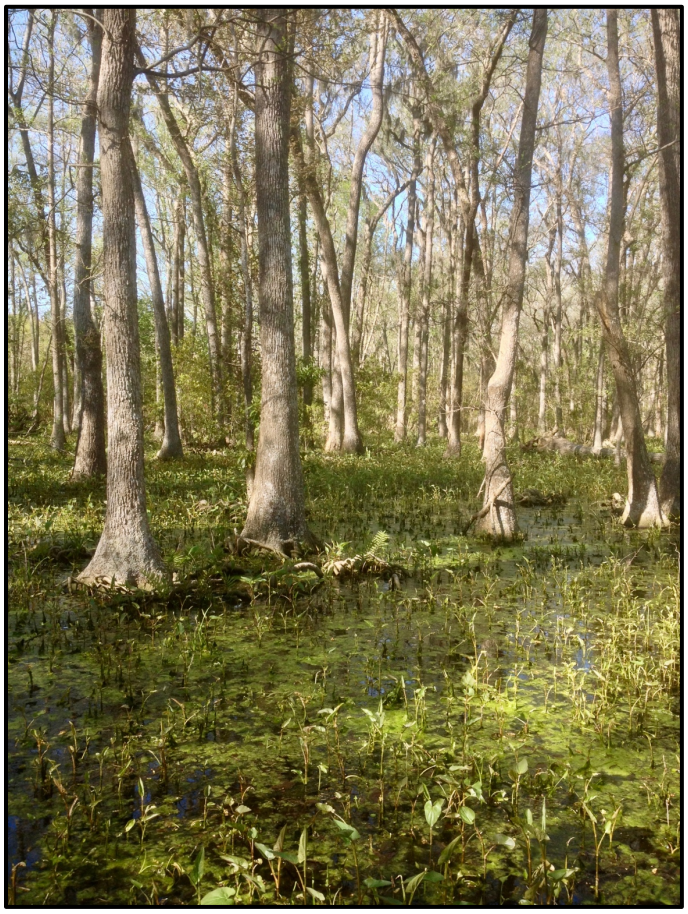
PALMETTO HALL
RECYCLED WATER PROJECT
Hilton Head Public Service District
Hilton Head Island, South Carolina

2016-2017 BIENNIAL BIOLOGICAL MONITORING REPORT

Boulder, Colorado
March, 2018



Ballantine
ENVIRONMENTAL RESOURCES

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1. Introduction

THIS BIENNIAL REPORT analyzes results from two-years of biological monitoring of Recycled Water (RW), projects in the Palmetto Hall community, Hilton Head Island, South Carolina. The Hilton Head Public Service District ("HHPSD") discharged RW (advanced-treated domestic dechlorinated influent) into two freshwater wetlands in the Palmetto Hall community: the Forest Wetland ("Wooded Wetland" in permit documents) and the Golf Course Wetland ("Grassy Wetland" in permit documents). The following report describes scientific findings during the period from January 1, 2016 through December 31, 2017. The PSD has discharged RW in the wetlands since the late 1990s.

The National Pollution Discharge Elimination System (NPDES) Permit (No. SC0046191) requires specific biological monitoring parameters for the Palmetto Hall RW projects. The S.C. Department of Health and Environmental Control (SCDHEC) modified the permit on October 24, 2005. The permit revised maximum and RW loading totals, monitoring for vegetation, and the scientific report schedule. In compliance with the permit, and to maintain the ecological database, this report presents monitoring results for the ecological parameters: dry-down (no-flow) periods, weather effects, ecological change, wildlife and other changes exceeding the "threshold of concern," whether ecological or operational.

Consistent with the (NPDES) permit specifications, the following monitoring results are compared with conditions in the 1999 Baseline monitoring results (reported February 1, 2000). This report includes the site description, methodology summary, monitoring results, conclusions and recommendations, references and appendices.

2. GEOGRAPHIC LOCATION

The RW projects are located in the private 750-acre residential and golf community of Palmetto Hall, on lower, northeastern Hilton Head Island, in southern Beaufort County, South Carolina (Figure 2-1). Palmetto Hall features two golf courses: the Arthur Hills Course and Robert Cupp Course. The RW projects are located in natural (not manmade) wetlands contiguous to these facilities (Figure 2-2). See the Annual and Baseline Report for 1999 for a detailed description of the physical and biological conditions of the projects. Figure 2-1 Forest wetland boundaries have not changed. However, the native

