APPENDIX A

BDA
ENVIRONMENTAL CONSULTANTS

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AERIAL PHOTOGRAPHIC MONITORING, FLORIDA POWER CORPORATION, CRYSTAL RIVER POWER PLANT SALT DRIFT STUDY

FINAL REPORT 1994 AERIAL PHOTOGRAPHY

Submitted to:

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1.0 INTRODUCTION

Aerial photographic monitoring of vegetative communities at the Florida Power Corporation (FPC) Crystal River Plant continued during 1994, in compliance with the National Pollutant Discharge Elimination System permit requirements. Three aerial monitoring missions were flown during the year, during early, mid, and late growing season, as has been done for the past several monitoring years.

Objectives of this annual aerial photographic monitoring include: documentation of the condition of plant communities in the vicinity of the power plant; photointerpretation of the aerial photography; and a site inspection to verify present conditions of plant communities occurring in the vicinity of the various salt deposition monitoring sites.

2.0 METHODS

The aerial flights were spaced throughout the growing season in order to document foliage conditions at representative times of the year, as has been standard in previous monitoring years. The missions were flown on the following dates: April 11, June 26, and October 5, 1994.

This first and second aerial missions were flown using a Cessna 180 fixed-wing aircraft with a Hasselblad 70 mm camera system mounted in the floor of the fuselage. Filters were used to obtain the highest quality photographs under the varying conditions of haze, humidity, and sunlight at different altitudes. Low-, middle-, and high-altitude photography were shot along standard flight paths to obtain coverage of the entire power plant facility and surroundings, in addition to those areas where permanent monitoring stations are located. The final mission was flown by Aerial Cartographics of America, Inc. (ACA) using a 9 x 9 format camera system, in order to provide high resolution photography during late growing season conditions. In establishing the permanent monitoring stations and the aerial monitoring program, emphasis was placed on the natural communities in the vicinity of the cooling towers.

All of the aerial photographs were photointerpreted to assess the conditions of vegetative communities in all portions of the project area. The images were analyzed under optical magnification to determine the presence of any large-scale changes in the overall health of foliage conditions in the various plant communities. Primary indicators used in this procedure were color and texture patterns. Photo signatures considered to be atypical or suspicious were checked against actual field conditions, as well as photography from previous years, to verify whether any significant changes had occurred in the general conditions of the particular plant community.

An annual site inspection was conducted in late October. Several of the permanent monitoring sites were visited to record observations on the general health and conditions of canopy and understory vegetation. At this time, several of the 9 x 9 aerial photographs were checked for verification of color photo signatures. This process allows a continuing year-to-year analysis of the representative color patterns produced by evergreen and deciduous species occurring in wetland and upland communities throughout the project area.

Figure 1 is a high-altitude color-infrared (CIR) photograph of the Crystal River Power Plant and its environs, which shows the locations of the permanently established monitoring sites.

3.0 RESULTS

Aerial missions on April 11, June 26, and October 5, 1994 provided photographic documentation of the FPC Crystal River Plant and the surrounding natural areas. The first and second missions were flown in a Cessna 180 aircraft using a Hasselblad 70mm camera system to obtain a total of 38 CIR exposures at high and low altitudes. The third and final mission was flown by ACA at high, middle and low altitudes to provide a total of 25 CIR exposures. Tables 1 through 3 summarize the record of exposures and altitudes during these missions.

The photointerpretation of aerial photography combined with a groundtruthing inspection allowed a reliable and accurate means of documenting the current conditions of vegetative communities and assessing any significant trends of change in the health of these communities. Figures of aerial and ground photography are incorporated into the report to visually demonstrate these interpretations.

