

Mid-year Report Reclaimed Water for wetlands

**Forested Wetland
Golf Course Wetland
Palmetto Hall, Hilton Head Island, South Carolina**



Prepared July 31, 2012
For Hilton Head Public Service District
Hilton Head Island, South Carolina



Boulder, Colorado

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On the cover: View of the expansive marshland in the upper end of the Golf Course Wetland.

Photo: Marianne Ballantine.

1. Introduction

RECLAIMED WATER is the process of recycling advanced-treated, domestic “wastewater” in native freshwater wetlands. This environmentally sustainable technology was developed on Hilton Head Island, SC in 1980*. Since the mid-1990s, Hilton Head Public Service District has operated a reclaimed water (RCW) project in the Palmetto Hall residential-golf community on north-central Hilton Head Island.

Adding RCW to supplement water in the wetlands has: mitigated the effects of drought (since 1998); enhanced rare sawgrass marsh and old growth forest, rejuvenated watersheds, and replenished wildlife habitat—including refuge for global migratory songbirds. This report describes the results of semiannual biological monitoring in 2012, of two unique “Project Wetlands.”

The 119-acres **Forested Wetland** (called “Wooded Area” in the SCDHEC permit) is adjacent to the Arthur Hills Golf Course. This is bottomland-hardwood forest adapted to standing water for a long period of time.

The **Golf Course Wetland** (“Grassy Wetland” in the SCDHEC permit) is located along the Robert Cupp Golf Course on the western side of Palmetto Hall. A total of 98 acres in this wetland receives RCW. Ecological features include the largest sawgrass community on Hilton Head Island, a complex of seasonal ponds, and an emerging meandering pine flatwoods community. For more information on these



THE COLORS OF NATURE abound in the Palmetto Hall Golf Course Wetland.

Photo: Marianne Ballantine

wetlands, refer to the Project Description of the Palmetto Hall Reclaimed Water Project (Ballantine Environmental Resources, June 15, 1999).

Environmental Monitoring

The monitoring protocol adhered to requirements in Hilton Head Public Service District's NPDES Permit No. SC0046191. We collected data at permanent transect-stations in the above-mentioned "project wetlands." This document analyzes hydrology, vegetation conditions, and wildlife in these wetlands in the **growing season**—the optimum period of vegetation in growth and wildlife activity each year. These conditions are compared with those in the growing season of 1999—the comparative "baseline" for the RCW monitoring program. The report has a concise format with a detailed summary of findings, tables, figures, photographs, and conclusions.

Our next monitoring is scheduled for the dormant season of 2012. Following fieldwork, we will compile data for the season and complete the 2012 Annual Biological Monitoring Report for the Palmetto Hall Reclaimed Water Project. We will submit this report to Hilton Head Public Service District in February of 2013.

DEFINITIONS

Hydrology is the scientific study of the properties, distribution, and effects of water on the earth's surface, sub-surface and atmosphere. The primary value of reclaimed water is that it enhances the natural hydrology of wetlands.

Macro-invertebrates are animals lacking a backbone and large enough to identify without magnification. Reclaimed water enhances habitat for macro-invertebrates, which are a "prey organism" consumed by larger animals such as fish, frogs, lizards, and birds.

National Pollutant Discharge Elimination System (NPDES): A national program under Section 402 of the U.S. Clean Water Act for regulation of discharges of pollutants from point sources to waters of the United States, such as wetlands. NPDES categorizes RCW as a "non-conservative,"—mitigated by natural biodegradation in the wetlands.

* Ballantine Environmental Resources created the concept for the first RCW-wetland project in the U.S. This and five more projects were brought on line between 1983-1999. Hilton Head Public Service District operates four RCW-wetland projects on Hilton Head Island.

2. Data Summary

2.1. WETLAND HYDROLOGY

Table 2-1.
Monthly Rainfall in Inches
 January – June 2012
 Palmetto Hall Reclaimed Water Project

Month	2012 Rain	40-Yr. Average Rain
January	0.66	3.74
February	2.85	3.42
March	5.50	4.04
April	0.38	2.95
May	4.25	3.76
June	3.23	4.99
Total:	16.87	22.90

Hilton Head PSD measured precipitation at a point within one square mile of the project. The S.C. Water Resources Commission (now SCDNR) provided 40-year average rain data.