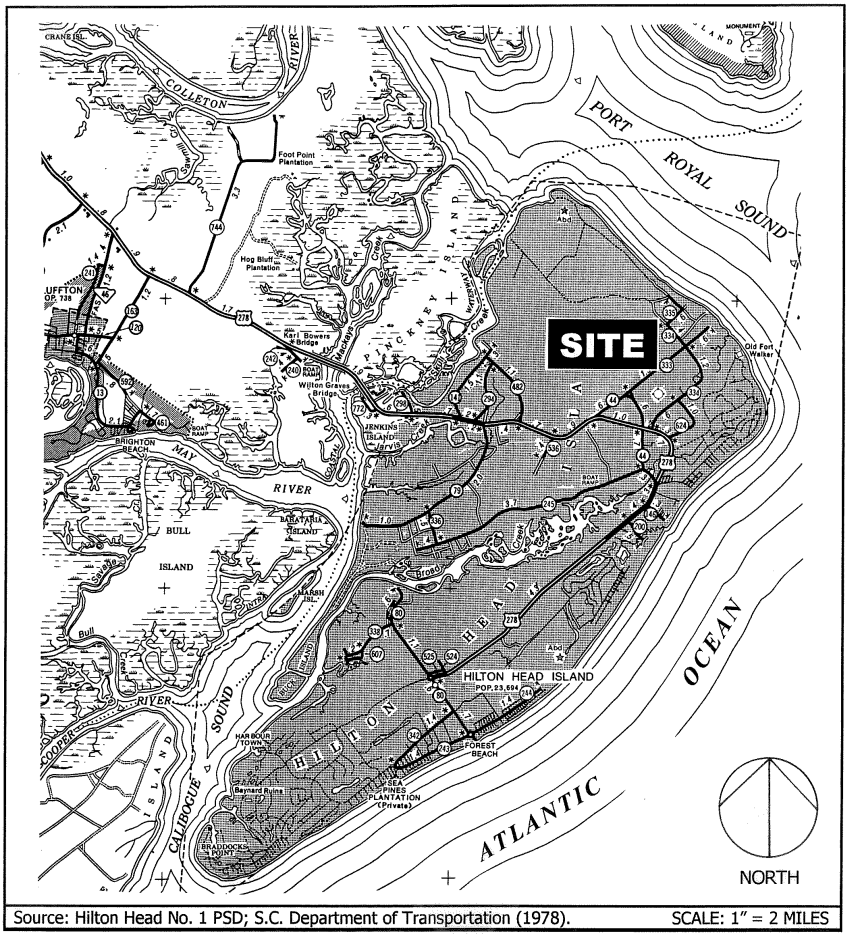
wetlands interior communities *have* changed since the Baseline monitoring. The wetlands *have* changed more rapidly through ecological succession since the Baseline. The supply of RW has enhanced the rate of succession and vegetation growth—especially trees—since the Baseline. In contrast, the wetlands have been impacted by climate change effects including drought and flooding. This has impacted biodiversity of plant and wildlife. But regular RW flow has been a stabilizing resource supporting ecological succession and biological diversity. The sustainable RW program has been in operation for the Hilton Head Public Service District since 1986—and in Palmetto Hall since 1999. RW is processed and distributed by Hilton Head Public Service District in two, large freshwater wetlands -- Forest and Golf Course to (1) provide additional uptake of water and nutrients; (2) eliminate discharges to other waters, such as tidal streams; and (3) enhance the natural hydrology and ecological conditions of the receiving wetlands, which have been impacted by land development and climate change. This report describes that climate-driven impacts continue in this RW project area.

For more information see the original Baseline report for this Project, contact Hilton Head Public Service District, or Ballantine Environmental Resources.

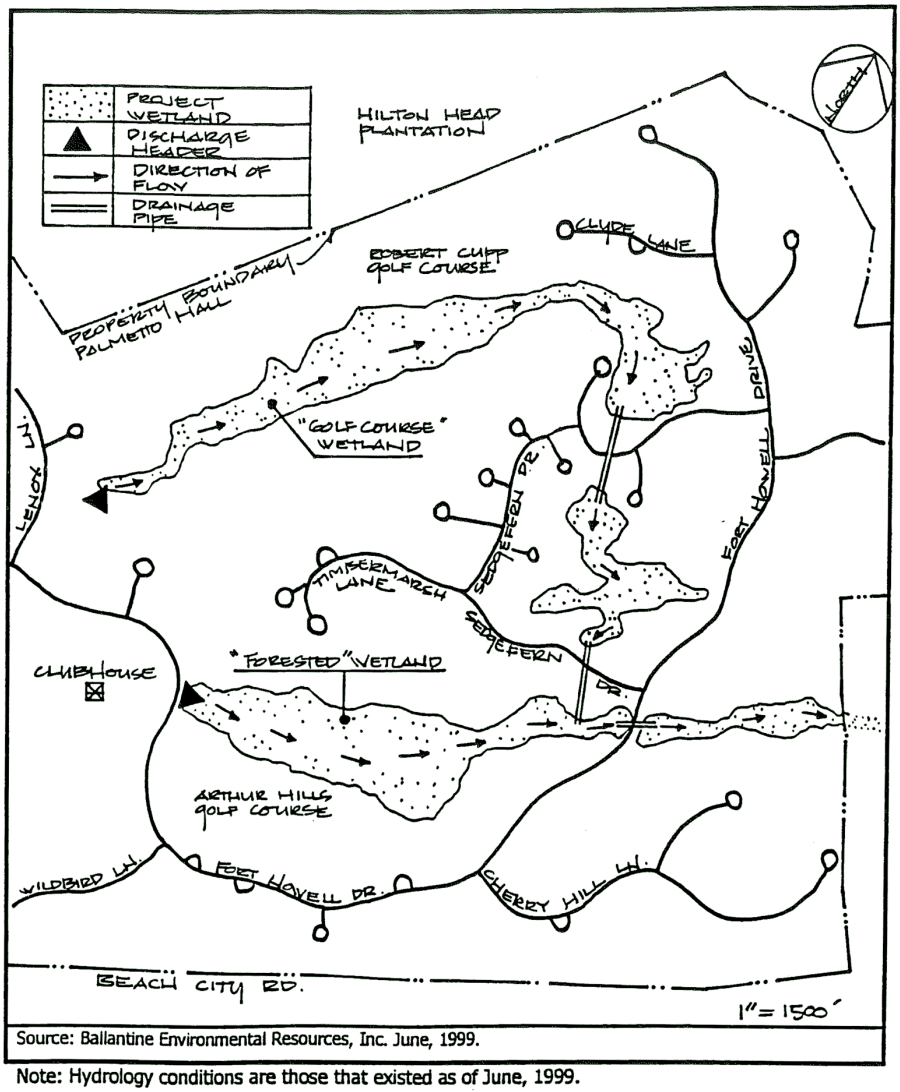
2.1 Site Description

The Forest Wetland (Figure 2-2) is 98 acres in area with significant long-term water storage capacity and wildlife value. One inch of water throughout this wetland is equal to 2.7 million gallons. The average elevation is 10-15 feet MSL. The linear wetland is part of the watershed drainage via percolation and slow overland flow toward Port Royal Sound. The hydric soils on the northern wetland edge, adjacent to Sedge-fern Drive, are the eastern edges of the lower wetland that store groundwater at a high level through most of the year. The Golf Course Wetland (Figure 2-3) is a palustrine-emergent marsh and palustrine-successional mixed pine-flatwood forest. A significant resource, in this wetland is the largest remaining sawgrass community on Hilton Head Island. The wetland has a seasonally and artificially flooded and/or saturated water regime. A header at the southern, upper end of the wetland discharges RW via low aerial spray. Sheet-flow moves through the wetland in a north-easterly direction, then turns to the southeast, and finally may discharge into the nearby Forest Wetland.

