be necessary to plant certain species to establish a specific wetland community or wildlife habitat. The value of a wetland for wildlife habitat and food depends upon water depth, the type and density of the vegetation, seed production, accessibility of edible plant parts, and the associated production of invertebrates. Vegetation stands that are too dense may be impenetrable to waterfowl, while those that are too sparse will be unattractive. The plant parts consumed must be abundant and available at the right times and in the right places (Kadlec and Wentz 1974). Therefore, if wildlife habitat is an important goal of the wetland creation, these factors must be considered when deciding upon a revegetation strategy and/or species to plant.

If erosion is a concern, especially where the banks slope steeply into the wetland, species should be chosen on the basis of their capacity for soil stabilization. Those with extensive root systems, rhizomes and erect stems that form dense bunches or turf, are best (Allen and Klimas 1986). However, initially it may be necessary to provide an additional degree of substrate stabilization by seeding with annual grasses (Erwin 1990).

It may be easier to control the spread of invasive species by planting early in the wetland construction process. Some marsh species have difficulty colonizing if more aggressive species become established first. Planting the desired species may give them a competitive edge over invasive species (Josselyn et al. 1990). Erwin (1990) states that some created wetlands have been overrun by invasive species such as Melaleuca or monocultures of cattails where substrates were exposed for an extended period of time prior to planting.

Planting also may be advisable because weedy and early-successional species tend to be long-lived in the seed bank (Glass 1989). This suggests that weedy and early successional species are likely to appear on a disturbed site (such as a newly created wetland), and that the seed bank, either existing or supplied in a mulch, cannot be counted on to produce the desired community. It is possible that the small numbers of FAC, FACU, and UPL species found on the created wetlands were pioneering species contained in the seedbank or that invaded the newly created wetland due to its disturbed nature and early successional state. If so, these species should gradually die out or become limited to transitional areas between the wetland and adjacent upland as the wetland matures. Monitoring of the created wetlands over an extended time period would help determine if this is true.

RECOMMENDATIONS

Evaluation of these created wetlands was limited by a lack of information within the project files. Project specifications were often vague, and construction plans and conceptual drawings often were inadequate. Without proper documentation of the intended project and the construction process, judgements of compliance cannot be made. In some instances where discrepancies occurred between the project specifications or the construction plans and the actual created wetland, it is likely that necessary changes were made during construction. As-built drawings of the wetland, drawn after the completion of the construction process, would provide an accurate portrayal of the newly constructed site. To be most useful, as-built drawings should contain a map indicating the location of the created wetland, and illustrate the project's size, shape, and vertical elevations. Map scales should be printed on the map. All sketches, lettering, scales, etc., should be clear and legible. The as-built drawings should also include the actual slopes built within the wetland, where vegetation species were planted; and documentation of any mid-course changes. In addition, the plans should contain the specific objectives of the creation. These should be related to specific vegetation or habitat types, wildlife values or other functional values considered in the design of the wetland (Fishman, et al. 1987).

Flexibility to make changes along the way is a crucial component of the wetland creation process. However, if mid-course changes are not documented by either the contractor or agency personnel, there are no means by which to determine if the project is out of compliance or if differences merely reflect a necessary change in the plans due to unanticipated conditions encountered during construction.

Many developers have short-term goals and create wetlands only to fulfill regulatory obligations. To ensure the created wetland persists in the landscape, the long-term goals (including monitoring) should be specified in the project plans (Shisler and Charette 1984). No specific long-term goals or plans for long-term monitoring were stated within any of the project files, although short-term monitoring was specified for five of the nine created wetlands studied (Sites 102, 103, 104, 204, and 208). The short-term monitoring of these sites consisted of quarterly reports to either the FDER or the Hillsborough County EPC for one or two years. The quarterly reports were to include:

- an analysis of the recruitment of desirable vegetation,
- documentation of the removal of nuisance species,
- counts of living trees and measurements of the growth rates of 50 individuals,
- an ecological evaluation of the created wetland,

- 85% survival of vegetation planted, with replacement to meet the minimum requirement, and

- replacement of trees to meet 80% survival at the end of the monitoring period.

Although the elements included in these quarterly reports constitute a step in the right direction, they lack consideration of factors such as hydrology, substrate, and site contours. Project monitoring should encompass more than plant survival. For example, changes in the inundated area of the project might occur from long-term climatic cycles (drought vs prolonged rainy seasons), or because of the failure of water control structures. Changes in site contours might occur due to slumping of banks, high sedimentation rates, or erosion. Monitoring should be conducted on all important characteristics of the created wetland, and the criteria by which the evaluations and analyses are made should be documented.

As-built drawings and documentation of changes made during the construction process would provide baseline information from which monitoring could be conducted. In addition, complete documentation, organized in a consistent manner and composed of specific data would allow resource agencies to more easily investigate and assess projects as they proceed. Inspections should be recorded on a standard data sheet which documents the same parameters for all projects. Future projects could then use the information to evaluate the methods and techniques used (Shisler and Charette 1984, Erwin 1990). None of the project files examined included documentation of the sequence of construction events or mid-course changes. However, the Hillsborough County EPC has instituted an inspection process which uses a standard data sheet for each wetland inspected. EPC Inspection Forms were found in the project files for six of the nine wetlands studied.

Mason and Slocum (1987) conducted an evaluation of 32 wetlands created in Virginia's coastal zone. Criteria used were establishment of vegetation, compliance with permit conditions, and evidence of wildlife use. They concluded that when permits contained specific conditions for creating the wetland, 86% were successful, whereas only 44% of projects without specific permit conditions were successful. Where time limits for completion of the wetland creation were specified in the permit, 100% of the projects were successful compared to only a 50% success rate when no time limits or deadlines were set. It appears that specific permit conditions help to ensure compliance with the permit and the establishment of the created wetland.

A more recent study was conducted by the FDER (1991) to assess the use and effectiveness of mitigation in Florida wetland resource regulation permitting. The study found a high rate of noncompliance in that only four of the 63 permits reviewed were in full compliance with their mitigation requirements. Noncompliance ranged from minor non-submittal of reports to major deviations from the mitigation design (e.g., construction of the wetland at incorrect elevations, truncation of the transition zone between wetland and upland, failure to apply appropriate soils and soil treatments, and

failure to plant required species). Among the recommendations made by FDER to improve the effectiveness of mitigation was the submittal of drawings of record of the constructed mitigation site, including a topographic survey (FDER 1991), in other words, submittal of an as-built plan.

In summary, the lack of complete information in the project files and the differences between the plans and permit specifications and the as-built conditions point to the need for verification of projects in both the planning and construction phases of wetland creation. The planning phase should focus on the development of a realistic approach using information from the scientific literature, past projects, and the history and surrounding landscape of the site of the planned created wetland. The construction phase should culminate in the production of an as-built plan. This would allow immediate checks to ensure that critical features have been included as intended, e.g., wetland area, vegetation type. It would also document any corrective measures that were taken due to unanticipated events during construction. As-built plans of the project would ensure that the details of the actual wetland created were available for future reference.

SECTION V

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APPENDIX I

DATA COLLECTED FOR EACH SITE: DESCRIPTIONS, PERMIT AND FIELD MAPS, BASIN MORPHOLOGY PROFILES, AND SPECIES LISTS

DESCRIPTION: SITE 101

Function/Purpose

Stormwater/runoff basin for an apartment complex.

General Physical Description

This site is a small, square retention basin, located within an apartment complex. It is bordered on the west by apartments and on the north by tennis courts, all of which are part of the development for which the mitigation was required. The east side of the wetland abuts the yards of houses not associated with the development. A berm separates the south side of the wetland from a natural cypress swamp, of which the land used for the retention basin was purportedly originally a part.

The walls of the basin are very steep-sided and the depth of the pond is two to three meters. The southeast corner has a small peninsula/island with a fairly large oak tree. The basin is about 35 meters in length on each side.

Hydrology

Water flowed into the northwest corner of the basin via a drainage ditch. Outflow occurred at the southwest corner through a low portion of the berm and into the adjoining cypress swamp. The water was only a few inches deep--well below the rim of the outflow ditch--and was very murky and stagnant. This condition may have been due to prevailing climatic conditions, since the site was sampled prior to the onset of the rainy season.

Soil/Substrate

The substrate was slimy and covered with algae. The soil chromas ranged from /4 to /1, with /2 the dominant chroma found. Mottling was found in most samples, especially at a depth of 25-30 cm.

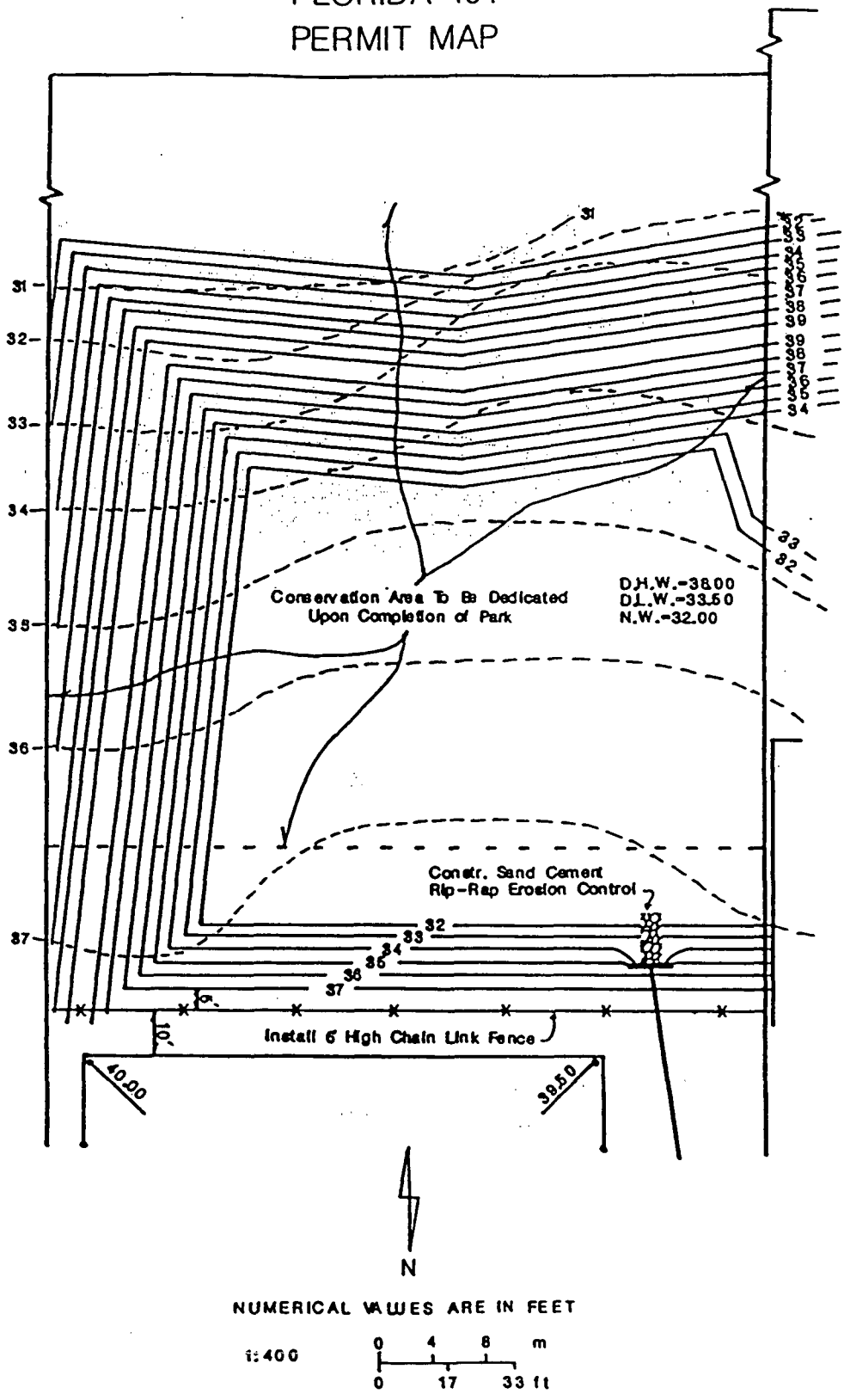
Dominant Vegetation

A profusion of cattails (**Typha domingensis**) grew along the west and north sides of the pond and were particularly thick at the inflow (northwest corner) of the basin.

Other invasive species dominating the site were primrose willow (**Ludwigia peruviana**), dog fennel (**Eupatorium capillifolium**) and salt-bush (**Baccharis halimifolia**). These were found along the sides and top of the berm, along with **Juncus effusus** and **J. megacephalus**.

See the Vegetation Summary section of this description for a complete listing of the species identified.

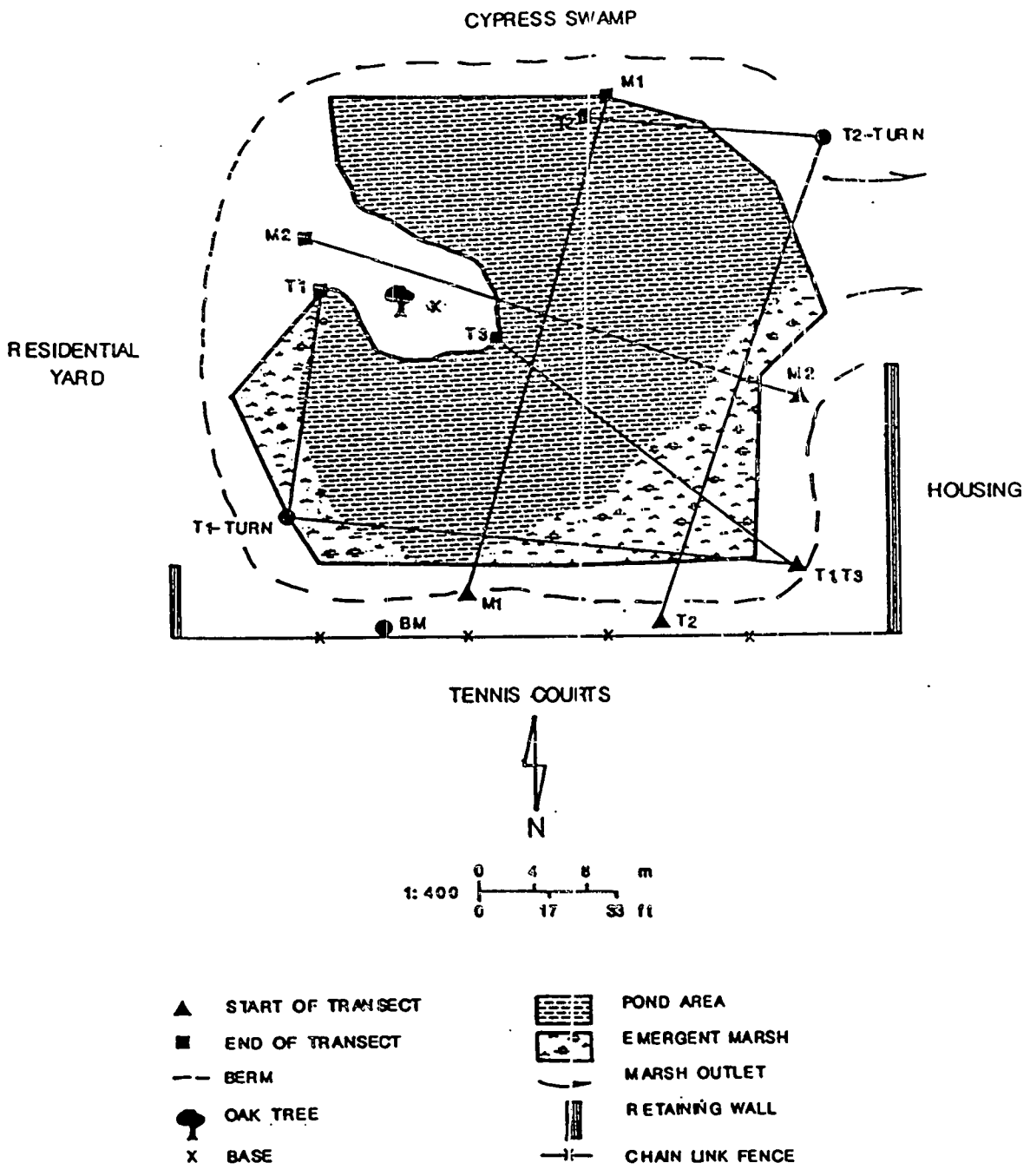
FLORIDA 101
PERMIT MAP



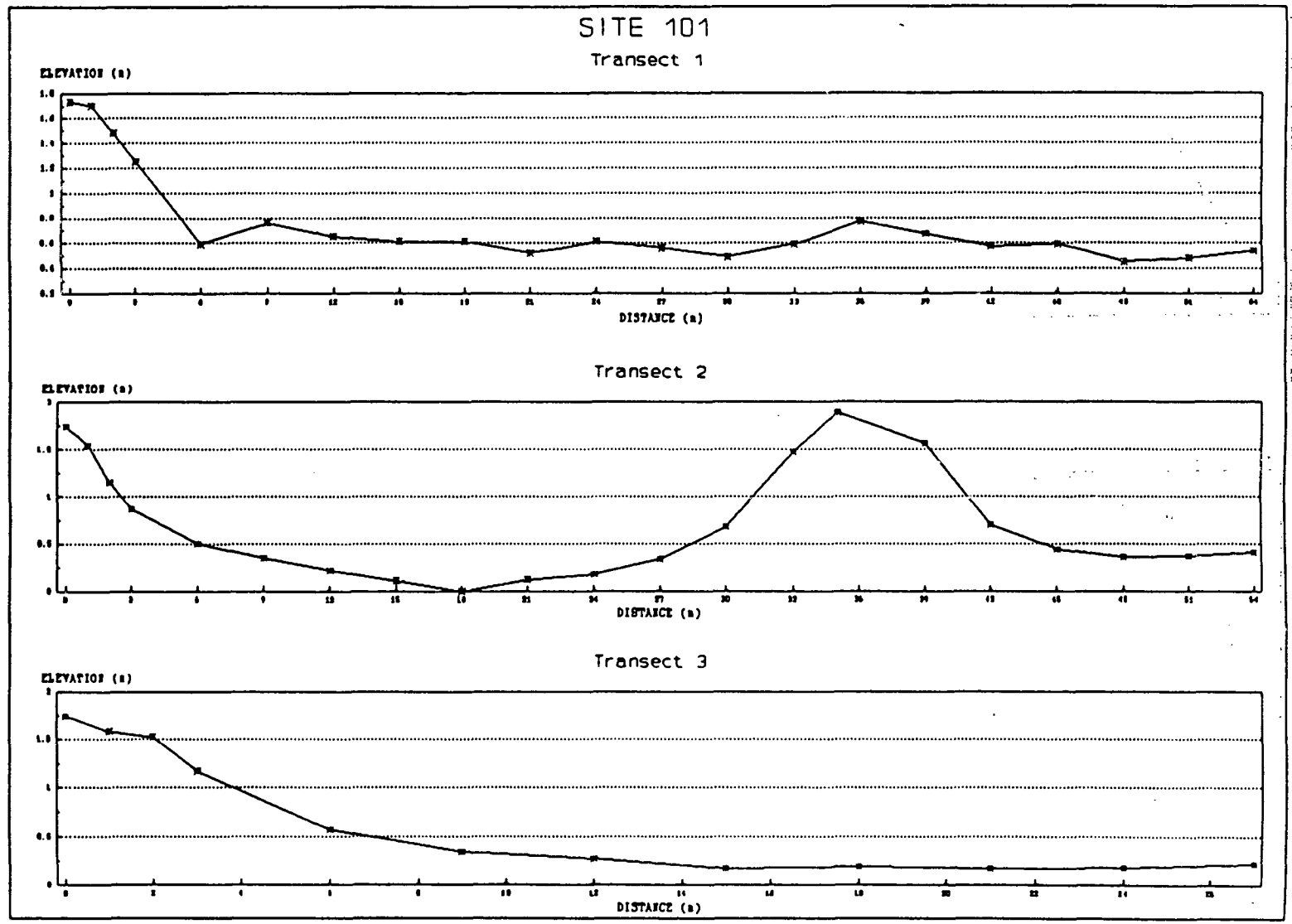
NUMERICAL VALUES ARE IN FEET

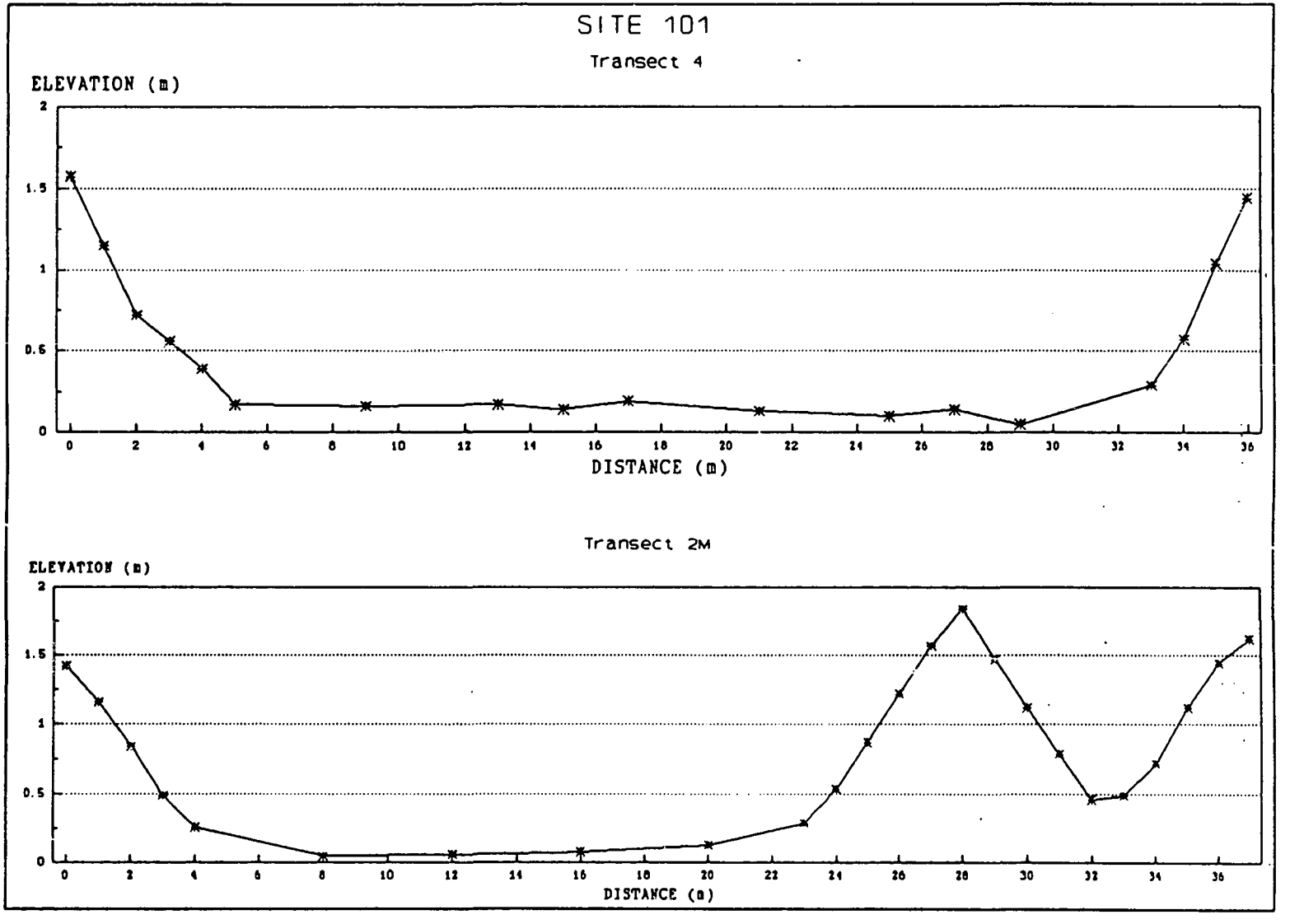
1:400 0 4 8 m
0 17 33 ft

FLORIDA 101
FIELD MAP



SOURCE: DATA COLLECTED MAY, 1988


SITE 101
Transect 1
ELEVATION (m)
DISTANCE (m)
Transect 2
ELEVATION (m)
DISTANCE (m)
Transect 3
ELEVATION (m)
DISTANCE (m)