*Total rainfall for the first six months of 2012 was 26% less than the average for the January-through-June period on Hilton Head Island. **Significant:** Low rainfall in April, May and June – critical months in the early growing season for vegetation. This was also a period of low reclaimed water flow for the wetlands because this water was supplied to contracting golf courses for irrigation.*

Table 2-2.
Monthly Influent Loading in acre-Inches
 January – June 2012
 Palmetto Hall Reclaimed Water Project

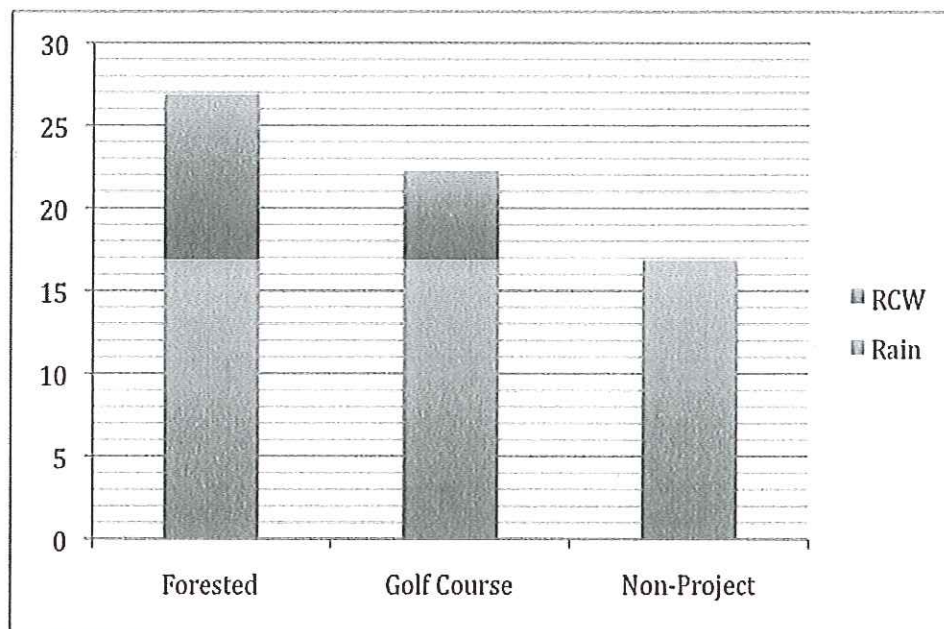
Month	Forested Wetland	Golf Course Wetland	Total Acre-Inches
January	3.45	2.20	5.65
February	0.88	0.00	0.88
March	1.34	2.46	3.80
April	3.81	0.72	4.52
May	0.53	0.00	0.53
June	1.34	0.47	1.81
Total:	10.01	5.38	15.40

Influent loading in MG: Hilton Head PSD. Conversion to acre-inches: Ballantine Environmental Resources.

More water to the Forest: The **Forested Wetland** received 65% of the RCW (acre-inches). The **Golf Course Wetland** therefore received 35% of the available RCW. In the baseline-growing season, the Golf Course system did not receive any influent flow. In the first half of 2012, the Forested project received a monthly average of 1.7 inches of RCW, and the Golf Course project received an average of 0.9 inches per month.

Figure 2-1.
Total Water in Project Wetlands
Palmetto Hall Reclaimed Water Project
January–June 2012

Total water is the sum (in acre-inches) of rain plus RCW influent in the project wetlands during a specific time period—the 2012 growing season in this report.