Figure 2-1. Location Maps



2-2 Site Map: Forest Wetland



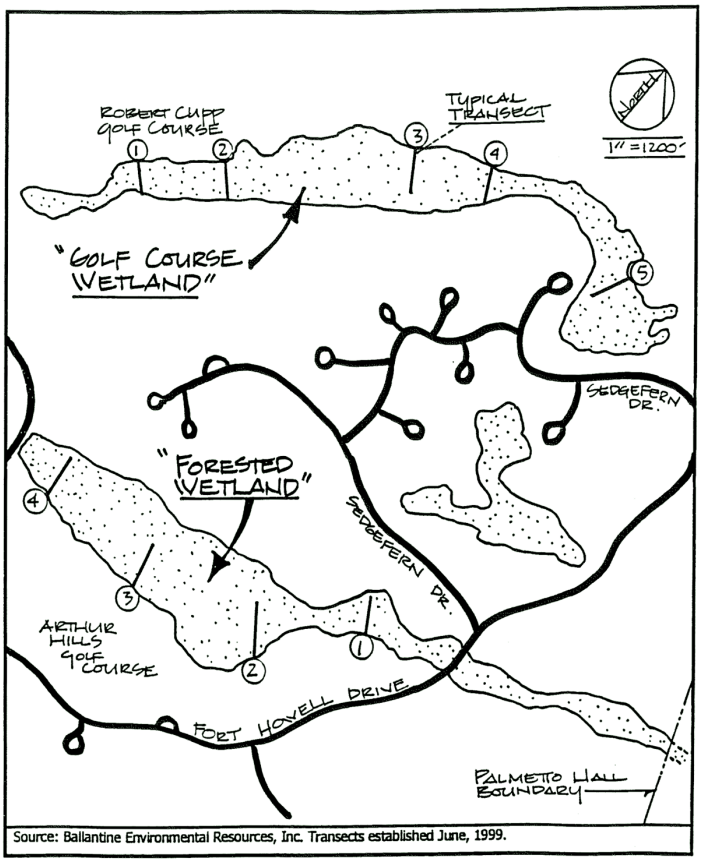
Source: Ballantine Environmental Resources, Inc. June, 1999.
Note: Hydrology conditions are those that existed as of June, 1999.

This map shows the site/location of the two project wetlands on northern Hilton Head Island. Notice the proximity to Port Royal Sound. This area is associated with a prehistoric shoreline and wetland. Soils in the area are often "hydric"— easily saturated or inundated in rainstorms or floods.

This linear basin has an average elevation of 10-15 feet mean sea level (MSL). It is a virgin old-growth hardwood forest association with most trees 50 to > 100 years in age—or technically: a palustrine-forest, bottomland hardwood community with a

seasonally and artificially-flooded water regime. RW is discharged by aerial spray from a header at the western end of the wetland. One inch of RW throughout this wetland is equal to 2.4 million gallons. Since the Baseline, Ballantine Environmental Resources has consulted and conducted scientific measurement and reporting in compliance with the SCDHEC NPEDS permit for this RW project, our monitoring has reported data for the overall ecological condition, hydrology, vegetation, wildlife, and any other factors that may or do impact the RW Project. The Conclusions and Recommendations assess the status of the wetlands and provide guidance for operational modifications, if practical, or justified environmentally.

2-3. Golf Course Wetland



Sheet-flow drains in an eastward direction through the wetland, then through downstream off-site wetlands, on its way to Port Royal Sound (Figure 2-3).

3. Monitoring Methodology

3-1. MONITORING SCHEDULE

As stipulated by the NPDES Permit No.SC0046191, Ballantine Environmental Resources monitored the project wetlands biennially in 2016 and 2017. We monitored hydrology, vegetation, and wildlife.

Of note, in the period between the two monitoring cycles, Hilton Head Island was impacted by Hurricane Matthew (October, 2016). The fallen debris from this storm interrupted the normal monitoring schedule. Monitoring was implemented in growing season of 2017.

3-2. MONITORING DATA

We used the line-transect and quadrat intercept method of data collection. In the Forest and Golf Course Wetland projects we maintain transects spanning the width of each wetland. Permanent sampling quadrat stations are established at equidistant point intercepts on the transects. Figures 2-2 and 2-3 show the location of monitoring transects in the project wetlands.

Our collected field data includes:

- ***Water depth*** measured at each station.
- ***Vegetation*** measured at each station. We recorded the diversity, dominance, and density of canopy species in cen-acre (1/100 acre) quadrats. In the shrub and groundcover stratum, we measured species diversity, dominance, and density in mil-acre (1/1,000 acre) stations.
- ***Wildlife:*** We identified macro-invertebrates (benthic, aerial and other) in stations and along transects. We recorded fish species identified visually in appropriate habitats at stations. We also identified indicator vertebrates visually or physically (by vocalizations, "sign," tracks, or trails).
- ***Significant impacts:*** We documented wetland impacts from natural causes. Such impacts include flood, drought, storms, plant disease, invasive or "nuisance" species, and wildlife activity, as well as human impacts (e.g., trash

dumping, mowing, vegetation removal, ditching or filling, or vandalism were also noted.