SITE 101
Transect 4
ELEVATION (m)
2
1.5
1
0.5
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
DISTANCE (m)
Transect 2M
ELEVATION (m)
2
1.5
1
0.5
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

<u>Species Listed for Planting in Created Wetland 101</u>

Pontederia cordata	OBL\NAT
Sagittaria lancifolia	OBL\NAT
Taxodium spp.	OBL\NAT

<u>Species Found On Site 101 during Summer 1988</u>

Acer rubrum	FAC\NAT
Andropogon glomeratus	FACW+NAT
Axonopus affinis	FACW-NAT
Baccharis halimifolia	FAC\NAT
Bacopa monnieri	OBL\NAT
Bidens alba	FACW-NAT
Carex albolutescens	FAC+NAT
Centella asiatica	FACW\NAT
Commelina diffusa	FACW\EXO
Cynodon dactylon	FACU\NAT
Cyperus brevifolius	FACW\NAT
Cyperus spp.	???
Dioscorea bulbifera	FACU\EXO
Eclipta alba	FACW-NAT
Erechtites hieracifolia	FAC-NAT
Erigeron quercifolius	FAC+NAT
Eriocaulon sp.	???
Eupatorium compositifolium	FACU\NAT
Euthamia tenuifolia	FAC\NAT
Hydrocotyle umbellata	OBL\NAT
Hypericum hypericoides	FACU\NAT

Juncus effusus	FACW+NAT
Juncus marginatus	FACW\NAT
Juncus megacephalus	OBL\NAT
Lindernia anagallidea	FAC+NAT
Lippia nodiflora	FACWdNAT
Ludwigia octovalvis	OBL\NAT
Ludwigia palustris	OBLdNAT
Ludwigia peruviana	OBL\NAT
Macroptilium lathyroides	FACU\EXO
Micranthemum glomeratum	OBL\NAT
Mikania scandens	FACW+NAT
Myrica cerifera	FAC+NAT
Oxalis florida	FACU\NAT
Panicum ciliatum	FAC\NAT
Parietaria floridana	FACdNAT
Paspalum notatum var. saurae	FACU+EXO
Paspalum urvillei	FAC\EXO
Phyla nodiflora	FACWdNAT
Pluchea odorata	FACW\EXO
Polygonum densiflorum	OBL\NAT
Polygonum hydropiperoides	OBL\NAT
Ptilimnium capillaceum	OBL\NAT
Sacciolepis indica	FAC\EXO
Sacciolepis striata	OBL\NAT
Salix caroliniana	OBL\NAT
Sesbania macrocarpa	FACW\NAT
Typha domingensis	OBL\NAT
Vitis rotundifolia	FAC\NAT

DESCRIPTION: SITE 102

Function/Purpose

Stormwater detention basin for office complex.

General Physical Description

The created wetland is a rectangular detention basin adjacent to the parking lot of an office complex located to the north and adjoining a swamp forest to the west. A westward-flowing creek meanders along the southern border of the basin, and the eastern side is flanked by a flat, upland area dominated by pines (**Pinus** spp.) and oaks (**Quercus** spp.). The basin is surrounded by a grassy berm, one to two meters high.

Hydrology

Stormwater enters the wetland through a two foot diameter concrete culvert located at the northern end of the basin. Primary outflow occurs at a low area in the berm at the northeast corner of the basin. From there, water flows into a canal which drains into the stream at the southern end of the site.

The western side of the basin has a concrete spillway designed to handle excessive water flows from the basin. Outflow from this structure is directed into the adjacent forested swamp.

Soil/Substrate

Low chroma values--primarily /1--were found in many of the soil samples. Mottles were found in nearly half the samples, however, the basin and soil pits were dry when sampled.

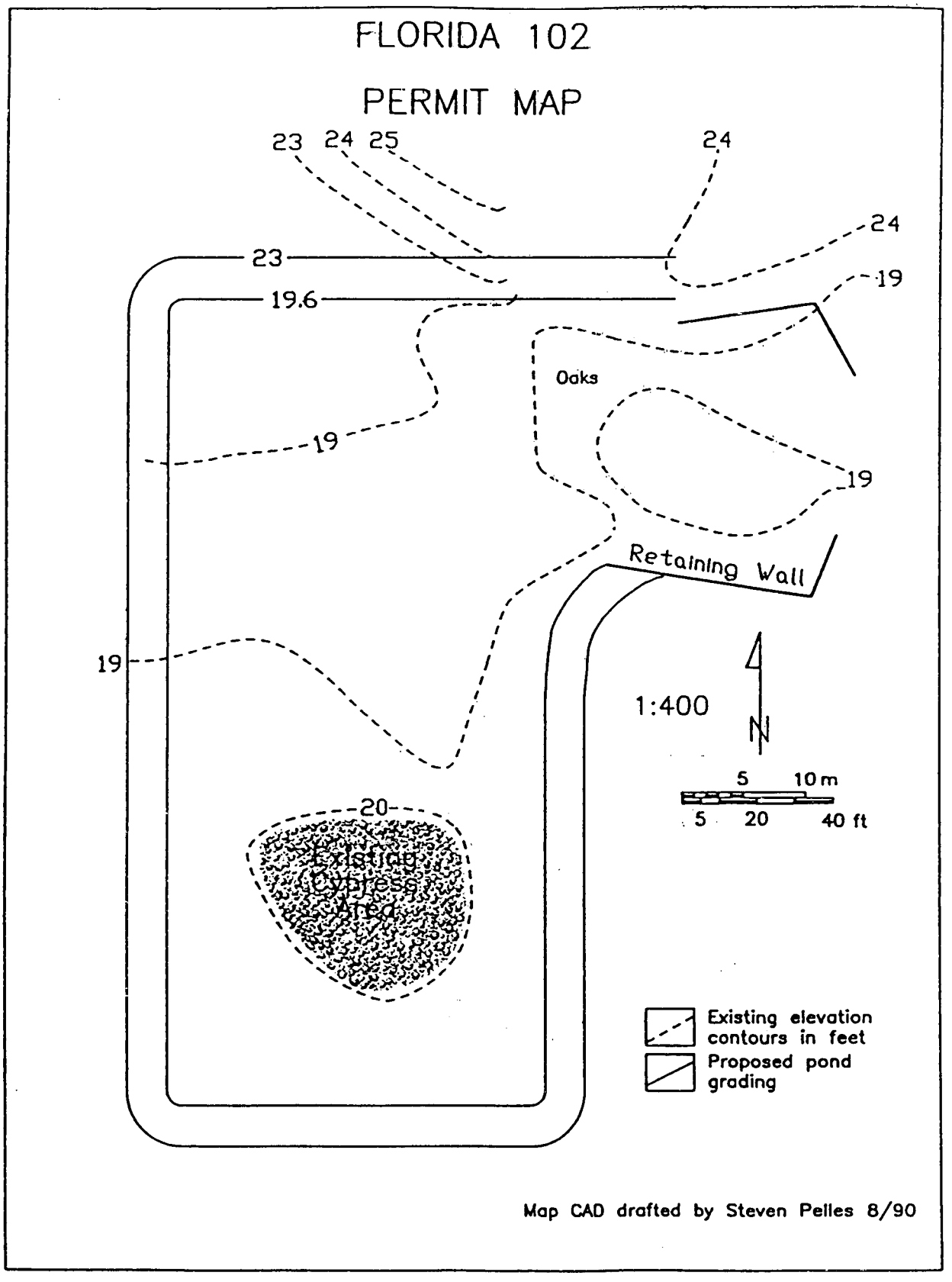
Dominant Vegetation

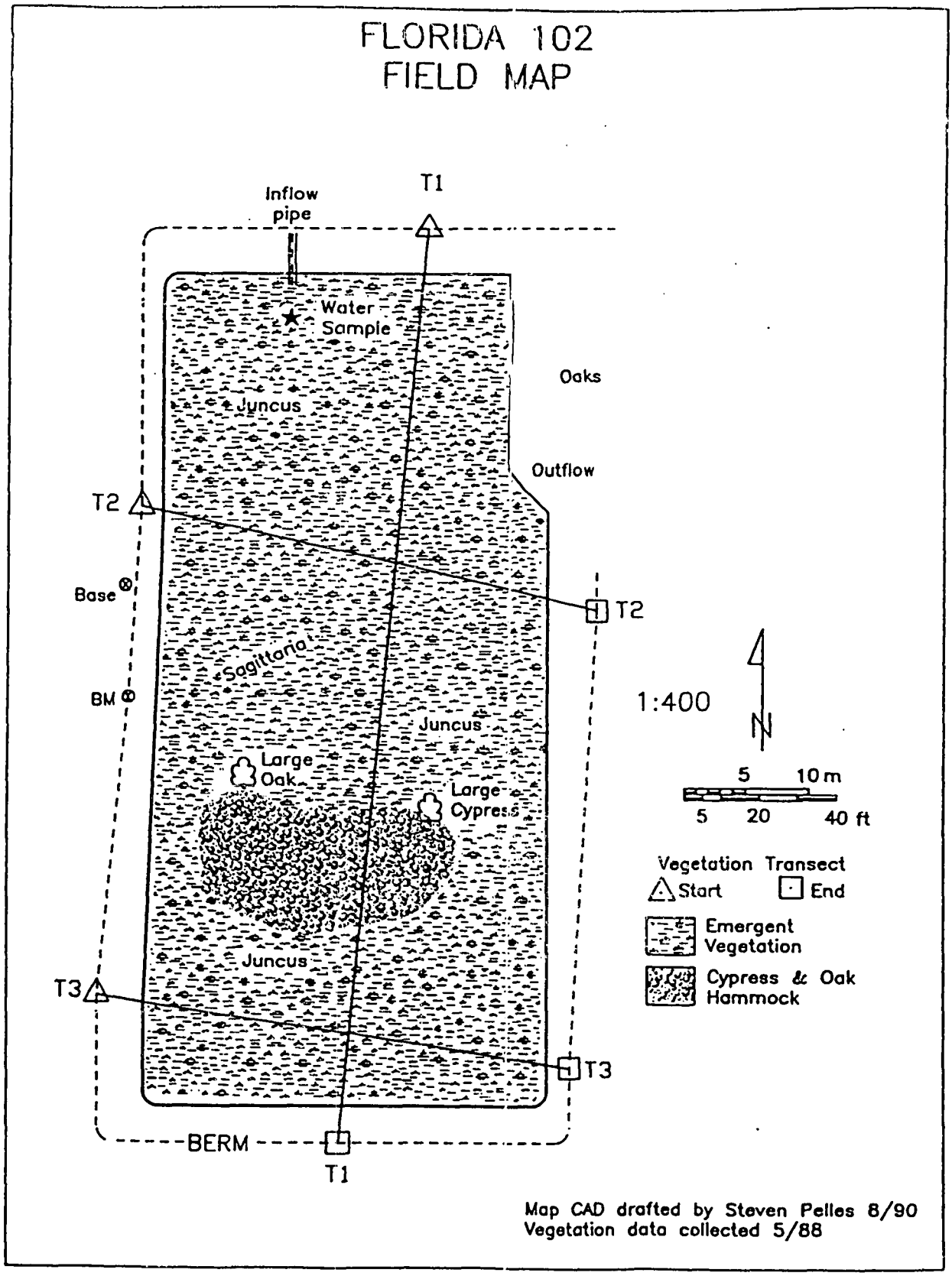
The site was lushly vegetated with a high diversity of species. The site was planned as a marsh and swamp system, survival of both herbaceous and woody vegetation was high. The dominant species--soft rush (**Juncus effusus**), pickerelweed (**Pontedaria cordata**), and arrowhead (**Sagittaria lancifolia**)--formed two major zones within the site. The **Juncus** community dominated the northern and southern portions of the site, and were separated by a **Sagittaria/Pontedaria** community, which formed a band running southwest to northeast across the wetland from the outfall structure to the overflow of the berm in the northeast corner.

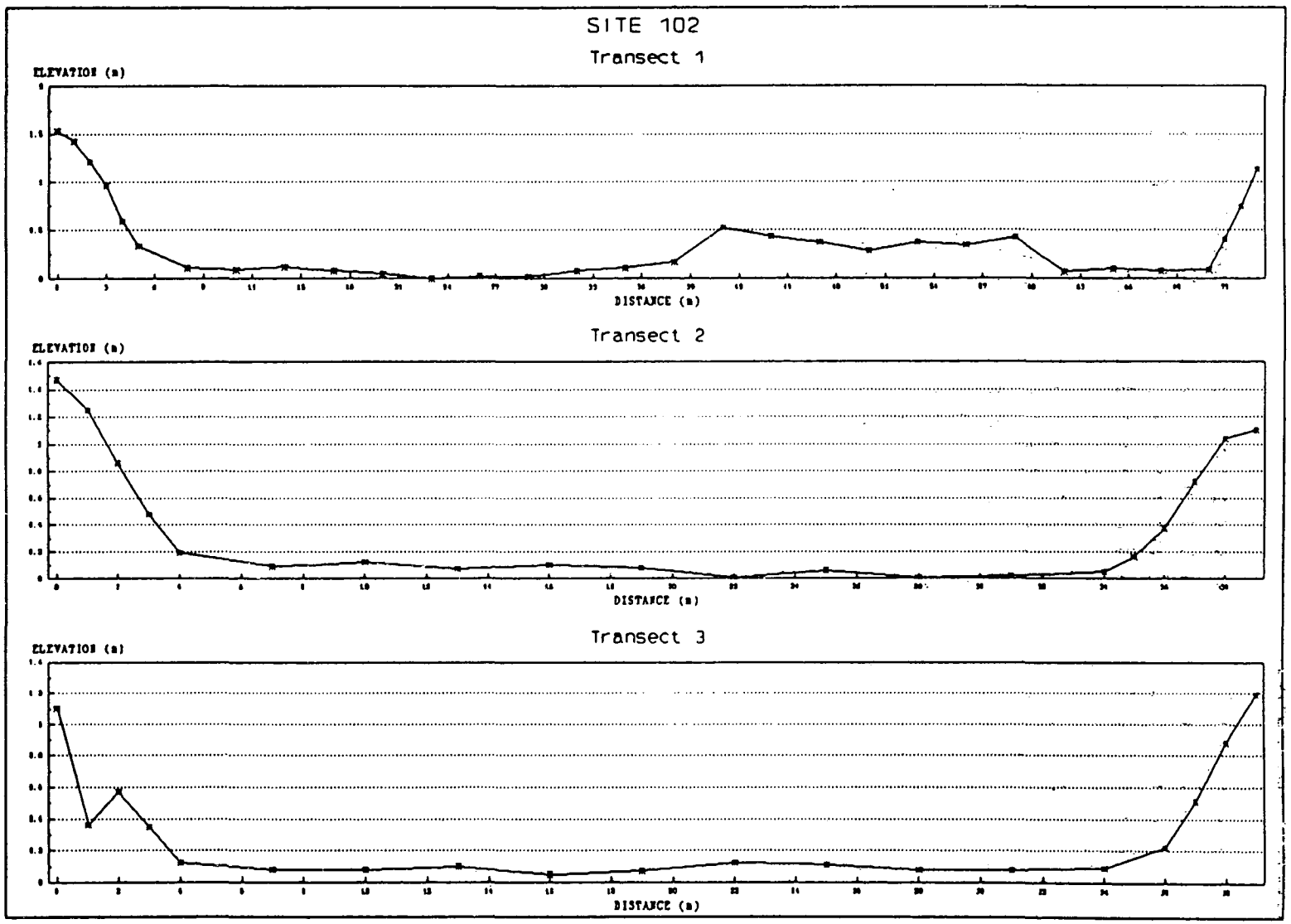
A small forested "hammock" located in the south-central portion of the wetland contained several bald cypress (**Taxodium distichum**), laurel oak (**Quercus laurifolia**)

and citrus (**Citrus** spp.) trees of fairly significant size. Cypress and oak seedlings were found throughout the site, as well as red maple (**Acer rubrum**) and willow (**Salix caroliniana**).

See the Vegetation Summary section of this description for a complete listing of the species identified.


FLORIDA 102
PERMIT MAP
23
24
25
24
24
23
19.6
19
Oaks
19
19
Retaining Wall
19
1:400
N
5
10 m
5
20
40 ft
20
Existing Cypress Area
Existing elevation contours in feet
Proposed pond grading
Map CAD drafted by Steven Pelles 8/90


FLORIDA 102
FIELD MAP
Inflow pipe
T1
Water Sample
Oaks
Juncus
Outflow
T2
Base
BM
Sagittaria
Juncus
Large Oak
Large Cypress
1:400
N
5 10 m
5 20 40 ft
Vegetation Transect
Start
End
Emergent Vegetation
Cypress & Oak Hammock
Juncus
T3
BERM
T1
Map CAD drafted by Steven Pelles 8/90
Vegetation data collected 5/88


SITE 102
Transect 1
ELEVATION (m)
DISTANCE (m)
Transect 2
ELEVATION (m)
DISTANCE (m)
Transect 3
ELEVATION (m)
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

Species Listed for Planting in Created Wetland 102

In addition to the species listed for planting, the site was mulched.

Ilex cassine	FACW\NAT
Iris hexagona*	OBL\NAT
Osmunda cinnamonea	FACW+NAT
Peltandra virginica*	OBL\NAT
Pontederia cordata*	OBL\NAT
Sagittaria lancifolia*	OBL\NAT
Saururus cernuus	OBL\NAT
Spartina bakeri*	FACW+NAT
Taxodium spp.	OBL\NAT

Species Found On Site 102 during Summer 1988

Acer rubrum	FAC\NAT
Alternanthera philoxeroides	OBL\EXO
Ambrosia artemisiifolia	FACU-NAT
Ammannia coccinea	FACW+NAT
Ampelopsis arborea	FAC+NAT
Baccharis halimifolia	FAC\NAT
Bacopa monnieri	OBL\NAT
Bidens alba	FACW-NAT
Canna flaccida	OBL\NAT
Carex albolutescens	FAC+NAT
Carex stipata	FACW\NAT
Celtis laevigata	FACW\NAT
Chamaecrista fasciculata	FACW\NAT

Citrus sp.	???
Commelina diffusa	FACW\EXO
Cynodon dactylon	FACW\NAT
Cyperus brevifolius	FACW\NAT
Cyperus haspan	OBL\NAT
Cyperus polystachyos	FACW\NAT
Cyperus rotundus	FAC-EXO
Cyperus spp.	???
Cyperus surinamensis	FACW\NAT
Digitaria decumbens	FACU\EXO
Eclipta alba	FACW-NAT
Erigeron quercifolius	FAC+NAT
Eryngium baldwinii	FACW+NAT
Eupatorium capillifolium	FACW\NAT
Fuirena pumila	OBL\NAT
Galium tinctorium	FACW\NAT
Galium uniflorum	FACW\NAT
Hydrocotyle umbellata	OBL\NAT
Hydrocotyle verticillata	OBL\NAT
Iris hexagona*	OBL\NAT
Juncus dichotomus	FACW\NAT
Juncus effusus	FACW+NAT
Juncus marginatus	FACW\NAT
Juncus megacephalus	OBL\NAT
Juncus scirpoides	FACW+NAT
Ludwigia octovalvis	OBL\NAT
Ludwigia palustris	OBLdNAT
Ludwigia peruviana	OBL\NAT
Ludwigia repens	OBL\NAT
Lythrum alatum	FACW\NAT
Micranthemum umbrosum	OBLdEXO
Mikania scandens	FACW+NAT
Oxalis sp.	???
Panicum maximum	FAC-EXO
Panicum repens	FACW-EXO
Paspalum distichum	OBL\NAT
Paspalum urvillei	FAC\EXO
Peltandra virginica*	OBL\NAT
Phyla nodiflora	FACWdNAT
Plantago virginicus	FACU-NAT
Pluchea odorata	FACW\EXO
Polygonum hydropiperoides	OBL\NAT
Pontederia cordata*	OBL\NAT
Ptilimnium capillaceum	OBL\NAT
Quercus laurifolia	FACW\NAT

Rhynchospora mixta	OBL\NAT
Rhynchospora spp.	???
Rubus sp.	???
Rumex pulcher	FACW\EXO
Sagittaria lancifolia*	OBL\NAT
Sagittaria latifolia	OBL\NAT
Salix caroliniana	OBL\NAT
Samolus valerandi	OBL\NAT
Scoparia dulcis	FACW\NAT
Senecio glabellus	FACW+NAT
Senna obtusifolia	FAC\NAT
Sesbania macrocarpa	FACW\NAT
Solidago sempervirens	FACW\NAT
Spartina bakeri*	FACW+NAT
Tall grass	???
Taxodium distichum	OBL\NAT
Thalia geniculata	OBL\NAT
Typha domingensis	OBL\NAT
Urena lobata	FACW\NAT
Verbena scabra	FACW+NAT
Vigna luteola	FACW\NAT

DESCRIPTION: SITE 103

Function/Purpose

This wetland is one of five marshes created as mitigation for a large residential subdivision. Totalling approximately six acres, the five created wetlands are scattered throughout the development. Two of the five mitigation sites were sampled: site 103 was one; site 104 was the other.

