ANNUAL WETLAND MONITORING REPORT (YEAR 4)

BARRA FARMS CAPE FEAR REGIONAL MITIGATION BANK
CUMBERLAND COUNTY, NORTH CAROLINA

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CUMBERLAND COUNTY, NORTH CAROLINA

1.0 INTRODUCTION

ECOBANK, a private sector mitigation banking company, has established the Barra Farms Cape Fear Regional Mitigation Bank (the Bank) within the Coastal Plain region of the Cape Fear River Basin. The Bank comprises 623 acres located along upper reaches of Harrison Creek in Cumberland County (Figure 1). Wetland restoration/enhancement activities were completed in the winter of 1997-1998 as described in the detailed mitigation plan. A mitigation banking instrument has also been prepared through ongoing coordination with the mitigation banking review team (MBRT) as outlined in the Federal Guidance on the Establishment, Use, and Operation of Mitigation Banks (60 FR 12286-12293, 1995).

Hydrological and vegetation monitoring are important components of a successful mitigation plan and are required for release of compensatory mitigation credits. The Barra Farms monitoring plan requires annual monitoring for a five-year period and analysis of the data to evaluate success in the establishment and maintenance of diagnostic wetland parameters. The mitigation credit schedule and monitoring plan are attached for reference in Appendices A and E.

This document represents the Annual Wetland Monitoring Report (AWMR) for Year 4 of the monitoring plan. Monitoring was performed during the 2001 growing season for hydrology and vegetation, consisting primarily of a comparison between hydrology model predictions, reference wetlands, and wetland restoration areas in the Bank. Subsequently, the success criteria are analyzed and verified to facilitate issuance of mitigation credit designated in the MBI at the end of Year 4 monitoring.

In the beginning of the restoration process at the Bank, extremes in weather made achieving success criteria difficult. Heavy rainfall in the winter/spring of 1998 and in the fall of 1999 created ponding over much of the site and contributed to seedling mortality. As expected, Year 2 monitoring performed in the fall of 1999 revealed low seedling survivability, and subsequent contingency measures were employed to increase survivorship. Six drainage pipes were installed to alleviate ponding and over 40,000 seedlings were planted in the winter of 2000 to increase species abundance and achieve success criteria. Because of these measures and subsequent achievement of success criteria in 2000, Year 2 and 3 credits were released and the Bank is on schedule for release of Year 4 credits.

Year 4 hydrologic monitoring at the Bank has been occurring throughout the year, with regular checks of manual and automated wells within the Bank and adjacent reference areas. Vegetation monitoring was conducted in October of 2001 and consisted of identifying woody and herbaceous species within 34 plots that are each 0.1 acre in size. After compiling and analyzing the data, it has been determined that the hydrology and vegetation success criteria identified in the mitigation plan have been achieved.

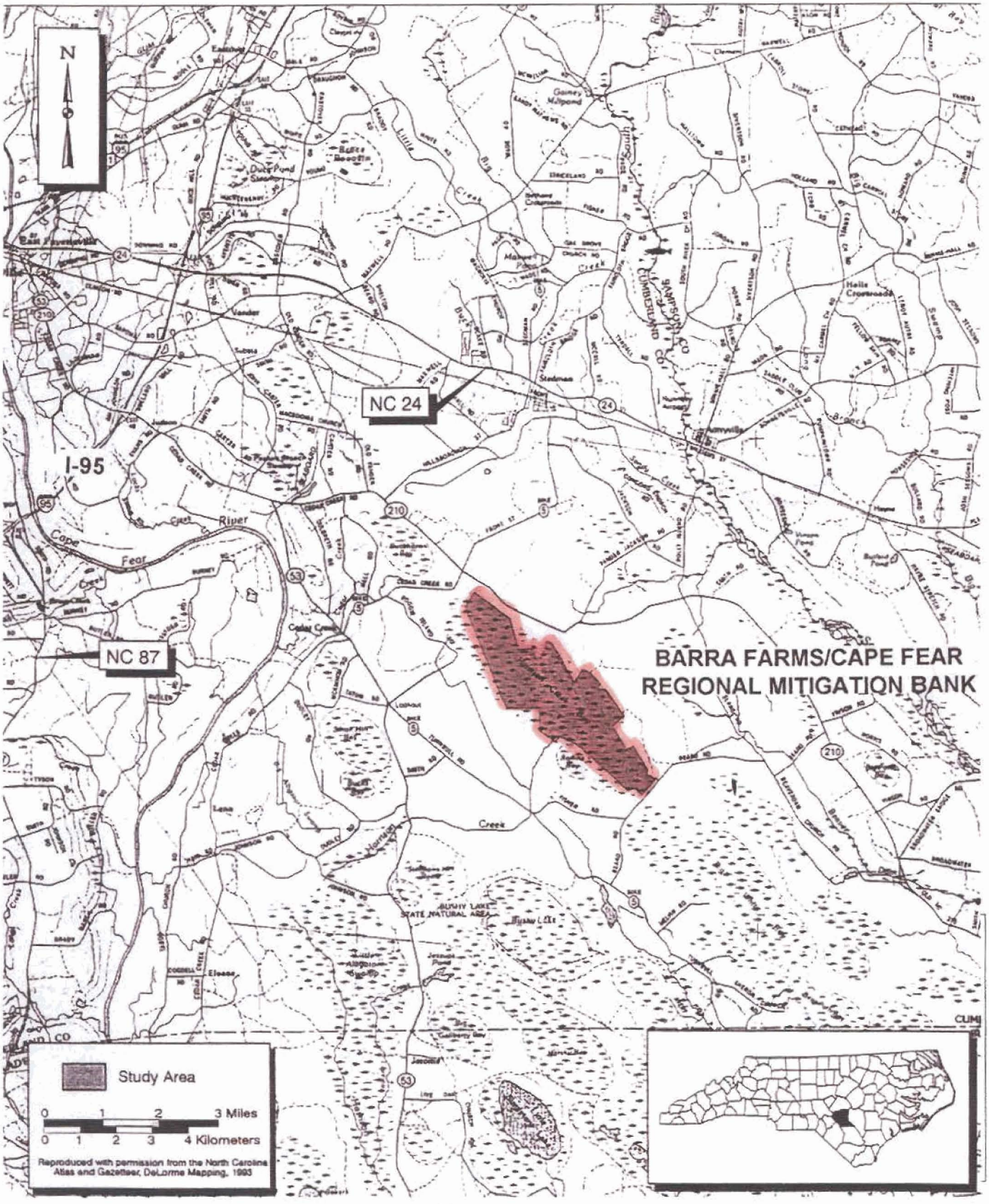

Figure 1. Vicinity Map

Barra Farms Cape Fear Regional Mitigation Bank
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Cumberland County, NC

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2.0 HYDROLOGY MONITORING

2.1 Monitoring Program

Twenty three surficial monitoring wells (manual recording) were located throughout the Barra Mitigation Bank to provide representative coverage and flow gradients extending through each of the four physiographic landscape areas: 1) uplands; 2) groundwater flats; 3) headwater slope; and 4) riverine floodplain. Figure 2 depicts the approximate location of monitoring wells in the Bank. In addition, five automated recording wells were placed on-site to provide continuous data that can be extrapolated to manual recording devices. Monitoring wells were installed and downloaded by a subcontractor in accordance with specifications in U.S. Corps of Engineers' Installing Monitoring Wells / Piezometers in Wetlands (WRP Technical Note HY-IA-3.1, August 1993). The manual monitoring wells are set to a depth of approximately 24 inches below the soil surface and had bentonite plugs to prevent surface flow introduction.

Five manual monitoring wells and two automated recording wells were placed in reference wetlands to compare hydrology between the Bank and relatively undisturbed wetlands in the region. Four wells (3 manual and 1 automated) were located in the reference groundwater flats along the northwestern periphery of the Bank. Three additional wells (2 manual and 1 automated) were located in the reference riverine wetland along Colly Creek in the Bushy Lake/Horse Shoe Lake Natural Area. These wells provided comparative annual hydroperiods within the organic soil flat and riverine floodplain physiographic areas of the site. The headwater slope physiographic area was interpolated from the two adjacent systems as described in the mitigation plan and the MBI.

Hydrological data continue to be collected at weekly intervals on-site and within the reference sites. The data extending from March 21, 2001 (1st reading within the growing season) to September 26, 2001 (last reading prior to submission of this report) have been utilized in this Year 4 monitoring report.

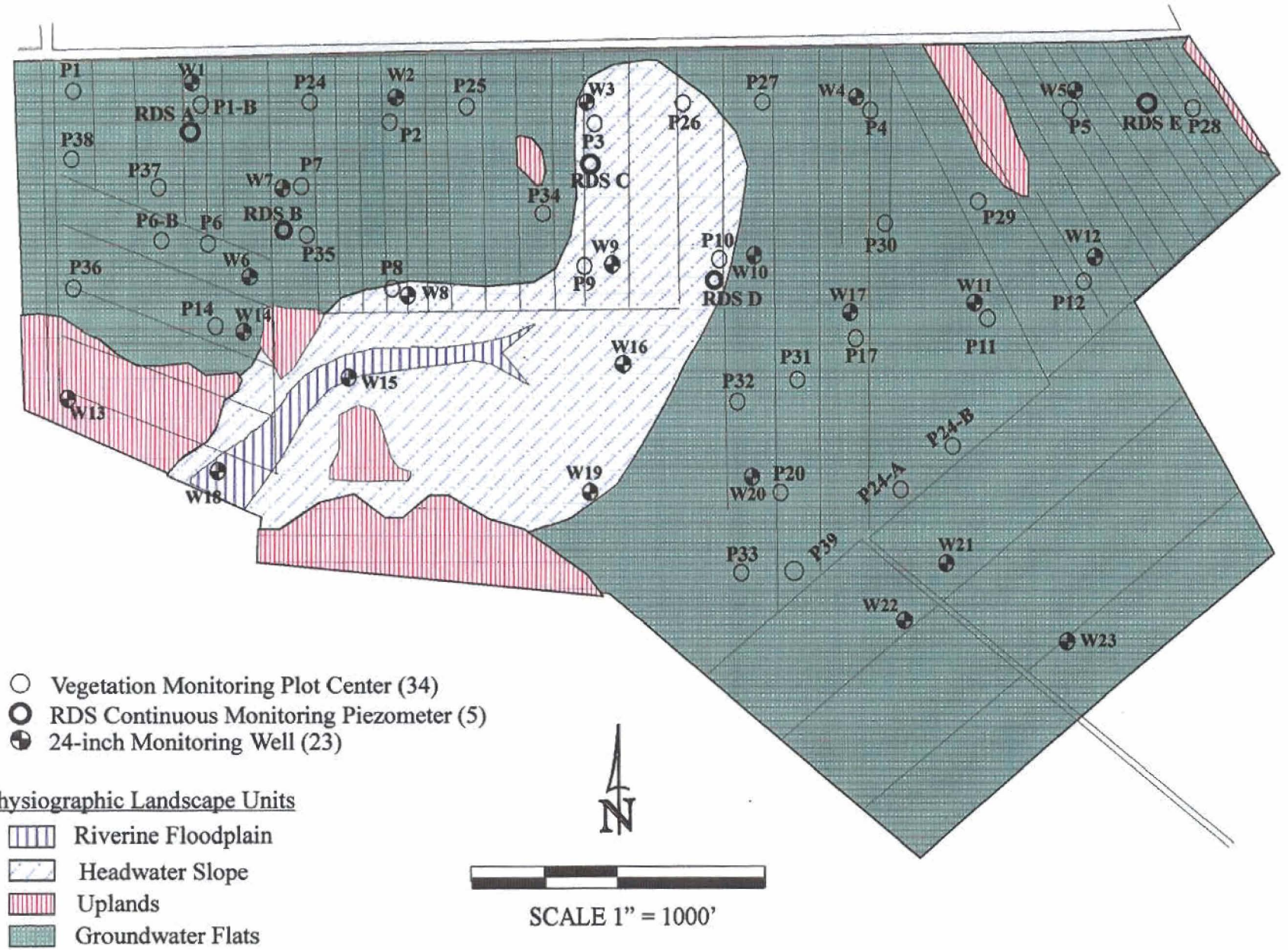

Figure 2. Plot and well locations for year 4 monitoring.

Barra Farms Cape Fear Regional Mitigation Bank
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Cumberland County, North Carolina

Land Management Group, Inc.

2.2 Monitoring Results

The raw well data are depicted in hydrograph and tabular format in Appendix B. Wetland hydrology criteria in number of consecutive days and percent of the growing season are also summarized in Table 1. Line intersection at 12 inches below the surface was used as the cut off for wetland hydrology, following the regulatory wetland criterion requiring saturation (free water) within one foot of the soil surface. As in previous years, groundwater levels were highest in early spring, followed by dry periods during summer months.

Well data have been subdivided into three wetland physiographic wetland types: 1) groundwater flats (GF); 2) headwater slopes (HS); and 3) riverine floodplains (RF).

Groundwater Flats (GF)

Three wells located within reference groundwater flats provided a general indication of the average 2001 hydroperiod on groundwater flats supporting steady state forest structure and organic soils. Data indicated that the reference groundwater flats habitat maintained wetland hydrology during 17.3% of the growing season. The automated reference well located within this same reference area recorded wetland hydrology for 19.7% of the growing season.

The groundwater flats data from the restoration wetland area had an average wetland hydrology of 17.7% of the growing season and ranged from 16.3 to 37.2% (Table 1). Year 1 and Year 2 monitoring indicated that the wetland hydrology within this habitat correlated with vegetation cover and soil organic matter content, with the wettest hydrology in areas of high organic matter and low vegetation cover and the driest hydrology in areas with mineral soil flats. Year 4 results are similar to Year 3 in that there was no significant difference between the average hydrology of former farmland and pocosin vegetation, or between that of mineral soil flats and organic soil flats. This is likely

because as more vegetation becomes established within the bank, causing evapotranspiration, hydrological differences between these areas are diminished.

The automated monitoring wells located within groundwater flats habitat at the Bank (wells A, B, and E; Figure 2) documented wetland hydrology within this habitat for 19.2%, 10.9%, and 7.5% of the growing season, respectively (Appendix B). Well B stopped reading during the growing season, when its water table was high, and most likely would have documented a longer duration of wetland hydrology had data been collected throughout this time period. (Well B stopped reading for a total of 36 days because of bear damage and has since been repaired. Please see section 2.3 for more information on automated well problems.) Data from well E were unusual and showed a somewhat flashy pattern that did not appear to correlate with rainfall. Data from this well documented a shorter wetland hydrology duration than the other wells largely because two days in April dropped slightly below 12" from the soil surface, breaking up the continuous number of days of wetland hydrology.

Riverine Floodplains (RF)

Two manual wells are located in reference riverine floodplain habitat. The data from these wells indicated that the average wetland hydrology for small stream swamps was approximately 43.1% of the growing season. The two reference hydrology wells had the same number of consecutive saturation days and therefore no difference in hydrology due to proximity of well to stream channel was noted. The automated well located in the reference riverine floodplain habitat documented wetland hydrology for 32.6% of the growing season.

Data from the two manual wells located in the restoration riverine floodplain habitat showed that wetland hydrology averaged 16.3% of the growing season. Both wells exhibited the same duration of wetland hydrology, therefore, differences in hydrology could not be correlated to proximity to the stream channel.

Headwater Slopes (HS)

Reference wetland hydrology for the headwater slope habitat was simulated by averaging wetland hydrology exhibited by adjacent riverine floodplain and groundwater flats. The average amount of time the reference headwater slope habitat met wetland hydrology was 27.6% of the growing season and ranged from 17.3% (groundwater flats) to 43.1% (riverine floodplain).