- A detailed description of monitoring methods and calculations is provided in the "Palmetto Hall Reclaimed Water Project Description" (April 15, 1999), included in the Annual and Baseline Report.

3-3. REPORTS

The current SCDHEC NPDES permit requires biennial reports. However, as needed by Hilton Head PSD, Ballantine Environmental Resources provides additional monitoring, updates, outreach publications, and site investigation about the two RW projects.

This ***Biennial Biological Monitoring Report*** compares data collected in the growing and dormant seasons of 2016-2017 with conditions in the Baseline, according to parameters ascribed by the SCDHEC. We submit all reports to the Hilton Head PSD, which forwards the information to SCDHEC and other stakeholders.

4. Monitoring Results

NPDES Wetland Parameters

2016-2017
PALMETTO HALL RECYCLED WATER PROJECT
Hilton Head Island, SC
NPDES Permit No. No.SC0046191
S.C. DHEC Monitoring Parameters
Forest Wetland and Golf Course Wetland
Palmetto Hall, Hilton Head Island, South Carolina
2016-2017 Conditions Compared with The 1996 Baseline Year
Todd Ballantine, Lead Environmental Scientist,
Ballantine Environmental Resources, Boulder Colorado

Parameter A.
Hydroperiod

A-1. Biennial RW loading averaged annually compared to 40-year average rainfall and the Baseline.

The 40-year average rainfall, or "hydroperiod" for Hilton Head Island is 51 inches per year (acre-inches). This is the Baseline against which to compare the sum of annual RW loading plus rainfall in inches as recorded by HHPSD. In 2016-2017 the Golf Course and Forest Wetlands received above-average rainfall: 7% above the historical 50-year mean.

Over the two-year monitoring period, the project area received 87 acre-inches of RW, distributed as 74 acre-inches in the Forest Wetland and 11 inches in the Golf Course Wetland.

A-2. Depth of water in the RW wetlands. The average depth of water in the Forest Wetland was 3 inches, similar to the depth in the Baseline (2.8 inches). The deepest water was 12 inches in the center channel of this bottomland system. Approximately 60 percent of the wetland was inundated—compared to 83 percent coverage in the Baseline.

In the Golf Course Wetland, the average depth was less than 1 inch—shallower than in the Baseline (8 inches). The only surface water we observed

was a shallow (3 inches) channel trickling down the center portion of the wetland in a westerly direction.

A-3. Distribution of Water in the Wetlands. Surface water covered 50 percent of the ground in the Forest Wetland and <5% percent of the Golf Course wetland. In the Forest Wetland standing, water appeared to be of long duration. In the Golf Course wetland the only water was of short duration—in the above mentioned channel.

A-4. Hydrology Compared to the Baseline. Surface water was less widespread and shallower than in the Baseline in each wetland. The effect of SCDHEC mandated dry-down (no flow) periods has substantially lowered the ground water tables in each wetland.

Parameter B.
Canopy Species

B-1. Basal Area of Trees. In the Forest Wetland, the basal area of trees declined by 15% or less due to windthrow from Hurricane Matthew. As was observed in other wetlands, trees facing the North-Northwest exposure were most vulnerable to blow-down. The interior of the wetland is still populated by mature hardwoods such as swamp blackgum and red maple. The density of these trees baffled the strong winds and protected the inner forest.

On the Golf Course wetland, pine trees were vulnerable in exposed areas and were felled by storm winds. These trees were removed prior to our latest monitoring. Windfall of other trees offered a beneficial mass of branches and limbs on the perimeter of this wetland. This debris provides shelter habitat for songbirds, reptiles, and amphibians.

B-2. Density of Canopy Trees. Basal area, related to tree density, dropped in the wetlands due to the hurricane. The average decline in the Forested wetland was 10-15%, likewise in the Golf Course wetland.

B-3. Importance Value. In order of importance value, an ecological standard of productivity, trees of the wetlands are: swamp blackgum, red maple, sweetgum, water oak, loblolly pine, pond pine and Carolina willow.

Parameter C.
Shrub and Groundcover Species
Averaged for the wetland and compared to the Baseline

C-1. Species Diversity. Compared to and since the Baseline, species diversity declined moderately in all strata due to the hurricane. We estimate that this decline was a range of 10-20%. However, the decline did not impact the wetland function for storing and filtering RW. The declines in groundcover will be mitigated by regrowth hastened by more sunlight reaching the ground.

C-2. Total Cover of Dominant Species. Dominant trees, described above currently provide the approximated cover:

- Forest wetland: 85% cover
- Golf Course wetland: 45% cover

C-3. Importance Value. This parameter is the comparative sum of relative dominance, (maximum 100 points), density (maximum 100 points), frequency (maximum 100 points) and wildlife habitat (maximum 100 points)—rated on an optimum score of 400 points. The Forest Wetland Importance Value has been reduced to 350, fundamentally due to the effects of Hurricane Matthew. The Golf Course wetland: due to recurring dry-down, hurricane, and low flow of RW this wetland has declined to a score of 150. Dieback of the rare sawgrass community is a primary impact in this wetland.

Parameter D.
Nuisance Plant Species

Nuisance plant species occur almost entirely when there is a decline in one parameter of the wetland. In the case of Palmetto Hall, nuisance grasses and invasive pines have degraded formerly rare sawgrass wetlands. Additionally, as a result of recurring drought, dry down, and hurricane flooding, the sawgrass marsh has declined almost 100%. It appears that this wetland will undergo shrub growth followed by invasion of loblolly pine. This change is natural but the lost sawgrass marsh cannot be replicated or restored. Addition of RW will not bring the sawgrass marsh back, we predict. With the exception of pines, we have not observed the invasion or recurrence of invasive plant species described in previous reports.