General Physical Description

This wetland is a long, narrow pond situated between a major thoroughfare of the subdivision and a large cypress (**Taxodium distichum**) swamp. A grassy area along the northern border of the wetland separates it from the roadway. A small shrubby island separates the wetland from the road at it's northwest corner, and the cypress swamp is adjacent to the wetlands's southern edge. The southwestern tip of the site borders a golf course which is part of the subdivision. Dozens of golf balls were found throughout the eastern portion of the marsh.

The created wetland is somewhat shallow, gently grading from the upland edge to a depth of one to two meters. Unlike many of the study sites which were created to serve as stormwater retention ponds, the morphology of this site is much more similar to the morphology of natural Florida marshes.

Hydrology

This marsh is hydrologically connected to the adjacent cypress swamp by three small drainage ditches. These ditches allow the marsh to drain into the swamp when water levels rise above the vegetated portion of the system. No direct inflow pipes or ditches were noted during the field survey. The created wetland probably receives runoff waters from the golf course and, to lesser degree, from other portions of the development.

Soil/Substrate

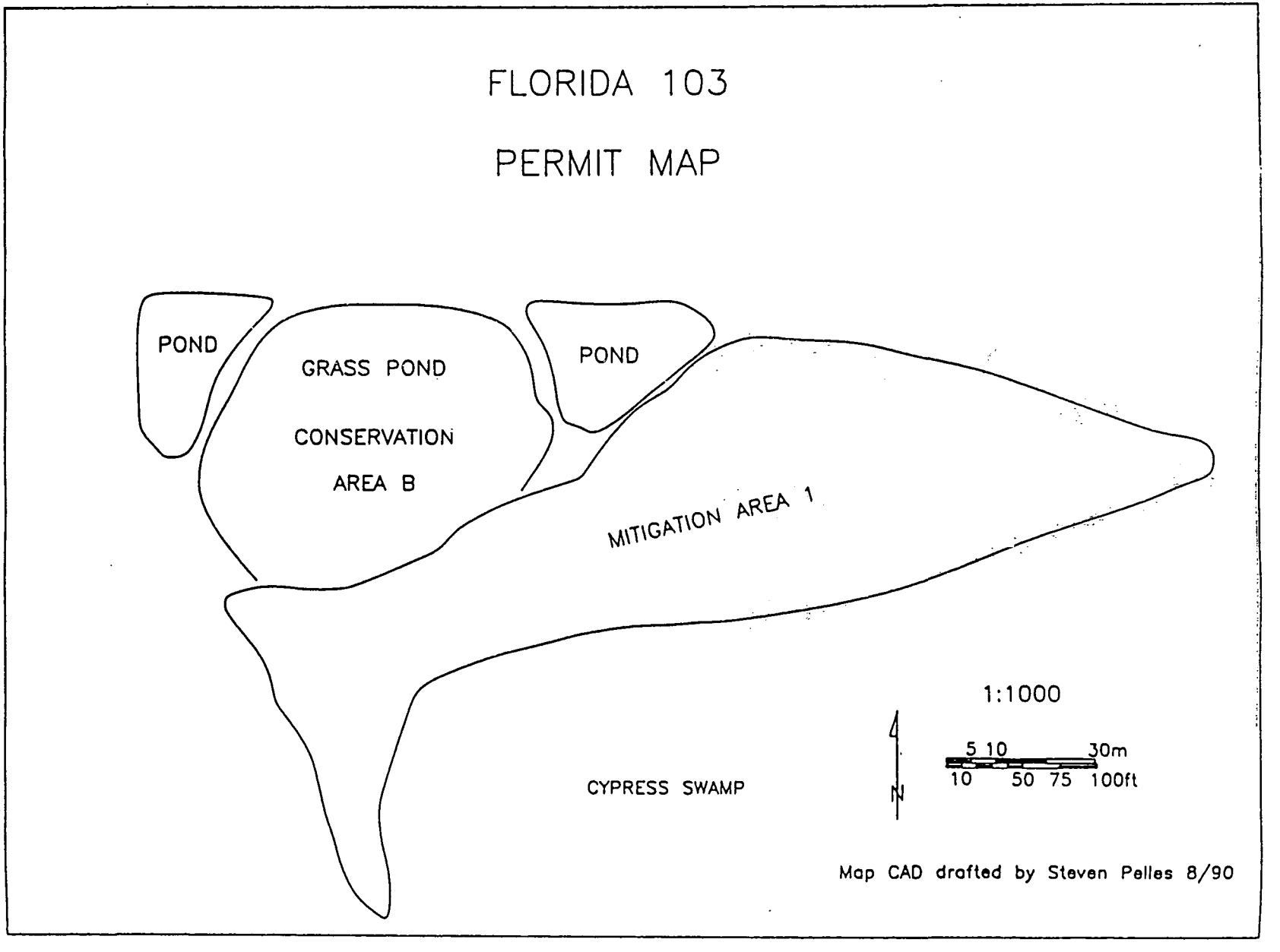
A wide range of soil chromas were found. Most were either /1 or /4, although chromas of /2, /3 and /8 were noted. Mottling occurred in upper and lower layers of all the core samples except one.

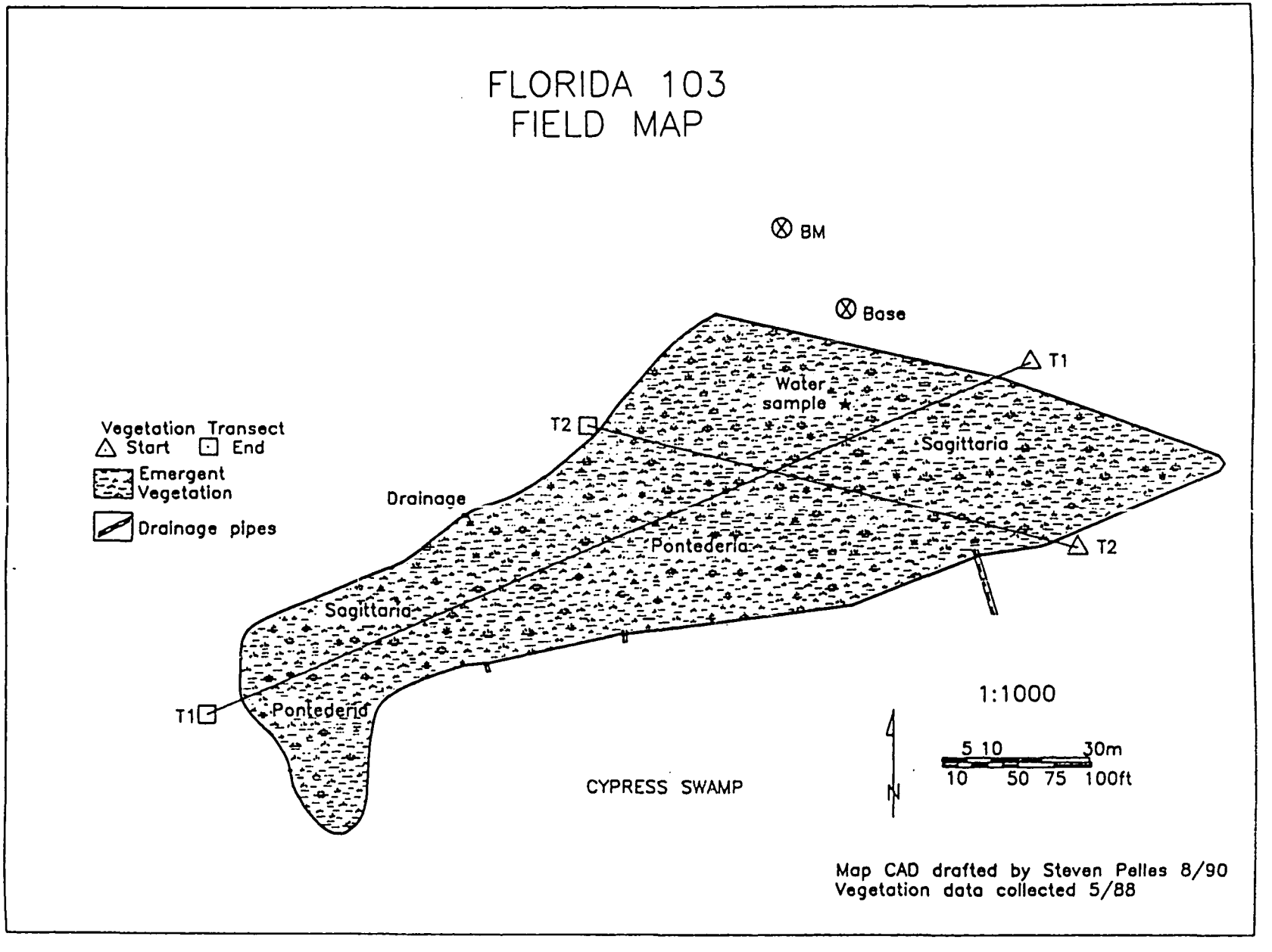
Dominant Vegetation

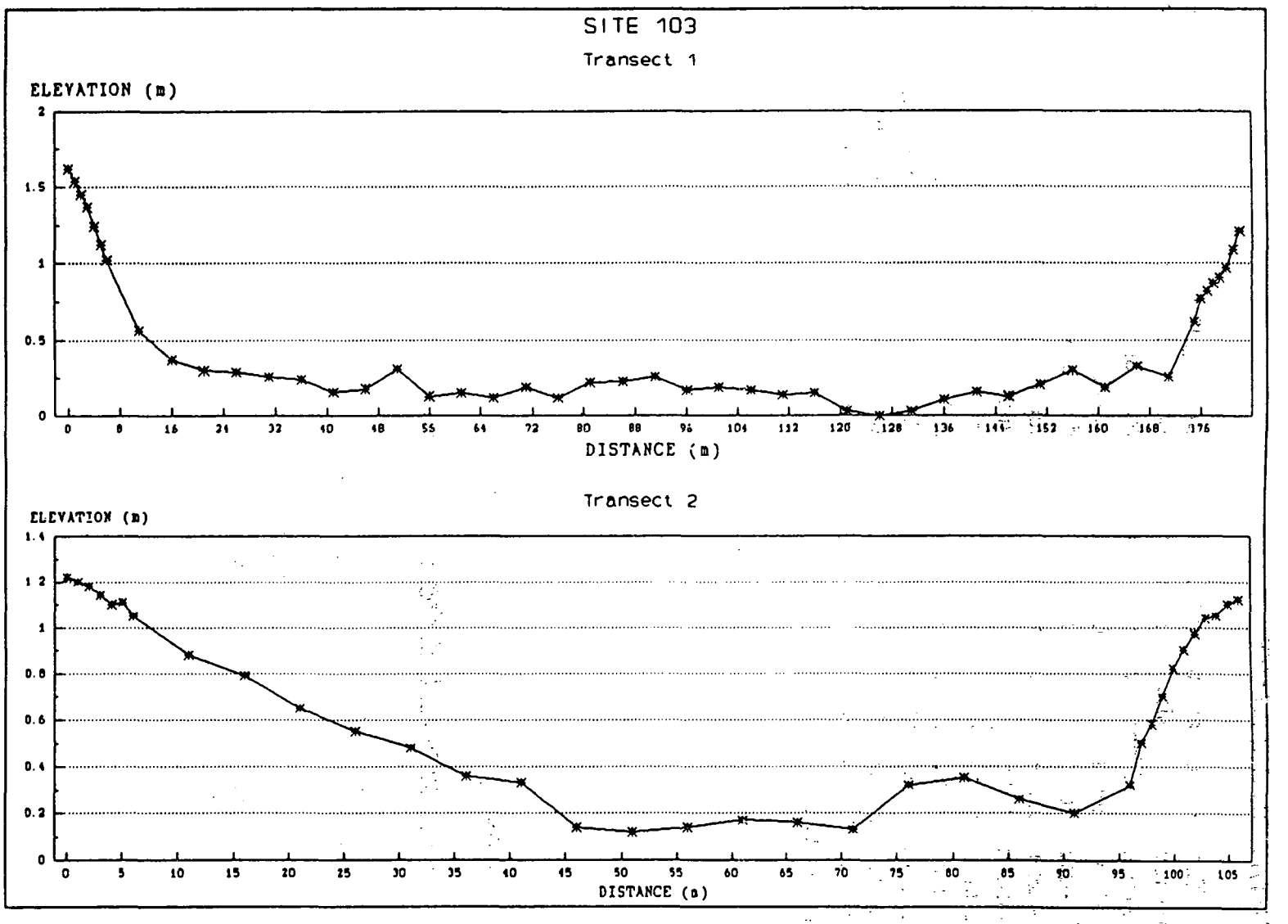
A large proportion of the created wetland was dominated by pickerelweed (**Pontedaria cordata**) and arrowhead (**Sagittaria lancifolia**). Only 28% (11/40) of the

plots sampled had any other species and these were primarily found along the outer margins of the marsh.

See the Vegetation Summary section of this description for a complete listing of the species identified.


FLORIDA 103
PERMIT MAP
POND
GRASS POND
CONSERVATION
AREA B
POND
MITIGATION AREA 1
CYPRESS SWAMP
1:1000
N
5 10 30m
10 50 75 100ft
Map CAD drafted by Steven Pelles 8/90


FLORIDA 103
FIELD MAP
BM
Base
T1
Water sample
T2
Sagittaria
Vegetation Transect
Start
End
Emergent Vegetation
Drainage pipes
Drainage
Pontederia
T2
Sagittaria
T1
Pontederia
CYPRESS SWAMP
1:1000
5 10
30m
10 50 75 100ft
N
Map CAD drafted by Steven Pelles 8/90
Vegetation data collected 5/88


SITE 103
Transect 1
ELEVATION (m)
DISTANCE (m)
Transect 2
ELEVATION (m)
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

Species Listed for Planting in Created Wetland 103

In addition to the species listed for planting, the site was mulched.

Hypericum fasciculatum	FACW+NAT
Juncus effusus*	FACW+NAT
Pontederia spp.	???
Sagittaria spp.	???
Spartina bakeri	FACW+NAT

Species Found on Site 103 during Summer 1988

Andropogon virginicus	FAC-NAT
Axonopus affinis	FACW-NAT
Axonopus furcatus	OBL\NAT
Carex albolutescens	FAC+NAT
Cyperus globulosus	FAC\NAT
Cyperus haspan	OBL\NAT
Cyperus polystachyos	FACW\NAT
Cyperus spp.	???
Eleocharis baldwinii	FACW+NAT
Eryngium baldwinii	FACW+NAT
Eupatorium capillifolium	FACU\NAT
Euthamia tenuifolia	FAC\NAT
Gratiola pilosa	FACW-NAT
Hydrocotyle umbellata	OBL\NAT
Hypericum cistifolium	FACW\NAT
Hypericum mutilum	FACW\NAT
Juncus dichotomus	FACW\NAT

Juncus effusus*	FACW+NAT
Juncus marginatus	FACW\NAT
Juncus scirpoides	FACW+NAT
Lachnanthes carolininana	OBL\NAT
Lachnocaulon anceps	OBL\NAT
Leersia hexandra	OBL\NAT
Linaria sp.	???
Ludwigia maritima	FACW\NAT
Ludwigia palustris	OBLdNAT
Ludwigia peruviana	OBL\NAT
Ludwigia repens	OBL\NAT
Ludwigia spp.	???
Luziola fluitans	OBL\NAT
Mikania scandens	FACW+NAT
Myrica cerifera	FAC+NAT
Panicum repens	FACW-EXO
Polygonum hydropiperoides	OBL\NAT
Polypremum procumbens	FAC\NAT
Pontederia cordata	OBL\NAT
Ptilimnium capillaceum	OBL\NAT
Rhynchospora fascicularis	FACW+NAT
Rhynchospora microcarpa	FACW+NAT
Rhynchospora microcephala	OBL\NAT
Sacciolepis indica	FAC\EXO
Sagittaria lancifolia	OBL\NAT
Sagittaria sp.	???
Scoparia dulcis	FACU\NAT
Typha domingensis	OBL\NAT
Urena lobata	FACU\NAT
Utricularia fibrosa	OBL\NAT
Woodwardia virginica	OBL\NAT
Xyris jupicai	OBL\NAT

DESCRIPTION: SITE 104

Function/Purpose

This marsh was created in the same subdivision as Site 103. This created wetland is located just off an access road in what was an as-yet-unbuilt portion of the development.

General Physical Description

This wetland is nearly circular in shape. The south and west sides are bordered by grassy-scrub, comprised of various grasses and patches of saw palmetto (**Serenoa repens**). The northwestern portion of the site borders on two large, concrete retention basins which separate the created wetland from an adjacent access road. Two cypress (**Taxodium** spp.) domes are near the northwest and southwest edges of the site.

The wetland was built in 1978-1979. No vegetation was planted on the site, however, the area was "mulched" with organic matter from three donor wetlands.

Hydrology

No surface inflow points were found around the perimeter of the marsh and there was no connection between this site and the nearby retention basins. A small outflow ditch at the northwest edge of the created wetland connected it with an adjacent cypress dome. A small concrete weir is located in the ditch, about halfway between the created wetland and the cypress dome. A small pond, about one meter deep, was located in the center of the created wetland.

Soil/Substrate

Soil chromas varied, although most were hydric, as might be expected since the site received peat from other wetlands. The majority of the chromas were /0 and /1, however, /2, /3 and /4 were present.

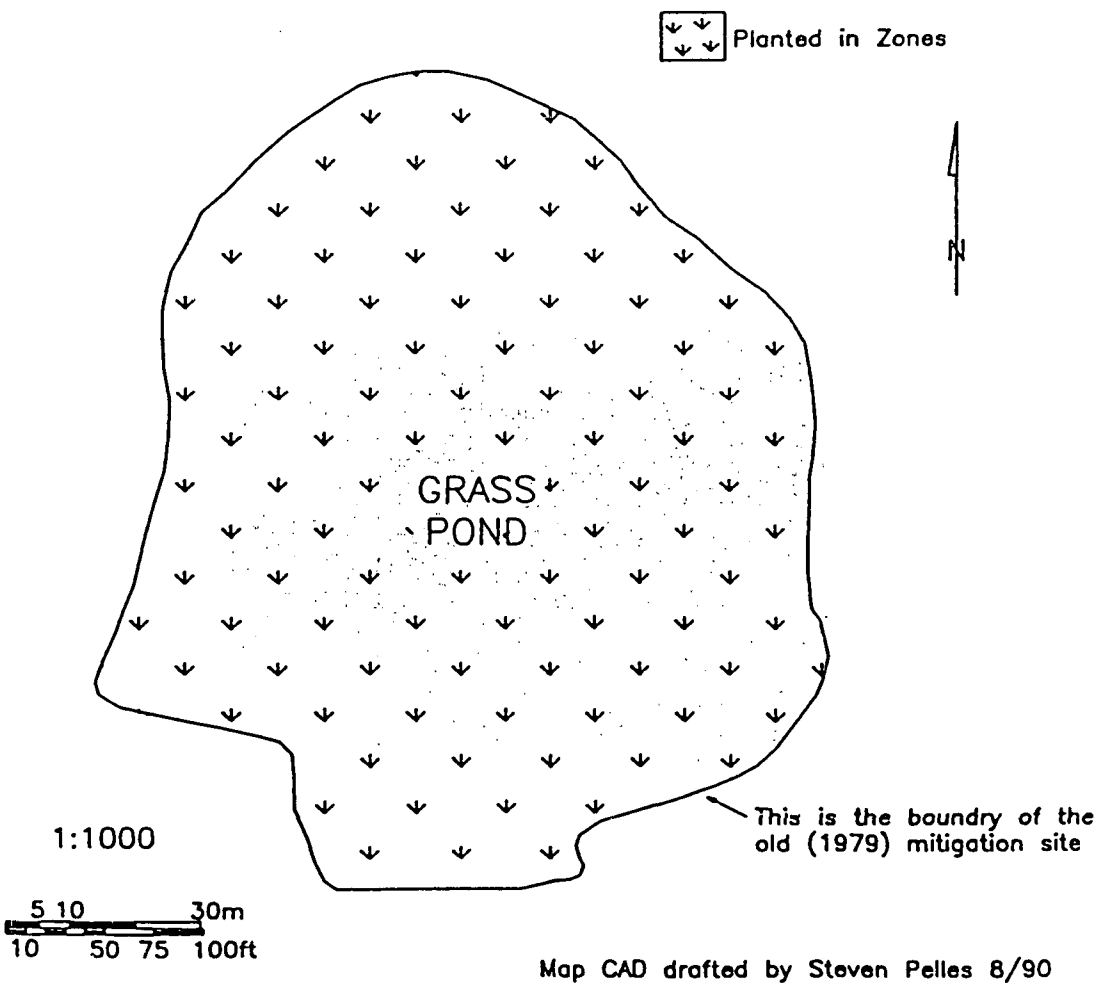
Dominant Vegetation

The created wetland was divided into four distinct zones, including the open water in the center of the site. Shoreward from the open water, the other three zones were dominated by pickerelweed (**Pontedaria cordata**), maidencane (**Panicum hemitomon**) and St. John's wort (**Hypericum fasciculatum**), respectively.