Headwater slope in the restoration wetlands supported wetland hydrology averaging 16.3% of the growing season, with all wells achieving this percentage. Unlike previous years, because all wells achieved the same hydrology percentage, hydrology did not appear to be influenced by landscape position within the headwater storage area or vegetation cover.

The automated monitoring well (well C; Figure 2) located within the headwater slope habitat recorded a wetland hydrology for 11.7% of the growing season (28 consecutive days). Well C stopped reading during the growing season (mid-April), when the water table at this location was well above the soil surface, and would likely have documented a longer duration of wetland hydrology had data been collected throughout this time period (Appendix B). (Well C stopped reading for a total of 35 days because of bear damage and has since been repaired. Please see section 2.3 for more information on automated well problems.)

2.3 Evaluation of Success Criteria

Success in the restoration of wetland hydrology in the Bank required saturation (free water) within one foot of the soil surface for at least 50% of the time the reference habitat achieved wetland hydrology. This criterion was applied separately to each of the restored habitats.

The reference groundwater flats, riverine floodplain, and headwater slope habitats exhibited wetland hydrology for a period averaging 17.3%, 43.1%, and 27.6%, respectively. In the Bank, restoration wetlands supported wetland hydrology averaging 17.7% (102% of reference), 16.3% (37.9% of reference), and 16.3% (59.1% of reference), respectively. When comparing manual wells located in the restored habitats to manual wells located in the reference areas, the groundwater flats and headwater slope habitats fulfilled the wetland hydrology criterion, however, the riverine floodplain habitat did not. This appears to be due to an exceptionally long wetland hydrology duration exhibited by the reference riverine manual wells. In fact, this duration is longer than that exhibited in Years 2 and 3, when rainfall was above normal for the area (see Appendix B for a comparison of rainfall during Years 3 and 4). However, the restored riverine area still surpasses ACOE wetland hydrology standards of being within 12" of the soil surface for at least 12% of the growing season (restored riverine wells documented wetland hydrology for 16.3% of the growing season). In addition, data from the manual wells located within the restored riverine habitat achieved wetland hydrology for 50% of the automated reference well (36 continuous days and 72 continuous days, respectively), which is within the success criterion. Therefore, the restored riverine habitat does achieve the hydrology success criterion. The unusually long wetland hydrology exhibited by the manual wells located in the reference riverine habitat may be a result of riverine bleed out and artesian effect as seasonal surface flow changes. Also, evapotranspiration may be reduced in this forested area due to cooler temperatures exhibited this year.

Automated wells are dependable and accurate ways of recording hydrology. It should be noted, however, that it has become increasingly difficult to keep the automated wells at the Bank functioning continuously because of black bears in the area. They use these wells as scratching posts and often chew the caps off of the tops of the wells. In fact, the well located near plot 10 (well D) has been replaced three times this year because a bear has broken it; the last time completely snapping it in two (Appendix F). A subcontractor reads

both the manual and automated wells frequently and repairs any problems promptly. However, gaps in the data do occasionally occur. Most of the gaps that have occurred in data at the Bank are due to natural circumstances that actually demonstrate that the mitigation site is providing habitat for wildlife.

Table 1. Summary of 2001 hydrology monitoring data at the Bank.

Well Number	Maximum Consecutive Saturation Days	Percent of Growing Season (Saturat'n Days/239)	Comments
Groundwater Flats			
Restored Wetland			
W1	39	16.3	former farmland (FF)
W2	46	19.2	FF
W4	89	37.2	FF
W5	39	16.3	FF, mineral soil flat
W6	39	16.3	FF, mineral soil flat
W7	39	16.3	FF
W10	39	16.3	FF
W11	39	16.3	FF
W12	39	16.3	FF, mineral soil flat
W14	39	16.3	FF, mineral soil flat
W17	54	22.6	FF, located on fill material in backfilled ditch
W20	54	22.6	FF
W21	39	16.3	Existing pocosin vegetation (PV), end organic soil flat (targeted swamp forest community)
W22	39	16.3	PV
W23	39	16.3	PV
Average	**42.2**	**17.7**	Range: 16.3-37.2%
Reference Wetland			
JB1	39	16.3	Existing forest vegetation (FV), mineral soils
JB2	39	16.3	FV, organic soils
JB3	46	19.2	FV, organic soils
Average	**41.3**	**17.3**	Range: 16.3-19.2%

Table 1 continued. Summary of 2001 hydrology monitoring data at the Bank.

Well Number	Maximum Consecutive Saturation Days	Percent of Growing Season (Saturat'n Days/239)	Comments
Riverine Floodplain			
Restored Wetland			
W15	39	16.3	existing forest vegetation (FV), upstream reach, outer floodplain
W18	39	16.3	FV, downstream terminus, inner floodplain
Average	**39**	**16.3**	Range: none
Reference Wetland			
SS1	103	43.1	FV, outer floodplain
SS2	103	43.1	FV, inner floodplain
Average	**103**	**43.1**	Range: none
Headwater Slope			
Restored Wetland			
W3	39	16.3	Former farmland (FF), upper reaches
W8	39	16.3	FV, interior slope
W9	39	16.3	FF, interior slope
W16	39	16.3	FV, interior slope
W19	39	16.3	existing pocosin vegetation (PV), upper reaches
Average	**39**	**16.3**	Range: none
Reference hydroperiod*	**66**	**27.6**	Average of riverine and groundwater flats

* The reference hydroperiod for the headwater slope physiographic area is calculated as the average hydroperiod exhibited by both the groundwater and riverine floodplain reference wells.

3.0 VEGETATION MONITORING

3.1 Monitoring Program

Quantitative sampling of vegetation was conducted in October of 2001 and was similar to the sampling performed in 1999 and 2000. Thirty-four plots that were each 0.1-acre in size were sampled resulting in 3.4 total acres of former cropland being surveyed (Figure 2). The center of each plot has been permanently established with a labeled, white polyvinyl chloride (PVC) pipe marked with orange flagging. The coordinates of each of these plot centers has been identified with a global positioning system (GPS) unit.

Plot centers are located within two community types at the Bank: groundwater flats habitat, which represents 324 acres, and headwater slope habitat, which comprises approximately 38 acres. No plots are located within the riverine habitat since none of this habitat type was formerly cropland. Twenty-nine plots are located within the groundwater flats and 5 plots are located within the headwater slope.

At each plot center, woody species within a 37.2-foot radius of the plot center were flagged, identified, and measured for height. Diameter at breast height (DBH) measurements equal to or greater than one inch were also recorded. In most cases, clumps of multiple black willow (*Salix nigra*) stems originating from a common root source were counted as a single stem. Although differences between the two *Nyssa* species that were planted (*Nyssa biflora* and *Nyssa aquatica*) are beginning to appear, such as leaf size and serrations, we continued to group them into one category because these differences were still difficult to distinguish in most seedlings.

Herbaceous vegetation at each plot was recorded and assigned to one of seven cover classes: 1 = 0-0.5%, 2 = 0.5-1%, 3 = 1-3%, 4 = 3-15%, 5 = 15-33%, 6 = 33-66%, 7 = 66-99%. Cover classes for all species were determined by visually estimating the area of

ground surface covered by its vertical projection.

3.2 Monitoring Results

Herbaceous Vegetation

During Year 4 monitoring, a total of 21 herbaceous species were identified within the 34 sample plots (Appendix C). As in previous years, the most common were woolgrass (*Scirpus cyperinus*), goldenrod (*Solidago spp.*) and broomsedge (*Andropogon virginicus*). The headwater slope and wetter groundwater flats plots, located within the center of the site, contained dense stands of woolgrass. The drier plots, located at the western and eastern ends of the site, supported more aster, goldenrod, and panic grass. Broomsedge was found throughout the Bank in areas not exceptionally wet or dry.

Groundwater Flats

Within the groundwater flats habitat, 28 woody species were surveyed among the 29 plots. Of the 28 species, 20 were tree species and 8 were shrub species. Of the tree species, 12 were planted and 8 were volunteer. All shrubs were volunteer. Most common tree species included red maple (*Acer rubrum*), bald cypress (*Taxodium distichum*), swamp tupelo and/or water tupelo (*Nyssa biflora, N. aquatica*), and black willow (*Salix nigra*).

The vegetation observed within groundwater flats averaged 940.0 stems/acre with approximately 260.4 stems/acre from planted species. When using the number of trees/acre by species that can be applied to the stems/acre criterion (≤ 20% of 320 stems/acre for hardwoods and ≤ 10% of 320 stems/acre for softwoods), the total number of trees that can be counted per acre was 393.4 (see Table 3, column 5).

Headwater Slope

A total of 13 woody species was identified within this habitat, of which 8 were planted and 5 were volunteer. The most common tree species included red maple (*Acer rubrum*), black

willow (*Salix nigra*), and swamp tupelo and /or water tupelo (*Nyssa biflora, N. aquatica*). Density averaged 1746.0 stems/acre, with 282.0 stems/acre resulting from planted species. When success criteria percentages were used (≤ 20% of 320 stems/acre for hardwoods and ≤ 10% of 320 stems/acre for softwoods), the total number of trees that can be counted per acre was 378.0 (see Table 4, column 5).

3.3 Evaluation of Success Criteria

Success criteria for the Barra Farms Mitigation Plan included a minimum mean density of 320 characteristic trees/acre. At least five character tree species must be present, and no hardwood species can comprise more than 20 percent of the 320 stems/acre (64 stems). Softwood species cannot comprise more than 10 percent of the 320 stems/acre (32 stems).

Several plots within both the groundwater flats habitat (P7, P32, and P35) and the headwater slope habitat (P8) contained an abundance of red maple stems, which elevated the average number of maple stems well above 20% of the total number of stems. These plots are located near the forest edge, where the seedlings are growing opportunistically in areas of open sunlight. Because maple numbers are continuing to increase in certain areas, the effect that these seedlings have on planted species was evaluated by comparing vegetation data in 2000 and 2001, specifically the number of trees observed in each plot and the average height of each species in both years (Appendix D). As is shown from these data, although a few plots continue to support large amounts of maple, this species is not inhibiting the number or height of planted species. In fact, the average height of most planted species within these plots continues to increase. Observations made in plots that support many maple seedlings demonstrate that they are growing in place of herbaceous vegetation and are having no greater effect on planted trees than any other herbaceous species. Furthermore, research has shown that red maple is a typical component of early successional forest regeneration of a bay forest community type (Sharitz and Gibbons, 1982).

When evaluating the success criteria, only 20% of the 320 stems/acre criterion (64 stems) was used for maple or any other hardwood that exceeded this value. Only 10% of the 320 stems/acre criterion was used for softwood species.

Tables 2 and 3 show the number of trees/acre by species that can be applied to the stems/acre criterion. For groundwater flats, a mean density of 940.0 stems/acre was found across 26 character wetland species, with an average of 6.4 tree species/plot. An average of 393.4 stems/acre can be applied to the vegetation success criterion. In the headwater slope habitat, a mean density of 1746.0 stems/acre was found across 13 wetland species, with an average of 7.0 tree species/plot. An average of 378.0 stems/acre in this habitat can be applied to the vegetation success criterion. Therefore, both of these wetland community types meet the vegetation success criteria.

Table 2. Woody species found in groundwater flats habitat, average number of trees/acre, and the number of trees allowed in success criteria.

Common name	Scientific Name	Avg # of trees/ acre	% of total # of trees/ac	# trees/ac allowed in criteria	Comments
Red Maple	*Acer rubrum*	427.2	45.4	64	Volunteer hardwood; three plots had many seedlings (see Appendix D)
Winged Sumac	*Rhus copallina*	157.9	16.8	32	Volunteer softwood; mostly from 2 plots
Bald Cypress	*Taxodium distichum*	89.0	9.5	64	Planted hardwood
Swamp/ Water Tupelo	*Nyssa spp.*	76.9	8.2	76.9	Planted hardwood
Black Willow	*Salix nigra*	64.5	6.9	32	Volunteer softwood
Overcup Oak	*Quercus lyrata*	24.8	2.6	24.8	Planted hardwood
Willow Oak	*Quercus phellos*	24.1	2.6	24.1	Planted hardwood
Atlantic White Cedar	*Chamaecyparis thyoides*	14.5	1.5	14.5	Planted
Sweetgum	*Liquidambar styraciflua*	13.8	1.5	13.8	Volunteer hardwood
Red Bay	*Persea borbonia*	12.1	1.3	12.1	Volunteer softwood
Pond Pine	*Pinus serotina*	6.9	0.7	6.9	Planted softwood
Swamp Chestnut Oak	*Quercus michauxii*	6.2	0.6	6.2	Planted hardwood
Green Ash	*Fraxinus pennsylvanica*	4.5	0.5	4.5	Planted hardwood
Water Oak	*Quercus nigra*	4.5	0.5	4.5	Planted hardwood
Longleaf Pine	*Pinus palustris*	3.5	0.3	3.5	softwood
Pond Cypress	*Taxodium ascendens*	2.4	0.3	2.4	Planted hardwood
Loblolly Pine	*Pinus taeda*	2.1	0.2	2.1	Volunteer softwood
Eastern Sycamore	*Platanus occidentalis*	1.7	0.2	1.7	Planted hardwood
Tulip Poplar	*Liriodendron tulipifera*	1.4	0.1	1.4	Planted hardwood
Cottonwood	*Populus heterophylla*	1.0	0.1	1.0	Volunteer hardwood
Unknown (no leaves)		1.0	0.1	1.0	No leaves, but stem alive
TOTAL		**940.0**	**100**	**393.4**	

Table 3. Woody species found in headwater slope habitat, average number of trees/acre, and the number of trees allowed in success criteria.

Common name	Scientific Name	Average # of trees/ acre	% of total # of trees/ac	% of total / ac allowed in criteria	Comments
Red Maple	*Acer rubrum*	1300.0	74.4	64	Volunteer hardwood; one plot had many seedlings (see Appendix D)
Swamp/Water Tupelo	*Nyssa spp.*	158.0	9.0	128	Planted hardwood
Black Willow	*Salix nigra*	134.0	7.7	32	Volunteer softwood
Bald Cypress	*Taxodium distichum*	64.0	3.7	64	Planted hardwood
Overcup Oak	*Quercus lyrata*	28.0	1.6	28	Planted hardwood
Loblolly Pine	*Pinus taeda*	18.0	1.0	18	Volunteer softwood
Green Ash	*Fraxinus pennsylvanica*	14.0	0.8	14	Planted hardwood
Atlantic White Cedar	*Chamaecyparis thyoides*	8.0	0.4	8	hardwood
Swamp Cottonwood	*Populus heterophylla*	6.0	0.3	6	hardwood
Sweetgum	*Liquidambar styraciflua*	6.0	0.3	6	hardwood
Eastern Sycamore	*Platanus occidentalis*	4.0	0.2	4	Planted hardwood
Willow Oak	*Quercus phellos*	4.0	0.2	4	Planted hardwood
Pond Pine	*Pinus serotina*	2.0	0.1	2	Planted softwood
TOTAL		**1746**	**100**	**378**	

4.0 WETLAND FUNCTIONAL ATTRIBUTES AND MITIGATION CREDIT

Post-Restoration Conditions (October 2000 to October 2001)

The following is a brief summary of the conditions observed at Barra Farms Cape Fear Regional Mitigation Bank during the past year.

Species noted this past year: great blue heron (*Ardea herodias*), American kestrel (*Falco sparverius*), white-tailed deer (*Odocoileus virginianus*), quail, black bear (*Ursus americanus*) tracks, mallard (*Anas platyrhynchos*), and belted kingfisher (*Megaceryle alcyon*). In addition, many insects were observed throughout the tract including grasshoppers, dragonflies, and butterflies.