Parameter E.
Exceeding the Threshold of Concern: Canopy

The Gulf Course Wetland was damaged by the hurricane causing tree fall and loss of limbs on the windward side. This community is undergoing ecological succession from a mixed forest-marsh to a more dense pine flatwood association. This emerging pineland is less biologically diverse. The Forest Wetland had less damage to trees due to its geographic position. The density of hardwood trees provided a form of "safety in numbers" for the dense, mature swamp blackgum forest. The primary tree loss was due to the hurricane as expressed above, but overall, the forest remains vibrant and productive.

Parameter F.
Exceeding the Threshold of Concern:
Shrub and Groundcover

The Forest shrub and groundcover suffered very little damage due to the protective nature of the dominant hardwood trees. This community is highly resilient. The Golf Course wetland was exposed to wind and water depredation. The primary example of the impact was flooding and sedimentation in the former sawgrass marsh which declined substantially by storm flooding and sedimentation.

Dieback of the Salt Marsh Community in the Golf Course Wetland.

Parameter G.
Natural Causes

The natural causes of change in the wetlands, in order of prevalence were: isolated tree fall, stormwater flooding, sedimentation, dieback of rare species (sawgrass), and alteration of drainage patterns in the wetlands.

Parameter H.
Benthic Macro-Invertebrates

In the Forest Wetland, we saw fewer species and smaller populations of fish and macro invertebrates, possibly due to the severity of storms and disruption of habitat and impact of dry-down. However, the prevalence of debris in the wetland is likely to offer new cover and breeding areas for fish and invertebrates. In the Golf Course Wetland, the low water and clusters of blown-down cover also will offer new habitat for invertebrates but less so for fish until the dry-down requirement is suspended.

Parameter I.
Fish

The fish populations will take longer to recover from storm damage. Fish species reported in prior reports are primarily insectivorous. With the regeneration of the population of invertebrates, fish population should recover--as long as there is sufficient water in the wetlands. We observed a lower number of wading birds hunting fish in the pools of the Forest Wetland and ponds of the Golf Course Wetland. This is an indication of habitat alteration due to storm damage and low water.

Parameter J.
Endangered or Threatened Species

In the course of monitoring the Palmetto Hall wetlands, we observed no federally or state of South Carolina-listed endangered or threatened wildlife

species in the Palmetto Hall RW wetlands. These species are: Heel-spitter clam, Northern myotis bat, and Red Knot.

Parameter K.
No Discharge Period In the Wetland

From 2016 to 2017 the Golf Course Wetland received only 8% of available RW water. The prolonged dry-down reduced habitat diversity and productivity significantly. The Forest Wetland
received a more regular monthly supply of RW. Habitat was not impacted by dry-down in this wetland.

Sturdy swamp blackgums in The Forest Wetland

Conclusions and Recommendations

CONCLUSIONS

This Biennial Report analyzed the results from biological monitoring in 2016 through 2017 of RW operations in the Palmetto Hall Forest and Golf Course Wetlands. Comparison of the two-years' data with conditions in the baseline year 1999 leads to the following conclusions:

1. Hurricane Matthew has had a continuing impact on the wetlands.
2. The most impacted wetland has been the Golf Course component.
3. The Golf Course Wetland is in transition and has become less ecologically productive. Without more regular supply of RW water, this wetland will mature as a drier pineland.
4. Both wetlands will recover slowly due to the scale of the disruption of the storms, however, the Forest Wetland is more mature, deeper and larger. This community should recover much more quickly.

RECOMMENDATIONS

1. Operational changes are recommended: To rectify significant natural and human impacts, eliminate the rigid dry-down mandate and instead, apply dry-down only as a flexible alternative to benefit the ecology of the wetland, rather than stress it. This action will; (1) help sustain critical functions of the wetlands, including water quality enhancement sought by the U.S. Clean Water Act; (2) preserve critical habitat for protected international migratory wildlife, such as the songbirds and raptors that currently use the wetlands.
2. Continue to detail specific impacts of climate change on the RW wetlands. This is vital to assure the success of the RW project.
3. Hilton Head PSD should continue its successful outreach program to educate customers and the general public about the valuable Recycled Water Program pioneered on Hilton Head Island.

6. Glossary

Adsorption Accumulation of liquids or solids on the surface of leaves.

Basal Area The cross-sectional area of a tree trunk measured in square inches or square feet at 4.5 feet above ground.

Biennial A duration of two years.

Bottomland A low terrain that contains freshwater or a high water table.

Climate Change Any significant change in the measures of climate lasting for an extended period of time. Climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer.

Colonial Wading Birds Herons, egrets and ibises and other long-legged water birds that nest in dense communities called "rookeries."

Cover The degree to which above-ground portions of vegetation cover the ground surface. Also called areal cover.

Dominance The measure of a plant species compared with other species, based on areal cover (groundcover) and caliper inches converted to basal area (trees).

Density The number of individuals of a species per unit area.

Dry-down A mandated period in which no Recycled Water flows into a wetland.

Drought A period of abnormally low rainfall that affects growing or living conditions.

Ecological Succession The process in which communities of plant and animal species in a particular area are replaced over time by a series of different and more complex communities.

Endangered Species A species of plant or animal that is in danger of going extinct.

Emergent Plant A plant with its lower part underwater and its upper part, usually leaves and flowers, above the water surface.

Evapotranspiration The process in which water is changed into vapor by atmospheric pressure, wind, humidity, solar radiation, and released through plant leaves and bark.

Flyway A globally fixed route along which birds (e.g., songbirds and waterfowl) migrate.

Frequency The distribution of individuals of a plant species in an area.

Growing Season The portion of the year that is frost-free.

Habitat A place where a plant or animal lives. A productive habitat provides sufficient food, cover and water.

Hardwood A broad-leaved tree such blackgum, red maple, or sweet gum.

Hydrology The properties, distribution and circulation of water.

Hydroperiod The average annual cycle of rainfall of a location.

Importance Value The relative influence of a plant species in a plant community, obtained by summing relative dominance, density and frequency.