See the Vegetation Summary section of this description for a complete listing of the species identified.

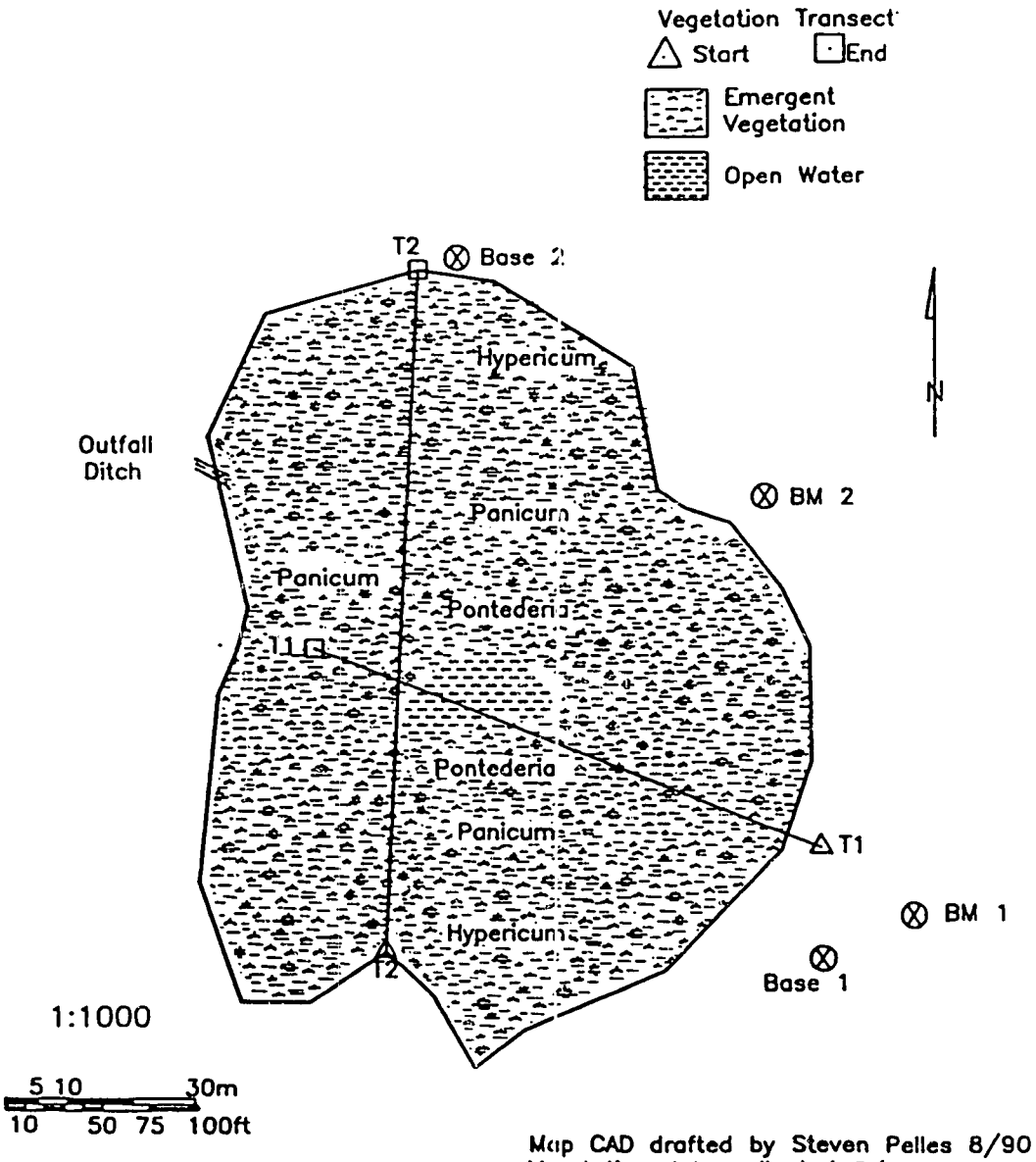
FLORIDA 104

PERMIT MAP

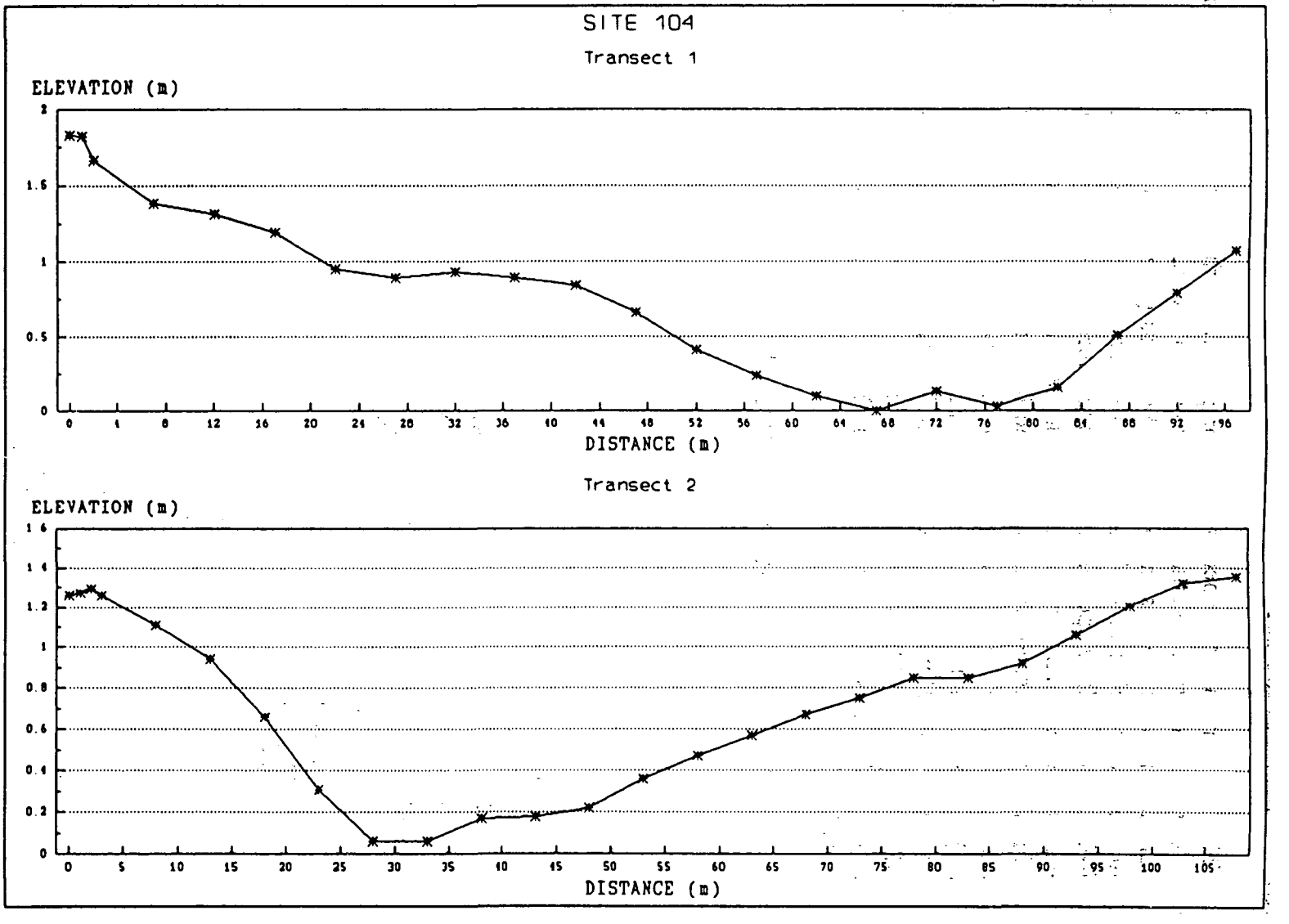


Map CAD drafted by Steven Pelles 8/90

FLORIDA 104
FIELD MAP



Map CAD drafted by Steven Pelles 8/90
Vegetation data collected 5/88


SITE 104
Transect 1
ELEVATION (m)
DISTANCE (m)
Transect 2
ELEVATION (m)
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

Species Listed for Planting in Created Wetland 104

This site was not planted, however, it was mulched.

Species Found On Site 104 during Summer 1988

Amphicarpum muhlenbergian	FACW\NAT
Andropogon virginicus	FAC-NAT
Aristida spiciformis	FAC\NAT
Axonopus affinis	FACW-NAT
Centella asiatica	FACW\NAT
Drosera capillaris	OBL\NAT
Eleocharis baldwinii	FACW+NAT
Eleocharis interstincta	OBL\NAT
Eriocaulon compressum	OBL\EXO
Eriocaulon decangulare	OBL\EXO
Eupatorium leptophyllum	FAC+NAT
Eupatorium mohrii	FACU\NAT
Euthamia tenuifolia	FAC\NAT
Fuirena scirpoidea	OBL\NAT
Gratiola ramosa	FACW\NAT
Hypericum fasciculatum	FACW+NAT
Hypericum myrtifolium	FACW\NAT
Juncus megacephalus	OBL\NAT
Lachnanthes carolininana	OBL\NAT
Oxypolis filiformis	FACW+NAT
Panicum erectifolium	OBL\NAT
Panicum hemitomon	OBL\NAT
Panicum laxiflorum	FACW\NAT

Paspalum setaceum	FAC\NAT
Pluchea rosea	FACW\NAT
Polygala ramosa	OBL\NAT
Pontederia cordata	OBL\NAT
Proserpinaca pectinata	OBL\NAT
Rhexia mariana	FACW+NAT
Rhexia nuttallii	FACW+NAT
Rhynchospora filifolia	FACW-NAT
Rhynchospora microcephala	OBL\NAT
Rhynchospora mixta	OBL\NAT
Rhynchospora tracyi	OBL\NAT
Sagittaria graminea	OBL\NAT
Syngonanthus flavidulus	FACW+NAT
Xyris caroliniana	FACW+NAT
Xyris elliottii	OBL\NAT

DESCRIPTION: SITE 105

Function/Purpose

This site is one of two (see Site 106) stormwater runoff basins in a residential development.

General Physical Description

The wetland is a very small, deep pond in the midst of a high density development. It is bordered by lawns and is completely surrounded by the development. The south side abuts a sidewalk and roadway, and the west side is separated from housing by a brick wall. The north and east sides are bordered by extensive lawns, which contain a duck pond and a clubhouse. The sides of the created wetland are fairly steep and grade into a deep pond.

Hydrology

In addition to runoff from the surrounding lawn, the wetland is fed by a pipe which drains directly from an adjoining roadway to the southeast of the wetland. An outfall structure leads from the created wetland into a cypress swamp, located to the south.

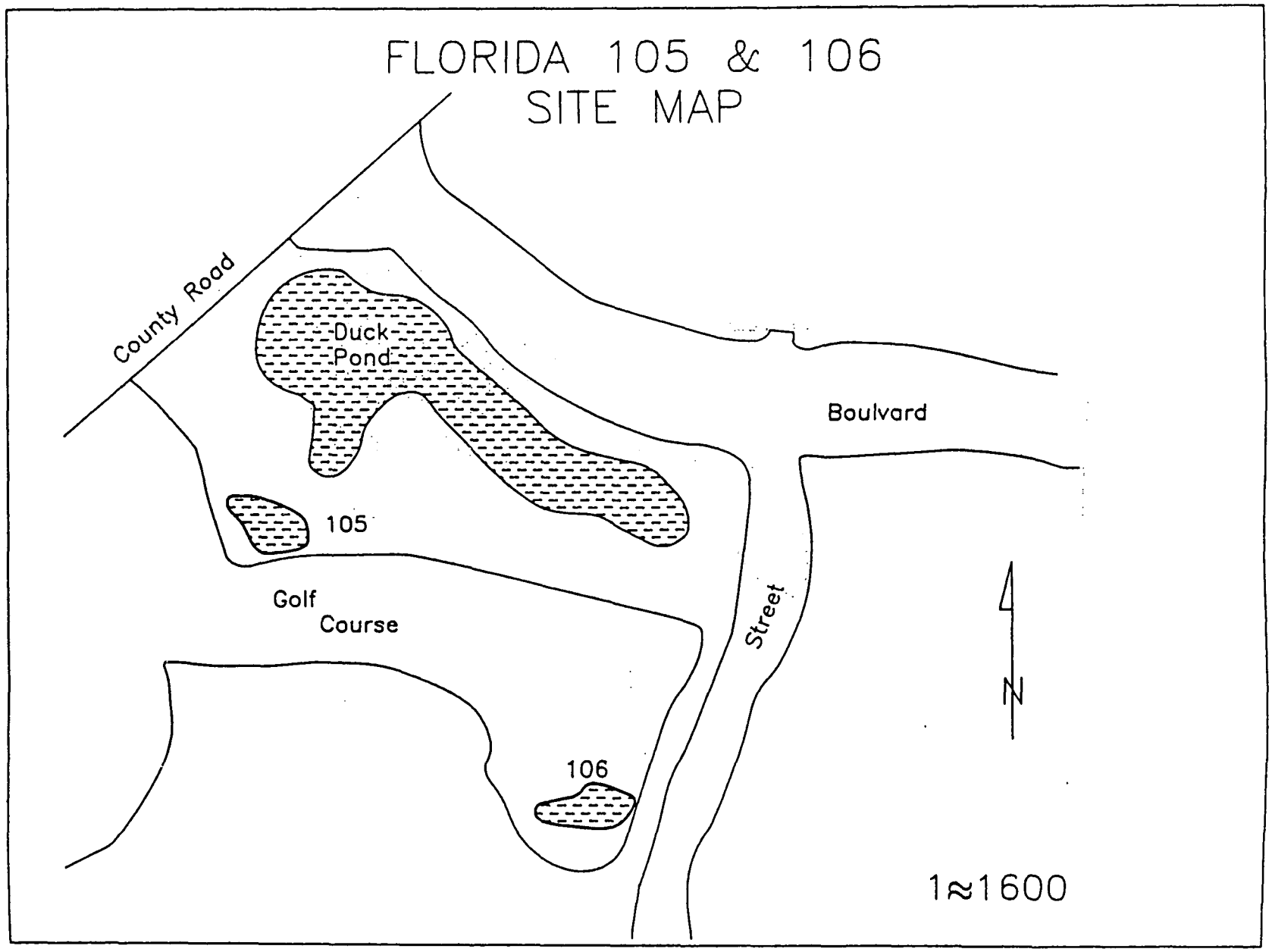
Soil/Substrate

Eight of the soil samples had chromas of /1, while the remaining two had a chroma of /2. No mottling was evident.

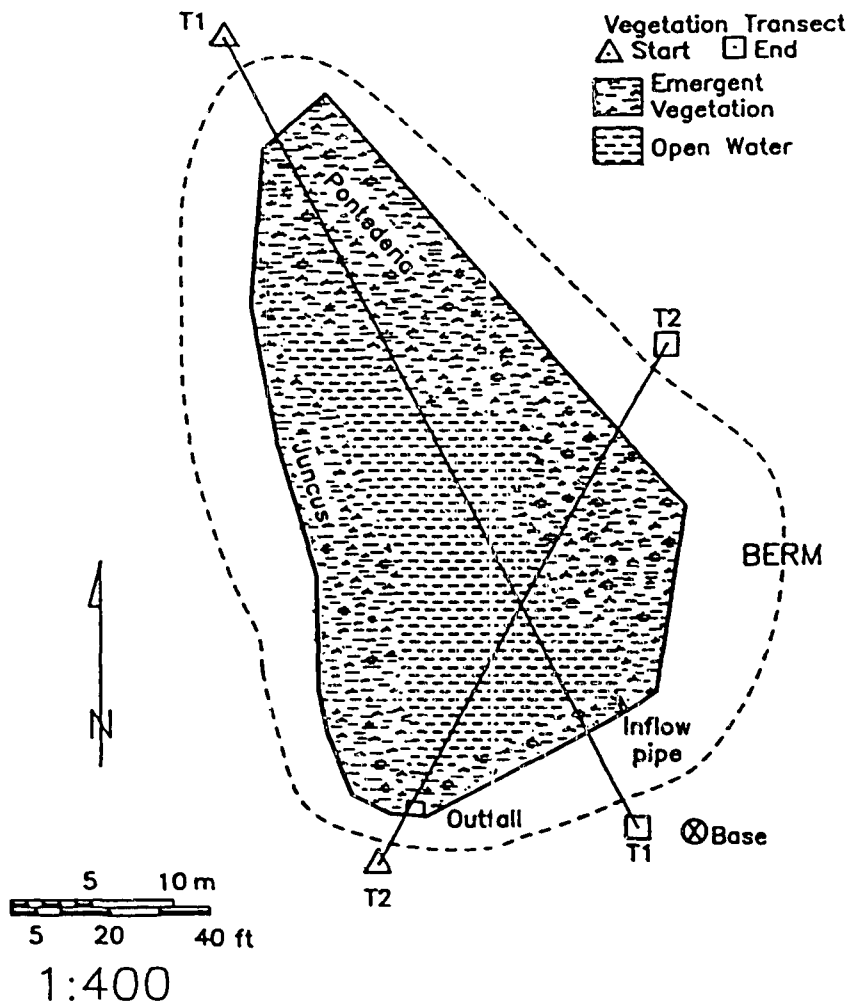
Dominant Vegetation

The primary species found were the broad-leaved emergents pickerelweed (**Pontedaria cordata**) and arrowhead (**Sagittaria lancifolia**). These were found from shallow water depths out to the open water, interspersed with cannas (**Canna flaccida**), and several mats of spikerush (**Eleocharis vivipara**). Fragrant water-lily (**Nymphaea odorata**) was found in the open water areas. Along the upland edges of the site, soft rush (**Juncus effusus**) grew in abundance.

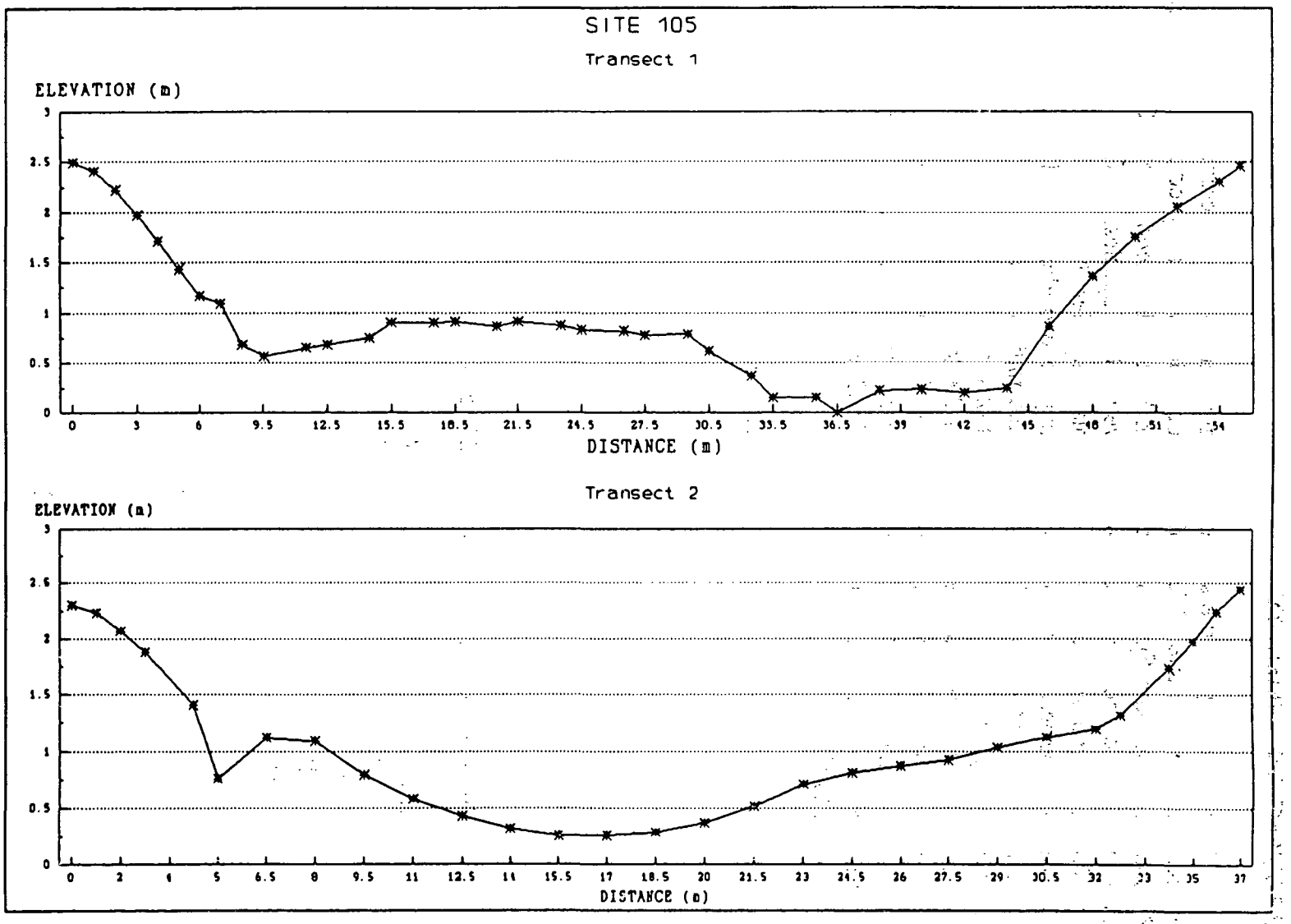
See the Vegetation Summary section of this description for a complete listing of the species identified.


