ABACOA
MANAGEMENT PLAN

SECTION B: WATER MANAGEMENT

CONTENTS

1.O INTRODUCTION

Specific to Abacoa's long-range management objectives of preservation, restoration, and enhancement, the construction of the water management systems are analogous to functioning wetland features having utilitarian benefits. This system offers the greatest challenge and conversely, the greatest opportunity to design, construct and reformulate an ecosystem component back into the landscape which has been all but lost onsite.

The real opportunity and objective from the onset was to design a regenerative water-flow system which, over time, would provide optimum conditions under which an evolving vegetative feature could begin to re-establish aquatic system benefits and provide a resource utility in the form of a natural appearing water system.

1.1 EXISTING HYDROLOGICAL FEATURES

The existing hydrologic features within Abacoa exist in several distinct functional aspects. They can be described as follows:

1.1.1. Isolated Wetlands. Specifically located in the southeast corner of the site within Range I, (see Exhibit A for Range location) these isolated wetlands still retain many of their historically relevant hydrologic aspects of recharge, hydroperiod fluxing in relation to rain regimes, and isolated wildlife habitat for many species of bird found nowhere else onsite (Snipe, Least Tern, Green Heron, Black-necked Stilt), as well as, resident populations of amphibians exclusive to the pine flatwood isolated wetland habitat (Southern Leopard Frog, Florida Chorus Frog, Oak Toad, with possible residence Florida Gopher Frog). These areas are presently in almost pristine conditions with only minor elements of Melaleuca (incidental numbers) within upper gradient portions where slash pine have developed successionally over the last decade, perhaps as indicators of draw-down affects associated with the lateral canal systems effectiveness during drier periods.

Other isolated wetlands are found just north of this tract in Range II (see Exhibit A for Range location) within the proposed school site. Overall function is appreciably compromised by Melaleuca and drier site conditions.

Severely diminished functional aspects are attached to many of the older isolated Cypress domes which are sporadically located across the site. Most of these features are hydrologically depressed with little or no seasonal standing water. Cypress features except in minor instances have been included in the Upland Preserve and will eventually be restructured back into the Constructed Surface Water Management System which will meander and course through the Upland Preserve corridor as both an amenity and a functional hydrological system for water conveyance, retention and wildlife support elements.

1.1.2. **Lateral Drainage Canals**. Utilized by the Northern Palm Beach County Improvement District (NPBCID) these canals form the matrix of the present surface water management system which cuts through the site causing fragmentation and surface water drainage interiorally. Most of the canals, with the exception of the southern and eastern most canals, will be filled during the process of development at Abacoa. As the phased construction of the water management system is initiated throughout the development of the site, the canals will be phased out.

1.2 PROPOSED HYDROLOGICAL SYSTEMS

The proposed hydrologic features within Abacoa will be constructed in several distinct and functional systems. They can best be described as follows:

1.2.1 **The Constructed Surface Water Management System.** This system will be established by recontouring and recomposing relic isolated wetland features over now perched and dry sites dominated by Brazilian Pepper thickets, which have established dominance in these lower gradient locations over the last two decades. Utilizing their vegetative signature on the landscape the Constructed Surface Water Management System will, through methodic resculpturing and recontouring, turn a liability into a long-term asset with habitat benefits not seen over the landscape in a quarter of a century. The Constructed Surface Water Management System will establish two distinct habitat features:

A. Dry Basin and Dry Channel Features will be primarily constructed west of the Central Boulevard alignment, in reference to the upper gradients and depressed ground-water tables associated with existing well withdrawals. The main function of the Dry system is expressed as detention.

B. Wet Basin and Wet Channel Features will be primarily constructed east of the Central Boulevard alignment, in reference to the middle and lower gradients of the site where water persists as a year-round element. The main attributes of the Wet system will be wildlife habitat restoration and whose function is expressed as retention and ground-water recharge.

1.2.2 **Created Wetland Areas.** This area consist of 7.3 acres of wetland, as mitigation for impacts to marginally functional insitu wetland areas which will be altered by the development process. The area will be located at the extreme southeastern quadrant of the site, within Range I, to assure longevity in accordance with specific hydrological wetland features (see Exhibit A for Range location).

2.0 OBJECTIVES

Ultimately, the perceived system, of Dry Retention and Wet Detention Basins and Channels, will emulate a watershed system, working in a dynamic balance with the surrounding Upland Preserve System, which physically envelopes it on all sides. This systems objective will be to function in the following manner:

A. The Constructed Surface Water Management System will function as an "open" hydrologic transport system, taking in both rainfall accumulations, run-off storage from the built environment, and sheetflow from the pine flatwood Upland Preserve Area.

B. Managing storm water in regenerative ways, will imply retaining and utilizing rain water near to where it falls, contributing to recharge of the local aquifer.

C. The system will match use to capacity of basic processes, and will distribute use, across key processes of conversion, distribution, filtration, assimilation and storage (sink), according to inherent characteristics of the landscape and will control both volume and quality of water flows in such ways as to maintain them within given limits.

D. The system will follow a strategy of dispersal, or spreading out over the ecosystem, making full use of basic vegetative processes of filtration.

E. Combined with some degree of augmentation of this process, routing alternatives to flow will be utilized to spread concentrations and slow dispersal. These will include deflectors, rock rubble weirs, channel constrictors, log sills, aerators etc. that will produce heterogeneity and diversity of water features conducive to wildlife diversity.

F. The Constructed Wet Basin vegetative features are designed to mimic a slow flowing Cypress Slough/Creek open water riparian system.