Indicator Species A species that indicates whether an ecosystem is vibrant or degrading.

Keystone Species A species that affects other species in a community.

Macro-Invertebrate An animal species lacking a backbone and which can be seen without the aid of optical magnification.

Neotropical The geographic region including Central and South America.

NPDES National Pollution Discharge System permit under the Clean Water Act.

Old-growth Forest A forest community with large trees for the site and species type; multiple canopy layers; and wide spacing between trees. Example: the Palmetto Hall Forest Wetland.

Palustrine A freshwater community. Example: Palmetto Hall Golf Course Wetland.

Recycled Water Advanced-treated domestic water discharged into wetlands to restore ecological functions, values, wildlife habitat, and human recreation opportunities. Formerly named "reclaimed water."

Surface Plant A species of vegetation that keeps leaves above the surface of the water.

Wetland An area that is inundated or saturated by surface or ground water at a frequency and duration to support vegetation adapted to saturated or flooded soil.

7. Wetland Vegetation
Inventory of Observed Plant Species:
1999-Present

FOREST WETLAND

Common Name	Scientific Name
Blackgum	Nyssa biflora
Broomsedge Bluestem	Andropogon virginicus
Bur Marigold	Bidens laevis
Button Bush	Cephalanthus occidentalis
Carolina Willow	Salix caroliniana
Climbing Hempweed	Mikania scandens
Cushion Moss	Leucobyrum glaucum
Creeping Primrose	Ludwigia palustris
Dog Fennel	Eupatorium capillifolium
Duckweed	Lemna minor
Duckweed	Lemna vadiviana
False Nettle	Boehmeria cylindrica
Fetterbush	Lyonia lucida
Floating Bladderwort	Utricularia inflata
Frog's Bit	Limnobium spongia
Gallberry	Ilex glabra
Grass-leaved	Sagittaria graminea
Highbush Blueberry	Vaccinium corymbosum
Lizard Tail	Saururus cernuus
Loblolly Pine	Pinus taeda
Maidencane	Panicum hemitomon
Marsh Pennywort	Hydrocotyle umbellata
Mosquito Fern	Azolla caroliniana
Netted Chainfern	Woodwardia areolata
Pickerelweed	Pontederia cordata
Persimmon	Diospyros virginiana
Poison Ivy	Toxicodendron radicans
Pond Pine	Pinus serotina
Primrose Willow	Ludwigia peruviana
Red Bay	Persea borbonia
Red Bay/Swamp Red Bay	Persea palustris
Red Maple	Acer rubrum
Red-root	Lachnanthes caroliniana
Royal Fern	Osmunda regalis
Shade Mudflower	Micranthemum umbrosum

Southern Blueflag Iris	Iris versicolor
Spanish Moss	Tillandsia usneiodes
Sweet Gum	Liquidamber stryaciflua
Switch Grass Panicum	Panicum virgatum
Virginia Chainfern	Woodwardia virginica
Walter's Sedge	Carex walteri
Water Net	Hydrodicton sp.
Water Pennywort	Hydrocotyle ranunculoides
Water Pepper	Polygonum hydropiperoides
Waxmyrtle	Myrica cerifera
Wingstem	Verbesina occidentalis
Wolffia (Water Meal)	Wolffia punctata
Yellow Cyperus	Cyperus flavescens

Total: 47 Species

GOLF COURSE WETLAND

Common Name	Scientific Name
Black-Gum	Nyssa biflora
Blue-green Algae	Lyngbya sp.
Bracken Fern	Pteridium aquilinum
Broomsedge Bluestem	Andropogon virginicus
Bur marigold	Bidens laevis
Carolina Willow	Salix caroliniana
Cattail (Tall)	Typha latifolia
Chinese Tallowtree	Sapium sebifera
Cinnamon Fern	Osmunda cinnamomea
Climbing Hempweed	Mikania scandens
Cushion Moss	Leucobyrum glaucum
Dahoon Holly	Ilex cassine
Duckweed	Lemna vadiviana
False Nettle	Boehmeria cylindrica
Fetterbush	Lyonia lucida
Floating Bladderwort	Utricularia inflata
Gallberry	Ilex glabra
Giant Cane	Arundinaria gigantea
Giant Plume Grass	Erianthus gigantea
Loblolly Pine	Pinus taeda
Maidencane	Panicum hemitomon
Marsh Pennywort	Hydrocotyle umbellata
Mosquito Fern	Azolla caroliniana
Netted Chainfern	Woodwardia areolata
Persimmon	Diospyros virginiana
Pickerelweed	Pontederia cordata
Plume Grass	Setaria magna

Poison Ivy	Toxicodendron radicans
Red Maple	Acer rubrum
Red Bay	Persea borbonia
Red-root	Lachnanthes caroliniana
Royal Fern	Osmunda regalis
Saw Palmetto	Serenoa repens
Sawgrass	Cladium jamaicense
Sedge sp.	Carex sp.
Smartweed (Dense-flower)	Polygonum densiflorum
Soft Rush	Juncus effusus
Southern Blueflag Iris	Iris versicolor
Spanish Moss	Tillandsia usneiodes
Swamp Dewberry	Rubus hispidus
Swamp Knotweed	Polygonum hydropiperoides
Virginia Chainfern	Woodwardia virginica
Virginia Creeper	Parthenocissus quinquefolia
Water Milfoil	Myriophyllum sp.
Water Net Algae	Hydrodictyon sp.
Water Pennywort	Hydrocotyle ranunculoides
Water Spider Orchid	Habenaria repens
Waxmyrtle	Myrica cerifera
Wolffia (Water Meal)	Wolffia punctata

Total: 48 Species

8. Wetland Wildlife
Inventory of Observed Animal Species: 1999-Present

FOREST WETLAND

Common Name:	Scientific Name:

VERTEBRATES

Amphibians: 4 Species

Green Treefrog	Hyla cinerea
Southern Dusky Salamander	Desmognathus auriculatus
Southern Chorus Frog	Pseudracis nigrata
Southern Leopard Frog	Rana sphenocephala

Birds: 29 Species

American Robin	Turdus migratorius
Barred Owl	trix varia
Blue Jay	Cyanocitta cristata
Carolina Chickadee	Parus carolinensis
Carolina Wren	Thyrothorus ludovicianus
Chuck-Will's Widow	Caprimulgus carolinensis
Common Crow	Corvus brachyrhynchos
Common Grackle	Quiscalus quiscula
Downy Woodpecker	Picoides pubescens
Eastern Phoebe	ayornis phoebe
Gray Catbird	Dumetella carolinensis
Great Blue Heron	Ardea herodias
Great Egret	Casmerodius albus
Green-backed Heron	Butorides striatus
Northern Cardinal	Cardinalis cardinalis
Osprey	Panodiun haliaetus
Pileated Woodpecker	Dryocopus pileatus
Red-bellied Woodpecker	Melanerpes carolinus
Red-shouldered Hawk	Buteo lineatus
Red-tailed Hawk	Buteo jamaicensis
Rufous-sided Towhee	Pipilo erythrophthalmusi
Snowy Egret	Egretta thula
Tufted Titmouse	Parus bicolor
Turkey Vulture	Cathartes aura
Yellow-bellied Sapsucker	Sphyrapicus varius
Yellow-rumped Warbler	Dendroica coronata
Wood Duck	Aix sponsa
Wood Stork	Mycteria americana
White Ibis	Eudocimus albus

Fish: 1 Species

Eastern Mosquitofish	Gambusia affinis

Mammals: 4 Species

Eastern Gray Squirrel	Sciurus carolinensis
Raccoon	Procyon lotor
White-tailed Deer	Odicoileus virginianus
hiltonensis	

Reptiles: 6 Species

American Alligator	Alligator mississippiensis
Five-lined Skink	Eumeces fasciatus
Green Anole	Anolis carolinensis carolinensis
Southern Black Racer	Coluber constrictus priapus
Eastern Cottonmouth	Agkistrodon piscovorus
Northern Copperhead	Agkistrodon contrortrix-mokasen

Macro-Invertebrates

Arachnids: 16 Species

Black and Yellow Argiope Spider	Argiope aurantia
Brown Daddy-long-legs	Phalangium opilio
Carolina Wolf Spider	Lycosa carolinensis
Comb-footed Spider	Anelosimus studiosus
Chigger (Harvestmite)	Trombicula sp.
Dwarf Spider	Ostearius melonopyius
Forest Wolf Spider	Lycosa gulosa
Golden Silk Spider	Nephila clavipes
Jumping Spider	Metaphidippus galathen
Mabel Orchard Spider	Leucauge mabelae
Sheetweb Spider	Linyphiinnia sp.
Six-spotted Fishing Spider	Dolomedes triton
Thin-legged Wolf Spider	Pardosa sp.
Water Mite	Hygrobates sp.
Water Spider	Argyronera aquatica
White Micranthena Spider	Micranthena mitrata

Copepods: 2 Species

Calanoid Copepod	Copepoda sp.
Diaptomus Copepod	Diaptomus sp.

Crustaceans: 2 Species

Isopod	Asellus sp.
Scud	Hyalella azteca

Diplopods: 2 Species

Millipede	Sirobolid sp.
Millipede	Platydesmid sp.

Insects: 46 Species

American Dagger Moth	Acronicta americana
Angular-winged Katydid	Microcentrum retinerve
Black-faced Skimmer Dragonfly	Libellul cyanea
Black Salt marsh Mosquito	Aedes taeniorynchus
Broad-shouldered Water Strider	Microvelia borealis
Brown Daddy-long-legs	Phalngium opiolo
Chironomid midge	Chironomid sp.
Common Water Strider	Gerris remigis
Crane Fly	Tipula sp.
Creeping Water Bug	Pelocoris sp.
Deerfly	Chrysops sp.
Earwig	Foricula sp.
Elmid Beetle	Stenelnis lateralis
Field Cricket	Gryllus pennsylvanicus
Fire Ant	Solenopsis gominata
Golden Salt marsh Mosquito	Aedes solicitans
Green Clearwing Dragonfly	Erythemis simpliciollis
Green Darner Dragonfly	Ajax junius
Green Midge	Tanytarsus sp.
Green Water Strider	Gerris sp.
Katydid	Pseudophyllinae sp.
Marsh Fly	Tetanocera sp.
Mydas Fly	Mydas clavatus
Mud Dauber Wasp	Sceliphron caementarium
Leaf Beetle	Donacia sp.
Leafhopper	Cicallid sp.
Long-legged Fly	Dolichoplus longipennis
Love Bug	Plecia neartica
Nessus Sphinx Moth	Amphion nessus
Northern Katydid	Pterophylla camefolia
Palamedes Swallowtail Butterfly	Pterourus palamedes

Periodical Cicada	Magicicada sp.
Planthopper	Delphacid sp.
Scarab Beetle	Scarabaedid sp.
Southern House Mosquito	Culex pipiens quinquefaxciatus
Small Whirligig Beetle	Gyrinus sp.
Southern Spread-wing Damselfly	Lestes austalis
Summer Mosquito	Aedes atlanticus
Tree-hole Mosquito	Aedes triseriatus
Water Boatman	Corixa sp.
Water Lily Leaf Beetle	Donacid sp.
Water Strider – Broad-shouldered	Microvelia borealis
Water Strider	Gerris marginatus
Water Treader	Mesovelia mulsanti
White Fly	Aleyrodid sp.
Widow Dragonfly	Libelulla lucoasa
Yellow Jacket	Vespula sp.