Figures 2 through 4 are mid- and low-altitude aerial photographs of areas west and north of the power plant facility. These figures graphically demonstrate the continued pattern of stress and mortality to several tree species in the lower-lying areas along the coastal transition between upland forested communities and the estuarine marsh system. Although the total aerial extent of this stress is not established with a high degree of accuracy, the aerial photography and limited groundtruthing have verified those areas most heavily affected, as depicted in these figures. Figures 5a and 5b show the moderately high density of dead or heavily stressed trees in some of the areas near the Southwest Open Hammock site. Other, nearby, areas at somewhat higher elevations do not appear to be affected. Figures 6 and 7 show the condition of these forested communities in the vicinity of the West Open Pine site. Similarly, some of the depressional areas which have freshwater forested

Table 1. Areas of Coverage, First Aerial Flight for Crystal River Power Plant 1994 Monitoring.

Page	Frame (Left to Right)	Station/Coverage
1	1-2	High altitude, plant entrance area
	3-5	High altitude, communities surrounding power plant and quarry operation
	6-9	High altitude, coastal edge in vicinity of power plant
2	1-3	High altitude, forested and coastal marsh communities east and south of power plant
	4-6	High altitude, planted pine and hardwood forests south of entrance road.
	7-9	Vicinity of north east open pine site
3	1-2	Vicinity of fish hatchery
	3-6	Vicinity of east open pine site
	7-9	Vicinity of northeast open pine site
4	1-4	Vicinity of east open pine site and fish hatchery
	5-9	Vicinity of control site
5	1-5	Vicinity of north open pine site and northeast open pine site
	6-9	Vicinity of northwest open pine site
6	1-4	Vicinity of west open pine site
	5	Vicinity of southwest open hammock site
	6-9	Vicinity of control site
7	1-4	Vicinity of 8 and 4
	5-6	Vicinity of southwest open hammock site
	7-9	Vicinity of northwest open pine site
8	1-7	Vicinity of 5 and 9
	8-9	Area north of the northwest open test site

Table 2. Areas of Coverage, Second Aerial Flight for the Crystal River Power Plant 1994 Monitoring.

Page	Frame (Left to Right)	Station/Coverage
1	1-3	High altitude near plant entrance.
	4	Planted pine (*Pinus* sp.) and hardwoods in vicinity of fish hatchery (high altitude).
	5-9	Forested and estuarine community to the north, east, and south of the power plant (high altitude).
2	1	Hardwood and pine forests south of the fish hatchery (high altitude).
	2-3	Estuarine communities south of the power plant (high altitude).
	4-6	High altitude showing land use and pine forests near plant entrance.
3	1-6	Low altitude photographs of mixed hardwood and cabbage palm (*Sabal palmetto*) community near settling basin.
4	1-2	Low altitude, west open pine site.
	3-4	Low altitude, northeast open test site.
	5-6	Low altitude, control site.
5	1-2	Low altitude, vicinity of southwest open hammock site.
	3-4	Low altitude, vicinity of northwest open pine site.
	5-6	Low altitude, north open pine site.
6	1-5	Low altitude, vicinity of northeast open pine site.
7	1-2	Low altitude, vicinity of east open pine site.
	3-4	Low altitude, vicinity of open hardwood control site.
	5-6	Low altitude, vicinity of coastal control site.

Table 3. **Record of 9 x 9 Aerial Photography of the Florida Power Corporation Crystal River Power Plant, October 1994.**

Frame[1]	Scale	Coverage[2]
Low Altitude		
1-22	1:3000	9
1-23	1:3000	9
2-24	1:3000	10
2-25	1:3000	10
3-26	1:3000	4, 8
3-27	1:3000	4, 8
4-28	1:3000	5
4-29	1:3000	5
5-30	1:3000	11
5-31	1:3000	11
6-32	1:3000	7
6-33	1:3000	7
7-34	1:3000	6, 12
7-35	1:3000	13
8-36	1:3000	13
8-37	1:3000	13
Middle Altitude		
10-16	1:6500	1, 2, 3, 4, 7, 8
10-17	1:6500	1, 2, 3, 4, 7, 8
10-18	1:6500	7
11-19	1:6500	6
11:20	1:6500	6, 12
11:21	1:6500	12
High Altitude		
9-13	1:35,000	Areas East of Power Plant
9-14	1:35,000	Power Plant Centered
9-15	1:35,000	Areas West of Power Plant

[1]Correlates with flight paths depicted in Appendix 1.

