Rowel Branch Tract:
Year Four Monitoring Report

Brunswick County, NC

Prepared for:
ECOBANK
Winter Park, FL

Prepared by:
Land Management Group, Inc.
Wilmington, NC

December 2004

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Monitoring Report for the
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1.0 Introduction

Throughout 2000 and 2001, ECOBANK restored 16.1 acres of bottomland hardwood wetlands at the Rowel Branch tract (Figure 1) in Brunswick County, North Carolina. This restoration was used as mitigation for unavoidable wetland impacts associated with the construction of the Wilmington Bypass by the NCDOT. Details of the mitigation activities are presented in the Revised Compensatory Mitigation Plan for the Rowel Branch Tract, dated July 21, 2000. Construction activities were consistent with the mitigation plan.

The Rowel Branch tract consists of a riverine ecosystem, which was bypassed in the 1970's with the construction of a large water diversion canal (Figure 2). In addition, four areas within this floodplain were filled to facilitate better tract access during construction of an adjacent railroad yard. In order to restore this tract, ECOBANK 1) removed the fill from these four different sections of the site to restore the natural floodplain (winter of 2000), 2) planted trees within the floodplain (spring of 2000), 3) removed the earthen plug that separated the natural stream and the canal (spring of 2001), and 4) filled the large diversion canal with the previously excavated material in order to restore hydrology back to the stream and its floodplain (summer of 2001).

2.0 Hydrology

2.1 Success Criteria

According to the Rowel Branch Tract Mitigation Plan, two hydrological success criteria were established. The first criterion ensures that wetland hydrology for this site is achieved and requires the establishment of a static water table at or within 12” of the soil surface, ponded or flooded for 12.5% of the growing season during normal precipitation conditions. The growing season in Brunswick County extends 265 days, between March 7 and November 28. Normal precipitation is defined as total monthly precipitation falling

within the 30th and 70th percentiles of a 30-year period. Therefore, to meet the first success criterion, the water table should remain at or within 12" of the soil surface for at least 33 consecutive days between March 7 and November 28. The second criterion deals with riverine hydrology and requires the establishment of overbank flooding events at a frequency and duration within 10% of the reference site.

2.2 Methods

Six automated groundwater monitoring gauges were installed throughout the Rowel Branch site to monitor groundwater hydrology for at least five years (Figure 3). These gauges were located within three transects, with each transect containing two gauges: one within the stream channel and one 50' from the channel. Four of these gauges (A1, A2, B1, and B2) were installed on July 20, 2000 and the remaining two gauges (C1 and C2) were installed on November 29, 2000. Two reference gauges located off site were installed on July 29, 2000 (Figure 2). Each gauge was programmed to read the groundwater level once a day.

In March of 2000, the channel in the restored wetland was restored to the grade of the previous streambed, resulting in 2,640 linear feet of stream restoration to be utilized by NCDOT. In June and July of 2001, the existing diversion canal was filled to divert all flow back through the restored riverine system. The existing fill was removed and contoured to natural grade. Topographical data and drainage calculations demonstrated that the restored floodplain was lower and wider than the old canal; therefore the restoration would not cause upstream flooding (see Appendix A). Also in July of 2001, NCDOT maintenance contractors installed a second 7' drainage culvert under Mt. Misery Road to enhance downstream flow.

For this monitoring report, hydrology and riverine data between October of 2003 and October of 2004 were analyzed. To evaluate the riverine success criterion, the cross-section of each gauge transect was surveyed in 2002 (Figure 4) and the gauges were calibrated to mean sea level so that water level data collected on site could be compared to reference gauge data. The number of events (frequency) and the length of each event (duration) that

gauges documented overbank flooding between October of 2003 and October of 2004 were calculated and compared to data from the reference gauges to evaluate this success criterion. It should be noted that the riverine success criteria were not fulfilled during the second or third year of monitoring (2002 and 2003).