FLORIDA 105 & 106
SITE MAP
County Road
Duck
Pond
Boulvard
105
Golf
Course
Street
N
106
1≈1600

FLORIDA 105
FIELD MAP



Map CAD drafted by Steven Pelles 8/90
Vegetation data collected 5/88


SITE 105
Transect 1
ELEVATION (m)
DISTANCE (m)
Transect 2
ELEVATION (m)
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

<u>Species Listed for Planting in Created Wetland 105</u>

Canna flaccida*	OBL\EXO
Iris virginica	OBL\NAT
Nymphaea odorata*	OBL\NAT
Pontederia spp.	???
Sagittaria spp.	???
Spartina spp.	???

<u>Species Found On Site 105 during Summer 1988</u>

Canna flaccida*	OBL\NAT
Eleocharis vivipara	OBL\NAT
Galium tinctorium	FACW\NAT
Hydrocotyle sp.	???
Juncus effusus	FACW+NAT
Nymphaea odorata*	OBL\NAT
Paspalum distichum	OBL\NAT
Pontederia cordata	OBL\NAT
Sagittaria lancifolia	OBL\NAT
Solidago fistulosa	FAC+NAT
Spartina bakeri	FACW+NAT
Stenotaphrum secundatum	FAC\NAT
Typha domingensis	OBL\NAT

DESCRIPTION: SITE 106

Function/Purpose

This site is one of two (see Site 105) stormwater runoff basins in a residential development.

General Physical Description

This wetland is similar in structure and setting to Site 105. It is a small, deep pond with lush, planted wetland vegetation bordered by landscaped lawns. Located at the end of a cul-de-sac, the created wetland is bordered on the north by a house and yard, on the east by a sidewalk and roadway, and on the south and east by a cypress swamp.

Hydrology

This wetland was fed primarily by surface inflow, with no man-made structures evident. An outflow structure drains high water into the adjoining cypress swamp.

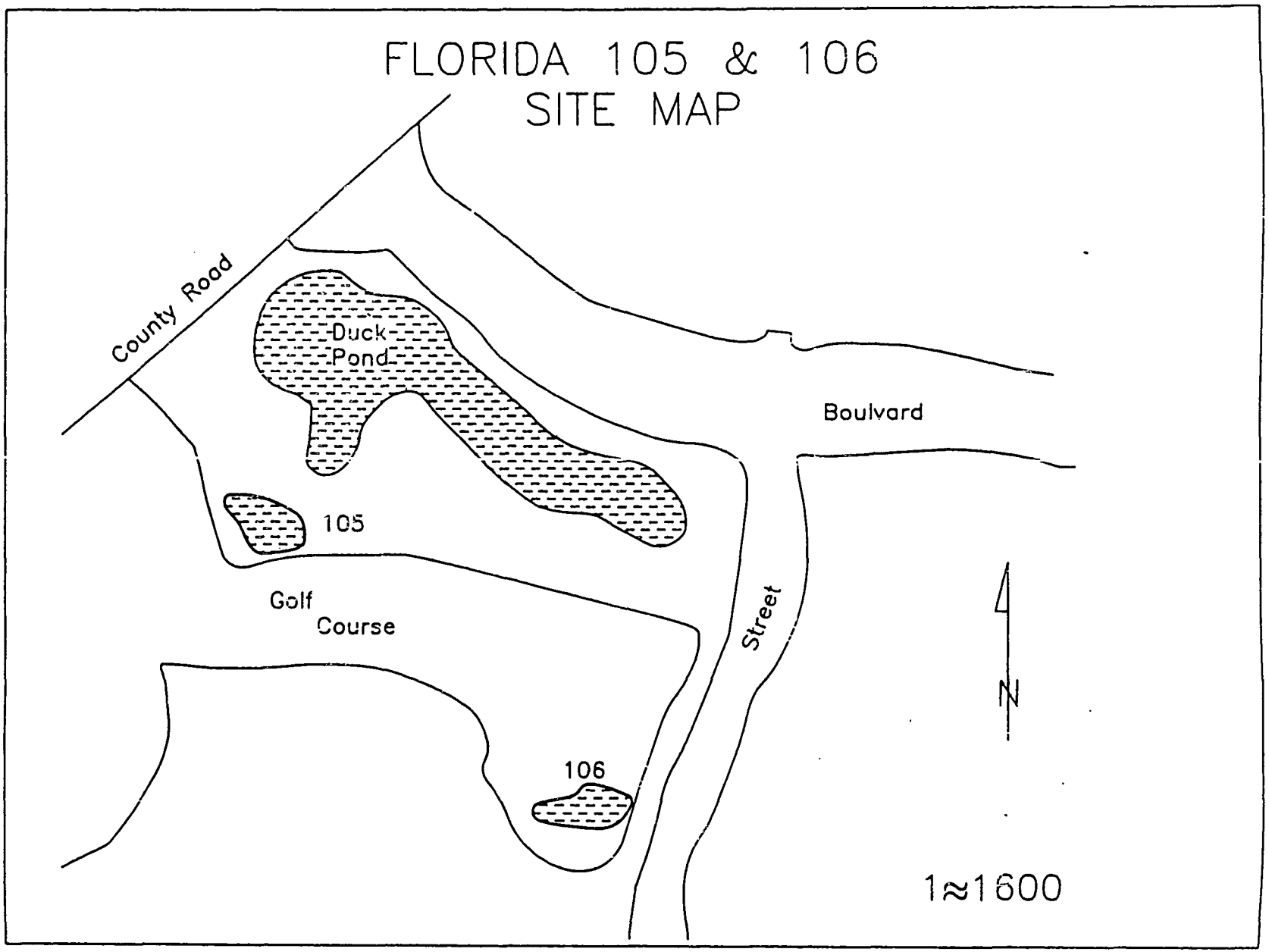
Soil/Substrate

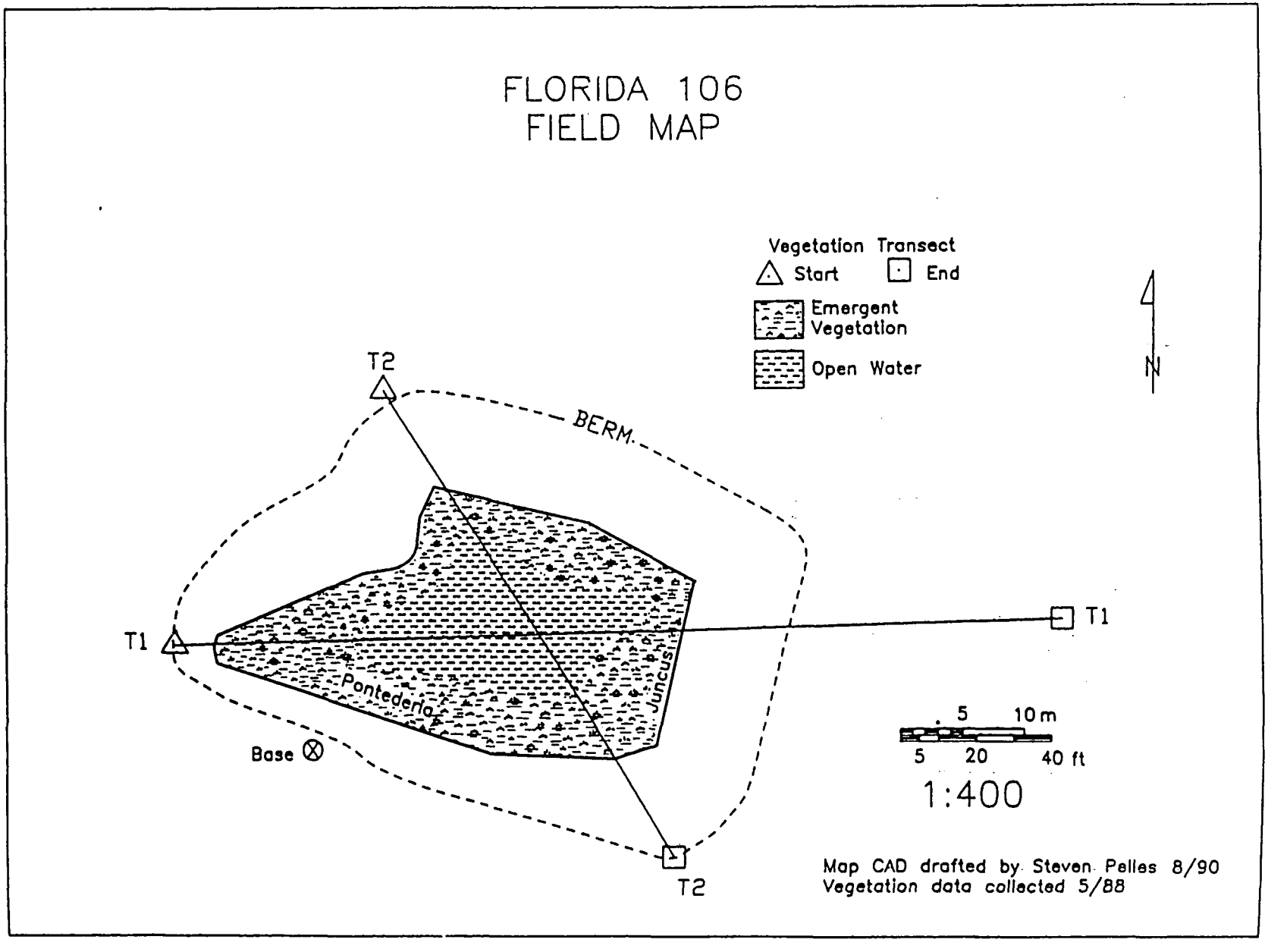
Soil chromas were primarily /2 and /3. No mottling was found.

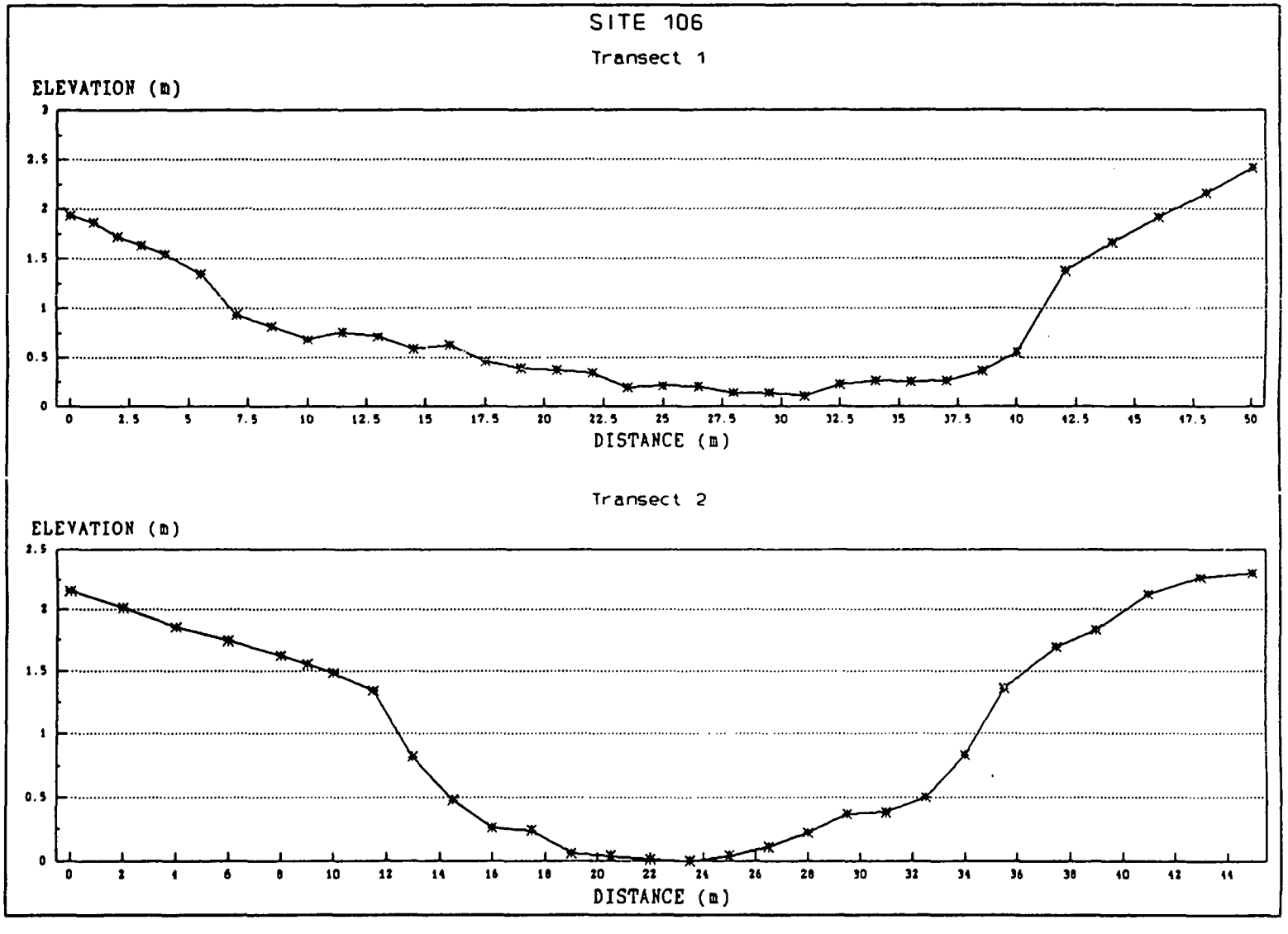
Dominant Vegetation

The open water areas were covered with a mat of salvinia (**Salvinia** spp.), interspersed with fragrant water lilies (**Nymphaea odorata**). Shallower water areas were dominated by pickerelweed (**Pontedaria cordata**), pennywort (**Hydrocotyle umbellata**), bladderwort (**Utricularia fibrosa**), and bacopa (**Bacopa monnieri**). The transitional margins were dominated by torpedo grass (**Panicum repens**) and soft rush (**Juncus effusus**).

See the Vegetation Summary section of this description for a complete listing of the species identified.


FLORIDA 105 & 106
SITE MAP
County Road
Duck
Pond
Boulvard
105
Golf
Course
Street
N
106
1≈1600


FLORIDA 106
FIELD MAP
Vegetation Transect
Start
End
Emergent Vegetation
Open Water
N
T2
BERM
T1
T1
Pontederia
Juncus
Base
T2
5 10 m
5 20 40 ft
1:400
Map CAD drafted by Steven Pelles 8/90
Vegetation data collected 5/88


SITE 106
Transect 1
ELEVATION (m)
DISTANCE (m)
Transect 2
ELEVATION (m)
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

<u>Species Listed for Planting in Created Wetland 106</u>

Canna flaccida*	OBL\NAT
Iris virginica	OBL\NAT
Nymphaea odorata*	OBL\NAT
Pontederia spp.	???
Sagittaria spp.	???
Spartina spp.	???

<u>Species Found On Site 106 during Summer 1988</u>

Acer rubrum	FAC\NAT
Alternanthera philoxeroides	OBL\EXO
Andropogon glomeratus	FACW+NAT
Baccharis halimifolia	FAC\NAT
Bacopa caroliniana	OBL\NAT
Bacopa monnieri	OBL\NAT
Canna flaccida*	OBL\NAT
Carex albolutescens	FAC+NAT
Cyperus brevifolius	FACW\NAT
Eclipta alba	FACW-NAT
Eleocharis baldwinii	FACW+NAT
Eryngium baldwinii	FACW+NAT
Eupatorium capillifolium	FACU\NAT
Hydrocotyle umbellata	OBL\NAT
Iris hexagona	OBL\NAT
Juncus dichotomus	FACW\NAT
Juncus effusus	FACW+NAT
Juncus megacephalus	OBL\NAT

Lolium perenne	FACU\EXO
Ludwigia octovalvis	OBL\NAT
Ludwigia peruviana	OBL\NAT
Ludwigia spp.	???
Micranthemum umbrosum	OBLdEXO
Mikania scandens	FACW+NAT
Nymphaea odorata*	OBL\NAT
Panicum repens	FACW-EXO
Paspalum distichum	OBL\NAT
Polygonum spp.	???
Pontederia cordata	OBL\NAT
Ptilimnium capillaceum	OBL\NAT
Sagittaria lancifolia	OBL\NAT
Salix caroliniana	OBL\NAT
Scoparia dulcis	FACU\NAT
Typha domingensis	OBL\NAT
Utricularia fibrosa	OBL\NAT

DESCRIPTION: SITE 204

Function/Purpose

This wetland was created to mitigate for the destruction of wetlands by development in the area. Planned as a "streamside marsh and swamp", it is an expansion and reforestation of a stream floodplain.

General Physical Description

The wetland is located within a residential development and connects a lake to a downstream forested swamp. Apartment buildings and lawns adjoin the eastern side of the site, and a major roadway adjacent to the southern end of the site separates it from the forested swamp. The western and northern sides of the wetland are bordered by lawns and parking lots.

Hydrology

The entire site is surrounded by a low berm which excludes overland flow from the wetland. It was uncertain as to how construction of the wetland may have altered the natural water flow from the lake into the stream. Two bridges allow unimpeded flow, however, there was no flow at the time of the study, as the wetland was dry.