Compared to Years 1 through 3, Year 4 at the Bank has been uneventful. Rainfall has been at normal levels for a majority of the year and the tract is no longer ponded. This change was also noted in the duration of wetland hydrology across the tract, which was shorter than in previous years. Many trees throughout the tract are continuing to flourish. The average heights of most species are considerably higher than last year. The preponderance of black willow, which was noted in Years 1 and 2, has lessened considerably and other species, including red maple, winged sumac, groundsel bush, and sweet pepperbush are volunteering into the tract.

5.0 SUMMARY

Success in the restoration of wetland hydrology in the Bank required saturation (free water) within one foot of the soil surface for at least 50% of the time that the reference wetland exhibited wetland hydrology. The reference groundwater flats, riverine floodplain, and headwater slope habitats exhibited wetland hydrology for a period averaging 17.3%, 43.1%, and 27.6%, respectively. In the Bank, restoration wetlands supported wetland hydrology averaging 17.7% (102% of reference), 16.3% (37.9% of reference), and 16.3% (59.1% of reference), respectively, when comparing data from manual wells. The wetland hydrology success criterion was met for groundwater flats and headwater slope.

However, the restoration riverine floodplain habitat achieved wetland hydrology for only 37.9% of that of the reference habitat. This is due to an unusually long wetland hydrology (102 days) exhibited by the two reference wells, which was actually longer than that exhibited in Years 2 and 3, when rainfall was above normal for the area. Despite this, the manual wells located within the restored riverine habitat meet ACOE wetland hydrology success criteria (saturation within 12" of the soil surface for 12% of the growing season) and the wetland hydrology duration of the manual wells is within 50% of the automated well located within reference riverine habitat. Furthermore, hydrology within the restored riverine habitat met the hydrology success criterion in all previous years of monitoring at the Bank. Finally, the unusually long wetland hydrology exhibited by the manual wells located in the reference riverine habitat may be a result of riverine bleed out and artesian effect as the seasonal surface flow changes. Because of these reasons, it is concluded that the restored riverine floodplain habitat meets the hydrology success criterion.

The wetland vegetation success criterion was met during Year 4 monitoring. According to the mitigation plan, at least 320 trees/acre and at least five character wetland species must survive in order to meet success criteria. After factoring in acceptable percentages of hardwoods and softwoods, the groundwater flats habitat contained 448.5 stems/acre across 24 wetland species. Headwater slope habitat supported 380 stems/acre and 14 character wetland species. Although the

number of red maples in several plots within the Bank is above the 20% hardwood threshold, these maples are not inhibiting the growth or survival of planted species.

The installation of drainage pipes to alleviate ponding, along with normal weather conditions and cooler steady temperatures in 2000 and 2001, have created better growing conditions for planted vegetation. In addition, supplemental planting in the winter of 2000 increased the number of stems/acre to acceptable levels.

Year 4 monitoring found both hydrology and vegetation at the Barra Farms Cape Fear Regional Mitigation Bank to meet the success criteria stated in the mitigation plan. Therefore, the conclusion of this monitoring report is that this mitigation site is thus far successful and Year 4 credits should be released.

6.0 References

Sharitz, R.R. & J.W. Gibbons. 1982. *The Ecology of Southeastern Shrub Bogs (Pocosins) and Carolina Bays: A Community Profile*. U.S. Fish and Wildlife Service, November, 1982.

APPENDIX A:
Mitigation Credit Release Schedule

MITIGATION CREDIT RELEASE SCHEDULE

BARRA FARMS CAPE FEAR REGIONAL MITIGATION BANK

DECEMBER 1998

Task	Projected Completion Date	Percent of Credit Allotted (% cumulative)	Wetland Credit Allotted	Cumulative Wetland Credit Allotted	Stream Channel Credit Allotted	Cumulative Stream Channel Allotted
1.0 Signing of the MBI	12/1998	15 (15)	36	36	----	----
2.0 Completion of all Restoration Activities	3/1998	15 (30)	36	72	----	----
3.0 Monitoring Plan						
3.1 Year 1: Fulfill Success Criteria	11/1998	10 (40)	24	96	----	----
3.2 Year 2: Fulfill Success Criteria	11/1999	15 (55)	36	132	960	960
3.3 Year 3: Fulfill Success Criteria	11/2000	15 (70)	36	168	720	1680
3.4 Year 4: Fulfill Success Criteria	11/2001	10 (80)	24	192	240	1920
3.5 Year 5: Fulfill Success Criteria	11/2002	20 (100)	48	240	480	2400

1: Insufficient data has been collected to fulfil success criteria for the Year I AWMR. Therefore, release of stream credit will begin at the end of Year 2 monitoring as depicted when sufficient data has been collected to evaluate restoration success.

Appendix B: Wetland Hydrology Data and Hydrographs

Table B1. Wetland hydrology data for the wells located within the groundwater flats habitat at Barra Farms during 2001.

Date	Day of Growing Season	Groundwater Flats														Reference Wells		
		W1	W2	W4	W5	W6	W7	W10	W11	W12	W14	W17	W20	W21	W22	W23	JB1	JB2	JB3
3/14/01		0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-6	0-12	0-12	-7	0-12	0-12
3/21/01	4	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-4	0-12	0-12	-4	0-12	0-12
4/04/01	18	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-12	0-12	0-12	-9	-9	0-12
4/11/01	25	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-2	0-12	0-12	0-12	0-12	-8	0-12	0-12	-9	-9	0-12
4/18/01	32	0-12	-3.5	0-12	-1	0-12	0-12	0-12	-4	0-12	0-12	0-12	0-12	-8	-4	0-12	-12	-11	0-12
4/25/01	39	**0-12**	0-12	0-12	**0-12**	**0-12**	**0-12**	**0-12**	**0-12**	**0-12**	**0-12**	0-12	0-12	**-6**	**0-12**	**0-12**	**-8**	**-6.5**	0-12
5/02/01	46	>-24	**-11**	0-12	>-24	>-24	>-24	-15	>-24	>-24	>-24	-6	0-12	>-24	>-24	-18	>-24	>-24	**-10**
5/10/01	54	>-24	-17	0-12	>-24	>-24	>-24	-15	>-24	>-24	>-24	**-12**	**-6**	>-24	>-24	-23	>-24	>-24	-13
5/16/01	60	>-24	>-24	0-12	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	-15	>-24	>-24	>-24	>-24	>-24	-16
5/23/01	67	>-24	>-24	-9	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	-21	>-24	>-24	>-24	>-24	>-24	-22
6/07/01	82	>-24	>-24	-11	>-24	>-24	>-24	>-24	>-24	>-24	>-24	-16	-6	>-24	>-24	>-24	>-24	>-24	-12
6/14/01	89	>-24	>-24	**-11**	>-24	>-24	>-24	>-24	>-24	>-24	>-24	-16	-20	>-24	>-24	>-24	>-24	>-24	>-24
6/21/01	96	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	-22	-20	>-24	>-24	>-24	>-24	>-24	>-24
6/28/01	103	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
7/04/01	109	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
7/11/01	116	>-24	>-24	>-24	>-24	->-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
7/18/01	123	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
7/25/01	130	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
8/01/01	137	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
8/08/01	144	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
8/15/01	151	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
8/22/01	158	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24

Table B1 contd. Wetland hydrology data for the wells located within the groundwater flats habitat at Barra Farms during 2001.

9/5/01	172	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
9/12/01	179	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
9/19/01	186	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
9/26/01	193	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24

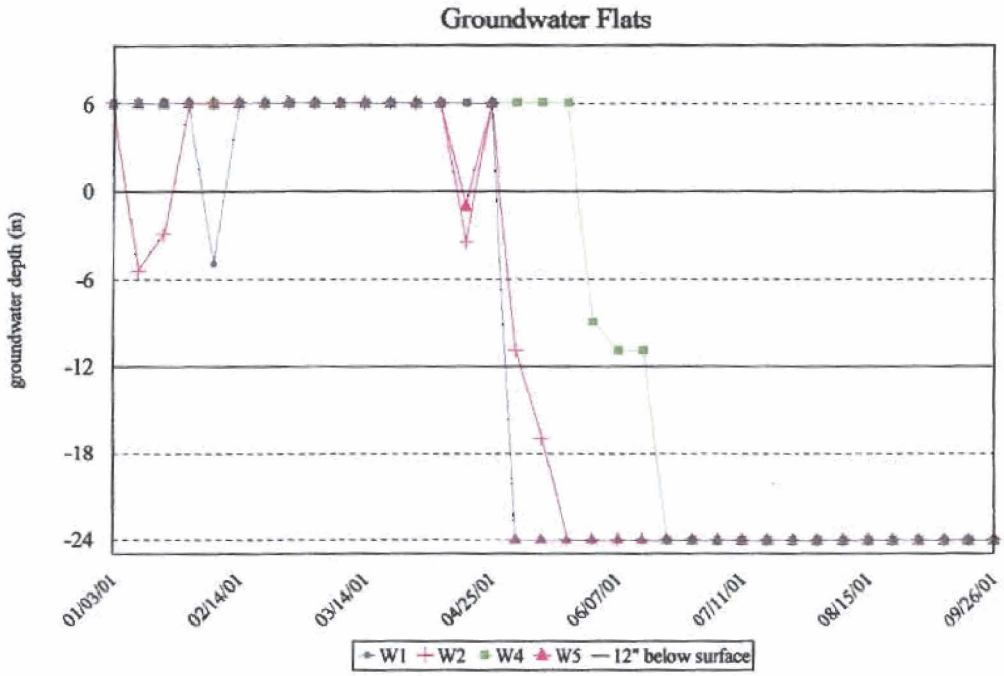
Table B2. Wetland hydrology data for wells located within the riverine floodplain, riverine reference, headwater slope, and upland habitats during 2001.

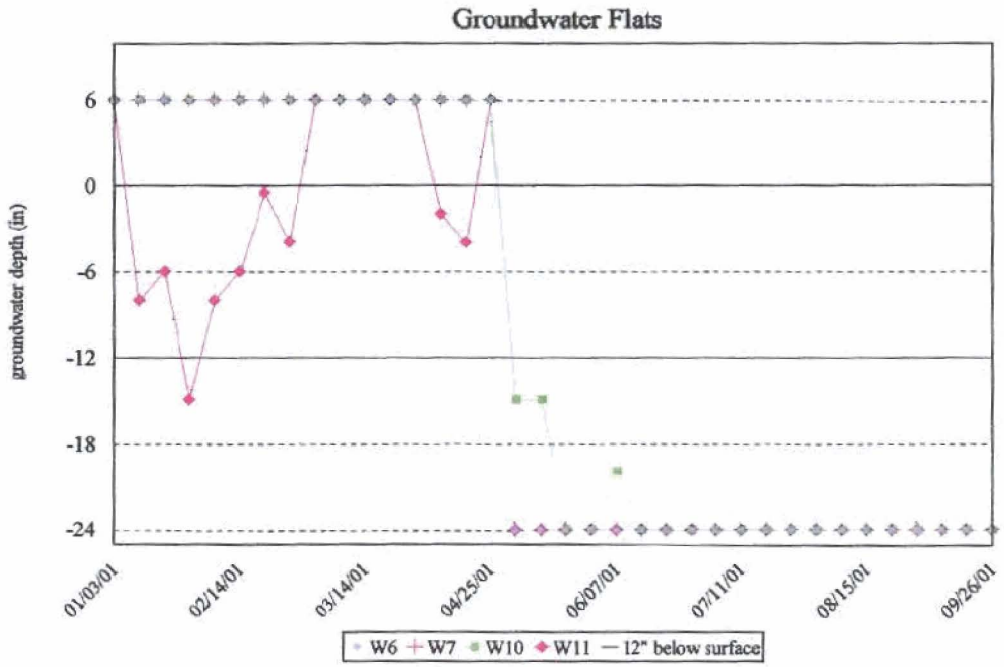
	Day of Growing Season	Riverine Floodplain		Riverine Reference		Headwater Slope					Upland
		W15	W18	SS1	SS2	W3	W8	W9	W16	W19	W13
3/14/01	--	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-12
3/21/01	4	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-7.5
4/04/01	18	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-9
4/11/01	25	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-15.5
4/18/01	32	-5.5	0-12	0-12	0-12	0-12	0-12	0-12	0-12	0-12	-17
4/25/01	39	**0-12**	**0-12**	0-12	0-12	**0-12**	**0-12**	**0-12**	**0-12**	**0-12**	-12
5/02/01	46	>-24	>-24	0-12	0-12	>-24	>-24	>-24	>-24	>-24	>-24
5/10/01	54	>-24	>-24	0-12	0-12	>-24	>-24	>-24	>-24	>-24	>-24
5/16/01	60	>-24	>-24	0-12	-3	>-24	>-24	>-24	>-24	>-24	>-24
5/23/01	67	>-24	>-24	-5	-8	>-24	>-24	>-24	>-24	>-24	>-24
6/07/01	82	>-24	>-24	0-12	0-12	>-24	>-24	>-24	>-24	>-24	>-24
6/14/01	89	>-24	>-24	0-12	0-12	>-24	>-24	>-24	>-24	>-24	>-24
6/21/01	96	>-24	>-24	0-12	0-12	>-24	>-24	>-24	>-24	>-24	>-24
6/28/01	103	>-24	>-24	**0-12**	**0-12**	>-24	>-24	>-24	>-24	>-24	>-24
7/04/01	109	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
7/11/01	116	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
7/18/01	123	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
7/25/01	130	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
8/01/01	137	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
8/08/01	144	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
8/15/01	151	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24

Table B2 contd. Wetland hydrology data for wells located within the riverine floodplain, riverine reference, headwater slope, and upland habitats during 2001.