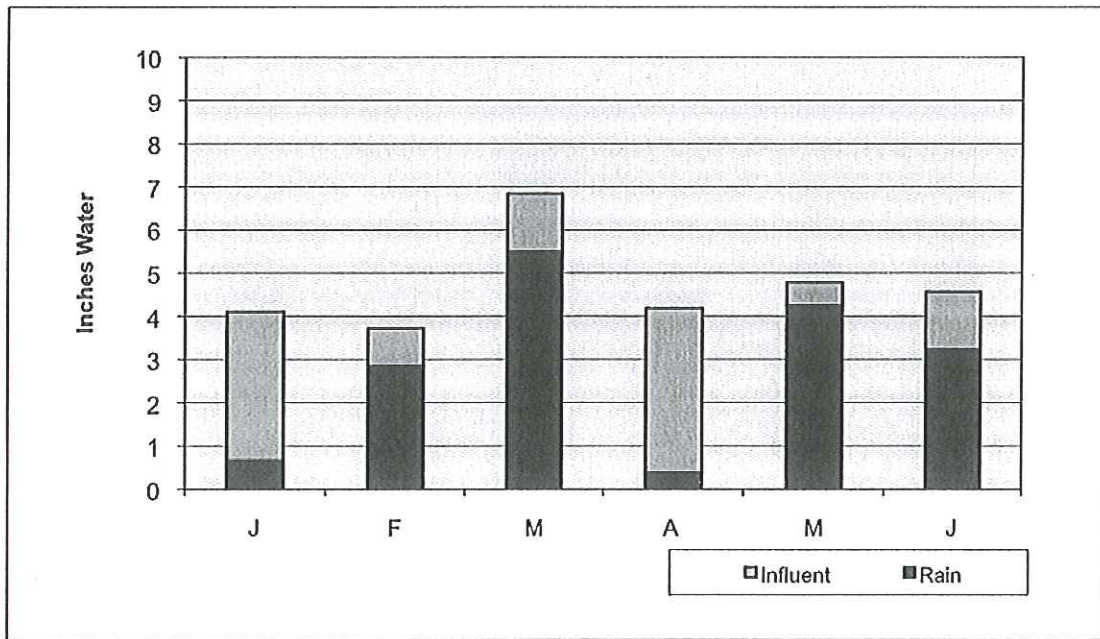
The Benefit
Total water input significantly influences wetland biology. Addition of reclaimed water reduces the impact of low rainfall. This enhances wetland vegetation and wildlife—especially during periods of low rainfall.

Figure 2-1 reveals that both project wetlands received more water than “non-project” wetlands on Hilton Head Island due to: (1) RCW surplus water and (2) slightly more rain than in the baseline year.

The **Forested Wetland** received nearly 27 acre-inches of total water. RCW added 59% more water to precipitation for the period. However, this volume was lower than the wetland received in the baseline.

The **Golf Course Wetland** received 22.3 acre-inches of total water. RCW added a 32% surplus volume in the first half of 2012. This six-month volume was 6% more total water than the same period of the baseline. Note: in the baseline, the Golf Course Wetland received no RCW.

Figure 2-2.
Inches of Total Water by Month: Forested Wetland
January-June 2012
Average Monthly: 4.5 inches



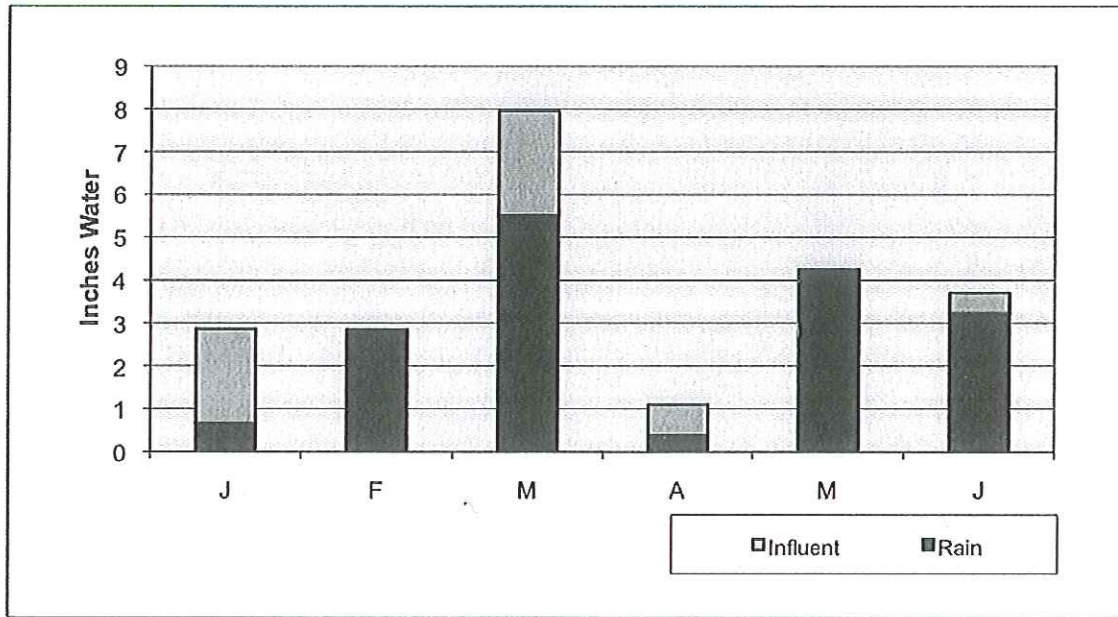
“Influent” is reclaimed water. The hydroperiod is the seasonal and cyclical pattern of rainwater in a wetland. Compare totals in this graph to the historical hydroperiod:

January – 3.74”
February – 3.42”
March – 4.04”
April – 2.95”
May – 3.70”
June – 4.99”

Summary

- Total water input into the **Forested Wetland** exceeded the natural hydroperiod in five months – January through May of 2012.
- The surplus of total water over the hydroperiod provided a benefit to the wetland because rainfall was below average.
- In the growing season the wetland was significantly dry: only 20% of the community had any surface water.
- Shallow water (3.5”) was found in the upper southern quarter of the wetland. This area typically has the deepest water.

Figure 2-3.
Inches of Total Water by Month: Golf Course Wetland
January-June 2012
Average Monthly: 3.7 inches

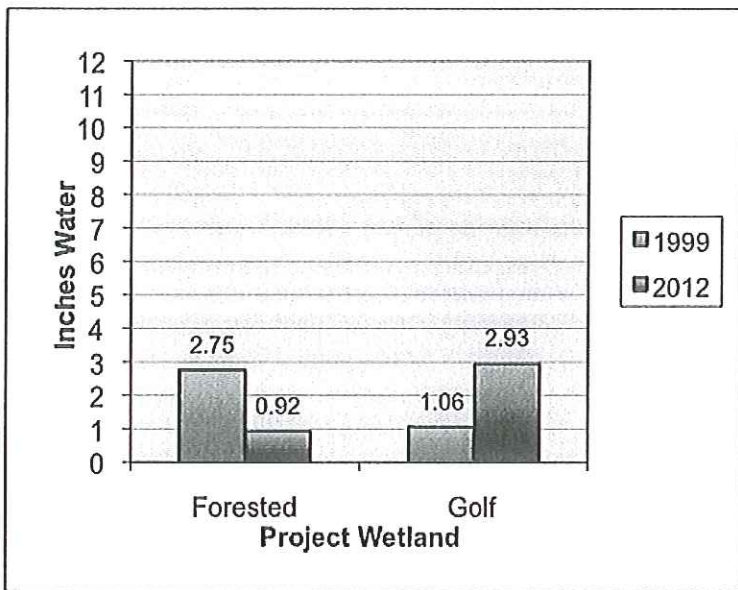


Hydroperiod
January – 3.74"
February – 3.42"
March – 4.04"
April – 2.95"
May – 3.70"
June – 4.99

Summary

- In the **Golf Course Wetland**, total water exceeded the hydroperiod in two months— March and May.
- RCW flow decreased after January.
- The high demand for golf course RCW irrigation is why a low volume was provided for this wetland February-June.

Figure 2-4.
Average Surface Water Depth
Forested Wetland and Golf Course Wetland
Growing Seasons: 2012 and Baseline 1999



Where the Water Goes
Surface water is always lower in the growing season. Vegetation and evaporation removes most of the water. Surface water seldom flows out of the project

Analysis

Figure 2-4 shows that the average water level in the Golf Course Wetland was slightly higher than in the Forested Wetland. But the distribution of water was significantly different in the two communities.

Forested Wetland:

- The average water level was nearly twice as deep as in the baseline.
- Surface water occurred in only 25% of this wetland. In the baseline, surface water was distributed through 83% of the wetland.
- The modal (most frequently occurring) water depth in 2012 was 0 inches. In the baseline the modal depths were 6 and 0 inches.
- Typical water condition: lightly tannic.

Golf Course Wetland:

- The average 2012 water level was 7 inches lower than in the baseline.
- Water was distributed through 25% of the wetland, compared with 47% in the baseline.
- The most frequent water depth in 2012 was 5 inches – compared with no water in the baseline (no flow).
- Typical water condition: tannic with suspended organic matter.