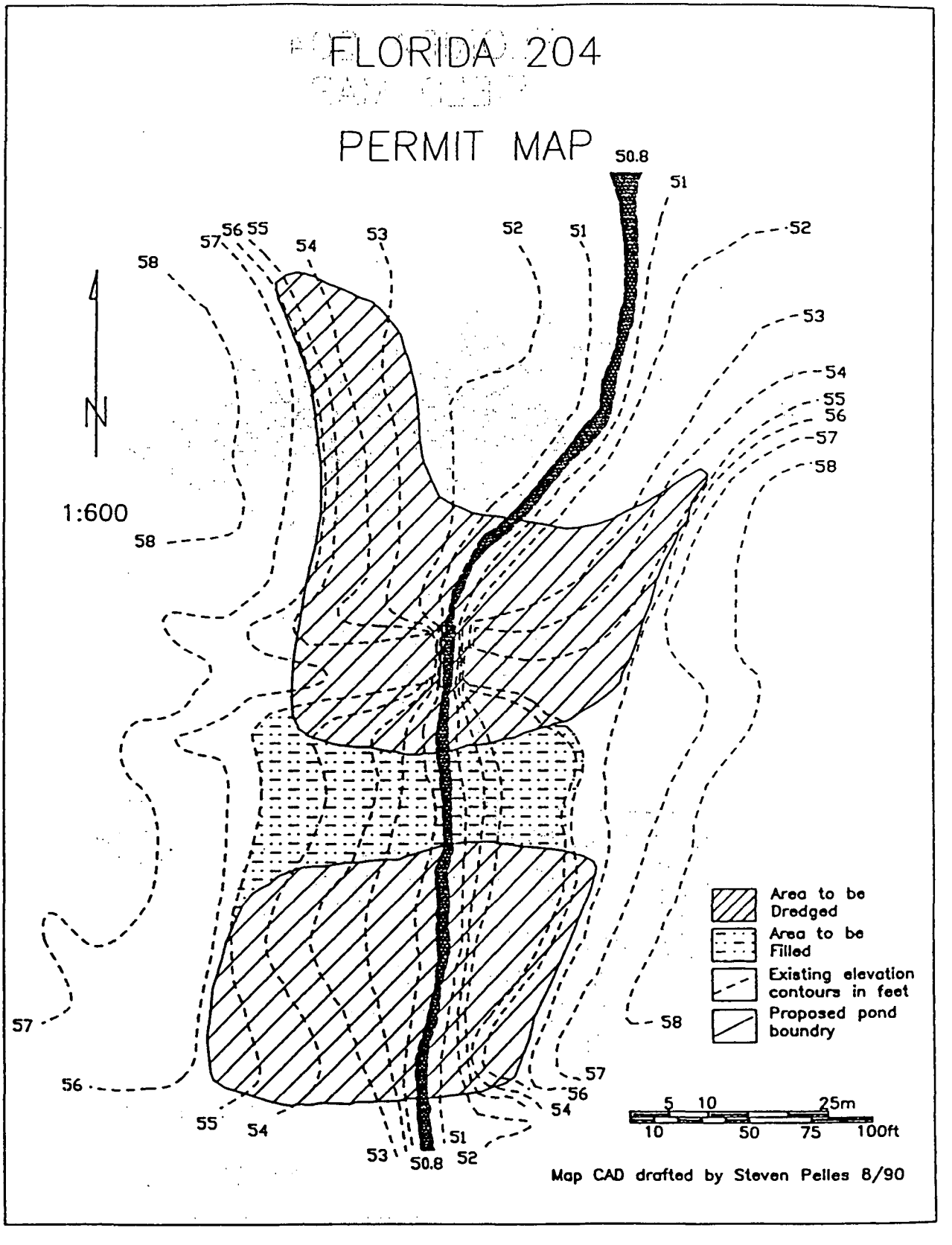
Soil/Substrate

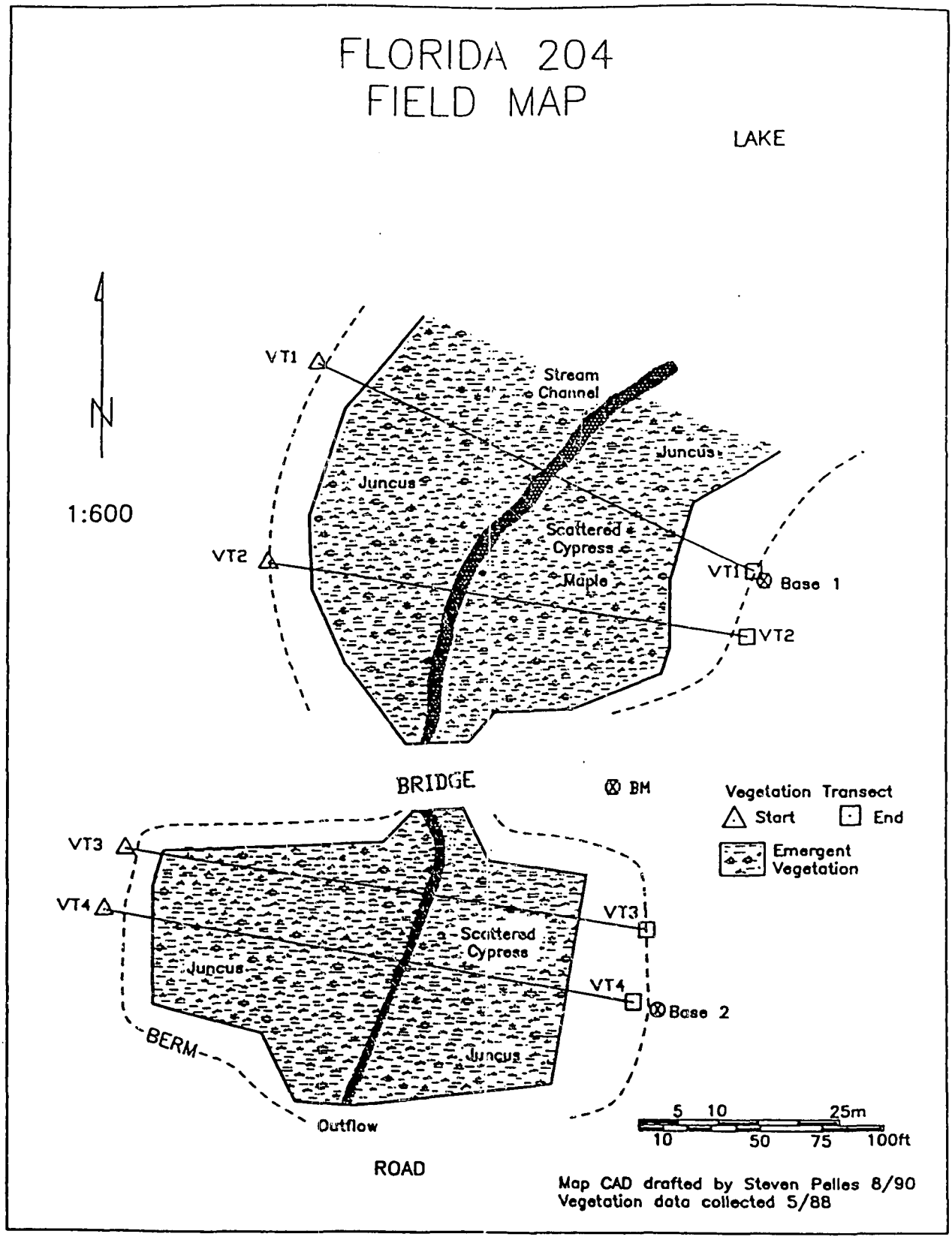
The majority of soil samples had a chroma of /1 , with two samples having a chroma of /2. Some mottling was found in the lower horizons (25-30 cm) of the soil cores.

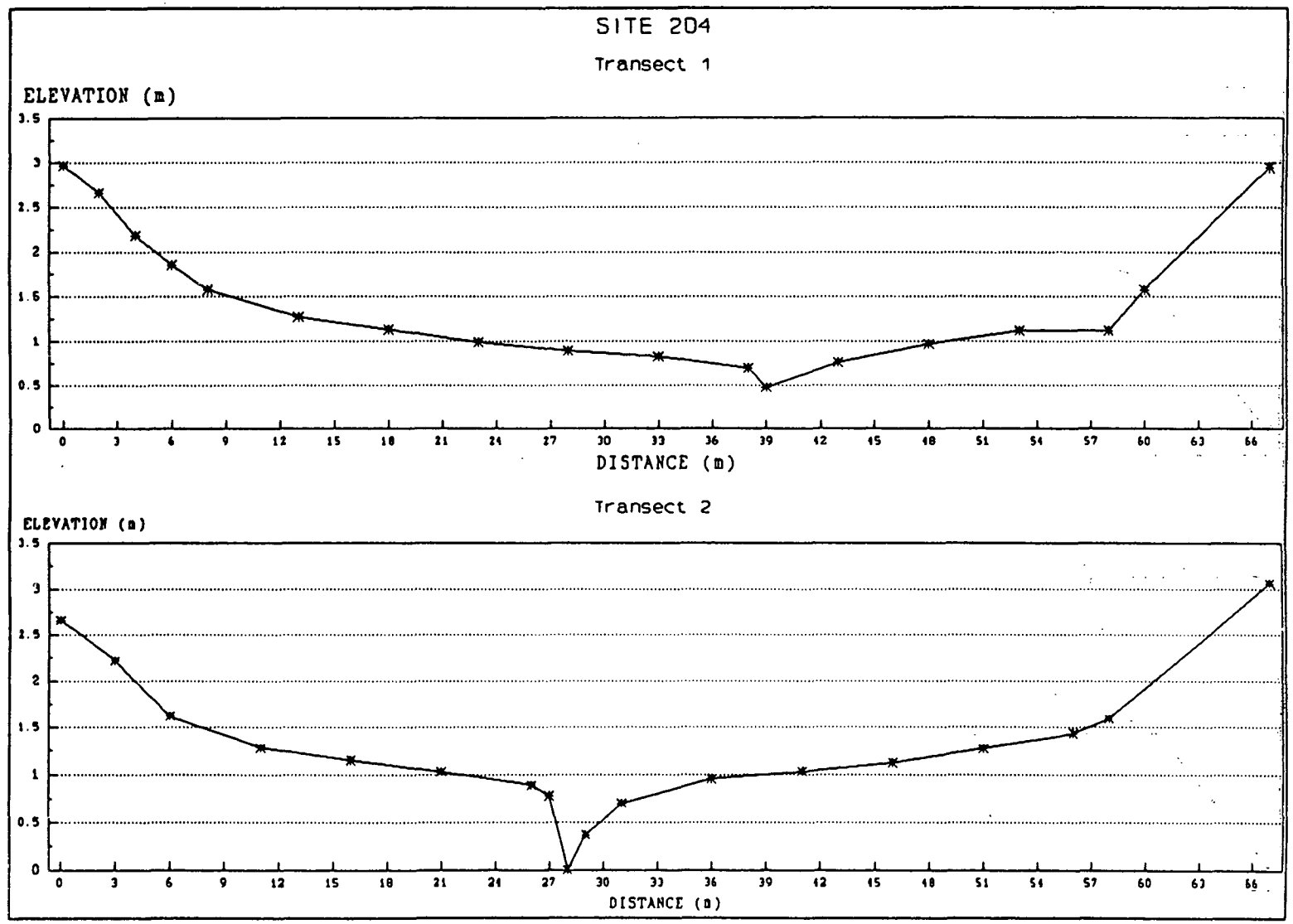
Dominant Vegetation

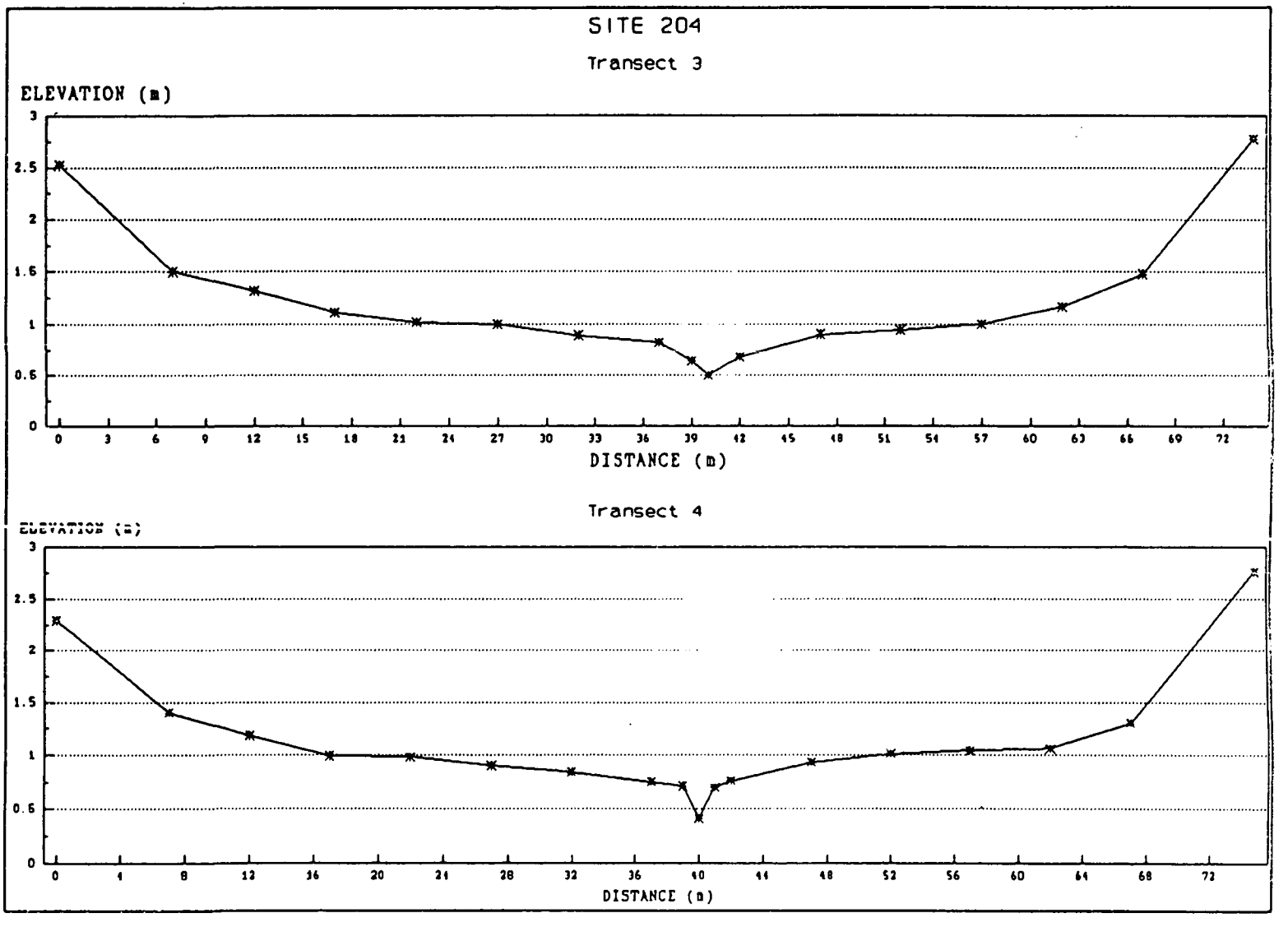
The vegetation community was very diverse with both planted and volunteer species. The most common species were soft rush (**Juncus effusus**) and sand cordgrass (**Spartina bakeri**). Also frequently found were primrose willow (**Ludwigia peruviana**), climbing hempweed (**Mikania scandens**), bushy bluestem (**Andropogon glomeratus**), dwarf St. Johns wort (**Hypericum mutilum**), viviparous spikerush (**Eleocharis vivipara**), American cupscale (**Sacciolepis striata**), prairie iris (**Iris hexagona**), coinwort (**Centella asiatica**), mock-bishopweed (**Ptilimnium capillaceum**), sweet-broom (**Scoparia dulcis**). Tree seedlings common throughout the site included cypress (**Taxodium ascendens** and **T. distichum**), willow (**Salix caroliniana**), loblolly bay (**Gordonia lasianthus**), blackgum (**Nyssa sylvatica var. biflora**) and red maple (**Acer rubrum**).

See the Vegetation Summary section of this description for a complete listing of the species identified.


FLORIDA 204
PERMIT MAP
1:600
N
50.8
51
52
53
54
55
56
57
58
Area to be Dredged
Area to be Filled
Existing elevation contours in feet
Proposed pond boundry
5 10 25m
10 50 75 100ft
Map CAD drafted by Steven Pelles 8/90


FLORIDA 204
FIELD MAP
LAKE
N
1:600
VT1
Stream
Channel
Juncus
Juncus
Scattered
Cypress
Maple
VT2
VT1
Base 1
VT2
BRIDGE
BM
Vegetation Transect
Start
End
Emergent
Vegetation
VT3
VT4
VT3
Scattered
Cypress
Juncus
VT4
Base 2
BERM
Juncus
Outflow
5 10 25m
10 50 75 100ft
ROAD
Map CAD drafted by Steven Pelles 8/90
Vegetation data collected 5/88


SITE 204
Transect 1
ELEVATION (m)
3.5
3
2.5
2
1.5
1
0.5
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66
DISTANCE (m)
Transect 2
ELEVATION (m)
3.5
3
2.5
2
1.5
1
0.5
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66
DISTANCE (m)


SITE 204
Transect 3
ELEVATION (m)
3
2.5
2
1.5
1
0.5
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72
DISTANCE (m)
Transect 4
3
2.5
2
1.5
1
0.5
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

<u>Species Listed for Planting in Created Wetland 204</u>

In addition to the species listed for planting, the site was mulched.

Acer rubrum*	FAC\NAT
Bacopa caroliniana*	OBL\NAT
Blechnum serrulatum*	FACW+NAT
Canna flaccida*	OBL\NAT
Celtis laevigata	FACW\NAT
Gordonia lasianthus*	FACW\NAT
Ilex cassine	FACW\NAT
Iris sp.	???
Juncus effusus*	FACW+NAT
Ludwigia repens*	OBL\NAT
Myrica cerifera	FAC+NAT
Nyssa sylvatica	FAC\NAT
Osmunda regalis*	OBL\NAT
Pontederia cordata*	OBL\NAT
Quercus laurifolia	FACW\NAT
Sagittaria sp.	???
Salix spp.	???
Spartina bakeri*	FACW+NAT
Taxodium sp.	OBL\NAT
Thalia geniculata	OBL\NAT

<u>Species Found On Site 204 during Summer 1988</u>

Acer rubrum*	FAC\NAT
Agalinus fasciculata	FAC+NAT

Alternanthera philoxeroides	OBL\EXO
Ambrosia artemisiifolia	FACU-NAT
Andropogon glomeratus	FACW+NAT
Axonopus affinis	FACW-NAT
Baccharis halimifolia	FAC\NAT
Bacopa caroliniana*	OBL\NAT
Bidens mitis	OBL\NAT
Blechnum serrulatum*	FACW+NAT
Boehmeria cylindrica	FACW+NAT
Canna flaccida*	OBL\NAT
Carex albolutescens	FAC+NAT
Cassia nictitans	FACU\NAT
Centella asiatica	FACW\NAT
Cirsium horridulum	FAC+NAT
Commelina diffusa	FACW\EXO
Conyza canadensis	FACU\NAT
Crotalaria pallida	UPL\EXO
Cuphea carthagenensis	FACW\EXO
Cyperus compressus	FACW\NAT
Cyperus haspan	OBL\NAT
Cyperus ligularis	FACW\NAT
Cyperus polystachyos	FACW\NAT
Diodia virginiana	FACW\NAT
Eclipta alba	FACW-NAT
Eleocharis baldwinii	FACW+NAT
Eleocharis vivipara	OBL\NAT
Erechtites hieracifolia	FAC-NAT
Eryngium baldwinii	FACW+NAT
Eupatorium capillifolium	FACU\NAT
Eupatorium compositifolium	FACU\NAT
Euthamia tenuifolia	FAC\NAT
Galium uniflorum	FACU\NAT
Gordonia lasianthus*	FACW\NAT
Hedyotis uniflora	FACW-EXO
Hydrocotyle bonariensis	FACW\NAT
Hydrocotyle umbellata	OBL\NAT
Hydrocotyle verticillata	OBL\NAT
Hypericum mutilum	FACW\NAT
Hyptis alata	OBL\NAT
Iris hexagona	OBL\NAT
Juncus dichotomus	FACW\NAT
Juncus effusus*	FACW+NAT
Juncus marginatus	FACW\NAT
Juncus megacephalus	OBL\NAT
Juncus repens	OBL\NAT

Lachnanthes carolininana	OBL\NAT
Leersia hexandra	OBL\NAT
Ludwigia arcuata	OBL\NAT
Ludwigia linifolia	OBL\NAT
Ludwigia microcarpa	OBL\NAT
Ludwigia octovalvis	OBL\NAT
Ludwigia palustris	OBLdNAT
Ludwigia peruviana	OBL\NAT
Ludwigia pilosa	OBL\NAT
Ludwigia repens*	OBL\NAT
Lythrum alatum	FACW\NAT
Mecardonia acuminata	FACW\NAT
Mikania scandens	FACW+NAT
Nyssa sylvatica var. biflora	FAC\NAT
Osmunda regalis*	OBL\NAT
Oxalis sp.	???
Panicum dichotomum	FAC\NAT
Panicum hemitomon	OBL\NAT
Panicum repens	FACW-EXO
Parietaria floridana	FACdNAT
Paspalum urvillei	FAC\EXO
Phyla nodiflora	FACWdNAT
Pluchea odorata	FACW\EXO
Pluchea rosea	FACW\NAT
Polygonum hydropiperoides	OBL\NAT
Polypremum procumbens	FAC\NAT
Pontederia cordata*	OBL\NAT
Proserpinaca palustris	OBL\NAT
Ptilimnium capillaceum	OBL\NAT
Rhexia mariana	FACW+NAT
Rhynchospora caduca	OBL\NAT
Rhynchospora fascicularis	FACW+NAT
Rhynchospora microcephala	OBL\NAT
Rhynchospora mixta	OBL\NAT
Sacciolepis indica	FAC\EXO
Sacciolepis striata	OBL\NAT
Sagittaria lancifolia	OBL\NAT
Salix caroliniana	OBL\NAT
Scirpus cyperinus	OBL\NAT
Scoparia dulcis	FACU\NAT
Solidago fistulosa	FAC+NAT
Spartina bakeri*	FACW+NAT
Taxodium ascendens	OBL\NAT
Taxodium distichum	OBL\NAT
Toxicodendron radicans	FAC\NAT

Typha latifolia	OBL\NAT
Urena lobata	FACU\NAT
Viola lanceolata	OBL\NAT
Woodwardia virginica	OBL\NAT

DESCRIPTION: SITE 205

Function/Description

This wetland was created to 1) receive overflow from an adjacent retention basin and 2) as mitigation for berming and using a nearby cypress dome to receive additional stormwater runoff. The retention basin and created wetland receive stormwater flow from a parking lot, while the cypress dome receives roadside drainage and outflow from the created wetland.

General Physical Description

The wetland is rectangular, with short, steep banks and a flat interior surrounded by a low berm. A dirt access road and a junkyard adjoin the south side, and a small stand of trees is adjacent to the east end. The cypress dome is adjacent to the north side of the created wetland and the retention basin is along the west end. The site is in a heavily commercialized area, near a major county road and within the interchange of an interstate highway. There is little undisturbed land near this site.

Hydrology

An inflow ditch at the southwest corner of the wetland allows overflow from the retention basin into the site. The berm excludes all other surface inflow. An outfall structure at the northwest corner allows overflow from the created wetland into the cypress dome.

Soil/Substrate

Soil chromas were /2 and /3. There was no mottling.