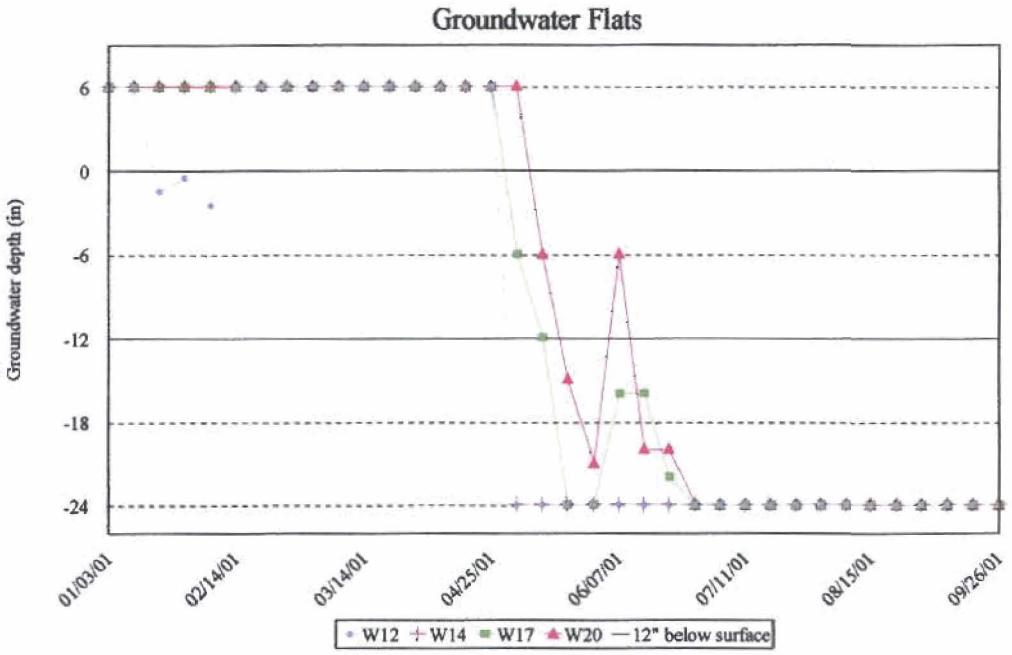
8/22/01	158	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
9/05/01	172	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
9/12/01	179	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
9/19/01	186	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24
9/26/01	193	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24	>-24

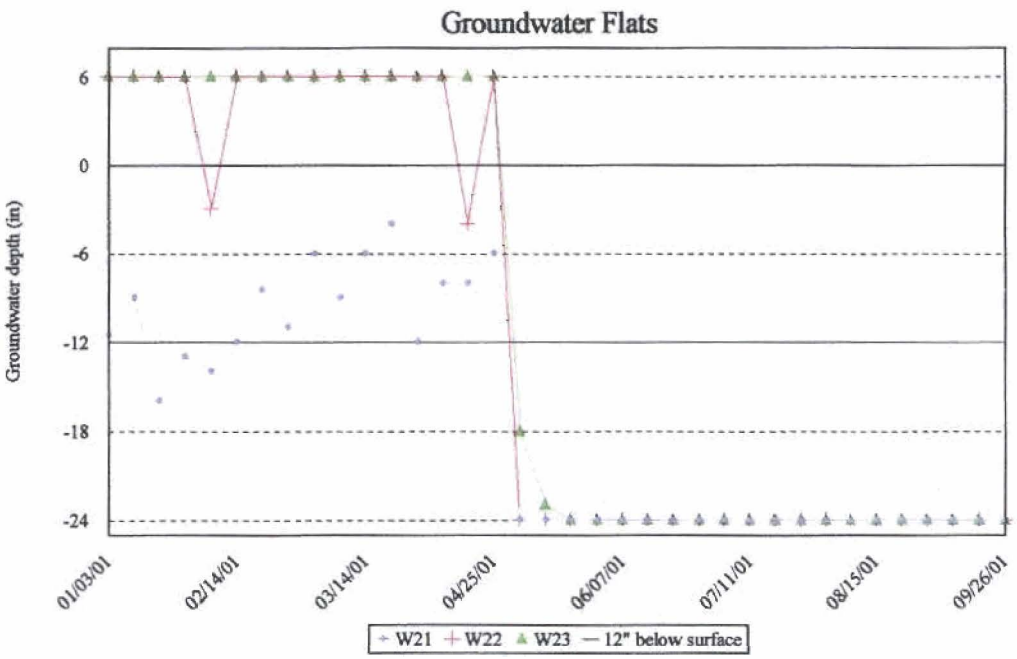
Hydrographs for Manual Wells at Barra Farms: 2001



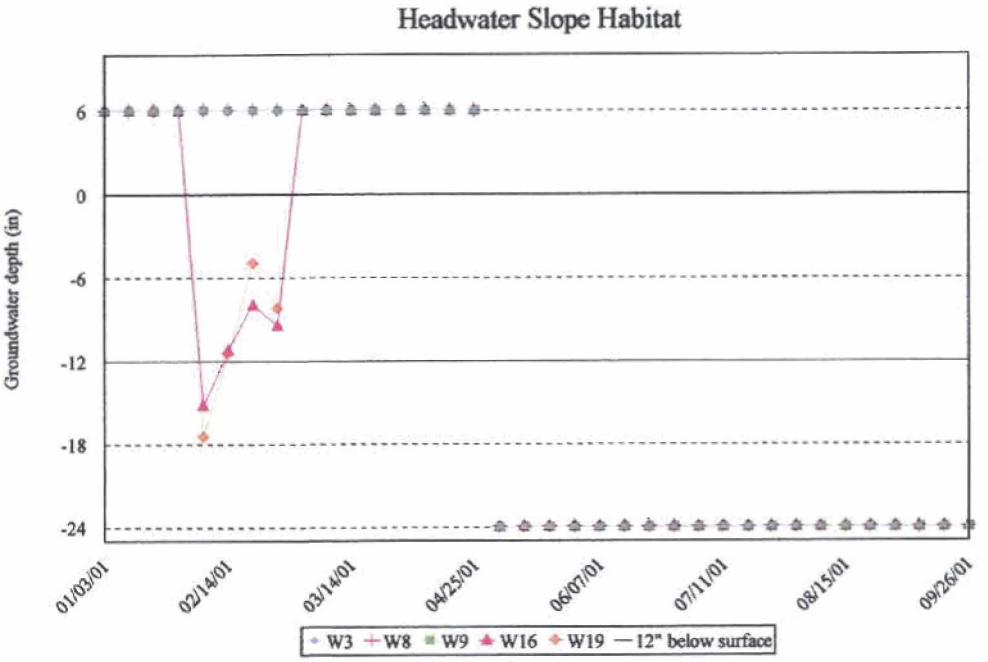


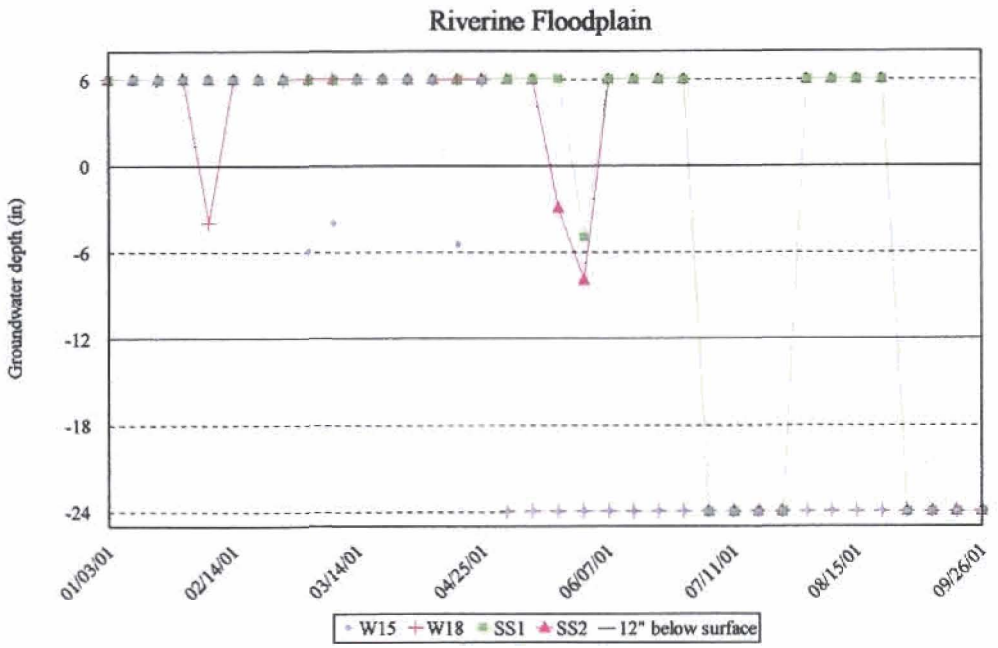
Hydrographs for Manual Wells at Barra Farms: 2001, contd.



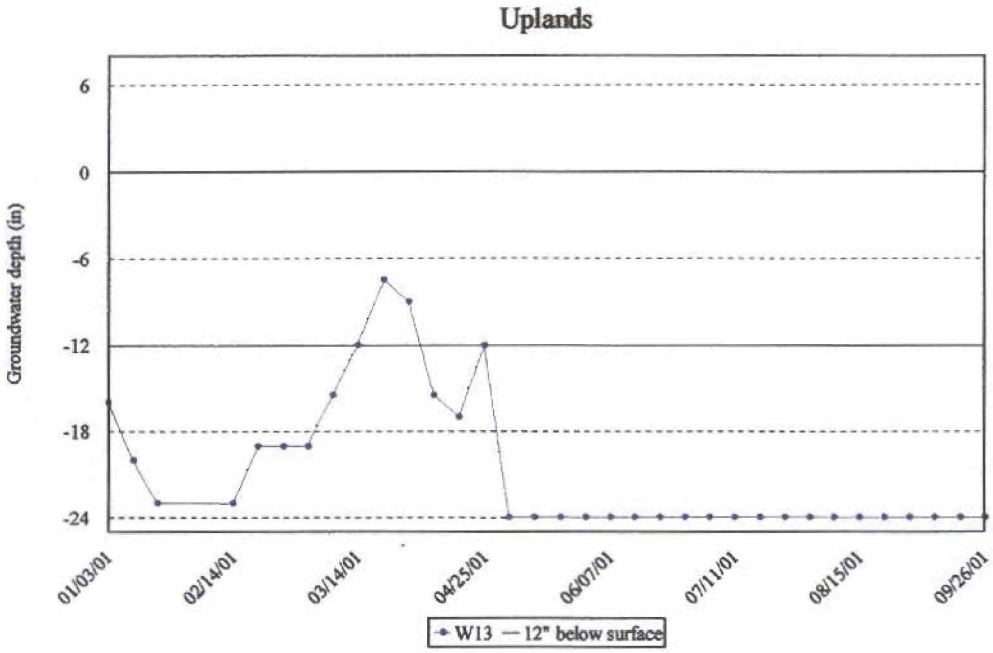


Hydrographs for Manual Wells at Barra Farms: 2001, contd.





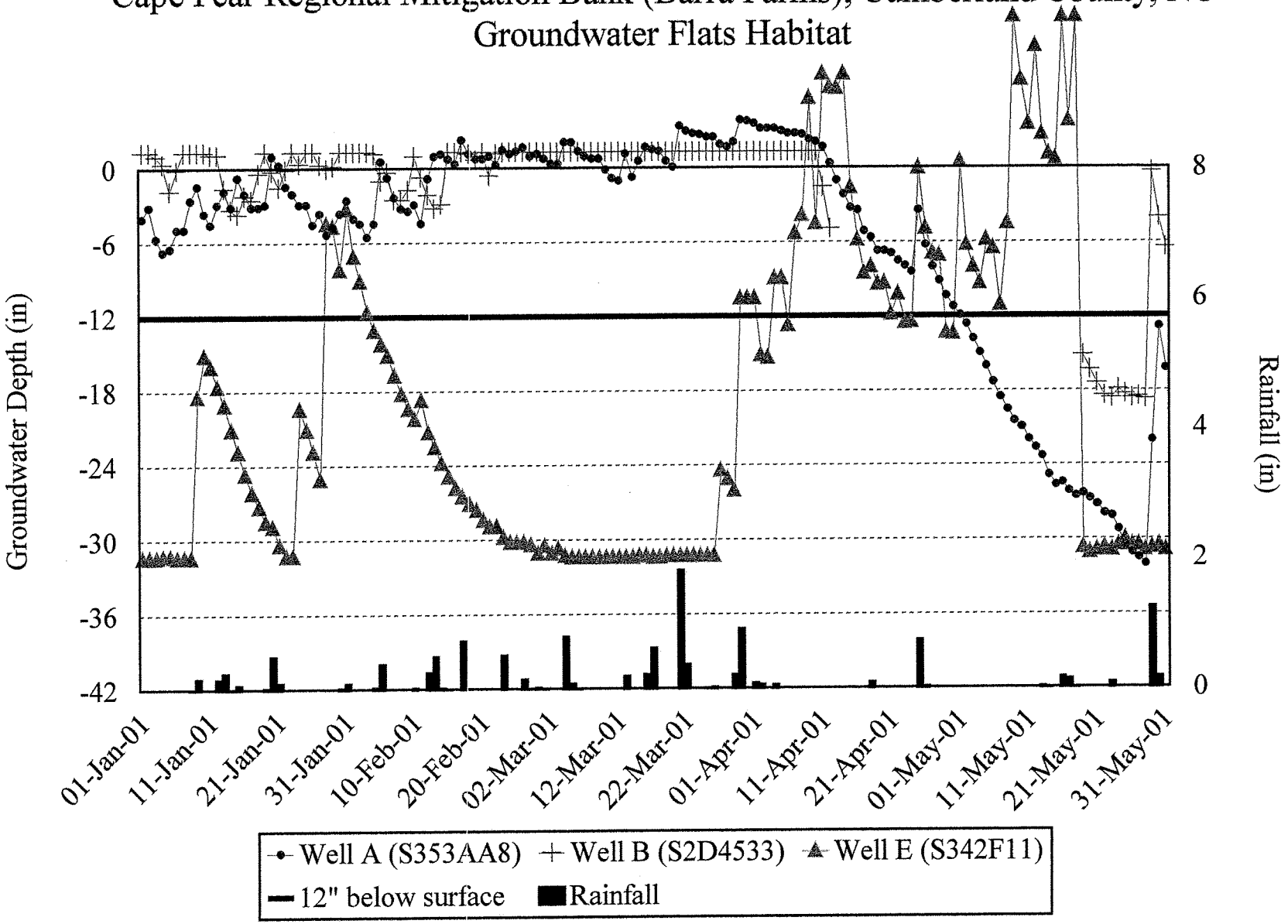
Hydrographs for Manual Wells at Barra Farms: 2001, contd.



Automated Monitoring Well Data for 2001

Cape Fear Regional Mitigation Bank (Barra Farms), Cumberland County, NC

Groundwater Flats Habitat



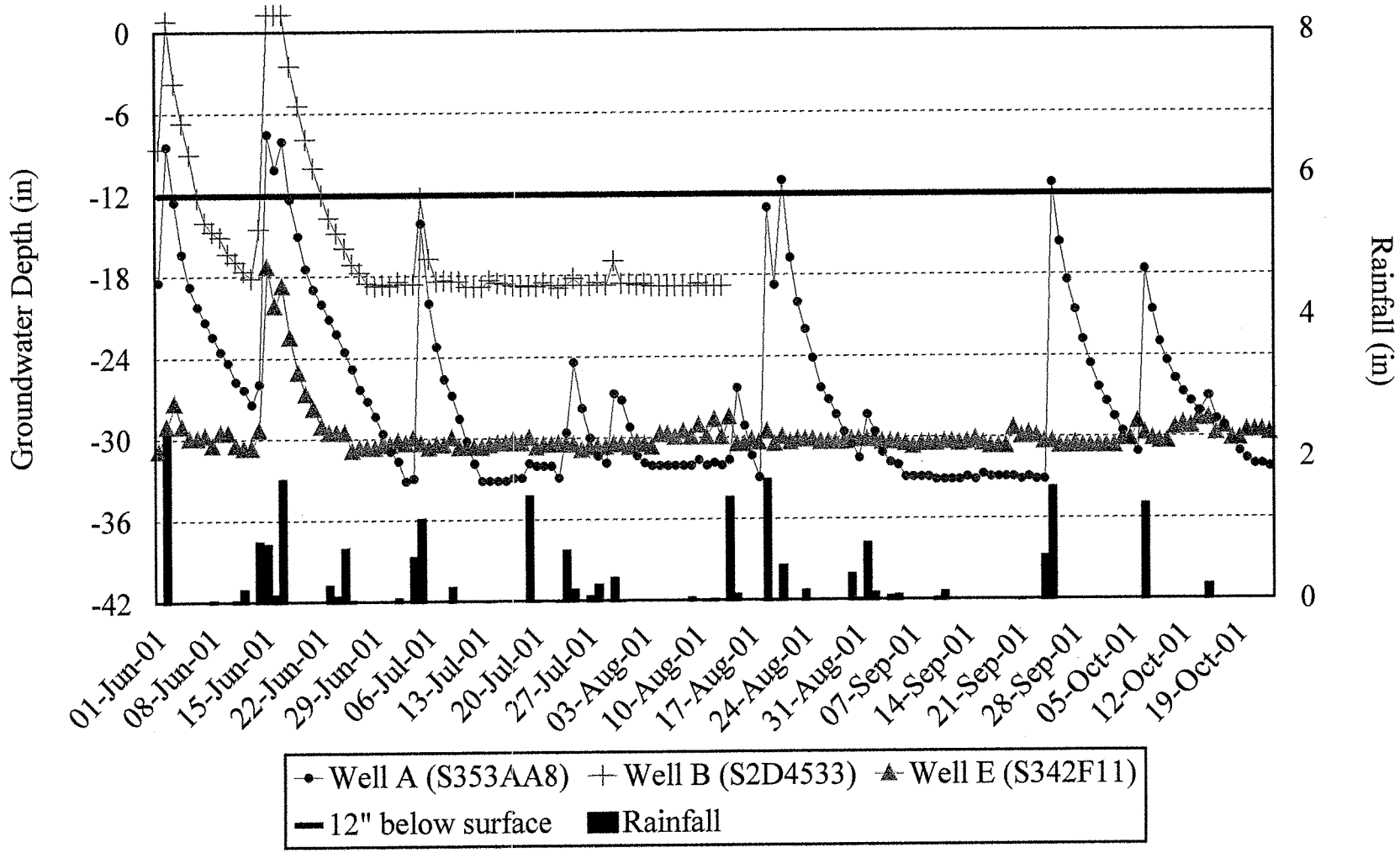
Rainfall data provided by Public Works Commission, Fayetteville, NC.
Cross Creek Site.