[2]Correlates with monitoring sites as shown in Figure 1.

wetland communities do not appear to have the severe pattern of dieback which has been observed in the coastal transition zone. Figure 8 demonstrates such an area typical of these communities in the general vicinity of the power plant.

Figures 9 to 12 are low-altitude aerial photographs documenting the vegetative conditions near the end of the growing season in the vicinity of several permanent monitoring stations. This high resolution photography indicates that the overall health of these various plant communities is good, with only a very small percentage of trees that are stressed or dead. In other words, no large scale patterns of stress to the communities is recognized as a result of the aerial photointerpretation and groundtruthing during 1994.

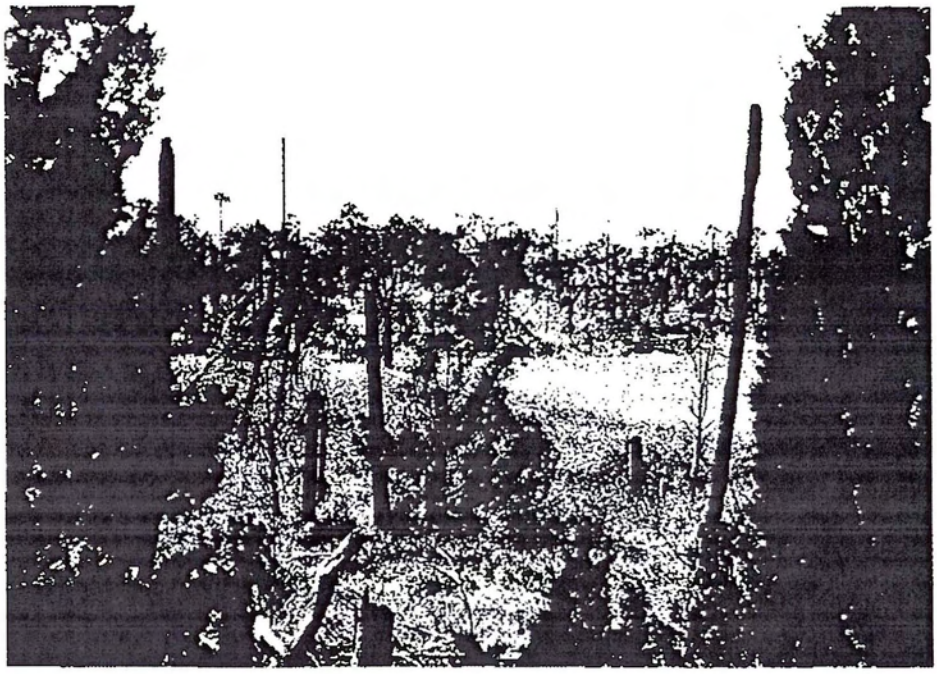
Figure 9 is an aerial showing a mosaic of different forested and herbaceous communities in a generally pine (*Pinus* sp.)-dominant area which has been under silviculture for several years. The North Open Pine site is located in this area. The Northeast Open Pine site is located immediately northeast of the power plant (Figure 10), in an area dominated mainly by planted slash pine (*Pinus elliottii*). The pines, as well as the intermixed hardwoods (primarily oaks (*Quercus* spp.)) are in good condition, having a 90-100% closed canopy.