G. The Constructed Wet Basin systems will not necessarily mimic or replicate the original type of depressional (isolated) wetlands which existed extensively on the site a half-century ago, but rather, will express the dynamic attributes of a mixed swamp forest providing multiple benefits and key habitat components of:
   - mast (fruit or seed) as an important food item
   - roosting, nesting, breeding and feeding sites
   - edible foliage supports (arboreal) insect populations, which support food chain activity
   - affords insularization and protection for canopy nesting species
   - buffers and screens feeding sites for bird species easily alarmed or disturbed
   - provides a contiguous habitat and corridor travel structure for many onsite vertebrate species

- forms transitional edge components of floodplain cypress strand forests, with mast -producing bottomland hardwoods, in proximity to other species in the adjoining pine flatwood (Preserve).
- at mid-maturity (15-20 years) will provide soil and slope stability and measurable affects on fate of precipitation into the watershed.

H. Combining the upper gradient Dry Retention (infiltration) basins, that possess induced permeable soils because of proximity to well-field influences, with the aforementioned Wet Basin, creates an expanded range of different habitat conditions, of temporal and spatial heterogeneity.

I. The Created wetland habitat which will function as refuge for wading bird species, specifically Wood Storks, and Least Terns known to frequent this portion of the site area. This will be accomplished by creating a shallow wetland depressional basin, held well above to consolidate layer, that will maintain hydroperiod conduct to tactile-groping feeding of the stork, with sandy exposed shoreline areas in the northern portion to encourage Least Tern resting and possible nesting sites. Hydroperiods will be elongated compared to present onsite wetland hydroperiods with occasional shallow water draw-downs for wading birds foraging habits.

J. Functionally the Created Wetland will be modeled after a pineland wet season pond with mixed wet flatwood pine vegetative profile that will form a visual and sound buffer on the southwest and western flanks insulating wildlife from surrounding built-environment movements and activities (Military Trail). Ecotones will proceed from deepest sections of submerged and floating species, up into wet prairie (Hypericum spp., Rynchospora spp.) species which will eventually interface with wet pine flatwood features.

2.1 DESIGN

Although the designed system will require less maintenance and input of energy in the long-term, initially at the early stages of construction and implementation, there will be a required collaborative effort from all participants (designer, engineer, construction team, installer, and habitat managers) for greater attention to detail and a certain amount of flexibility to coincide with the complexity of interfacing the constructed/created system to the existing (Upland Preserve).

Because the envisioned system will ultimately interface with the Upland Preserve Area, an "edge" will be created between the two initially distinct habitats. The Upland Preserve will be relatively stable, while the Constructed System will be unstable during the initial formative stages. Often this edge establishes an area prone to opportunistic weed development which could ultimately migrate into this Upland Preserve unless maintained during the gestation period.

2.2 GOALS

Primary to achieving the objectives of maintenance and management of these systems, especially at the interface level, a proposed ingress/egress maintenance/pedestrian trail will be established just beyond the boundary of the Upland Preserve Area. It will have combined elements of maintenance and passive recreation attached to it. It will form a serpentine walking system internal to the overall Upland Preserve, whereby additional micro-sited spur trails (walking only) may originate from and form switch and loop-back trails which would ultimately become the small vegetative fire brakes of the Gopher Tortoise Management Area, during prescriptive fire regimes. The main interface trail system will be wide enough (approx. 7 ft.) to accommodate maintenance equipment adapted to perform all necessary management procedures. No other motorized vehicles will be allowed within the trail system. Bicycles will be accommodated on the maintenance trails.

Beyond the pure maintenance and passive recreation aspects, which offer conceptual and physical overview of the systems, trails ultimately become wildlife corridors, and protective pathways for animals such as birds, reptiles, and small mammals to migrate among habitat features.

A central challenge of habitat management within the Constructed Surface Water Management Areas will be to maintain a balance between use and capacity of basic processes to assimilate mineral (nutrient) cycling within the confines of the system. The ultimate goal is to utilize the constructed hydrologic features to provide both value and function in the form of flood and retention/detention conveyance, sediment and erosion control, open space and aesthetic values, and wildlife habitat.

Management and restoration of the Constructed System will go from a symptomatic technical - mechanical approach stage high in active participation, to a systematic, multi-leveled ecological-approach with decreasing input.

3.0 MANAGEMENT

The water management system, regardless of whether they are existing (preserved) or constructed (Surface Water Management System), will react and interplay with the surrounding Upland Preserve ecosystem. Because of their locations within the overall, they will be acted on by elements specific to the terrestrial habitat systems (sheet-flow, upland floristic germination/development, faunal species exchanges and migration, mineral cycles, micro-climate adjusting) and must be interpreted as to long-range affects of these introductions. This becomes very important during routine selective culling and eradication management periods. Selective treatment of emerging, recruited vegetation will set future successional values.

3.1 MANAGEMENT INITIATIVES

Management will operate within a frame of reference to spatial and temporal scales that are important for each ecosystem component of concern. Within the context of the water management systems that will operate at Abacoa, there are primarily three components which will fall under

management initiatives: Constructed Surface Water Management Systems, preserved isolated Wetlands and Created Wetlands.

3.1.1 Constructed Surface Water Management Systems. Because the constructed dry and wet system will function as sources, sinks, or transformers of certain chemicals (organic and inorganic) from natural, as well as, man-made sources, managers will be relying on collected data (D.O., B.O.D., p.H., temperature, salinity, turbidity, Phosphorous, Nitrogen, redox potential) to assess incoming or ongoing degrees of disturbance associated with their concentrations, forms, and locales within the system (non-point and point sources).