2.3 Results

As in previous years, all six gauges located within Rowel Branch fulfilled the wetland hydrology criterion of a water table within 12" of the soil surface for 12.5% of the growing season, or 33 days (Table 1). Four of the six gauges recorded wetland hydrology from the beginning of the growing season (March 7, 2004) until the last reading taken prior to submitting this report (November 3, 2004). Two gauges (A2 & B2) located within the stream at Rowel Branch stopped reading during the growing season. Based on data from previous years, B2 most likely would have documented standing water throughout the year had it continued to read. For most of the year, A2 was reading a water level at ground level but fell below the 12” threshold twice during drier than normal conditions. The two reference gauges (R1 and R2) also exceeded the wetland hydrology criterion and had a water table within 12” of the soil surface for the entire monitoring period.

The 30-day running total for 2004 shows normal to slightly below normal rainfall for most of the year, except for late summer, which documented above normal rainfall (Appendix A). Several hurricanes passed through the region during this time period.

Table 1. Groundwater monitoring results for gauges located within the Rowel Branch tract and the reference site between March 7, 2004 and November 3, 2004.

Type	Gauge Number	Serial Number	# of Consecutive Days above 12"
Restoration	A1	S353B9B	242
	A2	S353A32	80*
	B1	S213EB6	242
	B2	S369807	48*
	C1	S353979	242
	C2	S126F6B	242
Reference	R1	S3539A7	242
	R2	S126F2F	242

* Gauge stopped reading during the monitoring period.

An evaluation of the riverine success criterion determined the frequency and duration of overbank flooding for all gauges within the tract and within the reference site (Table 2). The gauge (R1) located in the reference stream documented overbank flooding on 10 occasions. Each flooding event had an average duration of 19.2 days. As in 2002 and 2003, all three of the stream gauges at Rowel Branch experienced fewer flooding events and at a shorter average duration than the reference stream gauge. Gauge A1 experienced 6 flooding events with an average duration of 6.2 days and gauge B1 documented 6 flooding events with average duration of 8.2 days. The stream gauge located farthest north (C1) only recorded 2 flooding events with an average duration of 1 day. None of the mitigation gauges located at the stream met the success criterion of establishing overbank flooding events at a frequency or duration within 10% of R1.

The gauge (R2) located 50’ away from the reference stream documented flooding on 13 occasions, with an average duration of 8.4 days. The frequency of flooding events documented at the mitigation gauges were lower (A2 (9), B2 (0), and C2 (6) than the frequency observed at R2. A2 and C2 recorded longer durations of flooding events than the

reference gauge and did not meet the 10% success criterion for duration. B2 did not exhibit any flooding events because it was malfunctioning during a majority of the monitoring period.

Table 2. Frequency and duration of flooding events for gauges located within the Rowel Branch tract and the reference site in 2004.

Type	Gauge Number	Serial Number	Frequency of Flooding Events	Average Duration of Flooding Events (days)
Restoration	A1	S353B9B	6	6.2
	A2	S353A32	9	11.8
	B1	S213EB6	6	8.2
	B2	S369807	*	*
	C1	S353979	2	1
	C2	S126F6B	6	29.0
Reference	R1	S3539A7	10	19.2
	R2	S126F2F	13	8.4

* Gauge malfunctioned during a majority of the monitoring period.

As in previous years, it was observed throughout 2004 that beavers were building dams in several locations within the creek, causing water levels near these dams to increase. Because of concern raised by neighbors that these dams were backing up water onto their property, the dams were periodically monitored and removed. The creek will continue to be monitored for the reappearance of dams.

3.0 Vegetation

3.1 Success Criteria

The Rowel Branch Mitigation Plan states that the vegetation success criterion for this project is the survival of 320 trees/acre, including acceptable volunteer species. In addition, no individual hardwood species may account for more than 20% of the total number of stems.