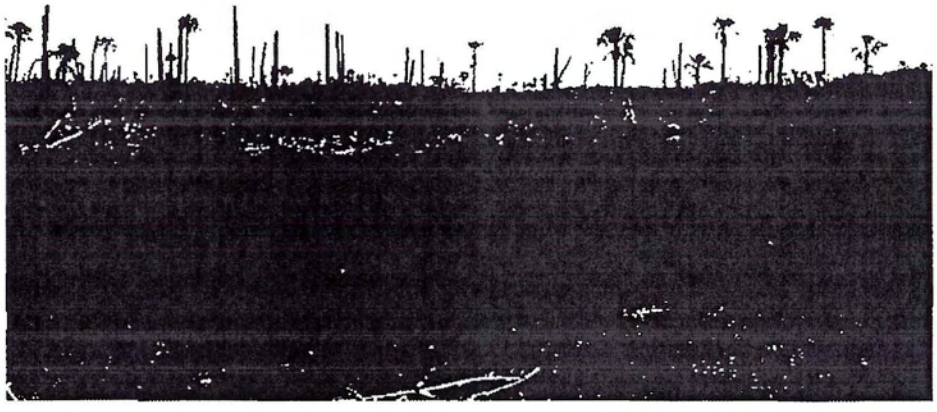
A mature, extremely dense hardwood forest characterizes the vicinity of the Open Hardwood Control site, southeast of the power plant. A transition into a higher density of slash pine occurs to the east, and only a relatively few trees in the entire community show evidence of foliage or branch dieback or, in a few cases, mortality. These conditions are relatively easy to observe in such a closed-canopy system, and thus the community is considered very healthy due to the general absence of canopy gaps.

In contrast, some of the transition edge and outlying island hammocks south of the power plant, in the vicinity of the coastal control site, have also experienced stress and mortality to the same host of species as seen near the Southwest Open Hammock site (Figure 12). The condition ranges from only scattered dead or stressed trees to very heavy loss of the woody species, and it is seemingly related to the relative elevational changes seen along the coastline. The lower edges near the tidal marsh appear to be most affected. Figures 13a and 13b show some of the representative conditions in this area.

Appendix A shows the flight paths used in the October, 1994 aerial mission at the FPC Crystal River Plant. The flight paths and altitudes maximize the results of coverage and resolution documented with CIR photography.

Appendix B is a composite of additional photographs documenting conditions at various locations surrounding the power plant facility. They provide a continuum of photographic coverage over the past several years to verify conditions of the vegetation in the study area.





Figures 13a and 13b. Areas of Heavy Cabbage Palm Stress and Mortality in the Brackish Marsh Zone West of the Coastal Control Site.

4.0 CONCLUSIONS

Aerial photographic monitoring of the FPC Crystal River plant has been completed for 1994. This consisted of three aerial missions and a groundtruthing inspection to verify current conditions of the plant communities surrounding the facility. A combination of high-, middle- and low-altitude photography provided the documentation of foliage conditions. The aerial exposures were photointerpreted to determine the overall condition of vegetation in representative plant communities, and in areas surrounding the permanent monitoring stations.

A total of 25 aerial exposures provided good coverage of the plant communities. Evaluation of the aerial photography and a detailed site inspection verified the health status of these communities. The 1994 monitoring study indicates that there are no observable effects to the vegetation which are considered related to the salt drift deposition. All of the forested and herbaceous communities which have been evaluated through aerial photography and ground inspection during this and past years continue to appear healthy, with the noted exception of those low-lying areas along the coastal transition zone which have shown symptoms of moderate to severe stress over a period of time. That condition has been noted for extensive areas to the north and south of the Crystal River Power Plant, as has been previously noted. It is thus concluded that there are no detectable negative effects to the nearby upland and wetland plant communities which would be related to salt drift deposition.

B-8 **Conditions in Forested Communities to the West of the Power Plant, October 1994.**

APPENDIX B

Appendix B. Sodium and Chloride Deposition (mg/m^2), Crystal River, Florida Power Corporation, 1993-94.