A. The dry system envisioned to operate in the northwestern sections of Abacoa will more closely resemble a hybrid dry/wet prairie which will display shortened hydrologic pulsing, conducive to infiltration and recharge, benefiting the immediate Upland Preserve system by moderating ground-water depletion, aggravated by the present and predicted well-field withdrawals. (see Exhibit B)

B. The wet system will operate very similar to natural cypress strand swamps which by virtue of accumulation of runoff from a larger watershed; in this case the built environment of Abacoa and the sheet-flow from the Upland Preserve; allows water to flow slowly meandering through a dynamic set of habitat exchanges before reaching its ultimate discharge point. (see Exhibit C)

C. Comparisons. The basic differences between the two habitat systems may be summarized as follows:

Variable	Wet Basin/Channel	Dry Basin/Channel
Main Function	Detention (storage, sink, conveyance)	Retention (infiltration, sink)
Hydroperiod	Intermediate to long	Short
Ecosystem types	Cypress Strand/Slough/Hardwood Swamp/Mesic	Dry Prairie hybrid/xeric transitional
Organism sizes	Large	Small
Life Cycles	Long-complex	Short-simple
Mineral (nutrient) cycles	Open	Closed
Role of Detritus	Important	Unimportant
Species Diversity	High	Low
Food Chains	Weblike, detritus	Linear, grazing

**One of the contributing factors to the apparent self-limiting aspects of the Dry Basin is stress associated with dry intervals which lead to dissipation*

3.1.2 Preserved (insitu) Existing Isolated Wetlands. These wetlands are randomly situated within the Upland Preserve System, almost exclusively in the southeast quadrant which is the furthest distance from the well-field cone of influence. These will be essentially left alone, with the exception of exotic removal (sporadic Melaleuca seedlings and fire

ants brought in by cattle) to play out changing successional seres which are operable at a micro-site level at present. Preserved insitu wetlands will be monitored and maintained from detrimental changes as prescribed in Section 3.3.2. no.4: d and g-1,2,3,6 and 7.

3.1.3 **Created Wetland Areas.** this wetland area, of 7.3 acres, will be constructed to mitigate/compensate for impacts to insitu wetland habitat altered by development and will be located at the extreme southeast quadrant of the site to assure its longevity. It will be developed in accord with specific hydrological wetland featuring.

3.2 IMPLEMENTATION

3.2.1 **Constructed Surface Water Management System.** Both Dry and Wet constructed surface water management systems will undergo a series of transformations which will reconfigure present contour gradients in ways which will develop them into conceptualized and serviceable hydrologic features. The sequence of events draw-similar inferences and differ only in final excavation depths and final function parameters.

This sequencing of events and other processes essential to the final functional aspects of the Dry and Wet constructed surface water management system shall include the following sequences:

A. **Dry Basin and Channel Surface Water Management System.** This system will be formulated primarily in the northwest section of the Upland Preserve System within the affected influence of the existing well-fields, located primarily west of Central Boulevard. Basin locations and alignment are within existing monotypic Brazilian Pepper stands and within the Central Boulevard median and western buffer. The following implementation sequences shall be utilized for constructing the Dry System:

1. Site boundaries deliniated.

2. Delineation of exotic and nuisance species (Brazilian Pepper, Melaleuca) as circumscribed on the landscape matrix. Staked and "ground-truthed" prior to eradication program to assess species profile, anomalies, micro-habitat features, and possible translocation/relocation candidate species or structural elements. Demarcate "Limits of Clearing" offset from actual interface line.

3. Protective measures implemented to maintain clear differentiation of Upland Preserve interface zone from "edited" habitat element of Brazilian pepper and other exotic nuisance species within the area of the constructed basin. To assure that encroachment into the Upland Preserve does not occur and induce alterations to insitu preserve habitat structure, a set back of eight (8') feet from the Upland boundary will be maintained until the final stage of clearing. Methodologies to

accomplish this include: fencing installed as a pre-relocation/release requirement related to the Gopher Tortoise recipient site process (see Section C), use of Kershaw mowers to cull the height of vegetation up to the Upland Preserve boundary lines and vegetative fire break structuring utilizing mowers to reduce fuel height.

4. Eradicate exotic and nuisance species up to the interface zone (offset) of Upland Preserve elements. Eradication will be conducted in the following manner:

a. Obtain early work vegetative removal permit from Town of Jupiter.

b. Exotic vegetation to be extracted from site and carried to nearby chipping/mulching site. Technique is dependant upon season of eradication as it pertains to Brazilian Pepper (dormant seasonally). Melaleuca will be addressed by the first process in all cases.

c. Exposed soils containing an active seed germination element will be addressed by an initial pass thru the constructed basin corridor with a paddle pan, removing the top 6"-8" layer of soil to remove a greater portion of seed bank prior to germination. Excavated soils will be utilized or treated in a manner which minimizes the recruitment of seeds.

d. Ingress and egress travel corridors laid out as maintenance easements and trail networks, will be formulated at the top of the surface water management system.

5. Conduct soil test of planting area within the constructed basin site. Analyze results pertinent to planting objectives.

6. Monitor for reintroduction and re-establishment of Brazilian Pepper/nuisance species seedlings and maintain with selective herbicide treatment.

7. Survey the cut and fill staking of constructed basin feature. Detail and field adjust design as necessary. Examine soil profile for possible "confining layer" as referenced by SFWMD. "Confining layer" if present should be verified for depth, thickness and permeability rates. "Confining layer" material may become factor in later planting process due to hardness and may necessitate mixing (discing) to permit planting and to increase oxygen exchange rates necessary for long-term plant survival within soil medium.

8. Re-establish "Limits of Clearing".

9. Establish and implement erosion control methods as necessary.

10. Proceed with excavation. Coordinate conceptual design in the field throughout the construction stages. Detail and field adjust design as necessary at this time, vertical soil may be relocated from areas outside of preserve and spread on side slopes where transitional habitat will be established.

11. Establish maintenance and recreation ingress and egress trail system waterward of Upland Preserve interface line.

12. Tie-in newly constructed basin to existing water management system. Hydrate system with tie-in sequence. Stabilize water levels and turbidity levels.

13. Actual water level results analyzed and compared to predicted levels and assimilated into planting plan. Adjust plan as necessary to changes in the field.

14. Staff gauge structural element installed and monitoring stations established for evaluation and ongoing analysis collection for water quality of nonpoint agents.

15. Limits and zones of planting re-established in reference water to elevation (NGVD) and slope gradients. Slopes redressed, mulched, or stabilized where necessary.

16. Plantings installed in accordance to plan. Juxtapose and adjust in relation to obvious dictates of land and water confirmations.