3.2 Methods

A list of the tree species that were planted in the spring of 2000 at the Rowel Branch tract is given in Table 3. These one-year and two-year seedlings were obtained from the NC Forest Service Nursery and were planted on a ten-foot spacing within the floodplain of Rowel Branch. The vegetation survey consisted of establishing a circular plot every 25 feet along two transects within the tract (Figure 5). The center of each plot was marked with a pink pin flag and the ends of the transects were marked with orange flagging. Each plot had a radius of 10 feet and an area of 314.2 ft^2. Transect 1 contained 7.5 plots and transect 2 contained 6.5 plots. Therefore, the total area surveyed was 4398 ft^2, or approximately 0.1 acre. Transect 1 was approximately 200 feet in length and began along the edge of a planted area that was relatively high in elevation. Progressing along the transect, elevation gradually dropped until the stream was encountered, which represented the lowest elevation and wettest point along the transect. Then the elevation rose again as it moved toward the stockpile area, where it ended. Transect 2 was approximately 175 feet in length. No major changes in elevation were observed along this transect except for a low ponded spot in the middle. The transect began at the canal, near where it turns 90E, and ended at the stream.

Table 3. Number and types of trees planted at Rowel Branch on March 15 and April 1 of 2000. Trees were planted at a density of 435/acre.

Common Name	Scientific Name	# Planted
Atlantic White Cedar (2 yr)	*Chamaecyparis thyoides*	1000
Bald Cypress (1 yr)	*Taxodium distichum*	1600
Green Ash (1 yr)	*Fraxinus pennsylvanica*	800
Water Oak (1 yr)	*Quercus nigra*	1000
Willow Oak (1 yr)	*Quercus phellos*	1300
Yellow Poplar (1 yr)	*Liriodendron tulipifera*	600
TOTAL		**6300**

3.3 Results

As in previous years, herbaceous vegetation observed within the drier areas of both transects included *Eupatorium capillifolium*, *E. hyssopifolium*, and *Rubus spp*. In the wetter areas, *Scirpus cyperinus*, *Peltandra virginica*, *Mikania scandens*, *Juncus effusus*, *Polyganum sagittatum*, and several sedge species (*Cyperus* and *Carex* spp.) were observed. Again, more herbaceous vegetation was observed in transect 1 than in transect 2, although transect 2 was becoming dense in vegetation (Appendix C).

The planted trees that were observed within the transects were in good condition and continue to grow. Several bald cypress (*Taxodium distichum*) trees were over 10 feet tall. Volunteer alder (*Alnus serrulata*) trees were found in wetter spots, especially near the stream in transect 1. As in previous years, most of the red maple observed was in transect 2. The number of red maple seedlings observed within the transects has decreased from 2003 and the average size of the species has slightly increased.

Table 4. Number and species of trees surveyed within two transects at Rowel Branch (7/30/04).

Common Name	Scientific Name	Average Height (in)	Total # of Trees Observed	# Counted Towards Criteria
Alder	*Alnus serrulata*	68.3	114	93.8
Atlantic White Cedar*	*Chamaecyparis thyoides*	52.0	3	3
Bald Cypress*	*Taxodium distichum*	80.6	49	49
Black Willow	*Salix nigra*	91.3	21	21
Eastern Baccharis	*Baccharis halimifolia*	62.0	3	3
Eastern Sycamore*	*Platanus occidentalis*	39.0	2	2
Green Ash	*Fraxinus pennsylvanica*	75.5	12	12
Loblolly Pine	*Pinus taeda*	51.35	26	26
Overcup Oak	Quercus	46.5	2	2
Red Maple	*Acer rubrum*	50.2	186	93.8
Sweetgum	*Liquidambar styraciflua*	52.4	15	15
Wax Myrtle	*Myrica cerifera*	49.4	21	21
Willow Oak*	*Quercus phellos*	58.3	9	9
Winged Sumac	*Rhus copallina*	36.0	6	6
TOTAL			**469**	**356.6**

(Data for the individual transects are given in Appendix D.)
*Species was planted in 2000.