Typesite 1 = On-Site Stations
Typesite 2 = Control Stations
Typesite 3 = Off-Site Stations

Period 1 = September 16 - October 15, 1993
Period 2 = October 16 - November 15, 1993
Period 3 = November 16 - December 15, 1993
Period 4 = December 15, 1993 - January 16, 1994
Period 5 ... etc.

Site neot = Northeast Open Test
Site nwop = Northwest Open Pine
Site swoh = Southwest Open Hammock
Site wop = West Open Pine
Site cc = Coastal Control
Site hc = Hardwood Control
Site oc = Open Contol
Site eop = East Open Pine
Site neop = Northeast Open Pine
Site nop = North Open Pine

TYPESITE	SITE	PERIOD	SODIUM	CHLORIDE
1.0000	neot	1.0000	77.8000	174.8000
1.0000	neot	2.0000	227.5000	525.0000
1.0000	neot	3.0000	141.2000	295.6000
1.0000	neot	4.0000	587.5000	1080.0000
1.0000	neot	5.0000	370.5000	837.4000
1.0000	neot	6.0000	489.4000	897.2000
1.0000	neot	7.0000	205.3000	429.9000
1.0000	neot	8.0000	215.4000	401.0000
1.0000	neot	9.0000	390.7000	742.1000
1.0000	neot	10.0000	354.4000	703.6000
1.0000	neot	11.0000	456.9000	1193.6000
1.0000	neot	12.0000	733.8000	1598.4000
1.0000	nwop	1.0000	209.3000	460.4000
1.0000	nwop	2.0000	253.4000	595.4000
1.0000	nwop	3.0000	91.7000	198.4000
1.0000	nwop	4.0000	270.6000	569.1000
1.0000	nwop	5.0000	179.2000	413.6000
1.0000	nwop	6.0000	233.8000	474.9000
1.0000	nwop	7.0000	42.2000	101.3000
1.0000	nwop	8.0000	137.7000	287.9000
1.0000	nwop	9.0000	154.9000	352.2000
1.0000	nwop	10.0000	289.3000	569.3000
1.0000	nwop	11.0000	477.1000	1066.5000
1.0000	nwop	12.0000	556.7000	1096.8000
1.0000	swoh	1.0000	.	.
1.0000	swoh	2.0000	.	.
1.0000	swoh	3.0000	271.0000	513.0000
1.0000	swoh	4.0000	986.1000	1785.7000
1.0000	swoh	5.0000	578.6000	1085.3000
1.0000	swoh	6.0000	806.5000	1442.4000
1.0000	swoh	7.0000	126.9000	425.6000
1.0000	swoh	8.0000	141.0000	285.6000
1.0000	swoh	9.0000	266.3000	519.6000
1.0000	swoh	10.0000	404.1000	851.9000
1.0000	swoh	11.0000	517.8000	1256.8000
1.0000	swoh	12.0000	828.1000	1499.1000
1.0000	wop	1.0000	158.4000	352.5000
1.0000	wop	2.0000	235.3000	531.3000
1.0000	wop	3.0000	67.8000	158.1000
1.0000	wop	4.0000	222.3000	556.6000
1.0000	wop	5.0000	177.6000	407.8000
1.0000	wop	6.0000	240.5000	459.1000
1.0000	wop	7.0000	83.4000	158.7000
1.0000	wop	8.0000	251.6000	466.9000
1.0000	wop	9.0000	136.7000	286.3000
1.0000	wop	10.0000	174.5000	349.2000
1.0000	wop	11.0000	433.2000	1036.3000
1.0000	wop	12.0000	647.7000	1218.3000
2.0000	cc	1.0000	130.1000	237.8000
2.0000	cc	2.0000	221.6000	506.2000
2.0000	cc	3.0000	91.3000	166.5000
2.0000	cc	4.0000	360.4000	646.4000
2.0000	cc	5.0000	104.7000	247.3000
2.0000	cc	6.0000	316.9000	562.7000
2.0000	cc	7.0000	70.5000	139.9000
2.0000	cc	8.0000	56.4000	112.1000
2.0000	cc	9.0000	125.1000	220.6000
2.0000	cc	10.0000	75.3000	163.1000
2.0000	cc	11.0000	181.6000	411.1000
2.0000	cc	12.0000	191.2000	373.4000
2.0000	hc	1.0000	57.1000	134.4000
2.0000	hc	2.0000	187.9000	438.2000