17. Monitor for re-germination of exotics or nuisance species.

B. Wet Basin/Channel Surface Water Management System. This system will be formulated primarily east of the Central Boulevard roadway alignment, which maintains higher ground-water levels due to lower gradient and distance relative to the existing well-field influences. This system is similar to the Dry Basin/Channel in that it too is advantageously located and aligned with Brazilian Pepper monoculture elements which historically displaced original aquatic systems which became dysfunctional decades ago, due to multiple draw-down functions operating with the present water-shed. The following implementation sequences shall be utilized for constructing the Wet System:

1. Site boundaries deliniated.

2. Delineation of exotic and nuisance species (Brazilian Pepper, Melaleuca) as circumscribed on the landscape matrix. Staked and "ground-truthed" prior to eradication program to assess species profile, anomalies, micro-habitat features, and possible translocation/relocation candidate species or structural elements. Demarcate "Limits of Clearing" offset from actual interface line.

3. Protective measures implemented to maintain clear differentiation of Upland Preserve interface zone from "edited" habitat element of Brazilian pepper and other exotic nuisance species within the area of the constructed basin. To assure that encroachment into the Upland Preserve does not occur and induce alterations to insitu preserve habitat structure, a set back of eight (8') feet from the Upland boundary will be maintained until the final stage of clearing. Methodologies to accomplish this include: fencing installed as a pre-relocation/release requirement related to the Gopher Tortoise recipient site process (see Section C), use of Kershaw mowers to cull the height of vegetation up to the Upland Preserve boundary lines and vegetative fire break structuring utilizing mowers to reduce fuel height.

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a. Obtain early work vegetative removal permit from Town of Jupiter.

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c. Exposed soils containing an active seed germination element will be addressed by an initial pass thru the constructed basin corridor with a paddle pan, removing the top 6"-8" layer of soil to remove a greater portion of seed bank prior to germination. Excavated soils will be utilized or treated in a manner which minimizes the recruitment of seeds.

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7. Survey the cut and fill staking of constructed basin feature. Detail and field adjust design as necessary. Examine soil profile for possible "confining layer" as referenced by SFWMD. "Confining layer" if present should be verified for depth, thickness and permeability rates. "Confining layer" material may become factor in later planting process due to hardness and may necessitate mixing (discing) to permit planting and to increase oxygen exchange rates necessary for long-term plant survival

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8. Re-establish "Limits of Clearing".

9. Establish and implement erosion control methods as necessary.

10. Proceed with excavation. Coordinate conceptual design in the field throughout the construction stages. Detail and field adjust design as necessary at this time, vertical soil may be relocated from areas outside of preserve and spread on side slopes where transitional habitat will be established. Install aeration system as required.

11. Establish maintenance and recreation ingress and egress trail system waterward of Upland Preserve interface line.

12. Tie-in newly constructed basin to existing water management system. Hydrate system with tie-in sequence. Stabilize water levels and turbidity levels.

13. Actual water level results analyzed and compared to predicted levels and assimilated into planting plan. Adjust plan as necessary to changes in the field.

14. Staff gauge structural element installed and monitoring stations established for evaluation and ongoing analysis collection for water quality of nonpoint agents.

15. Limits and zones of planting re-established in reference water to elevation (NGVD) and slope gradients. Slopes redressed, mulched, or stabilized where necessary.

16. Plantings installed in accordance to plan. Juxtapose and adjust in relation to obvious dictates of land and water confirmations.

17. Monitor for re-germination of exotics or nuisance species.

3.2.2 **Created Wetland Area.** The Created Wetland Area will be designed with a shallow depressional area with extended hydroperiod features through recontouring the marginal upland areas and areas populated in Brazilian Pepper within the Upland Preserve. The mitigation will be enacted in the northwest corner of Range I and contains the 7.3 acres (see Exhibit A). The rationale behind the selection of this specific site area is the following:

1. Furthest point onsite from the existing well-field cone of influence which gives reasonable assurances that a wet prairie system can operate within this area, from evidence of still operable isolated wetlands on site.

2. Area will be protected from encroachment by virtue of installed fencing as provisional component of the Gopher Tortoise Management Plan.

3. Locates mitigation wetland system as a contiguous site with merits as wildlife habitat, a sub-system of the larger upland flatwood habitat system, located within an area of considerable importance.

4. Efficiency in long-term management, maintenance, and monitoring of this wetland site, especially in respect to non-point source pollution, exotic and nuisance species migration, and assurances in successional responses to temporal factors.

A separate Created Wetlands implementation methodology will be provided to SFWMD to implement the Constructed Wetland.

3.3 MAINTENANCE/MONITORING

3.3.1 Dry and Wet Surface Water Management System. General patterns of maintenance will be toward maintaining long-term suitable conditions for the initial establishment of planted and transplanted material into the Constructed Water Management System. Decisions shall be based on continual quantitative and qualitative monitoring of water quality, vegetative growth and successional seres development to assure the success of the overall system toward long-term establishment goals.

Maintenance of the Constructed Water Management System shall immediately proceed installation of all components of the overall vegetative habitat system. Best Management Practices (BMPs) as presented by SFWMD should be adhered to in all approaches to stormwater management programs by minimizing adverse "non-point source" effects of stormwater through a coordinated system of source controls. Source controls emphasize prevention and reduction of nonpoint pollution and excess stormwater flow before it reaches the actual basin. Processes depend upon individual micro-site features but in broad general methods involve dispersal through natural drainage ways, depressions, sheetflow, highly permeable soils, and established vegetation features which provide natural infiltration, help control velocity of runoff, extend the time of concentration, filter sediments and other pollutants and recycle nutrients.

3.3.2 Created Wetland Area. Monitoring shall be established to assess long-term success of the system. The following criteria will apply to the Created Wetland mitigation area:

1. Design will be submitted to the SFWMD for permit approval prior to construction.

2. Monitoring quadrant sampling stations will be verified under design plan.

3. Schedules of monitoring and reporting will be submitted for approval to all applicable agencies and will follow the general condition of 5 years of monitoring as specified under monitoring standards adopted by the South Florida Water Management District (SFWMD).