Isoptera: 1 Species

Eastern Subterranean Termite	Reticulitermes flavipes

Mollusca: 1 Species

Hairy Wheel Snail	Gyraulus hirsutus

Tadpole Shrimp: 1 Species

Tadpole Shrimp	Triops longicaudatus

Water Fleas: 1 Species

Water Flea	Daphnia pulex

Total: 110 Species

GOLF COURSE WETLAND

Common Name:	Scientific Name:

VERTEBRATES

Amphibians: 1 Species

Green Treefrog	Hyla cinerea

Birds: 37 Species

American Black Duck	Anas rubripes
American Coot	Fulica americana
American Robin	Turdus migratorius
Anhinga	Anhinga anhinga
Bald Eagle	Haliaeetus leucocephalus
Black-crowned Night Heron	Nycticorax violacea
Blue Jay	Cyanocitta cristata
Carolina Chickadee	Parus carolinensis
Carolina Wren	Thyrothorus ludovicianus
Cedar Waxwing	Bombycilla cedrorum
Common Crow	Corvus brachyrhynchos
Common Grackle	Quiscalus quiscula
Common Yellow-shafted Flicker	Colaptes auratus
Eastern Bluebird	Sialia sialis
Great Blue Heron	Ardea herodias
Great Crested Flycatcher	Myiarchus crinitus
Great Egret	Casmerodius albus
Great Horned Owl	Bubo virginianus
Green-backed Heron	Butorides striatus
Moorhen (Common Gallinule)	Gallinula chloropus
Northern Cardinal	Cardinalis cardinalis
Osprey	Panodiun haliaetus
Peregrine Falcon	Falco peregrinus
Pileated Woodpecker	Dryocopus pileatus
Red-bellied Woodpecker	Melanerpes carolinus
Red-winged Blackbird	Agelaius phoeniceus
Red-shouldered Hawk	Buteo lineatus
Ruby-throated Hummingbird	Archilochus colubris
Rufous-sided Towhee	Pipilo erythrophthalmusi
Snowy Egret	Egretta thula

Tufted Titmouse	Parus bicolor
Turkey Vulture	Cathartes aura
Yellow-billed Cuckoo	Coccyzuz americanus
Yellow-rumped Warbler	Dendroica coronata
Wood Duck	Aix sponsa
Wood Stork	Mycteria americana
White Ibis	Eudocimus albus

Fish: 1 Species

Eastern Mosquitofish	Gambusia affinis

Mammals: 4 Species

Eastern Gray Squirrel	Sciurus carolinensis
Raccoon	Procyon lotor
River Otter	Lutra canadensis
White-tailed Deer	Odicoileus virginianus-hiltonensis

Reptiles: 4 Species

American Alligator	Alligator mississippiensis
Eastern Cottonmouth	Agkistrodon piscivorus-piscovorus
Green Anole	Anolis carolinensis carolinensis
Yellow-bellied Slider	Chrysemys scripta scriptai

Macro-Invertebrates

Arachnids: 9 Species

American Dog Tick	Dermacento variablis
Forest Wolf Spider	Lycosa gulosa
Dwarf Spider	Mycriphantinae sp.
Golden Silk Spider	Nephila clavipes
Pirate Wolf Spider	Pirata piraticus
Red Freshwater Mite	Limnocharus americana
Six-spotted Fishing Spider	Dolomedes triton
Wasp Spider	Halcti sp.
Water Mite	Hygrobates sp.

Crustaceans: 4 Species

Scud	Gammarus fasciatus
Scud	Hyalella asteca

Sow Bug	Oniscus asellus
Water Flea	Daphnia pulex

Insects: 35 Species	**Insects: 36 Species**
American Dagger Moth	Aconicta americana
Black Carpenter Ant	Camponotus pennsylvanicus
Black Fly	Simulium sp.
Black Salt marsh Mosquito	Aedes taenorhynchus
Citrine Forktail Damselfly	Ischnura hastata
Chironomid Midge	Chironomid sp.
Condylostylid Long-legged Fly	Condylostylid sp.
Common Water Strider	Gerris remigis
Crawling Water Beetle	Peltodytes lengi
Deerfly	Chrysops sp.
Eastern Malaria Mosquito	Aedes quidrimaculatus
Eastern Tent Moth	Malicosma americanum
Field Cricket	Gryllus pennsylvanicus
Green Clearwing Dragonfly	Erythemis simplicollis
Green Darner Dragonfly	Anax junius
Green Midge	Tanytarsus sp.
House Fly	Musca domestica
Leaf Beetle	Donacia sp.
Lightning Bug	Lampyrid sp.
Marsh Fly	Tetanocera sp.
Meadow Grasshopper	Convuphalinae sp.
Net-winged Damselfly	Argia sp.
Pale Bluet Dragonfly	Enallagma hastata
Periodical Cicada	Magicicidada sp.
Plant Bug	Mirid sp.
Planthopper	Delphacid sp.
Red Skimmer Dragonfly	Libellula saturata
Shore Fly	Ephyrdid sp.
Southern House Mosquito	Culex pipiens quinquefaxciatus
Spotless Nine-spotted Ladybug	Coccinella novemnota franciscana
Swift Long-winged Skimmer	Pachydiplax longipennis
Thrip	Thysanoptera sp.
Water Scorpion	Ranatra sp.
Water Strider – Broad-shouldered	sMicrovelia borealis
Whirligig Beetle	Dineutes americanas

Isoptera: 1 Species

Eastern Subterranean Termite	Reticulitermes flavipes

Worms: 2 Species

Earthworm	Lumbricus terristis.
Flatworm	Dugesia tigrina

Mollusks: 3 Species

Hairy Wheel Snail	Gyraulus hirsutus
Little Pond Snail	Amnicola limnosa
Winkle Snail	Vivaparus intertextus

Total: 100 Species

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