2.2. WETLAND VEGETATION

The vegetation component is a significant part of the monitoring and assessment in RCW water wetlands. In the 2012 growing season, Ballantine Environmental Resources monitored vegetation in the canopy and shrub/groundcover strata. Our data analysis considered seven parameters:

PARAMETERS FOR VEGETATION MONITORING
Observed in the Growing Season 2012 and the Baseline (1998)
Cypress Conservancy and Whooping Crane Conservancy

- **Vegetation Strata Measured: Canopy (C), Shrub-Groundcover (S/Gc)**
- **Diversity:** The total number of plant species measured in monitoring stations.
- **Dominance:** The percent basal area (C) or areal cover (S/Gc) of individual species, per transect station and averaged for the wetland, as a percent of 100 percent (all species).
- **Density:** The percent of live stems of individual species, per wetland, as a percent of 100 percent (density of all species).
- **Frequency:** The number of stations on which an individual species occurred, per wetland, as a percentage of 100 percent (total of all stations on which all species occurred).
- **Importance Value (I. Value):** The sum of relative dominance, relative density, and relative frequency. Values were calculated for individual species, monitoring stations, and as an average for the project wetland. Importance Values are calculated in the Annual Monitoring Report.
- **Nuisance species:** Invasive, exotic, and other problematic plant species that have the potential to degrade the wetland. Nuisance species were tracked according to relative dominance and I. Value.
- **Endangered and threatened species:** Federal and/or South Carolina listed plant species, if observed, were tracked according to Importance Value.



FIELDS OF GREEN spread eastward in the Golf Course Wetland. Reclaimed water flows from this point and past the horizon of this photo, nourishing diverse vegetation and wildlife habitat.

Photo: Marianne Ballantine

Table 2-3.
Diversity of Plant Species
 Forested and Golf Course Wetlands
 Growing Season 2012

Trees	Shrub and Groundcover	
Blackgum	Blue-flag Iris	Maidencane
Loblolly Pine	Cinnamon Fern	Fetterbush
Pond Pine	Common Cattail	Pickerelweed
Red Bay	Dewberry	Poison Ivy
Sweetgum	Duckweed	Sawgrass
Wax-Myrtle	Gallberry	Virginia Chainfern
	Giant Reed	White Avens

Forested Wetland Summary

- Species diversity has decreased since the 1998 baseline.
- Causes for the decline in diversity include recurring drought and inundation by water.
- The dominant canopy species is blackgum (*Nysaa biflora*). This species is considered an “old-growth” tree because it lives more than a century. It is highly valuable to groundcover as well as wildlife because it provides shade and dense high foliage for nesting and cover. Sweetgum trees (*Liquidamber styraciflua*) are colonizing the lower end of the wetland; these species will also provide habitat for welcome wildlife.
- The number of groundcover species has remained stable—the common lizard’s tail and marsh pennywort are perennially dominant. We particularly value Lizard’s tail for wildlife, as it provides shelter for reptiles, amphibians and invertebrates.
- Environmental factors: Reclaimed water has enhanced surface and groundwater, which is drawn down by nearby lagoons, evaporation, and transpiration by plants—especially black gum trees.
- Human factors: The Palmetto Hall wetlands are protected by conservation and water use easements, and thus were not impacted by human activity. The dry-down requirement did not impact the wetland in 2012.
- Most significant decline: red bay died out more than a decade ago due to drought (1998-2002).

Golf Course Wetland Summary

- Species diversity has decreased since the baseline. The causes are natural and manmade.
- Canopy species are predominantly loblolly pines. These trees have formed a “pine flatwoods” community in the center of the wetland, where water is shallow or intermittent. Pines spread invasively, however, and could out-compete more beneficial hardwoods such as blackgum. Other emerging species: Carolina willow, red maple and sweetgum.
- Groundcover is diverse in this wetland: sawgrass, a valuable and rare species on Hilton Head Island, has less areal coverage. New dominant species include cattail, pickerelweed, and other herbaceous species better adapted to large fluctuations in surface and ground water.
- The number of species has declined as this wetland matures from an open marsh system to a drier flatwoods and shallow ponds community.
- The greatest impact on vegetation has come from the SCDHEC mandated “dry down.” When this long period of restricted flow was coupled with drought or periods of low rainfall, the wetland suffered a high level of vegetation dieback—followed by colonization by less productive species. This is especially troubling because the Golf Course Wetland supports the last great stand of sawgrass, a threatened species on Hilton Head Island.
- Environmental factors affecting this wetland include recurring drought, invasive species (e.g., giant foxtail in 2011), and the spread of pines into marshes.
- Human factors: The permit-mandated dry-down period has stressed wetlands in periods of drought. In 2011, maintenance crews disposed of pine slash (tree trunks and foliage) in the marsh; this covered vegetation, altered drainage and impeded wildlife movement.
- Most significant decline: loss of sawgrass and open water in drought periods and dry-down.