4. Quality Assurance as it pertains to maintenance and monitoring to determine the survivorship of the plantings, shall include, at a minimum:

a. Ensure of at least 80% survivorship of all plantings for the overall (5 year) period. If in any area or habitat assemblage, establishment and recruitment of vegetation has not taken place after the specified period, additional planting or modification to the design may be required. Extension of the monitoring period will also be required until success criteria are met.

b. Quarterly and/or Semi-annual monitoring reports indicating number of surviving, by density comparisons; plantings, and any plantings made to maintain 80% survivorship. Indicator trends of plausible successional seres.

c. Control and/or removal of exotic or weedy opportunistic species or otherwise nuisance species, i.e. Melaleuca spp., Schinus spp., Typha spp., Ludwigia spp., or other species deemed problematic by agencies during monitoring period. The methods to be used for maintaining the 7.3 acres of mitigated wetlands after planting are attached as Exhibit D.

d. Monitoring reports will be driven by final mitigation development completion and will be submitted for 60 months (5 years) from time-zero (after completion of the mitigation per plan) to the fifth year report. Monitoring reports will be submitted annually as referenced above and for referenced periods of time. They are compiled from Semi-Annual and annual reported data.

e. All monitoring reports will document the following in a descriptive unit form derived from the established transects (referenced on aerial topo) through the entire mitigation area. All major vegetative zones and habitat assemblages will be represented within the transect. Information to be derived from transect shall include and/or analyze the following:

1. Water levels and depth represented by staff gauges, recorded monthly and summarized, and documentation of natural ground level elevations at each transect station.

2. Daily rainfall recorded and summarized and submitted with reports.

3. Water quality (temperature, D.O., pH, turbidity, etc.

4. Macro-invertebrate (crayfish, snails, shrimp) densities and specific sites.

5. Fish densities and specific sites.

6. Bird utilization recorded and summarized for report.

7. Vegetative species present, density, dominance and qualitative report.

8. Fixed panoramic photos from permanent stations.

9. Maintenance and survival data.

4.0 SUMMARY

The overall Water Management at Abacoa is specific to long-range management objectives which address multiple issues of preservation, creation, and construction of hydrologic aspects into existing site features. These issues are not exclusive of one another, but rather mutually inclusive to the formation of a whole system which will operate at an ecosystem level. Each will or already possess unique attributes which combined, will benefit the larger Upland Preserve Area by contributing aquatic site elements supportive of future biological diversity and function not presently operable onsite. Long-term management initiatives of these systems will provide Abacoa with:

A. Habitat structuring conducive to maintenance of biological diversity by creating new habitat niches.

B. Constructed Surface Water Management System designed as a natural component will add potentials for aquifer recharge in a variety of processes of retention/detention within an elongated cascading hydrologic system.

C. Constructed Surface Water Management System will provide a unique complex of conveyance features within an evolving habitat assemblage that will provide the opportunities in enhancement of wildlife species through vegetative structuring.

D. Basic to the management process is a multi-objectives approach which considers the hydrologic features as a contributing factor to long-term stability of the overall Upland Preserve System in which it is embedded. The approaches to the multiple issues can be summarized as:

1. Preservation of existing high quality wetlands or those that either because of isoline gradients or relative location within the overall site offered the best assurances for long-term maintenance of hydrologic features in consideration to existing well-field withdraws, were essentially set aside and preserve insitu or reformulated back into functional aspects within the Constructed Surface Water Management System.