Note: 1 reading/day

Automated Monitoring Well Data for 2001

Cape Fear Regional Mitigation Bank (Barra Farms), Cumberland County, NC

Groundwater Flats Habitat



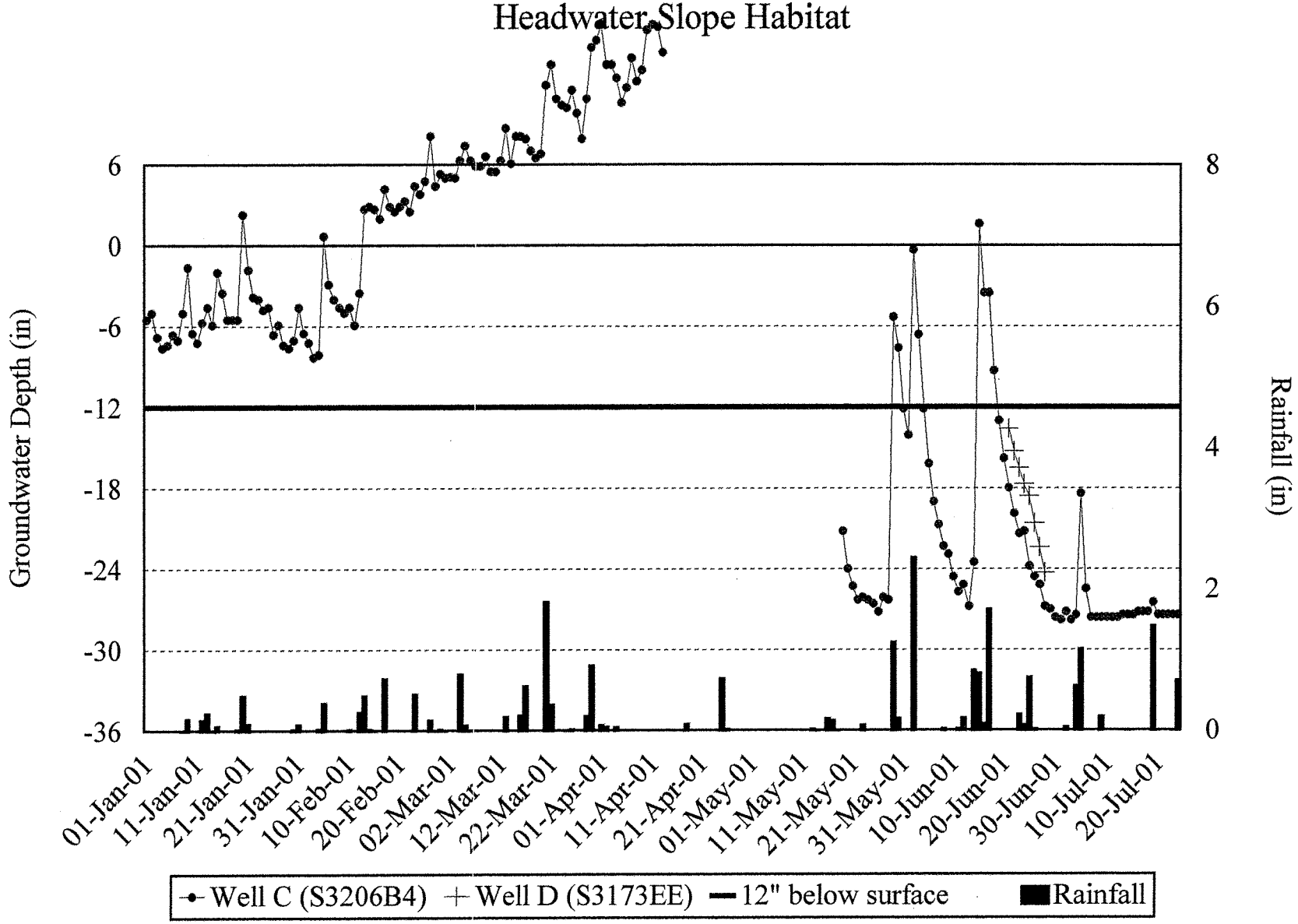
Rainfall data provided by Public Works Commission, Fayetteville, NC.
Cross Creek Site.

Note: 1 reading/day

Automated Monitoring Well Data for 2001

Cape Fear Regional Mitigation Bank (Barra Farms), Cumberland County, NC

Headwater Slope Habitat



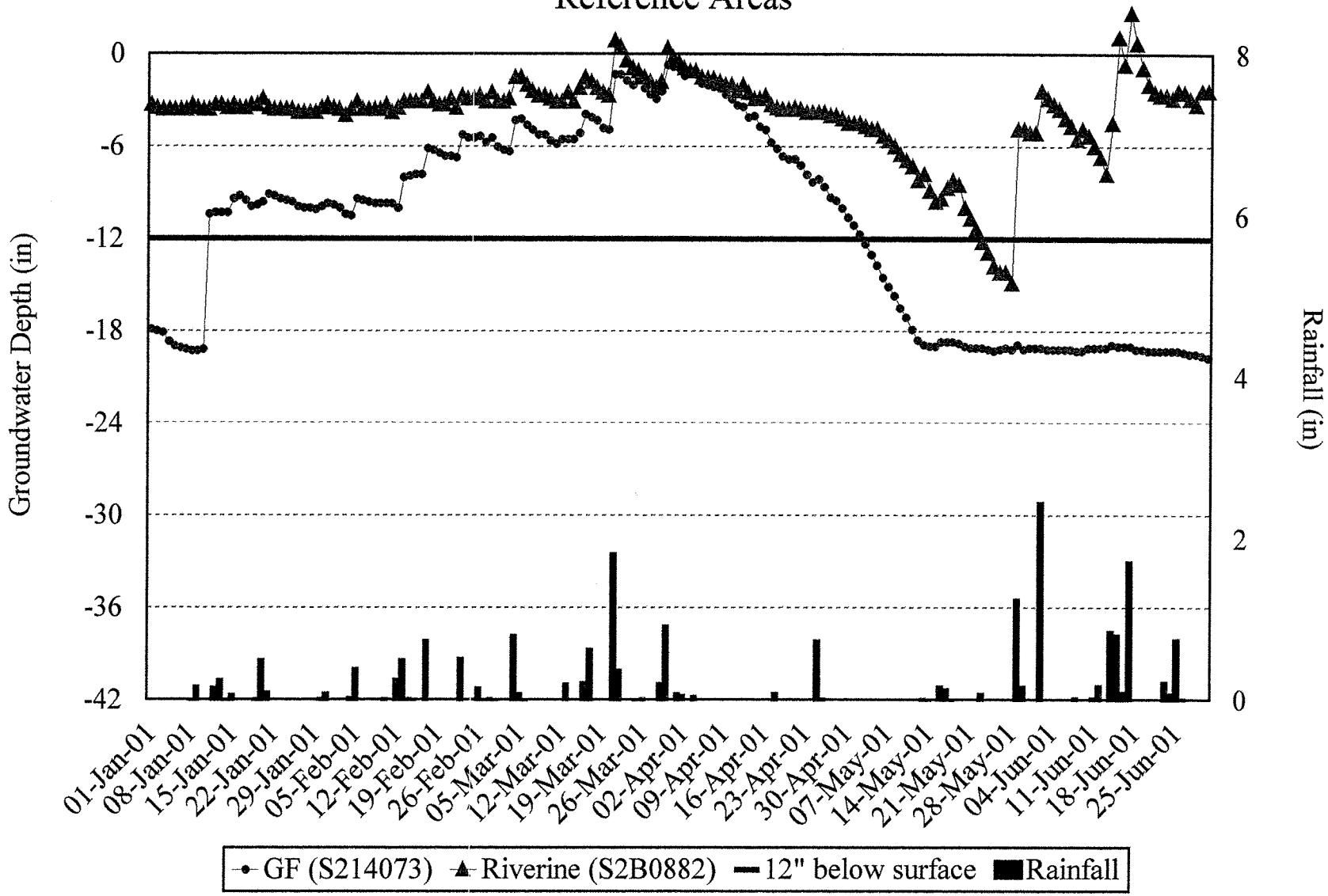
Rainfall data provided by Public Works Commission, Fayetteville, NC.
Cross Creek Site.

Note: 1 reading/day

Automated Monitoring Well Data for 2001

Cape Fear Regional Mitigation Bank (Barra Farms), Cumberland County, NC

Reference Areas



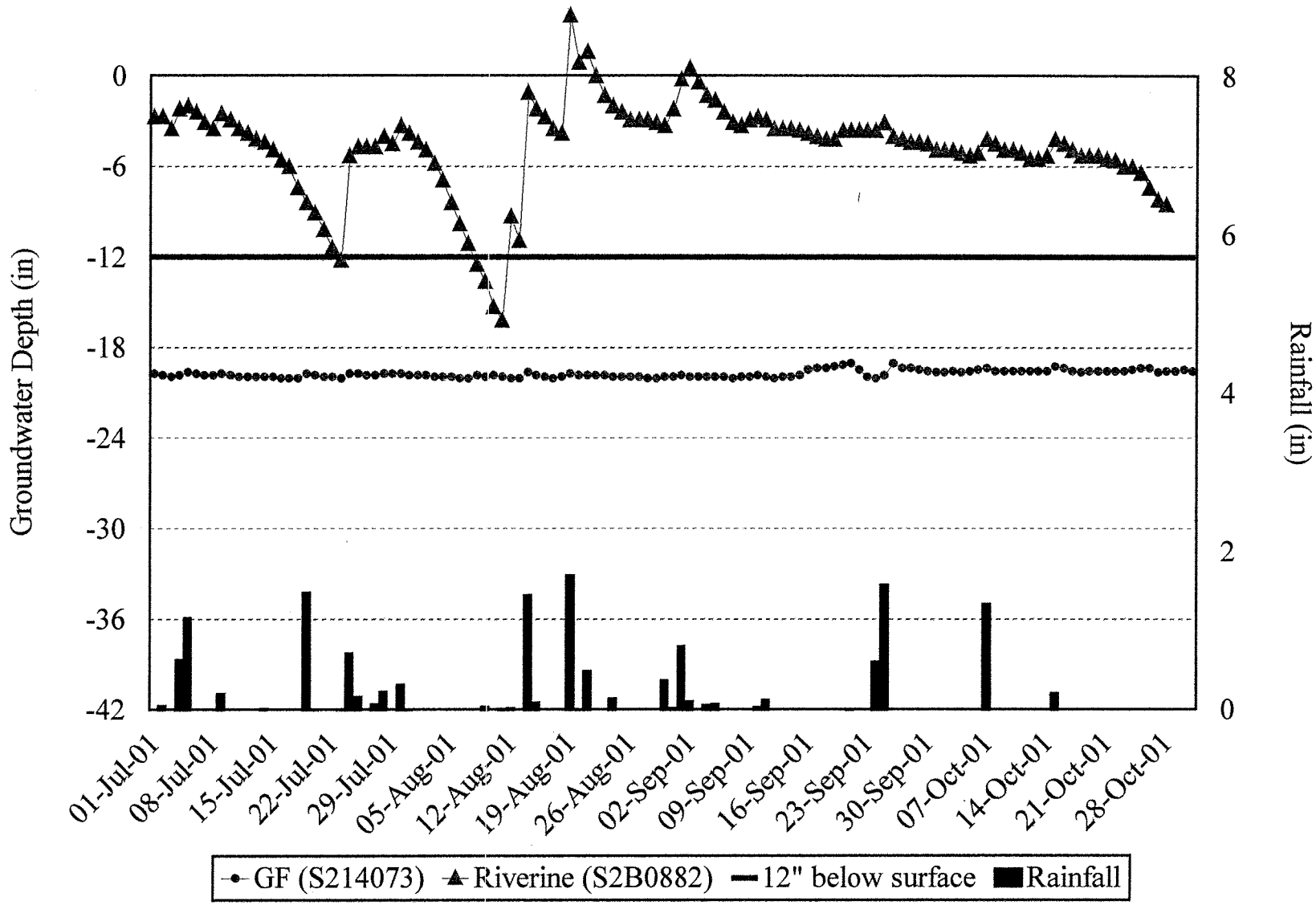
Rainfall data provided by Public Works Commission, Fayetteville, NC.
Cross Creek Site.

Note: 1 reading/day

Automated Monitoring Well Data for 2001

Cape Fear Regional Mitigation Bank (Barra Farms), Cumberland County, NC

Reference Areas



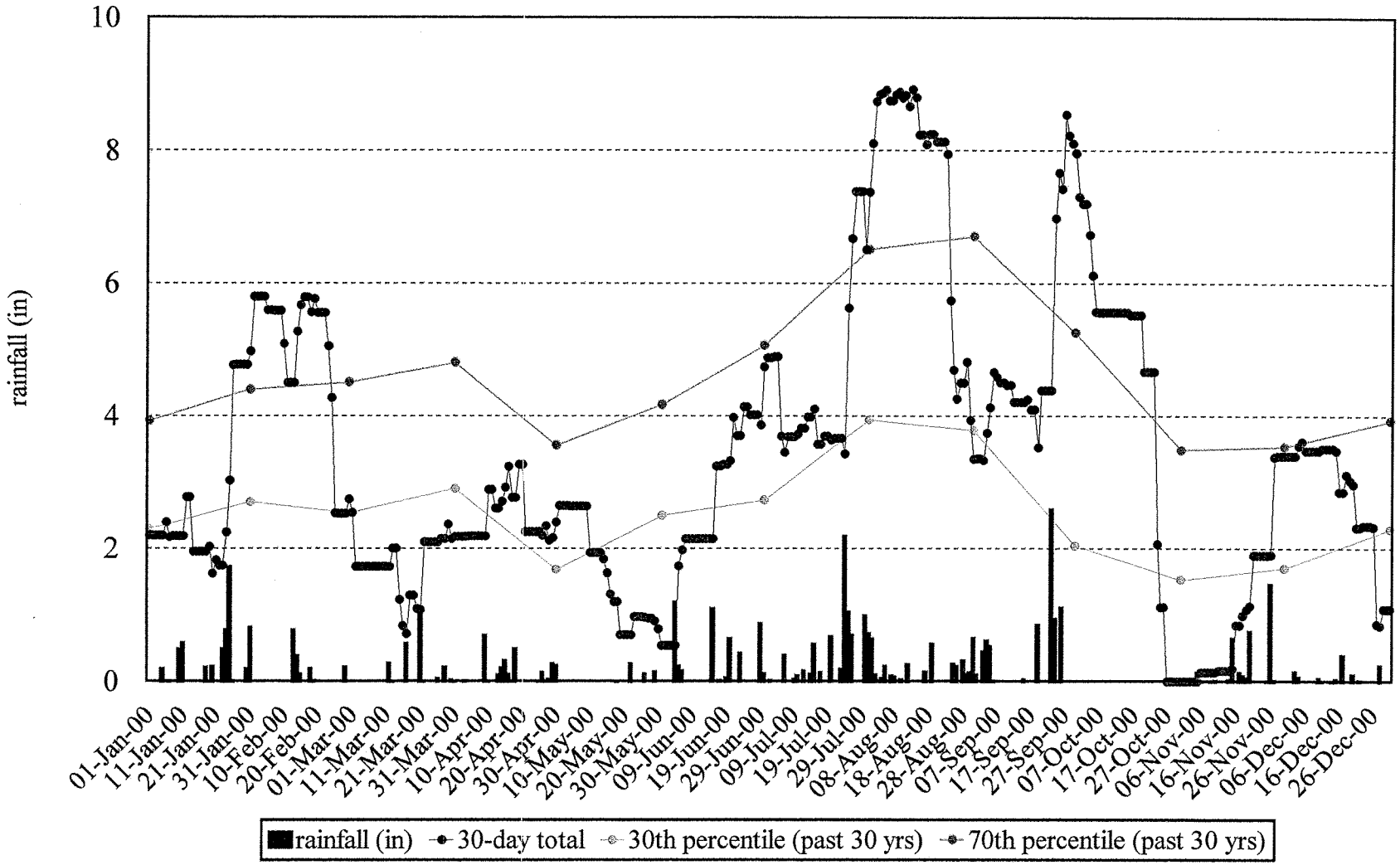
Rainfall data provided by Public Works Commission, Fayetteville, NC.
Cross Creek Site.