Endangered Species

No endangered or threatened species of vegetation or wildlife were observed in the Forested or Golf Course Wetlands during our 2012 monitoring.

Nuisance Species of Plants

In the baseline year, we identified three potential nuisance plants in the Palmetto Hall project wetlands. By definition, nuisance plants are non-native, non-aquatic, parasitic, or poisonous plants that impact the wetland. In the Palmetto Hall project wetlands, these species are: alligatorweed (*Alternanthera philoxeroides*), common reed (*Phragmites australis*), giant foxtail grass (*Setaria magna*), and maidencane (*Panicum hemitomon*). Table 2-6 compares the changes in value for these species in 2012 and the baseline.

Table 2-6. Nuisance Plant Species
 Forested and Golf Course Wetlands
 Growing Season 2012 and Baseline-1999

Species:	Project Wetland	Relative Cover		Importance Value	
		2012	1999	2012	1999
Alligatorweed	Forested	0%	0	0	0
Common Reed	Golf	0%	3%	0	21
Giant Foxtail	Golf	0%	0	0	0
Maidencane	Golf	12%	4%	8	32

MAIDENCANE has been most persistent since the Baseline. This grass out-competes with sawgrass under stressful conditions, such as drought and shading by trees. In this photo, Todd Ballantine stands at the boundary between invasive maidencane (darker green, behind) and productive sawgrass (lighter green, foreground).

Photo by Marianne Ballantine



2.3. WILDLIFE

Macro-invertebrates

Table 2-7. Observed Macro-invertebrate Species
 Forested Wetland and Golf Course Wetland
 Growing Season-2012 and Baseline-1999

Species	Frequency	Forested	Golf Course
Ant – Little Black	Occasional	X	X
Butterfly – Palamedes Swallowtail	Common	X	X
Dragonfly – Green Darner	Occasional	X	X
Grasshopper – Elegant	Occasional		X
Midge – <i>Chironomid</i>	Common	X	X
Mosquito – Golden Saltmarsh	Occasional	X	X
Moth – Dagger	Uncommon		X
Scud (Amphipod)	Uncommon		X
Spider – Fisher	Occasional		X
Water Treader	Uncommon		X
Total in 2012 Growing Season		5	10
Baseline Growing Season		11	10

Notes: No new species observed in the 2012-growing season. Key to species frequency: Numerous (>75% of stations); Common (50%-74% of stations), Occasional (25%-49% of stations); and Uncommon (1%-24% of stations).



IN FULL COLOR: The Golf Course Wetland
 Photo by Todd Ballantine

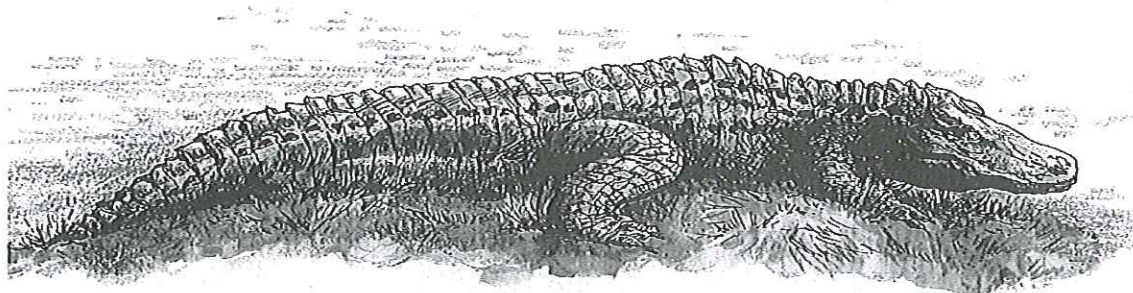
HABITAT VARIETY INVITES WILDLIFE DIVERSITY
The Golf Course Wetland provided living space for 100% more species of invertebrates than in the Forested wetland. The former community offers an array of “niches”—open pools, stream channels, grass marsh, scrub - shrub edge, and pine flatwoods. **The Forested Wetland** is universally forested, and is narrower. This is why the Golf Course Wetland had a broader spectrum of invertebrates. They are the foundation of the wetland food web.