5.0 EXHIBITS

A. Upland Preserve Range Designations

B. Dry Basin/Channel

C. Wet Basin/Channel

D. Mitigated Wetland Maintenance Methodology

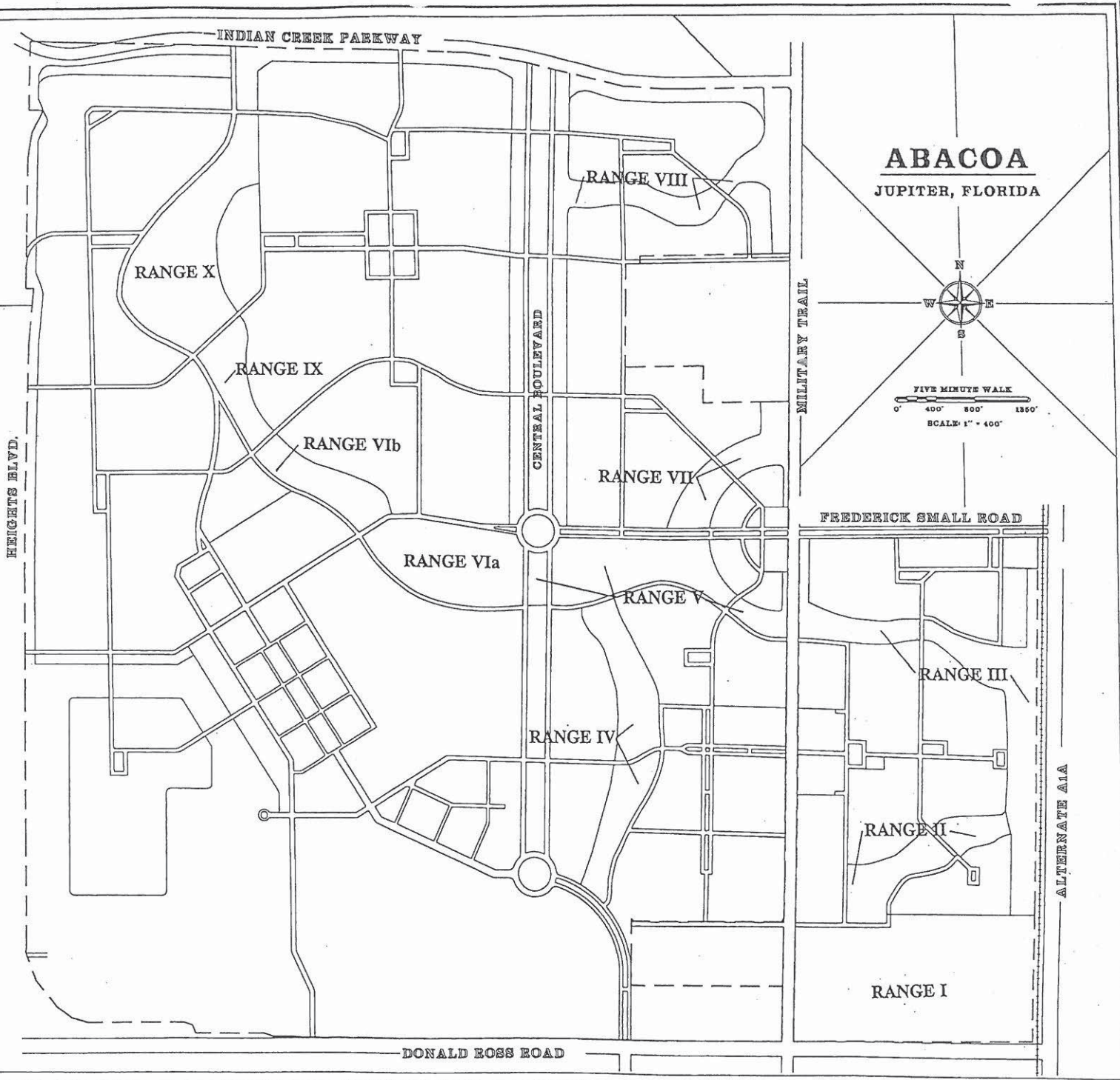
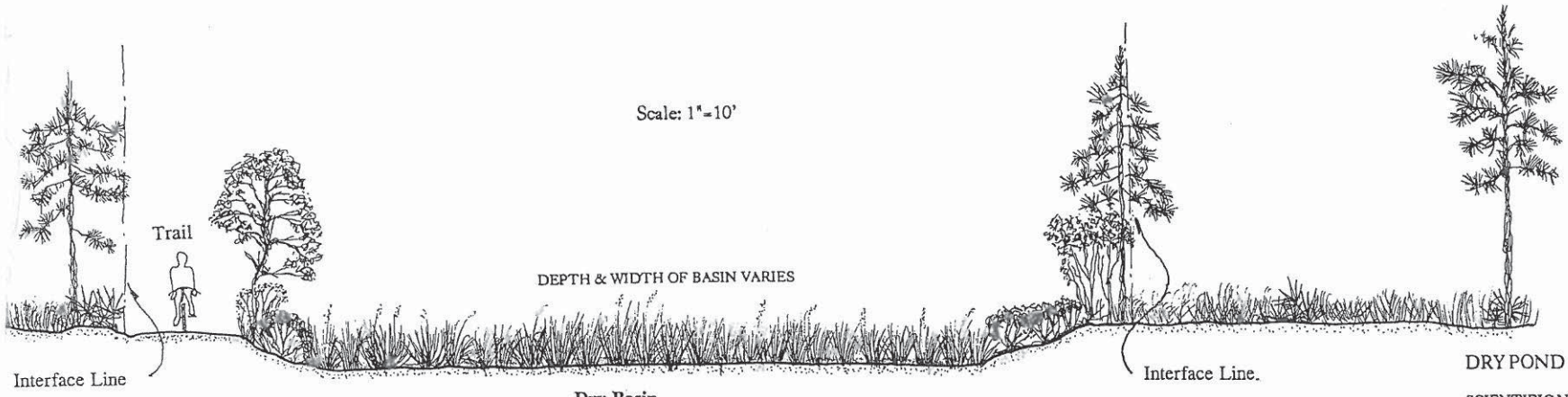


EXHIBIT A

UPLAND PRESERVE
RANGE DESIGNATIONS

EXHIBIT B
DRY BASIN/CHANNEL
SURFACE WATER MANAGEMENT SYSTEM
TYPICAL SECTION

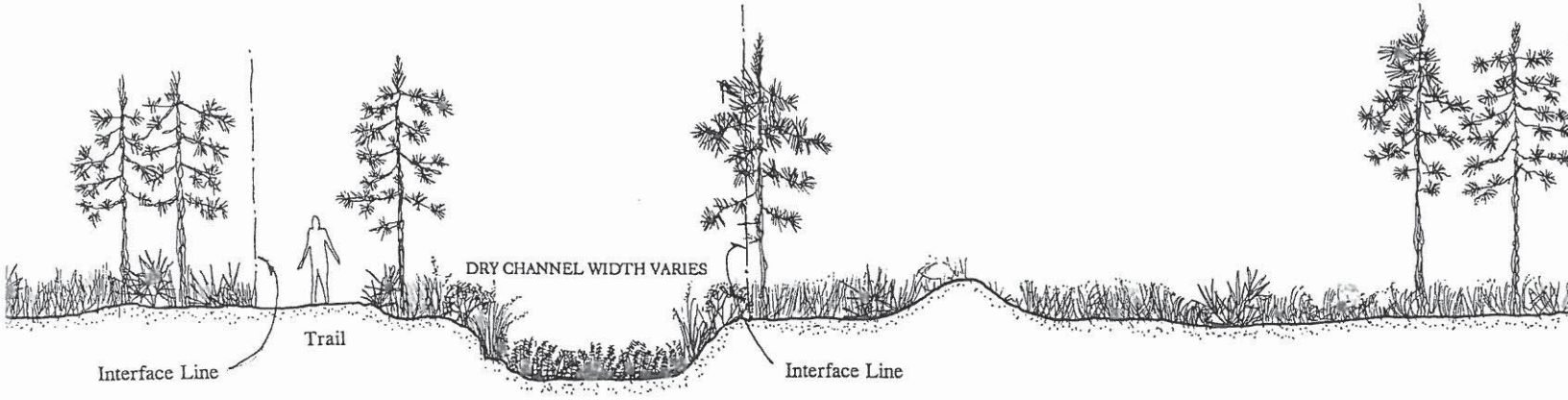


Dry Basin

Dry basins will primarily be constructed on sites, located in the N.W. section of the site and west of Central Boulevard, in areas occupied by Brazilian Pepper and the agricultural fields. In most cases, the constructed system will interface with the Upland Preserve vegetation of saw palmetto prairies, slash pine flatwoods, scrub brushland and/or herbaceous/grassy sites. Land elevations within these basins shall be consistant with the permitted Surface Water Management Plan and possess well drained soil variants.