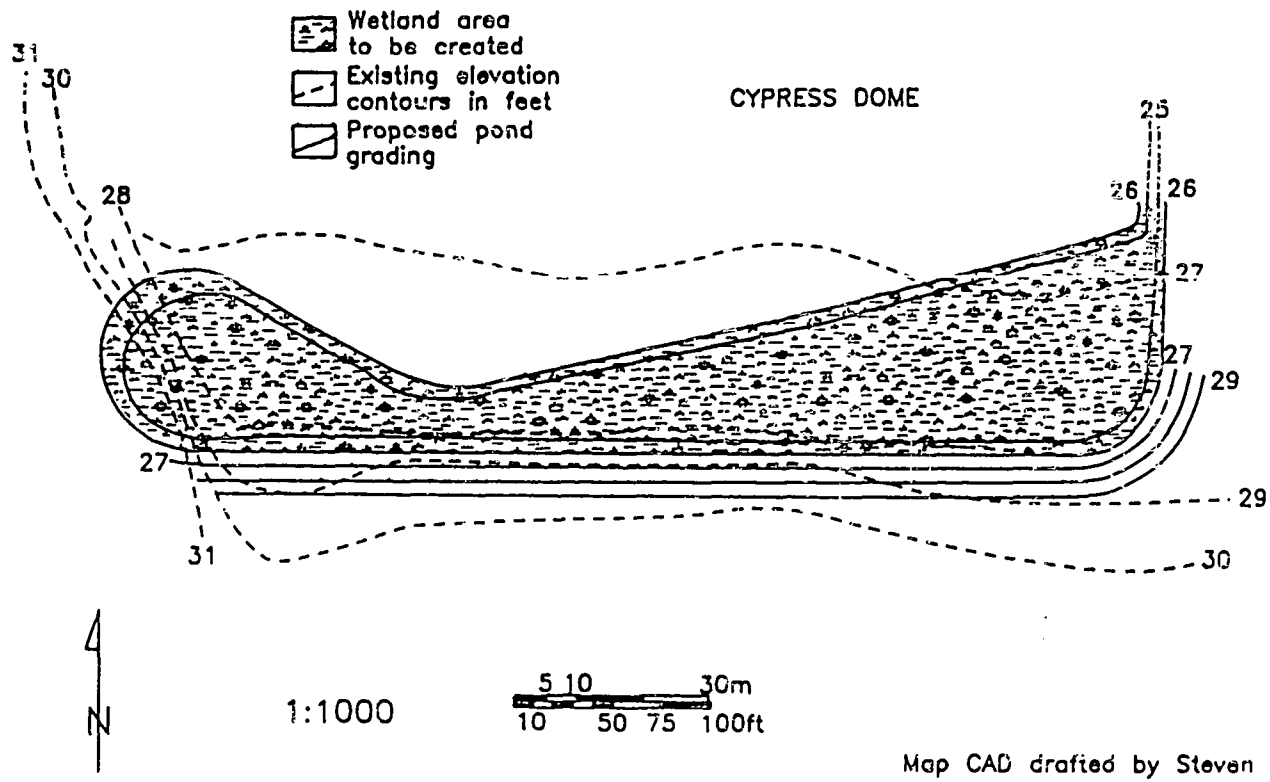
Dominant Vegetation

The dominant plant species on the site was pickerelweed (**Pontedaria cordata**), however, water smartweed (**Polygonum punctatum**) was found throughout the site. Primroses (**Ludwigia spp. L. octovalvis, and L. peruviana**), fragrant flatsedge (**Cyperus odoratus**), and creeping rush (**Juncus repens**) were scattered throughout many of the sampling plots.

See the Vegetation Summary section of this description for a complete lising of the species identified.

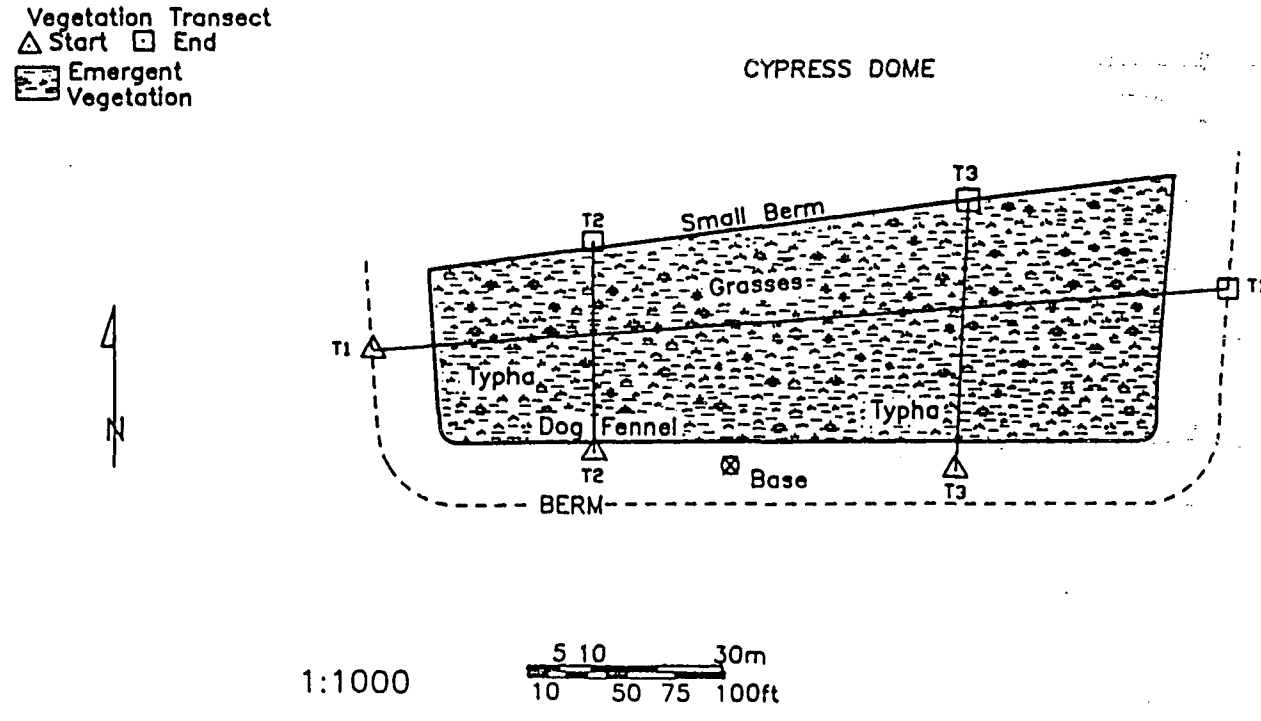
FLORIDA 205

PERMIT MAP

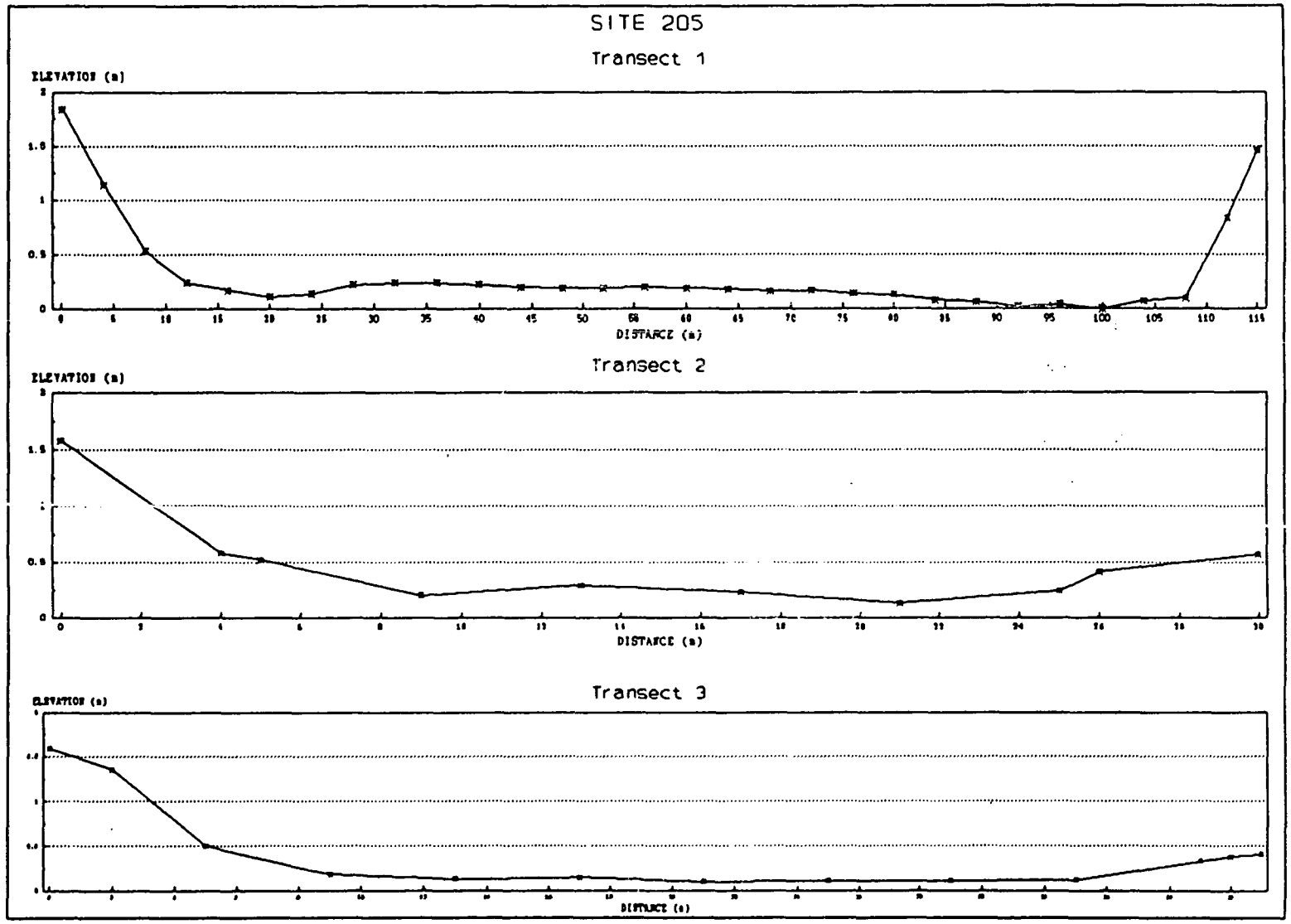


Map CAD drafted by Steven Pelles 8/90

FLORIDA 205
FIELD MAP



Map CAD drafted by Steven Pelles 8/90
Vegetation data collected 7/88


SITE 205
Transect 1
ELEVATION (m)
DISTANCE (m)
Transect 2
ELEVATION (m)
DISTANCE (m)
Transect 3
ELEVATION (m)
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

<u>Species Listed for Planting in Created Wetland 205</u>

In addition to the genera listed for planting, the site was mulched.

Juncus spp.	???
Pontederia spp.	???
Sagittaria spp.	???

<u>Species Found On Site 205 during Summer 1988</u>

Ambrosia artemisiifolia	FACU-NAT
Ammannia latifolia	OBL\NAT
Andropogon glomeratus	FACW+NAT
Baccharis halimifolia	FAC\NAT
Carex albolutescens	FAC+NAT
Conyza canadensis	FACU\NAT
Cyperus compressus	FACW\NAT
Cyperus odoratus	FACW\NAT
Cyperus polystachyos	FACW\NAT
Cyperus surinamensis	FACW\NAT
Eclipta alba	FACW-NAT
Erechtites hieracifolia	FAC-NAT
Eupatorium capillifolium	FACU\NAT
Galactia volubilis	FACU\NAT
Hydrocotyle umbellata	OBL\NAT
Juncus effusus	FACW+NAT
Juncus marginatus	FACW\NAT
Juncus megacephalus	OBL\NAT
Juncus repens	OBL\NAT

Juncus scirpoides	FACW+NAT
Ludwigia octovalvis	OBL\NAT
Ludwigia peruviana	OBL\NAT
Ludwigia spp.	???
Mikania scandens	FACW+NAT
Oxalis sp.	???
Pluchea odorata	FACW\EXO
Polygonum hydropiperoides	OBL\NAT
Polygonum punctatum	FACW+NAT
Polypremum procumbens	FAC\NAT
Pontederia cordata	OBL\NAT
Sagittaria lancifolia	OBL\NAT
Salix caroliniana	OBL\NAT
Scoparia dulcis	FACU\NAT
Typha latifolia	OBL\NAT

DESCRIPTION: SITE 208

Function/Purpose

Stormwater/retention basin for residential neighborhood.

General Physical Description

This wetland is long and narrow, and has steep sides grading down into open water. For the size requirements of the study, the created wetland sampled was arbitrarily cut off at the border of a lily pond at the south end, which contained a substantial amount of refuse. The north end of the wetland is bordered by a residential road. The residential development borders the east side of the wetland, and some household refuse is scattered along the edges of this side of the site. The west side is adjacent to a powerline easement, which is bordered further west by an oak hammock.

Hydrology

There may have been inflow/outflow points further downslope (beyond the limits of the study area), however, no inflow or outflow points were evident. Sheetflow runoff from adjacent roads probably occurs.

Soil/Substrate

The wetland was mulched with soil from a donor wetland to about 20 cm thick. Five of the soil samples had chromas of /1 and five had /2. There was no mottling.

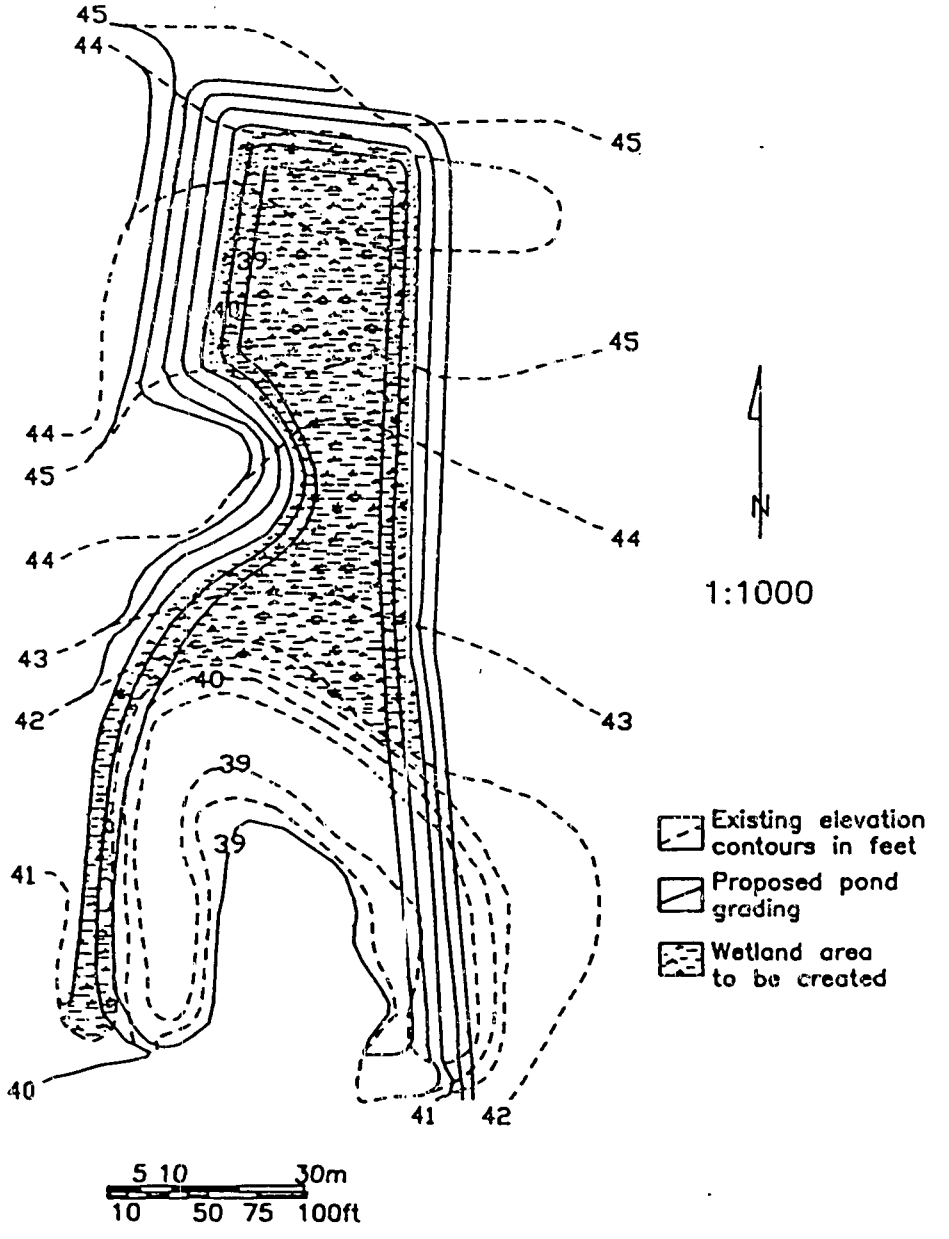
Dominant Vegetation

The dominant plant species found were cattails (**Typha domingensis** and **T. latifolia**), pennywort (**Hydrocotyle umbellata**), pickerelweed (**Pontedaria cordata**), American cupscale (**Sacciolepis striata**), primroses (**Ludwigia arcuata, L. peruviana, and L. repens**), smartweed (**Polygonum hydropiperoides**), spikerush (**Eleocharis baldwinii**), sedges (**Cyperus polystachyos** and **C. retrorsus**), soft rush (**Juncus effusus**), and arrowroot (**Thalia geniculata**).

See the Vegetation Summary section of this description for a complete listing of the species identified.

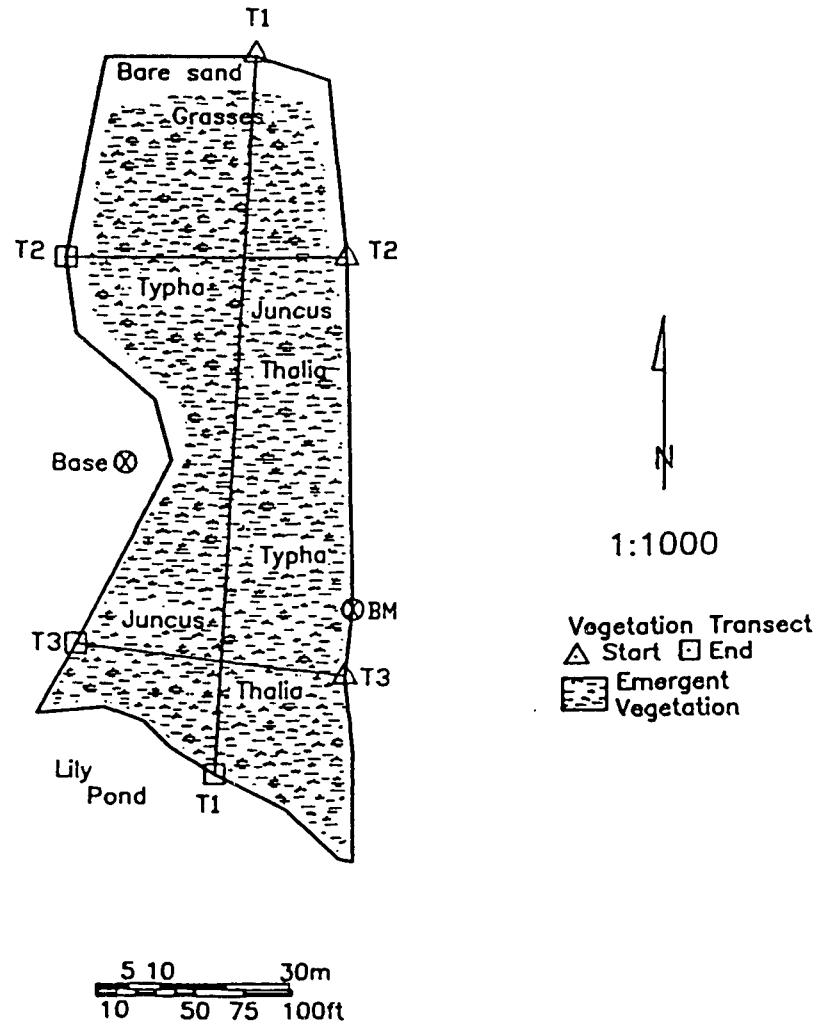
FLORIDA 208

PERMIT MAP

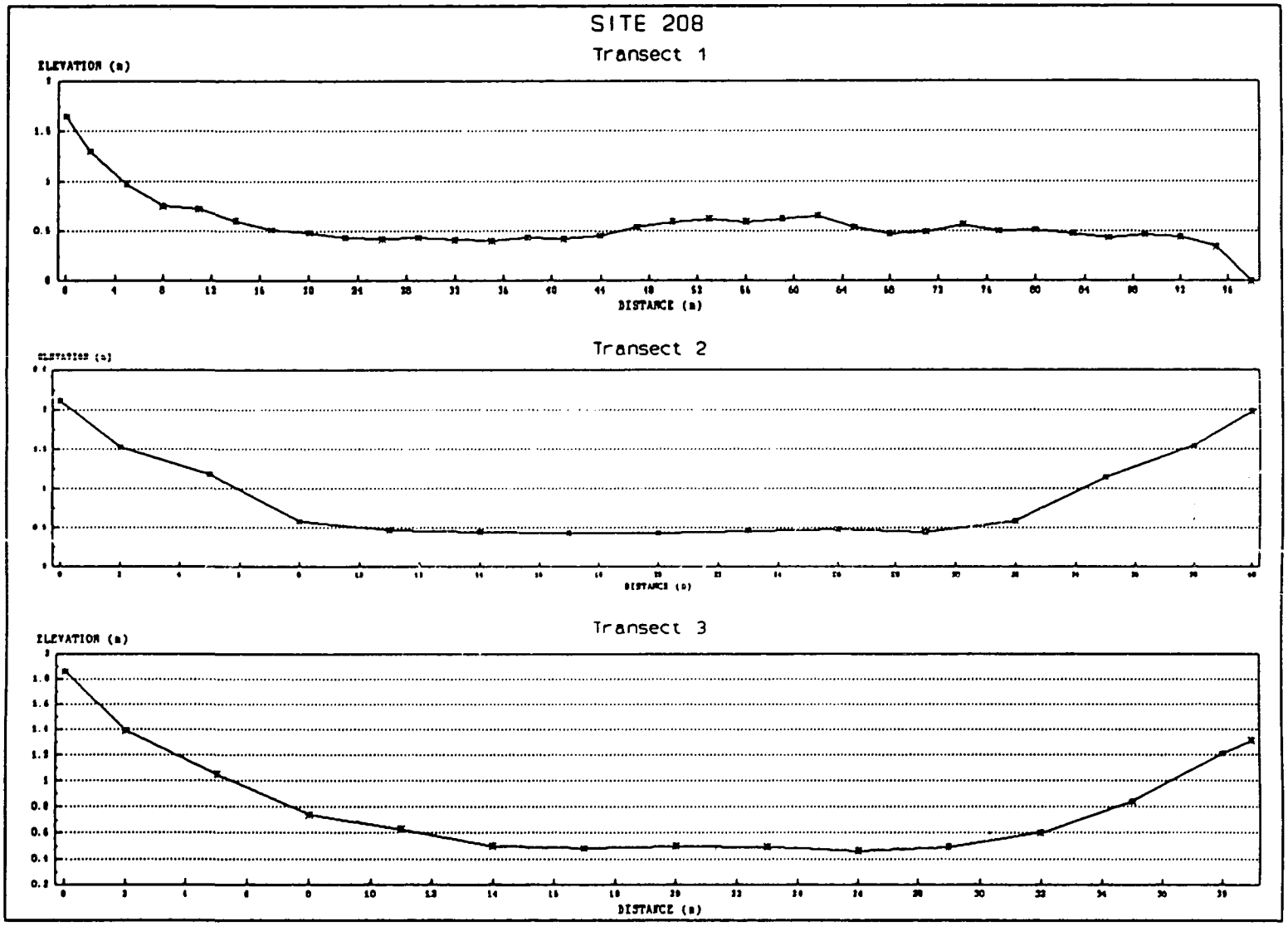


Map CAD drafted by Steven Pelles 8/90

FLORIDA 208
FIELD MAP



Map CAD drafted by Steven Pelles 8/90
Vegetation data collected 7/88


SITE 208
Transect 1
ELEVATION (m)
DISTANCE (m)
Transect 2
Transect 3
ELEVATION (m)
DISTANCE (m)

VEGETATION SUMMARY

The following are the species listed for planting in the created wetland and the species found on the site. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); "d" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which "Species Listed for Planting in Created Wetland" were also "Species Found On Site".