TYPESITE	SITE	PERIOD	SODIUM	CHLORIDE
2.0000	hc	3.0000	73.7000	162.2000
2.0000	hc	4.0000	196.7000	338.6000
2.0000	hc	5.0000	93.3000	261.9000
2.0000	hc	6.0000	217.9000	435.8000
2.0000	hc	7.0000	35.2000	96.8000
2.0000	hc	8.0000	63.6000	148.7000
2.0000	hc	9.0000	76.4000	199.7000
2.0000	hc	10.0000	81.8000	163.5000
2.0000	hc	11.0000	129.7000	390.4000
2.0000	hc	12.0000	151.0000	318.6000
2.0000	oc	1.0000	73.7000	149.0000
2.0000	oc	2.0000	223.1000	461.6000
2.0000	oc	3.0000	79.3000	169.3000
2.0000	oc	4.0000	299.3000	618.3000
2.0000	oc	5.0000	120.6000	344.7000
2.0000	oc	6.0000	252.7000	485.7000
2.0000	oc	7.0000	45.2000	121.0000
2.0000	oc	8.0000	92.6000	216.1000
2.0000	oc	9.0000	95.7000	261.1000
2.0000	oc	10.0000	77.4000	187.7000
2.0000	oc	11.0000	151.4000	432.7000
2.0000	oc	12.0000	152.7000	359.0000
3.0000	eop	1.0000	62.1000	130.8000
3.0000	eop	2.0000	157.5000	376.3000
3.0000	eop	3.0000	54.8000	103.0000
3.0000	eop	4.0000	206.2000	466.1000
3.0000	eop	5.0000	132.0000	342.8000
3.0000	eop	6.0000	173.2000	372.3000
3.0000	eop	7.0000	49.6000	104.0000
3.0000	eop	8.0000	87.6000	201.6000
3.0000	eop	9.0000	118.0000	264.4000
3.0000	eop	10.0000	98.4000	214.7000
3.0000	eop	11.0000	169.5000	439.9000
3.0000	eop	12.0000	183.8000	340.5000
3.0000	neop	1.0000	47.9000	121.4000
3.0000	neop	2.0000	163.7000	396.6000
3.0000	neop	3.0000	69.0000	135.1000
3.0000	neop	4.0000	153.8000	384.4000
3.0000	neop	5.0000	121.4000	334.7000
3.0000	neop	6.0000	148.0000	334.3000
3.0000	neop	7.0000	85.6000	160.2000
3.0000	neop	8.0000	67.5000	167.1000
3.0000	neop	9.0000	114.5000	259.3000
3.0000	neop	10.0000	96.7000	212.1000
3.0000	neop	11.0000	163.1000	460.5000
3.0000	neop	12.0000	184.5000	419.9000
3.0000	nop	1.0000	79.0000	161.6000
3.0000	nop	2.0000	245.9000	513.6000
3.0000	nop	3.0000	77.9000	175.8000
3.0000	nop	4.0000	187.1000	409.2000
3.0000	nop	5.0000	313.0000	635.8000
3.0000	nop	6.0000	276.5000	571.6000
3.0000	nop	7.0000	67.9000	158.1000
3.0000	nop	8.0000	70.1000	171.1000
3.0000	nop	9.0000	124.6000	302.9000
3.0000	nop	10.0000	140.8000	306.5000
3.0000	nop	11.0000	337.2000	906.3000
3.0000	nop	12.0000	351.2000	701.1000