DRY POND SPECIES LIST

SCIENTIFIC NAME	COMMON NAME
Spartina backerii	Cord Grass
Andropogan spp.	Beard Grass
Aristida stricta	Wire Grass
Sorghastrum secundum	Indian Grass
Muhlenbergia capillaris	Muhly Grass
Lyonia lucida	Fetterbush
Blechnum serrulatum	Blechnum Fern
Liscania michauxii	Gopher Apple
Ilex glabra	Gallberry
Carya floridana	Scrub Hickory
Myrica cerifera	Wax Myrtle
Ilex cassine	Dahoon Holly
Quercus laevis	Turkey Oak
Quercus mytifolia	Myrtle Oak



Dry Channel

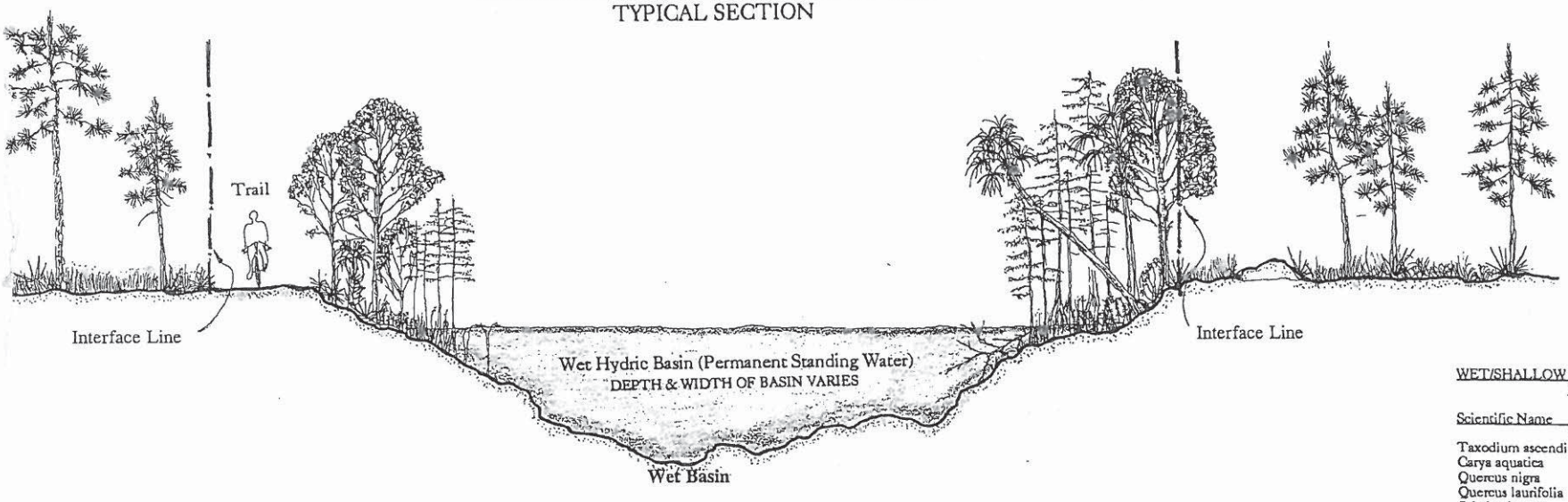
Dry channels will primarily be constructed within where hydrological connections must be formed and/or maintained to fulfill continuity of flow-way basin attributes. They will essentially be dry areas which function is detention areas and conveyance channel connections for the overall system. The channels will be narrower and have appreciable slop gradients, in comparison to the dry basin, which will be vegetated for slope stabilization, prevention of soil slump and promote shear resistance.

DRY CHANNEL SPECIES LIST

SCIENTIFIC NAME	COMMON NAME
Blechnum serrulatum	Swamp fern
*Lycopodium appressum	Southern Club Moss
Osmunda cinnamomea	Cinnamon Fern
Woodwardia virginica	Chain Fern
Ilex glabra	Gallberry
Myrica cerifera	Wax Myrtle
Licania michauxii	Gopher Apple
Lyonia lucida	Fetterbush

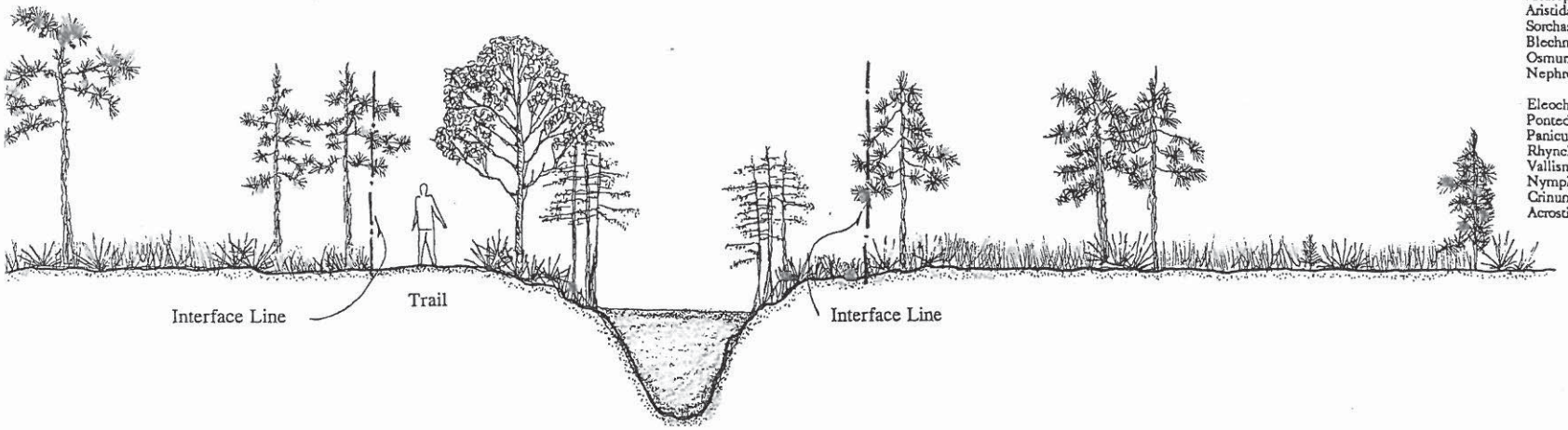
*Denotes species to be relocated from existing sites along ditch and canal banks.