Note: 1 reading/day

Rainfall Analysis

2000

Cape Fear Regional Mitigation Bank (Barra Farms), Cumberland County, NC

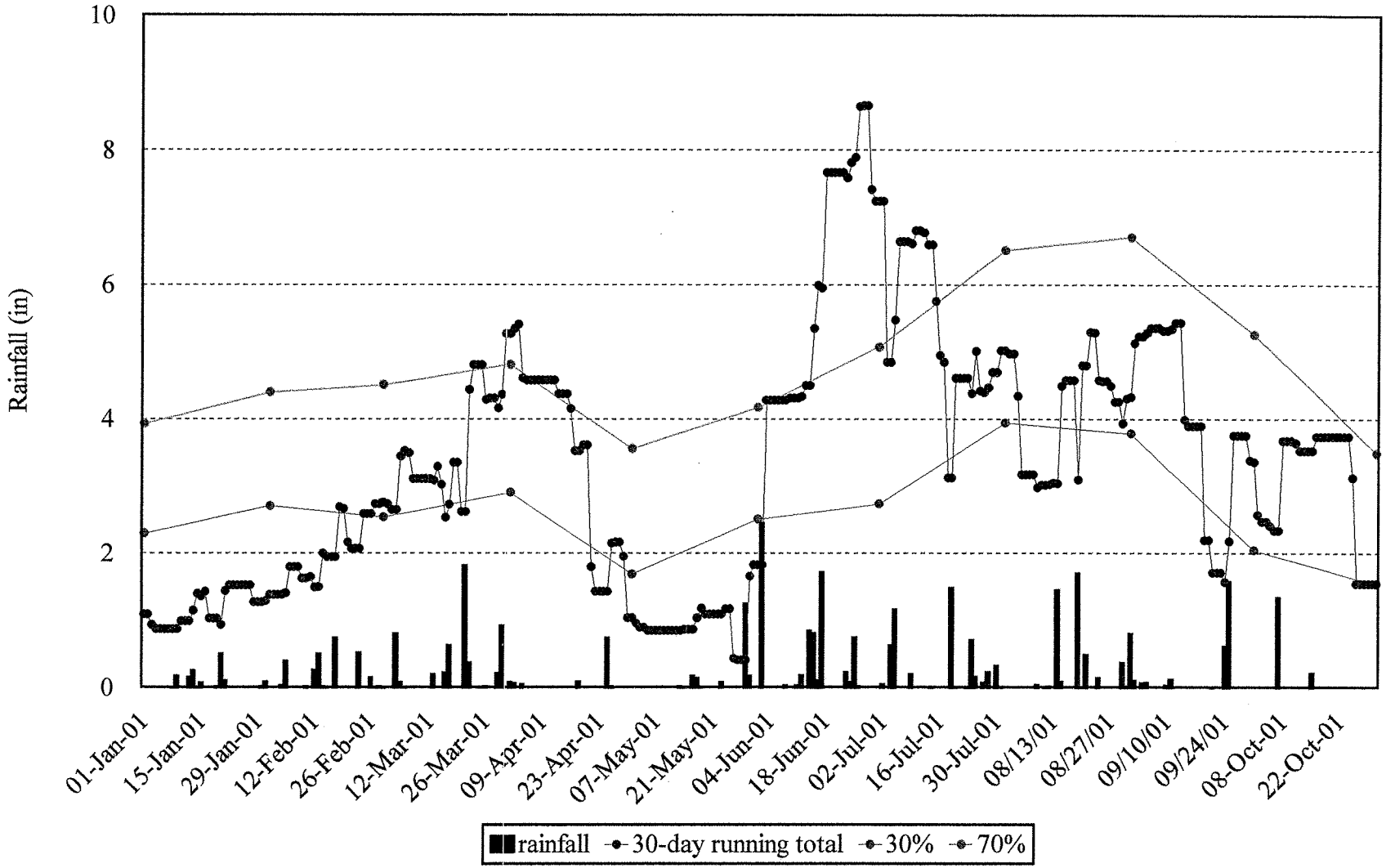


Rainfall data provided by Public Works Commission, Fayetteville, NC.
Percentile data provided by NRCS, USDA.

Rainfall Analysis

2001

Cape Fear Regional Mitigation Bank (Barra Farms), Cumberland County, NC



Rainfall data provided by Public Works Commission, Fayetteville, NC.
Percentile data provided by NRCS, USDA.

Appendix C: Wetland Vegetation Data

Table C1. Woody species found in groundwater flats habitat, average height, and DBH.

Species	# Found	Average height	# with DBH > 1"
Acer rubrum	1239	55.8	14
Rhus copallina	458	43.9	
Taxodium distichum	258	63.8	32
Nyssa spp.	223	53.2	12
Salix nigra	187	97.2	22
Baccharis halimifolia	87	51.6	
Quercus lyrata	72	49.5	3
Quercus phellos	70	39.9	
Persea borbonia	64	60.1	1
Clethra alnifolia	54	42.0	
Chamaecyparis thyoides	42	53.1	2
Liquidambar styraciflua	40	57.9	3
Pinus serotina	20	39.5	
Quercus michauxii	18	36.2	
Vaccinium corymbosum	16	57.8	
Fraxinus pennsylvanica	13	22.3	
Quercus nigra	13	20.5	
Lyonia lucida	12	26.0	
Pinus palustris	10	45.8	
Myrica cerifera	9	48.5	
Cyrilla racemiflora	7	47.7	
Taxodium ascendens	7	84.8	2
Pinus taeda	6	48.0	
Platanus occidentalis	5	107.5	4
Liriodendron tulipifera	4	58.7	
Myrica heterophylla	4	46.5	
Populus heterophylla	3	81.0	1

Table C2. Woody species found in headwater slope habitat, average height, and DBH.

Species	# Found	Average height	# with DBH > 1"
Acer rubrum	650	71.4	12
Nyssa spp.	79	77.3	11
Salix nigra	67	124.9	15
Taxodium distichum	32	103.2	8
Quercus lyrata	14	67.4	
Pinus taeda	9	52.4	1
Fraxinus pennsylvanica	7	44.2	
Chamaecyparis thyoides	4	54.7	
Liquidambar styraciflua	3	116.0	1
Populus heterophylla	3	176.0	2
Platanus occidentalis	2	114.0	
Quercus phellos	2	45.0	
Baccharis halimifolia	1	84.0	
Pinus serotina	1	36.0	

Table C3. Herbaceous species found in all 34 plots and average cover class.

Species	Average Cover Class
Scirpus cyperinus	3.1
Andropogon virginicus	2.8
Solidago sp.	2.3
Panicum verricosum	1.0
Aster pilosa	0.9
Erichtites	0.9
Juncus effusus	0.9
Eupatorium capillifolium	0.7
Polygonum sp. 1	0.7
Helenium amarum	0.5
Juncus canadensis	0.5
Eupatorium hyssopifolium	0.4
Ludwigia sp.	0.4
Rubus sp.	0.4
Hypericum hypericoides	0.3
Juncus effusus	0.3
Cyperus polystachos	0.1
Leersia	0.1
Pteridium aquilinum	0.1
Smilax laurifolia	0.1
Xanthium strumarium	0.1

Table C4. Number of trees, number of species, and habitat type found at each plot.

Plot #	Habitat Type	# of Trees	# of Species	Species
1	Groundwater Flats	90	8	Tupelo sp., Overcup Oak, Bald Cypress, Pond Pine, Pond Cypress, Willow Oak, Red Maple, Groundsel Bush
1-B	Groundwater Flats	66	10	Tupelo sp., Willow Oak, Bald Cypress, A. White Cedar, Green Ash, Groundsel Bush, Overcup Oak, Loblolly Pine, Pond Pine, Red Maple
2	Groundwater Flats	36	7	Red Maple, Tupelo sp., Overcup Oak, Willow Oak, Bald Cypress, A. White Cedar, Groundsel Bush
3	Headwater Slope	94	9	A. White Cedar, Tupelo sp., Overcup Oak, B. Willow, Bald Cypress, Red Maple, Pond Pine, Willow Oak, Groundsel Bush
4	Groundwater Flats	26	4	Tupelo sp., Bald Cypress, Red Maple, Black Willow
5	Groundwater Flats	48	7	B. Willow, Bald Cypress, Red Maple, Tupelo sp., Cottonwood, Willow Oak, Sumac
6	Groundwater Flats	38	9	Willow Oak, B. Willow, Bald Cypress, A. White Cedar, Green Ash, Water Oak, Overcup Oak, Swamp Chestnut Oak, Sumac
6-B	Groundwater Flats	62	13	Pond Pine, Overcup Oak, Swamp Chestnut Oak, Water Oak, Bald Cypress, Sweetgum, Sumac, B. Willow, Groundsel Bush, Tulip Poplar, Tupelo sp., Green Ash, Willow Oak
7	Groundwater Flats	266	8	Tupelo sp., Red Maple, Sweetgum, A. White Cedar, Grounsel Bush, Willow Oak, Bald Cypress, B. Willow
8	Headwater Slope	589	8	Red Maple, Overcup Oak, B. Willow, Bald Cypress, Loblolly Pine, Green Ash, Willow Oak, Sweetgum
9	Headwater Slope	69	5	Tupelo sp., Sweetgum, Red Maple, Green Ash, Sycamore
10	Headwater Slope	77	6	Red Maple, Sweetgum, Tupelo sp., Swamp Cottonwood, Green Ash, B. Willow
11	Groundwater Flats	90	9	Maple, Sweet Pepperbush, Titi, Sumac, Sweetgum, Bald Cypress, Tupelo sp., Groundsel Bush, Overcup Oak
12	Groundwater Flats	92	11	Red Maple, Tupelo sp., Sycamore, Overcup Oak, Swamp Chestnut Oak, Willow Oak, Bald Cypress, Sumac, Groundsel Bush, Sweetgum, Wax Myrtle
14	Groundwater Flats	99	4	Tupelo sp., B. Willow, Red Maple, Sweetgum
17	Groundwater Flats	37	6	Tupelo sp., Red Maple, Pepperbush, Red Bay, Blueberry, Titi
20	Groundwater Flats	77	6	Red Maple, Sweetgum, Tupelo sp., Red Bay, Bald Cypress, Pepperbush

Table C4 continued. Number of trees, number of species, and habitat type found at each plot.

Plot #	Habitat Type	# of Trees	# of Species	Species
24	Groundwater Flats	30	6	B. Willow, Bald Cypress, Tupelo sp., A. White Cedar, Groundsel Bush, Red Maple
24A-B	Groundwater Flats	95	13	Red Bay, Overcup Oak, Bald Cypress, Red Maple, A. White Cedar, Pepperbush, Fetterbush, Willow Oak, Tupelo sp., Sumac, Titi, Bayberry, Wax Myrtle
25	Groundwater Flats	75	7	Tupelo sp., Bald Cypress, Overcup Oak, Red Maple, Willow Oak, Groundsel Bush, Pond Pine
26	Headwater Slope	45	8	Red Maple, Tupelo sp., B. Willow, Bald Cypress, Green Ash, Sycamore, A. White Cedar, Overcup Oak
27	Groundwater Flats	9	6	B. Willow, Tupelo sp., Sweetgum, Sumac, Red Maple, Willow Oak
28	Groundwater Flats	53	5	Overcup Oak, Willow Oak, B. Willow, Bald Cypress, Sweetgum
29	Groundwater Flats	422	13	Groundsel Bush, Tulip Poplar, Tupelo sp., Overcup Oak, Swamp Chestnut Oak, Willow Oak, Sumac, Red Maple, Wax Myrtle, Pond Pine, Sycamore, Bald Cypress, A. White Cedar
30	Groundwater Flats	28	4	B. Willow, Bald Cypress, Tupelo sp., Overcup Oak
31	Groundwater Flats	24	6	Bald Cypress, Red Bay, Red Maple, Sweetgum, Pond Cypress, Wax Myrtle
32	Groundwater Flats	267	5	Red Maple, Tupelo sp., Bald Cypress, Red Bay, Sweetgum
33	Groundwater Flats	137	12	Red Maple, Sweetgum, Tupelo sp., Red Bay, Pond Pine, Bald Cypress, Blueberry, Pepperbush, Fetterbush, Willow Oak, Wax Myrtle, Sumac
34	Groundwater Flats	97	8	Red Maple, Wax Myrtle, Swamp Cottonwood, Sumac, Willow Oak, B. Willow, Tupelo sp., Bald Cypress
35	Groundwater Flats	426	9	Red Maple, Bald Cypress, Tupelo sp., A. White Cedar, Overcup Oak, Loblolly Pine, Willow Oak, Pond Pine, B. Willow, Sweetgum
36	Groundwater Flats	32	8	Tupelo sp., Longlf Pine, Overcp Oak, Willow Oak, P. Pine, Sweetgum, Fetterbush, Groundsel Bush, Lob. Pine
37	Groundwater Flats	33	6	A. White Cedar, Sweetgum, Willow Oak, Red Maple, Sumac, Overcup Oak
38	Groundwater Flats	54	13	Red Maple, A. White Cedar, Winged Sumac, B. Willow, Sweetgum, Water Oak, Tupelo sp., Pepperbush, Red Bay, Pond Pine, Groundsel Bush, Overcup Oak, Bald Cypress
39	Groundwater Flats	54	5	Bald Cypress, Red Maple, A. White Cedar, Pond Cypress, Tupelo sp.

Appendix D: Comparison of 2000 and 2001 Vegetation Data

Appendix D. Comparison of species numbers and average height between years 2000 and 2001 within the groundwater flats habitat.