Fish and Other Vertebrates

We did not observe fish species in the project wetlands. Lack of surface water in the Forested Wetland precluded fisheries habitat. In the Golf Course Wetland, dense grasses and duckweed obscured visibility of the water.

Species Observed in 2012

American alligator	Green Anole Lizard
American crow	Green Treefrog
Carolina Wren	Green Tree-snake
Common moorhen	Northern cardinal
E. Bluebird	Redwing blackbird
E. Cottonmouth snake	Red-shouldered Hawk
E. King Snake	Rough green snake
Gray Squirrel	Yellow-bellied Slider Turtle
Great Blue Heron	Yellow-rumped Warbler
Great egret	



ALWAYS NEAR

The American alligator hunts, sleeps and nests in the RCW wetlands.

Illustration by Todd Ballantine

Endangered or Threatened Wildlife Species

We observed no Federal or South Carolina listed endangered or threatened species in either project wetland. The eastern wood stork has been a familiar sight in past years; its current "Threatened Species" status will soon be removed. The alligator was also a Threatened Species in South Carolina through the 1970s. RCW and other conservation uses of wetlands provide food, shelter and water for rare species.

4. CONCLUSIONS

Monitoring of the Palmetto Hall Reclaimed Water (RCW) Projects, during the growing season of 2012, leads to the following conclusions:

- Total precipitation for the first six months of 2012 was more than one-quarter less than the average for the period.
- Rainfall was significantly lower during April through June—critical months of the early growing season for vegetation and wildlife reproduction.
- The Forested Wetland received nearly two-thirds of the RCW volume available for the Palmetto Hall project. The Golf Course Wetland received approximately one-third of the RCW volume—but this was 100% more RCW than in the baseline year's growing season (no flow).
- Measured in acre-inches received in the natural basins, the Forested Wetland received nearly twice as many acre-inches than did the Golf Course Wetland.
- In the Forested Wetland total water (RCW+rain) input exceeded the natural hydroperiod in five of the year's first six months. In the Golf Course Wetland, total water exceeded the hydroperiod in two months.
- Surface water in the Forested Wetland was twice as deep as in the baseline. In stark contrast, water in the Golf Course Wetland was seven inches lower: significant because this wetland is a shallow water system, and every inch of water counts for vegetation and wildlife.
- Since the baseline, the diversity of Forested and Golf Course Wetlands plant species has declined in the canopy and shrub/groundcover due to natural causes: recurring drought and then, coverage by water, usually October through February. A second factor is ecological succession in the Golf Course Wetland: increased shade by pines and shrubs, resulting in the decline in groundcover diversity. The "dry-down" period has accelerated the invasion of pines and invasive grass in the Golf Course Wetland.
- Trees will be measured and assessed in November—the dormant season—to accurately quantify the year's growth for the Annual Report.
- The most noteworthy change in the Golf Course Wetland shrub/groundcover stratum was the increasing impact of loblolly pine. Populating nearly three-fourths of the monitoring field, these fast-growing trees are shading out the rare sawgrass community and withdrawing groundwater from valuable wildlife pools. This is reducing biological diversity in many locations.

- The Forested Wetland is, and will continue to be, dominated with swamp blackgum trees. These hardwoods potentially live for centuries ("old growth") and offer significant wildlife habitat from their canopy to their roots. But these trees require water to survive.
- Maidencane was the only nuisance species observed in the project wetlands this year. This grass is out-competing sawgrass, and inhabits twice as much area as in the baseline.
- The number of observed macro-invertebrate species declined in both wetlands. Dry conditions throughout Hilton Head Island have probably limited the number of diversity, and mobility of invertebrates that migrate to the RCW sites.
- We did not observe fish species in either RCW wetland.
- Likewise, we observed no endangered or threatened species of plants or animals in the RCW wetlands.
- The next monitoring study will take place in the dormant season (November 2012). We will submit the 2012 Annual Biological Monitoring Report to Hilton Head PSD in February 2013.

Submitted July 31, 2012



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