EXHIBIT C
WET BASIN/CHANNEL
SURFACE WATER MANAGEMENT SYSTEM
TYPICAL SECTION



Wet Basin

Wet basins will primarily be constructed within in areas overgrown by either Brazilian pepper or Melaleuca, and are indicative of lower topographical features once containing limited wetland functions (1940's). These areas generally lie within the Upland Preserve and may be located interior or peripheral to this system. These basins are permanent water features located on lower topographical areas on the downside of the site flow-way. The wet basin is designed to mimic a meandering flow-way, with diverse spatial configurations and habitat options throughout its entire length. The main flow-way width will vary relative to the size and location of exotic vegetation at any given location. The wet basins will have composite vegetated assemblages designed to create a self-regulating biotic community indicative of a hydric hardwood system.



Wet channel

Wet channels will primarily be constructed as connective conduits in areas which do not possess topographical features which would naturally orient the direction of the flow-way system. Vegetation within these channels will be arranged to provide slop stability, expanded transitional/hydric vegetative components and provide future options for an array of species interaction.

WET/SHALLOW BASIN AND WET CHANNEL SPECIES

Scientific Name	Common Name
Canopy	
Taxodium ascending	Pond Cypress
Carya aquatica	Water Hickory
Quercus nigra	Water Oak
Quercus laurifolia	Laurel Oak
Sabal palmetto	Cabbage Palm
Persea palustris	Swamp Bay
Sub-Canopy	
Sabal palmetto	Cabbage Palm (seedling)
Serenoa repens	Saw palmetto
Myrsine guianensis	Myrsine
Ilex cassine	Dahoon Holly
Ilex glabra	Gallberry
Lyonia lucida	Fetterbush
Chrysobalanus icaco	Coco Plum
Ground-story	
Licania michauxii	Gopher Apple
Andropogan spp.	Beard Grass
Aristida stricta	Wire Grass
Sorchastrum secundum	Indian Grass
Blechnum serrulatum	Swamp Fern
Osmunda regalis	Royal Fern
Nephrolepis cordifolia	Sword Fern
Wetland	
Eleocharis cellulosa	Spike Rush
Pontederia lanceolota	Pickerel Weed
Panicum hemitomon	Maiden Cane
Rhynchospora tracyi	Tracy's Beakrush
Vallisneria americana	Eel grass
Nymphaea ordorata	White water lily
Crinum americana	String lily
Acrostichum	Leather Fern

EXHIBIT D

MAINTENANCE METHODOLOGY FOR CREATED WETLAND AREA

1. Ongoing maintenance of this system should immediately proceed the excavation/ recontouring sequence. Maintenance, at this point, will entail a monthly spot treatment removal program to target any potential exotic regrowth prior to the installation of the plant material.

2. During and after planting of this site, maintenance will be performed on a monthly basis to insure that the desirable vegetation does not become displaced with the more aggressive exotic/nuisance species.

   At a maximum the allowable percent coverage for exotic/nuisance species is 10% of the area. If the percent cover of exotics exceeds this established amount, maintenance must be performed within thirty days. Exotic vegetation that grows beyond three feet in height should be manually or mechanically cut down and removed from the site in an acceptable manner. In some instances aquatic vegetation may not be effectively treated until the foliage (leaf area) is substantially exposed.

3. Means of Control:

   a. Primary means of exotic/nuisance vegetation control within the Created Wetlands will be conducted using spot application of herbicides.

   b. Hand removal, mechanical removal (in extreme circumstances), and hand wicking (Sponge application of chemical, particularly where spot application may damage surrounding desirable vegetation) shall be used when necessary.

   c. Open water maintenance will be accomplished with the use of aquatic algicide and herbicides applied with the use of conventional motorized ground based spray equipment or small boats and or airboats. If submerged weeds are not effectively treated by herbicide controls, introduction of approved biological controls may be considered.

4. The Maintenance Contractor shall insure that all herbicide application is performed by qualified individuals possessing, or under the supervision of a person possessing, a current Department of Agriculture and Consumer Services Restricted Pesticides/ Herbicides Aquatic and Right of Way Applicator License. Copies of said license shall be provided to the owner or his representative before associated work is performed.

2. Created Wetlands (7.3 acres) were provisionally established within the highest quality Upland Preserve in the southeast corner of the site which is the furthest point from the existing well-field affects. This portion of the Upland Preserve also contained functional isolated Preserved Wetlands which suggested long-term assurances of functionality of the Created Wetland habitat.

3. Constructed Surface Water Management System will be established by recontouring and recomposing relic wetland depressional gradient sites [presently occupied by Brazilian pepper (exotic) elements] into a more natural feature than present lateral drainage canals. This system will be enhanced by vegetative structuring which will offer long-term habitat benefits of canopy, mast, cover, and erosion control within a forested waterway corridor located within the greater Upland Preserve.

Overall configuration of constructed, created, and preserved hydrologic system will eventually or presently interface into the greater Upland Preserve to create a more dynamic system becoming more significant than its constituent parts.