		2000	2000	2001	2001
Plot	**Species**	**Avg height**	**number**	**Avg height**	**number**
P1	*Quercus phellos*			82.20	2
	Taxodium ascendens	72.00	7	85.50	5
	Taxodium distichum	72.60	36	82.27	41
	Acer rubrum	5.00	15	25.36	25
	Pinus serotina	12.40	5	26.71	7
	Quercus lyrata	30.00	2	44.50	2
	Baccharis halimifolia			54.00	1
	Nyssa	59.14	7	78.57	7
	Myrica cerifera	24.00	1		
P1-B	*Baccharis halimifolia*	24.60	5	42.00	15
	Chamaecyparis thyoides	31.50	4	50.67	3
	Quercus phellos	39.00	2	98.00	3
	Nyssa	50.85	27	56.57	28
	Salix nigra	50.00	2	54.00	3
	Quercus lyrata	74.00	2	74.00	3
	Taxodium distichum	36.25	4	49.33	3
	Acer rubrum	8.00	2	36.00	5
	Pinus serotina	20.00	2	34.00	2
	Pinus taeda			66.00	1
	Fraxinus pennsylvanica	32.00	2		
P2	*Baccharis halimifolia*	48.00	1	65.33	6
	Quercus lyrata	42.10	11	69.90	10
	Taxodium distichum	54.00	8	79.11	9
	Nyssa	55.00	5	70.50	6
	Chamaecyparis thyoides	32.00	2	54.00	2
	Quercus phellos	35.30	3	72.00	2
	Acer rubrum	17.50	4	108.00	1
	Salix nigra	10.00	1		
P4	*Taxodium distichum*	78.00	8	85.50	8
	Nyssa	41.17	12	66.80	10
	Salix nigra	144.00	1	37.20	5
	Acer rubrum	8.50	4	12.00	3
P5	*Taxodium distichum*	74.00	13	96.00	7
	Acer rubrum	7.66	3	37.20	15
	Populus			16.00	1
	Salix nigra	73.58	38	131.37	20
	Quercus phellos			42.00	3
	Nyssa	32.00	1	48.00	1
	Rhus copallina			84.00	1
P6	*Quercus phellos*	26.00	2	16.50	4
	Taxodium distichum	34.67	3	30.00	2
	Fraxinus pennsylvanica	21.22	9	19.83	12
	Quercus lyrata	18.00	1	18.00	2
	Salix nigra	34.00	4	37.80	10
	Chamaecyparis thyoides	24.67	3	21.00	2
	Quercus nigra	21.00	3	22.50	4
	Quercus michauxii			24.00	1
	Rhus copallina			24.00	1

Appendix D contd. Comparison of species numbers and average height between years 2000 and 2001 within the groundwater flats habitat.

Plot	Species	2000 Avg height	2000 number	2001 Avg height	2001 number
6-B	*Quercus lyrata*	17.67	3	21.67	18
	Quercus nigra	17.74	19	18.57	7
	Liriodendron tulipifera	24.00	1	21.33	3
	Pinus serotina	30.00	1	49.00	2
	Quercus michauxii	15.83	6	22.43	7
	Liquidambar styraciflua	21.39	13	25.15	13
	Nyssa			10.00	1
	Taxodium distichum	35.80	5	36.00	4
	Baccharis halimifolia	26.00	1	22.00	1
	Fraxinus pennsylvanica			12.00	1
	Quercus phellos			12.00	2
	Salix nigra	144.00	1	156.00	1
	Rhus copallina	15.00	2	16.00	2
P7	*Nyssa*	61.13	31	86.93	30
	Acer rubrum	**7.88**	**153**	**47.87**	**228**
	Salix nigra	60.00	1	54.00	2
	Quercus phellos	30.00	2	24.00	1
	Chamaecyparis thyoides	33.00	2	66.00	1
	Taxodium distichum	39.00	2	60.00	2
	Baccharis halimifolia			30.00	1
	Liquidambar styraciflua	18.00	1	54.00	1
	Quercus lyrata	18.00	1		
P11	*Rhus copallina*	38.90	11	61.53	59
	Clethra alnifolia	33.79	33	42.32	19
	Baccharis halimifolia			54.00	1
	Liquidambar styraciflua	32.00	1	54.00	1
	Quercus lyrata			36.00	1
	Nyssa	23.00	6	33.00	2
	Taxodium distichum	34.00	3	64.50	4
	Acer rubrum	9.00	9	156.00	1
	Cyrilla racemiflora	44.82	17	45.00	2
P12	*Nyssa*	34.33	12	37.33	12
	Taxodium distichum	50.72	11	63.43	14
	Myrica cerifera			42.00	2
	Baccharis halimifolia	59.33	6	62.40	15
	unknown			36.00	3
	Quercus lyrata	60.33	6	86.00	7
	Quercus michauxii	25.00	4	46.80	5
	Quercus phellos	37.14	7	46.90	10
	Rhus copallina	34.50	2	24.00	1
	Platanus occidentalis	120.00	2	164.00	3
	Acer rubrum	30.36	20	51.83	18
	Liquidambar styraciflua	33.00	2	60.00	2
	Fraxinus pennsylvanica	12.00	1		
	Liriodendron tulipifera	60.00	1		
P14	*Acer rubrum*	5.49	42	31.30	73
	Salix nigra	57.72	50	102.27	54
	Liquidambar styraciflua	22.00	2	42.00	1
	Nyssa	45.60	5	52.29	7

Appendix D contd. Comparison of species numbers and average height between years 2000 and 2001 within the groundwater flats habitat.

Plot	Species	2000 Avg height	2000 number	2001 Avg height	2001 number
P17	*Clethra alnifolia*	31.00	20	30.50	12
	Nyssa	90.00	2	96.00	2
	Acer rubrum	54.88	17	77.21	14
	Cyrilla racemiflora			50.40	5
	Persea borbonia	114.00	2	112.00	3
	Vaccinium			60.00	1
P20	*Nyssa*	44.73	40	61.23	45
	Taxodium distichum	43.47	19	55.62	20
	Acer rubrum	91.60	5	140.57	7
	Liquidambar styraciflua	65.00	1	69.00	2
	Clethra alnifolia	33.00	2	60.00	1
	Persea borbonia	51.00	2	75.00	2
	Taxodium ascendens	48.00	1		
24-A	*Taxodium distichum*	42.50	6	48.57	7
	Persea borbonia	36.00	3	49.20	5
	Myrica heterophylla			46.50	4
	Acer rubrum	10.00	4	30.86	17
	Clethra alnifolia	27.27	11	38.00	4
	Nyssa	28.00	1	27.00	2
	Chamaecyparis thyoides	71.00	6	78.00	6
	Myrica cerifera			24.00	1
	Rhus copallina	30.00	1	36.00	3
	Quercus lyrata	16.00	2	45.00	2
	Cyrilla racemiflora	42.00	1		
	Quercus phellos	12.00	1		
24-B	*Clethra alnifolia*	26.53	15	33.00	14
	Chamaecyparis thyoides	53.33	6	66.13	8
	Nyssa	38.00	9	57.00	8
	Acer rubrum	24.00	5	68.00	3
	Persea borbonia	42.00	1	66.00	1
	Lyonia	34.00	5	40.00	6
	Taxodium distichum	46.00	5	72.00	4
P24	*Chamaecyparis thyoides*	21.33	3	45.50	4
	Nyssa	29.50	4	33.60	5
	Acer rubrum	6.00	2	50.00	3
	Taxodium distichum	54.54	13	81.08	12
	Baccharis halimifolia	28.00	1	62.40	5
	Salix nigra	63.00	1	108.00	1
P25	*Taxodium distichum*	60.13	15	82.44	18
	Acer rubrum	7.71	7	32.50	36
	Nyssa	67.83	12	70.50	12
	Pinus serotina	12.00	1	40.00	2
	Quercus phellos	18.00	1	22.00	1
	Quercus lyrata	16.00	3	30.00	2
	Baccharis halimifolia			60.00	4
	Taxodium ascendens	76.00	1		

Appendix D contd. Comparison of species numbers and average height between years 2000 and 2001 within the groundwater flats habitat.

Plot	Species	2000 Avg height	2000 number	2001 Avg height	2001 number
P27	*Rhus copallina*			24.00	1
	Salix nigra	144.00	2	204.00	3
	Liquidambar styraciflua	33.00	2	120.00	2
	Acer rubrum			12.00	1
	Nyssa	12.00	1	66.00	1
	Quercus phellos			36.00	1
P28	*Quercus phellos*	28.29	7	46.00	11
	Liquidambar styraciflua	36.50	2	48.00	2
	Quercus lyrata	36.00	1	54.00	3
	Taxodium distichum	49.74	19	57.92	24
	Salix nigra	34.82	11	41.00	13
P29	*Rhus copallina*	44.61	97	53.01	349
	Quercus michauxii	27.33	3	51.60	5
	Quercus lyrata	38.00	2	59.56	8
	Quercus phellos	43.00	4	61.50	4
	Myrica cerifera			48.00	1
	Pinus serotina			16.00	1
	Liriodendron tulipifera	40.00	1	96.00	1
	Acer rubrum			24.00	6
	Baccharis halimifolia	36.00	21	50.97	34
	Nyssa	47.00	5	52.50	8
	Platanus occidentalis			51.00	2
	Taxodium distichum			42.00	2
	Chamaecyparis thyoides			48.00	1
	Salix nigra	40.00	1		
P30	*Quercus lyrata*			87.00	4
	Taxodium distichum	66.00	6	109.10	10
	Nyssa			98.00	3
	Salix nigra	60.25	9	154.36	11
	Chamaecyparis thyoides	30.00	1		
	Liquidambar styraciflua	48.00	1		
	Quercus phellos	33.00	2		
P31	*Taxodium ascendens*			84.00	1
	Taxodium distichum	49.44	9	60.11	9
	Persea borbonia	16.80	5	36.44	9
	Liquidambar styraciflua	33.00	1	60.00	1
	Acer rubrum			44.00	3
	Myrica cerifera			48.00	1
	Nyssa	29.00	2		
P32	***Acer rubrum***	**11.13**	**71**	**33.83**	**267**
	Nyssa	43.50	6	58.36	11
	Liquidambar styraciflua	72.00	1	144.00	1
	Persea borbonia	23.00	3	27.00	2
	Taxodium distichum	42.00	1	36.00	2
	Quercus phellos	18.67	3		

Appendix D contd. Comparison of species numbers and average height between years 2000 and 2001 within the groundwater flats habitat.

Plot	Species	2000 Avg height	2000 number	2001 Avg height	2001 number
P33	*Acer rubrum*	41.87	89	68.31	68
	Nyssa	29.78	9	38.44	9
	Persea borbonia	40.80	10	55.33	12
	Liquidambar styraciflua	61.33	9	78.60	10
	Clethra alnifolia	39.78	9	48.00	1
	Vaccinium	46.00	4	55.60	15
	Taxodium distichum	39.60	5	48.00	10
	Lyonia			12.00	6
	Pinus serotina	108.00	1	120.00	1
	Quercus phellos			24.00	2
	Rhus copallina			72.00	1
	Myrica cerifera			54.00	2
P34	*Acer rubrum*	35.94	17	79.00	17
	Salix nigra	58.00	43	117.82	61
	Nyssa	28.00	3	23.33	3
	Taxodium distichum	30.00	2	50.00	3
	Quercus phellos	23.00	4	30.40	6
	Myrica cerifera	57.00	2	75.00	2
	Populus	81.00	2	120.00	2
	Rhus copallina			46.00	3
P35	***Acer rubrum***	**6.05**	**175**	**69.63**	**409**
	Pinus taeda			30.00	1
	Pinus serotina			12.00	1
	Taxodium distichum	60.33	6	79.00	6
	Quercus phellos			18.00	3
	Liquidambar styraciflua			12.00	1
	Chamaecyparis thyoides	30.00	2	54.00	3
	Salix nigra			66.00	1
	Nyssa	30.00	1	30.00	1
	Quercus lyrata	16.00	1		
P36	*Pinus palustris*	29.17	12	45.80	10
	Quercus phellos	18.30	13	22.57	14
	Nyssa	24.00	2	24.00	3
	Baccharis halimifolia			64.00	1
	Liquidambar styraciflua	18.00	1	18.00	1
	Quercus lyrata	16.67	3	38.00	1
	Pinus serotina	20.00	1	18.00	1
	Pinus taeda			48.00	1
	Lyonia	8.00	1		
P37	*Quercus lyrata*			29.00	6
	Acer rubrum	27.00	2	48.00	1
	Rhus copallina			42.17	23
	Quercus phellos			24.00	1
	Liquidambar styraciflua	19.67	3	26.00	1
	Chamaecyparis thyoides	30.00	1	48.00	1
	Quercus nigra	22.00	2		

Appendix D contd. Comparison of species numbers and average height between years 2000 and 2001 within the groundwater flats habitat.

Plot	Species	2000 Avg height	2000 number	2001 Avg height	2001 number
P38	*Quercus lyrata*			19.33	3
	Pinus serotina	16.00	3	19.80	6
	Rhus copallina	29.14	7	46.21	14
	Nyssa	19.20	5	35.60	5
	Acer rubrum	43.00	8	56.11	9
	Taxodium distichum			48.00	1
	Liquidambar styraciflua	22.00	1	40.00	1
	Persea borbonia	20.22	9	45.00	1
	Chamaecyparis thyoides	36.00	5	66.00	4
	Quercus nigra	18.00	8	24.00	2
	Clethra alnifolia	18.00	8	38.00	3
	Baccharis halimifolia	63.00	1	57.67	3
	Salix nigra	36.00	3	68.50	2
	Lyonia	24.00	1		
P39	*Acer rubrum*	33.44	9	58.67	9
	Taxodium distichum	52.19	36	64.00	36
	Taxodium ascendens	34.00	1	72.00	1
	Chamaecyparis thyoides	47.00	6	71.43	7
	Nyssa			24.00	1

Appendix D contd. Comparison of species numbers and average height between years 2000 and 2001 within the headwater slope habitat.

Plot	Species	2000 Avg height	2000 number	2001 Avg height	2001 number
P8	*Taxodium distichum*	70.94	17	99.93	15
	Pinus taeda			52.44	9
	Acer rubrum	**8.66**	**169**	**54.00**	**552**
	Quercus lyrata	49.80	5	95.00	5
	Fraxinus pennsylvanica			54.00	1
	Salix nigra	72.00	4	96.00	5
	Quercus phellos			54.00	1
	Liquidambar styraciflua			36.00	1
	Baccharis halimifolia	33.00	2		
	Nyssa	60.00	1		
P9	*Nyssa*	54.71	14	69.55	22
	Fraxinus pennsylvanica	30.00	1	51.00	4
	Acer rubrum	8.44	9	40.24	41
	Platanus occidentalis	42.00	1	120.00	1
	Liquidambar styraciflua			12.00	1
	Gordonia lasianthus	35.00	2		
P10	*Salix nigra*	97.97	60	141.09	45
	Acer rubrum	72.60	10	96.74	19
	Nyssa	66.00	2	65.25	8
	Liquidambar styraciflua	144.00	1	300.00	1
	Fraxinus pennsylvanica			48.00	1
	Populus	108.00	3	176.00	3
	Quercus lyrata	24.00	1		
P3	*Nyssa*	59.25	16	67.27	22
	Acer rubrum	6.47	49	46.03	37
	Quercus lyrata	63.57	7	83.25	8
	Chamaecyparis thyoides	33.00	2	55.33	3
	Quercus phellos	18.00	1	36.00	1
	Salix nigra	43.50	4	64.36	11
	Taxodium distichum	71.00	8	78.60	10
	Baccharis halimifolia	48.00	1	84.00	1
	Pinus serotina			36.00	1
	Taxodium ascendens	54.00	1		
P26	*Nyssa*	72.96	24	106.96	27
	Salix nigra	145.71	7	198.00	6
	Platanus occidentalis	54.00	1	108.00	1
	Taxodium distichum	83.00	4	131.14	7
	Fraxinus pennsylvanica	35.00	2	24.00	1
	Chamaecyparis thyoides			54.00	1
	Acer rubrum	93.00	2	120.00	1
	Quercus lyrata			24.00	1
	Taxodium ascendens	90.00	2		

APPENDIX E. Summary of Monitoring Plan

1.0 MONITORING PLAN

The Monitoring Plan will consist of a comparison between hydrology model predictions, reference streams and wetlands, and restoration areas on the Site. Stream restoration monitoring will be performed through analysis of in-stream flows, stream geometry, and biological stream attributes. Wetland monitoring will entail analysis of two primary parameters: vegetation and hydrology. Monitoring of restoration and enhancement efforts will be performed until success criteria are fulfilled.