Species Listed for Planting in Created Wetland 208

In addition to the species listed for planting, the site was mulched.

Acer rubrum	FAC\NAT
Bacopa monnieri	OBL\NAT
Fraxinus caroliniana	OBL\NAT
Gordonia lasianthus	FAC\NAT
Ilex cassine	FACW\NAT
Juncus effusus*	FACW+NAT
Nymphaea odorata*	OBL\NAT
Nyssa aquatica	OBL\NAT
Persea borbonia	FACW\NAT
Pontederia cordata*	OBL\NAT
Spartina bakeri*	FACW+NAT
Thalia geniculata*	OBL\NAT

Species Found On Site 208 during Summer 1988

Axonopus affinis	FACW-NAT
Bacopa caroliniana	OBL\NAT
Bidens alba	FACW-NAT
Bidens mitis	OBL\NAT
Bulbostylis ciliatifolia	FACU\NAT
Centella asiatica	FACW\NAT
Cyperus haspan	OBL\NAT
Cyperus ligularis	FACW\NAT
Cyperus odoratus	FACW\NAT
Cyperus polystachyos	FACW\NAT

Cyperus retrorsus	FACU+NAT
Cyperus strigosus	FACW\NAT
Echinocloa walteri	OBLdNAT
Eleocharis baldwinii	FACW+NAT
Eupatorium capillifolium	FACU\NAT
Eupatorium leptophyllum	FAC+NAT
Habenaria repens	OBL\NAT
Hydrocotyle bonariensis	FACW\NAT
Hydrocotyle umbellata	OBL\NAT
Hypericum mutilum	FACW\NAT
Juncus effusus*	FACW+NAT
Juncus megacephalus	OBL\NAT
Juncus scirpoides	FACW+NAT
Lachnanthes carolininana	OBL\NAT
Leersia hexandra	OBL\NAT
Lindernia grandiflora	OBL\NAT
Ludwigia arcuata	OBL\NAT
Ludwigia octovalvis	OBL\NAT
Ludwigia peruviana	OBL\NAT
Ludwigia repens	OBL\NAT
Lythrum alatum	FACW\NAT
Mikania scandens	FACW+NAT
Nuphar luteum	OBL\NAT
Nymphaea odorata*	OBL\NAT
Nyssa sylvatica var. biflora	FAC\NAT
Panicum anceps	FACW+NAT
Panicum hemitomon	OBL\NAT
Panicum repens	FACW-EXO
Paspalum distichum	OBL\NAT
Peltandra virginica	OBL\NAT
Phyla nodiflora	FACWdNAT
Pluchea rosea	FACW\NAT
Polygonum hirsutum	OBL\NAT
Polygonum hydropiperoides	OBL\NAT
Pontederia cordata*	OBL\NAT
Proserpinaca pectinata	OBL\NAT
Ptilimnium capillaceum	OBL\NAT
Rhexia mariana	FACW+NAT
Rhynchospora caduca	OBL\NAT
Sabatia sp.	???
Sacciolepis striata	OBL\NAT
Sagittaria lancifolia	OBL\NAT
Solidago stricta	OBL\NAT
Spartina bakeri*	FACW+NAT
Spilanthes americana	FACW\NAT

Thalia geniculata*	OBL\NAT
Typha domingensis	OBL\NAT
Typha latifolia	OBL\NAT
Vigna luteola	FACW\NAT

APPENDIX II

LISTS OF PLANT SPECIES TO BE ESTABLISHED AND ACTUALLY ESTABLISHED ON THE CREATED WETLANDS STUDIED

Following are the lists of all species intended for planting and the list of all species found on the created wetlands studied. Wetland indicator codes were adapted from categories in the Regional List of Plant Species that Occur in Wetlands (Reed 1988). Codes are: OBL--obligate wetland species; FACW--facultative wetland species; FAC--facultative species; FACU--facultative upland species; UPL--upland species; NAT--native species; and EXO--exotic species. The symbols separating the two elements of each code indicate the position of that species within the wetland indicator category. The symbol "+" indicates the species is toward the high end of the category (more frequently found in wetlands); "-" indicates the species is toward the low end of the category (less frequently found in wetlands); 'd" means drawdown; and "\" indicates the species is intermediate within the category. "???" indicates no information. Species names followed by "*" indicate which species on the "List of all species intended for planting" were also on the "List of all species found on created wetlands".

LIST OF ALL SPECIES INTENDED FOR PLANTING

The following list includes all species intended for planting within wetland areas of the created wetlands studied. Species listed for planting in buffer areas, banks and adjacent upland areas are not included.

Acer rubrum*	FAC\NAT	Red maple
Bacopa caroliniana*	OBL\NAT	Lemon bacopa
Bacopa monnieri*	OBL\NAT	Coastal water-hyssop
Blechnum serrulatum*	FACW+NAT	Swamp fern
Canna flaccida*	OBL\NAT	Canna lily
Celtis laevigata*	FACW\NAT	Sugarberry
Fraxinus caroliniana	OBL\NAT	Carolina ash
Gordonia lasianthus*	FACW\NAT	Loblolly bay
Hypericum fasciculatum*	FACW+NAT	St. John's-wort
Ilex cassine	FACW\NAT	Dahoon holly
Iris hexagona*	OBL\NAT	Prairie iris
Iris sp.	???	Swamp iris
Iris virginica	OBL\NAT	Virginia blueflag
Juncus effusus*	FACW+NAT	Soft rush
Juncus spp.	???	Rush
Ludwigia repens*	OBL\NAT	Red ludwigia
Myrica cerifera*	FAC+NAT	Wax myrtle

Nymphaea odorata*	OBL\NAT	White water-lily
Nyssa aquatica	OBL\NAT	Water tupelo
Nyssa sylvatica	FAC\NAT	Black gum
Osmunda cinnamonea	FACW+NAT	Cinnamon fern
Osmunda regalis*	OBL\NAT	Royal fern
Peltandra virginica*	OBL\NAT	Arrow arum
Persea borbonia	FACW\NAT	Red bay
Pontederia cordata*	OBL\NAT	Pickerel weed
Pontederia spp.	???	
Quercus laurifolia*	FACW\NAT	Laurel oak
Sagittaria lancifolia*	OBL\NAT	Bull-tongue arrowhead
Sagittaria sp.	???	Arrowhead
Salix spp.	???	Willows
Saururus cernuus	OBL\NAT	Lizard tail
Spartina bakeri*	FACW+NAT	Sand/smooth cordgrass
Spartina spp.	???	Cordgrass
Taxodium sp.	OBL\NAT	Cypress
Thalia geniculata*	OBL\NAT	Alligator flag/arrowroot

LIST OF ALL SPECIES FOUND ON CREATED WETLANDS

The following list includes all species found along transects that were placed to represent the vegetation communities of each created wetland studied. Transects were located within the wetland areas of the sites only. They were not placed in buffer areas, banks and adjacent upland areas.

Acer rubrum*	FAC\NAT	Red Maple
Agalinus fasciculata	FAC+NAT	Beach False-foxglove
Alternanthera philoxeroides	OBL\EXO	Alligator weed
Ambrosia artemisiifolia	FACU-NAT	Annual ragweed
Ammannia coccinea	FACW+NAT	Purple ammania
Ammannia latifolia	OBL\NAT	Pink ammania
Ampelopsis arborea	FAC+NAT	Pepper-vine
Amphicarpum muhlenbergian	FACW\NAT	Perennial goobergrass
Andropogon glomeratus	FACW+NAT	Bushy bluestem
Andropogon virginicus	FAC-NAT	Broom-sedge
Aristida spiciformis	FAC\NAT	Pinebarren 3-awn grass
Axonopus affinis	FACW-NAT	Southern carpet grass
Axonopus furcatus	OBL\NAT	Big carpet grass
Baccharis halimifolia	FAC\NAT	Eastern false-willow
Bacopa caroliniana*	OBL\NAT	Carolina water-hyssop
Bacopa monnieri*	OBL\NAT	Coastal water-hyssop
Bidens alba	FACW-NAT	Beggar-tick
Bidens mitis	OBL\NAT	Small-fruit beggar-tick

Blechnum serrulatum*	FACW+NAT	Toothed mid-sorus fern
Boehmeria cylindrica	FACW+NAT	Small-spike falsenettle
Bulbostylis ciliatifolia	FACU\NAT	Capillary hairsedge
Canna flaccida*	OBL\NAT	Canna lily
Carex albolutescens	FAC+NAT	Greenish-white sedge
Carex stipata	FACW\NAT	Stalk-grain sedge
Cassia nictitans	FACU\NAT	Sensitive partridge pea
Celtis laevigata*	FACW\NAT	Sugar-berry
Centella asiatica	FACW\NAT	Asian coinleaf
Chamaecrista fasciculata	FACW\NAT	
Cirsium horridulum	FAC+NAT	Yellow thistle
Citrus sp.	???	
Commelina diffusa	FACW\EXO	Spreading dayflower
Conyza canadensis	FACU\NAT	Canada horseweed
Crotalaria pallida	UPL\EXO	
Cuphea carthagenensis	FACW\EXO	Columbia waxweed
Cynodon dactylon	FACU\NAT	Bermuda grass
Cyperus brevifolius	FACW\NAT	Shortleaf flatsedge
Cyperus compressus	FACW\NAT	Poorland flatsedge
Cyperus globulosus	FAC\NAT	Baldwin flatsedge
Cyperus haspan	OBL\NAT	Sheathed flatsedge
Cyperus ligularis	FACW\NAT	Alabama swamp flatsedge
Cyperus odoratus	FACW\NAT	Rusty flatsedge
Cyperus polystachyos	FACW\NAT	Many-spike flatsedge
Cyperus retrorsus	FACU+NAT	Retrorse flatsedge
Cyperus rotundus	FAC-EXO	Purple flatsedge
Cyperus spp.	???	Flatsedges
Cyperus strigosus	FACW\NAT	Straw-color flatsedge
Cyperus surinamensis	FACW\NAT	Tropical flatsedge
Digitaria decumbens	FACU\EXO	Pangola grass
Diodia virginiana	FACW\NAT	Virginia buttonweed
Dioscorea bulbifera	FACU\EXO	
Drosera capillaris	OBL\NAT	Pink sundew
Echinocloa walteri	OBLdNAT	Coast cockspur
Eclipta alba	FACW-NAT	Yerba de tajo
Eleocharis baldwinii	FACW+NAT	Baldwin's spikerush
Eleocharis interstincta	OBL\NAT	Knotted spikerush
Eleocharis vivipara	OBL\NAT	Viviparous spikerush
Erechtites hieracifolia	FAC-NAT	American burn
Erigeron quercifolius	FAC+NAT	Oak-leaf fleabane
Eriocaulon compressum	OBL\EXO	Flattened pipewort
Eriocaulon decangulare	OBL\EXO	Ten-angle pipewort
Eriocaulon sp.	???	Pipeworts
Eryngium baldwinii	FACW+NAT	Baldwin coyote-thistle
Eupatorium capillifolium	FACU\NAT	Small dog-fennel

Eupatorium compositifolium	FACU\NAT	Yankee weed
Eupatorium leptophyllum	FAC+NAT	Fennel
Eupatorium mohrii	FACU\NAT	
Euthamia tenuifolia	FAC\NAT	
Fuirena pumila	OBL\NAT	Dwarf umbrella-sedge
Fuirena scirpoidea	OBL\NAT	Southern umbrella-sedge
Galactia volubilis	FACU\NAT	
Galium tinctorium	FACW\NAT	Stiff marsh bedstraw
Galium uniflorum	FACU\NAT	
Gordonia lasianthus*	FACW\NAT	Loblolly bay
Gratiola pilosa	FACW-NAT	Shaggy hedgehyssop
Gratiola ramosa	FACW\NAT	Branching hedgehyssop
Habenaria repens	OBL\NAT	Water-spider orchid
Hedyotis uniflora	FACW-EXO	
Hydrocotyle bonariensis	FACW\NAT	Coastal-plain pennywort
Hydrocotyle spp.	???	Pennyworts
Hydrocotyle umbellata	OBL\NAT	Many-flower pennywort
Hydrocotyle verticillata	OBL\NAT	Whorled pennywort
Hypericum cistifolium	FACW\NAT	Round-pod St.John's wort
Hypericum fasciculatum*	FACW+NAT	Sandweed St. John's wort
Hypericum hypericoides	FACU\NAT	
Hypericum mutilum	FACW\NAT	Slender St. John's wort
Hypericum myrtifolium	FACW\NAT	Myrtleleaf StJohn's wort
Hyptis alata	OBL\NAT	Cluster bushmint
Iris hexagona*	OBL\NAT	Prairie iris
Juncus dichotomus	FACW\NAT	Forked rush
Juncus effusus*	FACW+NAT	Soft rush
Juncus marginatus	FACW\NAT	Grass-leaf rush
Juncus megacephalus	OBL\NAT	Big-head rush
Juncus repens	OBL\NAT	Creeping rush
Juncus scirpoides	FACW+NAT	Needle-pod rush
Lachnanthes carolininana	OBL\NAT	Carolina redroot
Lachnocaulon anceps	OBL\NAT	White-head bogbutton
Leersia hexandra	OBL\NAT	Club-head cutgrass
Linaria spp.	???	
Lindernia anagallidea	FAC+NAT	False-pimpernel
Lindernia grandiflora	OBL\NAT	Savannah false-pimpernel
Lippia nodiflora	FACWdNAT	
Lolium perenne	FACU\EXO	Perennial ryegrass
Ludwigia arcuata	OBL\NAT	Piedmont seedbox
Ludwigia linifolia	OBL\NAT	Southeastern seedbox
Ludwigia maritima	FACW\NAT	Seaside seedbox
Ludwigia microcarpa	OBL\NAT	Small-fruit seedbox
Ludwigia octovalvis	OBL\NAT	Mexican seedbox
Ludwigia palustris	OBLdNAT	Marsh seedbox

Ludwigia peruviana	OBL\NAT	Peruvian seedbox
Ludwigia pilosa	OBL\NAT	Hairy seedbox
Ludwigia repens*	OBL\NAT	Creeping seedbox
Ludwigia spp.	???	Seedboxes
Luziola fluitans	OBL\NAT	
Lythrum alatum	FACW\NAT	Winged loosestrife
Macroptilium lathyroides	FACU\EXO	
Mecardonia acuminata	FACW\NAT	Purple mecardonia
Micranthemum glomeratum	OBL\NAT	Manatee mudflower
Micranthemum umbrosum	OBLdEXO	Shade mudflower
Mikania scandens	FACW+NAT	Climbing hempweed
Myrica cerifera*	FAC+NAT	Southern bayberry
Nuphar luteum	OBL\NAT	Yellow cow-lily
Nymphaea odorata*	OBL\NAT	White water-lily
Nyssa sylvatica var. biflora	FAC\NAT	Black gum
Osmunda regalis*	OBL\NAT	Royal fern
Oxalis florida	FACU\NAT	Florida woodsorrel
Oxalis spp.	???	Woodsorrel
Oxypolis filiformis	FACW+NAT	Water cowbane
Panicum anceps	FACW+NAT	Beaked panic grass
Panicum ciliatum	FAC\NAT	Little panicum
Panicum dichotomum	FAC\NAT	Cypress witchgrass
Panicum erectifolium	OBL\NAT	Erect-leaf witchgrass
Panicum hemitomon	OBL\NAT	Maiden-cane
Panicum laxiflorum	FACW\NAT	
Panicum maximum	FAC-EXO	Guinea grass
Panicum repens	FACW-EXO	Torpedo grass
Parietaria floridana	FACdNAT	Florida pellitory
Paspalum distichum	OBL\NAT	Joint paspalum
Paspalum notatum var. saurae	FACU+EXO	Bahia grass
Paspalum setaceum	FAC\NAT	Thin paspalum
Paspalum urvillei	FAC\EXO	Vasey grass
Peltandra virginica*	OBL\NAT	Arrow arum
Phyla nodiflora	FACWdNAT	Common frog-fruit
Plantago virginicus	FACU-NAT	Pale-seed plantain
Pluchea odorata	FACW\EXO	Shrubby camphor-weed
Pluchea rosea	FACW\NAT	Rosy camphor-weed
Polygala ramosa	OBL\NAT	Low pinebarren milkwort
Polygonum densiflorum	OBL\NAT	Dense-flower smartweed
Polygonum hirsutum	OBL\NAT	Hairy smartweed
Polygonum hydropiperoides	OBL\NAT	Swamp smartweed
Polygonum punctatum	FACW+NAT	Dotted smartweed
Polygonum spp.	???	Smartweeds
Polypremum procumbens	FAC\NAT	Juniper-leaf
Pontederia cordata*	OBL\NAT	Pickerel weed

Proserpinaca palustris	OBL\NAT	Marsh mermaid-weed
Proserpinaca pectinata	OBL\NAT	Comb-leaf mermaid-weed
Ptilimnium capillaceum	OBL\NAT	Hairlike mock bishopweed
Quercus laurifolia*	FACW\NAT	Laurel oak
Rhexia mariana	FACW+NAT	Maryland meadow-beauty
Rhexia nuttallii	FACW+NAT	Nuttal's meadow-beauty
Rhynchospora caduca	OBL\NAT	Falling beakrush
Rhynchospora fascicularis	FACW+NAT	Fasciculate beakrush
Rhynchospora filifolia	FACW-NAT	Thread-leaf beakrush
Rhynchospora microcarpa	FACW+NAT	Southern beakrush
Rhynchospora microcephala	OBL\NAT	Capitate beakrush
Rhynchospora mixta	OBL\NAT	Mingled beakrush
Rhynchospora spp.	???	Beakrushes
Rhynchospora tracyi	OBL\NAT	Tracy's beakrush
Rubus spp.	???	Blackberrys
Rumex pulcher	FACWdEXO	Fiddle dock
Sabatia spp.	???	Rose-gentian
Sacciolepis indica	FAC\EXO	Glenwood grass
Sacciolepis striata	OBL\NAT	American cupscale
Sagittaria graminea	OBL\NAT	Grass-leaf arrow-head
Sagittaria lancifolia*	OBL\NAT	Bulltongue arrow-head
Sagittaria latifolia	OBL\NAT	Broadleaf arrow-head
Sagittaria spp.	???	Arrow-heads
Salix caroliniana	OBL\NAT	Coastal-plain willow
Samolus valerandi	OBL\NAT	Water pimpernel
Scirpus cyperinus	OBL\NAT	Wool-grass
Scoparia dulcis	FACU\NAT	Licorice weed
Senecio glabellus	FACW+NAT	Grass-leaf groundsel
Senna obtusifolia	FAC\NAT	
Sesbania macrocarpa	FACW\NAT	Sesbania hemp
Solidago fistulosa	FAC+NAT	Pinebarren goldenrod
Solidago sempervirens	FACW\NAT	Seaside goldenrod
Solidago stricta	OBL\NAT	Willow-leaf goldenrod
Spartina bakeri*	FACW+NAT	Sand/Smooth cordgrass
Spilanthes americana	FACW\NAT	Creeping spotflower
Stenotaphrum secundatum	FAC\NAT	St. Augustine grass
Syngonanthus flavidulus	FACW+NAT	Bantam-buttons
Tall grass	???	
Taxodium ascendens	OBL\NAT	Bald cypress
Taxodium distichum	OBL\NAT	Bald cypress
Thalia geniculata*	OBL\NAT	Alligator flag
Toxicodendron radicans	FAC\NAT	Poison ivy
Typha domingensis	OBL\NAT	Southern cattail
Typha latifolia	OBL\NAT	Broadleaf cattail
Urena lobata	FACU\NAT	Caesar weed

Utricularia fibrosa	OBL\NAT	Fibrous bladderwort
Verbena scabra	FACW+\NAT	Sandpaper vervain
Vigna luteola	FACW\NAT	Hairy-pod cowpea
Viola lanceolata	OBL\NAT	Lance-leaf violet
Vitis rotundifolia	FAC\NAT	Muscadine grape
Woodwardia virginica	OBL\NAT	Virginia chainfern
Xyris caroliniana	FACW+\NAT	Carolina yelloweyedgrass
Xyris elliottii	OBL\NAT	Elliot's yelloweyedgrass
Xyris jupicai	OBL\NAT	Richards yelloweyedgrass