1.1 HYDROLOGY MONITORING

After hydrological modifications are being performed on the site, surficial monitoring wells will be designed and placed in accordance with specifications in U.S. Corps of Engineers', Installing Monitoring Wells/Piezometers in Wetlands (WRP Technical Note HY-IA-3.1, August 1993). Monitoring wells will be set to a depth of approximately 24 inches below the soil surface.

Twenty three surficial monitoring wells (manual recording) will be installed at the Site to provide representative coverage and flow gradients extending through each of the three physiographic landscape areas (Figure 2). Four monitoring wells will also be placed within the reference wetland site in similar landscape positions, where available. Three continuous recording (RDS24) wells will also be installed on-site to provide continuous data that can be extrapolated to manual recording devices.

Hydrological sampling will be performed on-site and within reference during the growing season (17 March to 12 November) at intervals necessary to satisfy the hydrology success criteria within the designated physiographic area (EPA 1990). In general, the wells will be sampled weekly through the Spring and early Summer and intermittently through the remainder of the growing season, if needed to verify success.

1.2 HYDROLOGY SUCCESS CRITERIA

Target hydrological characteristics have been evaluated using a potential combination of three different methods: 1) regulatory wetland hydrology criteria; 2) reference groundwater modeling; and 3) reference wetland sites.

Regulatory Wetland Hydrology Criteria

The regulatory wetland hydrology criterion requires saturation (free water) within one foot of the soil surface for 12.5 percent of the growing season under normal climatic conditions. In some instances, the regulatory wetland hydroperiod may extend for between 5 and 12.5% of the growing season.

Reference Groundwater Model

The reference groundwater model forecasts that the wetland hydroperiod in interior areas of the Site will average 22% of the growing season in early successional phases. As steady state forest conditions develop, the average wetland hydroperiod is forecast to encompass 40% of the growing season. Over the 31 year modeling period, the annual hydroperiod fluctuated from less than 12.5% to over 44% dependent upon rainfall patterns and successional phase. In addition, the on-site

landscape includes diverse wetland geomorphology, especially near uplands and the stream channel, which are not characterized by the model.

Due to wide fluctuations in modeled annual hydroperiod (<12-44+%), the groundwater model cannot provide a specific hydrology success criteria above the regulatory criterion (12.5%) on an annual basis. A specific success criteria such as a 22% target hydroperiod will fail in 50% of the years sampled. A success criteria of 12.5% (the regulatory criteria) will also fail in 10% of the years sampled in reference wetlands.

Reference Wetland Sites

Four monitoring wells will be placed in the groundwater flats reference wetland located in the northwestern periphery of Barra Farms. Wells will be also be placed in a riverine reference wetland in the Bushy Lake/Horse shoe Lake natural area dependent upon contact with the North Carolina Park and Recreation Service. These wells will provide annual hydroperiods on the organic soil flat, and riverine floodplain physiographic areas of the Site. The headwater slope physiographic area may be interpolated between the two systems. Transition zones from uplands towards the wetland interior will not be represented. Therefore, these wells will provide comparative information on interior wetlands only.

The hydrology success criteria for this Site will require saturation (free water) within one foot of the soil surface for at least 50% of the hydroperiod exhibited by the reference wetland.

Based on groundwater models, average wetland hydroperiods in groundwater flats will exhibit a steady, non-linear increase from 22% to 40% of the growing season during forest (post-farmland) development. This trend includes a hypothetical reduction in hydraulic conductivities and a 50% increase in surface water storage through the first 15 years of wetland development. Therefore, a goal of 50 +/-% hydroperiods relative to reference wetlands is warranted for the five year monitoring period. This 50% goal may not apply in non-organic soils as evapotranspiration may play a greater role in early successional hydroperiods than surface water storage.

1.3 VEGETATION

Restoration monitoring procedures for vegetation are designed in accordance with EPA guidelines presented in Mitigation Site Type (MiST) documentation (EPA 1990) and COE Compensatory Hardwood Mitigation Guidelines (DOA 1993). The following presents a general discussion of the monitoring program.

After planting has been completed in winter or early spring, an initial evaluation will be performed to verify planting methods and to determine initial species composition and density. Supplemental planting and additional site modifications will be implemented, if necessary.

During the first year, vegetation will receive cursory, visual evaluation on a periodic basis to ascertain the degree of overtopping of planted elements by weeds. Subsequently, quantitative sampling of vegetation will be performed between September 1 and October 31 after each growing season until the vegetation success criteria is achieved.

After planting plan implementation, 0.1 acre plots will be within each restored ecosystem type. Twenty three plots will be correlated with hydrological monitoring locations to provide point-related data on hydrological and vegetation parameters.

1.4 VEGETATION SUCCESS CRITERIA

Success criteria have been established to verify that the wetland vegetation component supports a species composition sufficient for a jurisdictional determination. Additional success criteria are dependent upon the density and growth of characteristic forest species. Specifically, a minimum mean density of 320 characteristic trees/ac must be present for the five year monitoring period. Characteristic tree species are those within the reference ecosystems, elements enumerated in the planting plan, along with natural recruitment of sweet gum, red maple, loblolly bay, loblolly pine, and pond pine. Loblolly or pond pine (softwood species) cannot comprise more than 10 percent of the 320 stem/acre requirement. In addition, at least five character tree species must be present, and no species can comprise more than 20 percent of the 320 stem/acre total. Supplemental plantings will be performed as needed to achieve the vegetation success criteria.

No quantitative sampling requirements are proposed for herb and shrub assemblages as part of the vegetation success criteria. Development of a forest canopy over several decades and restoration of wetland hydrology will dictate the success in migration and establishment of desired wetland understory and groundcover populations. Visual estimates of the percent cover/composition of shrub and herbaceous species and photographic evidence will be reported for information purposes.

1.5 STREAM

1.5.1 Initial Monitoring Plan

Monitoring and success criteria will be established through periodic measurement of stream stage and rainfall in the Bank. One staff gauge will be placed on central sections of the mitigation stream reach and the second staff gauge will be located approximately 300 feet below outfall from the Bank. Rain gauges will be placed at open locations within central portions of the Bank. Stream stage and rainfall will be measured weekly throughout the monitoring period.

1.5.2 Updated Monitoring Plan

Stream monitoring and success criteria will be established through measurement of in-stream flows, measurement of stream geometry, and measurement of biological stream attributes.

In-stream flows will be measured through placement of two continuos monitoring stream flow gauges. The gauges will be capable of recording velocity (ft/second) and discharge (cubic feet per second. CFS). Discharge is typically calculated by measuring height (or depth) of the water column and inputting the resulting cross-section. One gauge will be placed within the central reach of the restored stream channel on the mitigation site. The gauge will be located approximately 100 feet downstream of a former dirt road crossing in central portions of the site (Drainage Area: 2.5 mi^2). The second gauge will be placed within the riverine wetland reference site in Bladen Lakes State Forest. The reference gauge will be located a minimum of 100 feet upstream of the State road

crossing (Drainage Area: 6.7 mi^2). The data will be reported as mean daily flows for velocity (ft/second) and discharge (CFS) in tabular and graphic format.

Stream geometry will be measured along a fixed stream reach located immediately upstream and/or downstream of the stream gauge located on the mitigation site. The stream reach will extend for a minimum of 200 feet along the restored channel. Annual fall monitoring will include development of a channel plan view, three channel cross-sections, pebble counts, and a water surface profile of the channel. The data will be presented in graphic and tabular format as summarized in the attached table. Data to be presented will include: 1) cross-sectional area; 2) bankfull width; 3) average depth; 4) average width; 5) width/depth ratio; 6) meander wavelength; 7) beltwidth; 8) water surface slope; 9) sinuosity; and 10) stream substrate composition. The stream will subsequently be classified according to stream geometry and substrate (Rosgen 1996). Significant changes in channel morphology will be tracked and reported by comparing data between the reference stream and mitigation stream and by comparing data in each successive monitoring year.

Biological stream attributes will be measured annually at the mitigation site and in the reference wetland site between April 15 and May 15 of each year. Aquatic surveys will record presence/absence of macro-invertebrate, reptile, amphibian, and fish species populations. Presence/absence of species populations identified will be reported along with observations of changes to in-stream aquatic habitat or species presence/absence over time.

1.6 STREAM SUCCESS CRITERIA

1.6.1 Initial Monitoring Plan

Success criteria will include establishment of near-permanent stream flows within the Bank. Specifically, stream stage and observable flow must be present for a minimum of 80% of the calendar year. Intermittent flow may occur during periods of groundwater draw-down, generally confined to summer months.

1.6.2 Updated Monitoring Plan

Success criteria for stream restoration will include: 1) stream classification; 2) target mean daily stream flows; and 3) increased stream faunal recruitment and diversity.

Stream geometry measurements will be incorporated into the Rosgen stream classification system. The channel and flood prone area must support characteristics supporting an E, C, or DA stream type to fulfill the success criteria.

In-stream flow measurements must indicate that the mitigation stream reach supports mean daily flows per unit of drainage area equal to. or exceeding the mean daily flows per unit of drainage area within the riverine reference reach. The reference stream reach supports an approximate 6.7 mi^2 drainage area while the mitigation stream reach supports an approximate 2.5 mi^2 drainage area (37% of reference). Therefore, mean daily flows in the mitigation reach must equal to, or exceed 30% of the mean daily flows in reference. If the mitigation reach and/or reference reach support no

measurable flow during a drought period, fulfillment of success criteria will be based upon mean daily flows prior to, and following the no flow condition.

Biological monitoring will indicate similar species diversity as compared to reference conditions or an increase in species diversity towards reference conditions over time. Specifically, the type and number of species populations identified in the mitigation reach must be equal to, or increasing towards, the type and number of species identified in the reference reach in each successive monitoring year.

1.7 REPORT SUBMITTAL

Documentation will be submitted to the MBRT certifying completion of implementation activities. Any changes to this mitigation plan will be described in this documentation. The document will be provided within 60 days of completion of all work at the Site.

Subsequently, reports will be submitted yearly to the MBRT following each assessment. Reports will document the sample transect locations, along with photographs which illustrate site conditions.

Surficial well data will be presented in tabular/graphic format. The duration of wetland hydrology during the growing season will be calculated at each well. within each on-site physiographic area, and within the reference wetland site.

The survival and density of planted tree stock will be reported. In addition, characteristic tree species mean density and average height as formatted in the Vegetation Success Criteria will be calculated. Estimates and photographic evidence of the relative percent cover of understory and groundcover species will be generated.

1.8 CONTINGENCY

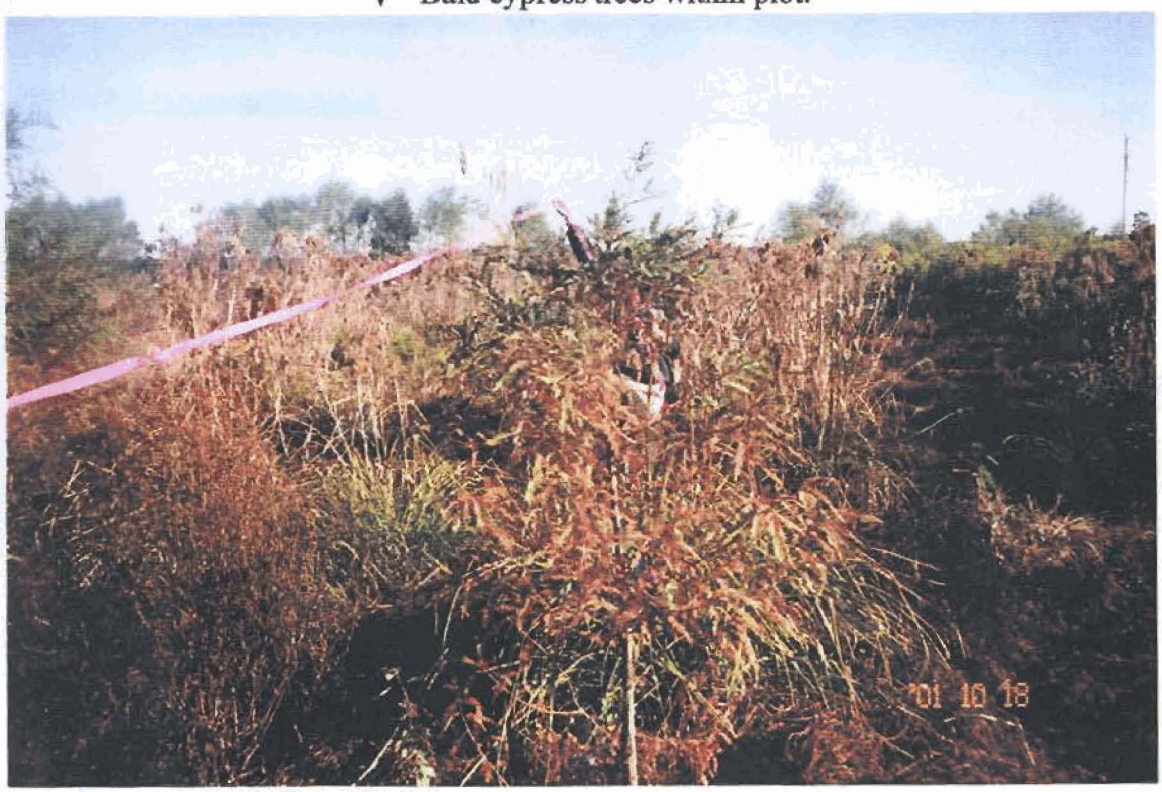
In the event that vegetation or hydrology success criteria are not fulfilled, a mechanism for contingency will be implemented. For vegetation contingency, replanting and extended monitoring periods will be implemented if community restoration does not fulfill minimum species density and distribution requirements.

Hydrological contingency will require consultation with hydrologists and regulatory agencies if wetland hydrology restoration is not achieved during the monitoring period. Recommendations for contingency to establish wetland hydrology will be implemented and monitored until the Hydrology Success Criteria are achieved. Performance bonds have been established to guarantee fiscal resources for remediation.

APPENDIX F. Photographs of Barras Farms

↓ Trees within a typical plot at Barra. Many trees are greater than 7′ tall.

↓ Bald cypress trees within plot.



Barra Farms Mitigation Site Cumberland County, NC	***Land Management Group, Inc.*** **Environmental Consultants** Wilmington, N.C. November 2001	Pictures of site.

↓ Water oak tree at Barra.

↓ Bald cypress trees.

Barra Farms Mitigation Site Cumberland County, NC	***Land Management Group, Inc.*** **Environmental Consultants** Wilmington, N.C. November 2001	Pictures of site.

↓ A majority of the herbaceous vegetation consisted of broomsedge.

↓ Goldenrod was found in drier sections.

Barra Farms Mitigation Site Cumberland County, NC	***Land Management Group, Inc.*** **Environmental Consultants** Wilmington, N.C. November 2001	Pictures of site.

↓ Red maple dominated several plots, however planted species continued to grow.

↓ Red maple appeared to have no more effect on planted species than herbaceous vegetation.

Barra Farms Mitigation Site Cumberland County, NC	***Land Management Group, Inc.*** **Environmental Consultants** Wilmington, N.C. November 2001	Pictures of site.

↓ Automated well broken at Barra Farms by a bear.

Barra Farms Mitigation Site Cumberland County, NC	***Land Management Group, Inc.*** **Environmental Consultants** Wilmington, N.C. November 2001	Pictures of site.