A total of 469 trees was observed within the surveyed plots (Table 4), which was slightly less than the number of trees observed in 2003 (479). The mitigation plan stated that no single tree species could represent more than 20% of the total number of trees observed. After factoring in this requirement, the number that was counted towards the vegetation success criterion was 356.6 trees, which was slightly greater than last year's value of 334.6. Because the total area of all the plots represented approximately 0.1 acre, the average number of trees/acre in 2004 was 3566. This was more than 10 times the minimum 320 trees/acre required by the mitigation plan. Therefore, vegetation met the success criterion during year four monitoring.

4.0 Conclusions

ECOBANK has restored 16.1 acres of bottomland hardwood wetlands at the Rowel Branch tract in Brunswick County, North Carolina as mitigation for unavoidable wetland impacts associated with the construction of the Wilmington Bypass by the NCDOT. To restore this area, fill was removed from the riverine floodplain, trees were planted within the floodplain, and a large diversion canal was filled to restore hydrology to the stream.

As in previous years, groundwater monitoring data collected from automated gauges during 2004 showed Rowel Branch to support wetland hydrology. All six of the gauges on site and the two reference gauges demonstrated groundwater levels at or within 12" of the soil surface for at least 12.5% of the growing season (33 days). In fact, four of the gauges located at Rowel Branch recorded wetland hydrology from the beginning of the growing season (March 7, 2004) until the last reading taken prior to submitting this report (November 3, 2004). The two gauges that demonstrated a shorter wetland hydrology stopped working during the monitoring period.

An evaluation of the riverine success criterion determined the frequency and duration of overbank flooding within the tract and within the reference site. As in 2002 and 2003, this evaluation did not determine a clear pattern between gauges. The reference gauge located within the stream (R1) documented flooding on 10 occasions, with an average duration of 19.2 days. All three of the gauges located within the restored stream at Rowel Branch (A1, B1, and C1) experienced fewer flooding events and shorter flooding durations than this reference and did not meet the 10% success

criterion for frequency or duration.

The reference gauge located 50' away from the stream (R2) documented flooding on 13 occasions, with an average duration of 8.4 days. Because B2 malfunctioned for most of the monitoring period, it did not record any flooding events and cannot be compared to R2. The other two gauges located 50' from the stream at Rowel Branch (A2 and C2) recorded fewer flooding events yet longer durations of flooding than what was recorded at R2. Neither A2 nor C2 met the 10% success criterion for frequency or duration.

The cross-sections showed that the reference stream at its transect location is smaller in area than the restored stream at those transect locations. Therefore, when comparing these points, the reference stream gauge floods more frequently. This has been documented in each monitoring report. However, no clear pattern has been observed for the gauges located 50' from the stream. In 2004, Gauges A2 and C2 (B2 malfunctioned) documented fewer flooding events than R2 yet with longer average durations. In 2003, A2, B2, and C2 documented more or the same number of flooding events with longer average durations than R2. In 2002, A2 and C2 recorded more flooding events with a shorter duration and B2 recorded fewer flooding events with a longer average flooding duration.

Another pattern that has been consistent at Rowel Branch is that the A and C transects have experienced more frequent flooding events 50' away from the stream than directly adjacent to the stream even though the gauges 50' away from the stream were at higher elevations than the top of the bank. This may be because the topography is flatter 50' away from the stream and short-term rainfall can create ponding in these areas. Closer to the stream, slopes are greater and rainfall is transported at a fast rate downstream, decreasing overbank flooding.

As discussed in previous monitoring reports, there are several reasons why the riverine success criterion was largely not achieved. First, the reference stream is located in the middle of Leland Industrial Park and receives a large amount of stormwater runoff from impervious cover associated with this development, which may cause additional flooding. Property surrounding Rowel Branch is mostly small residential units or undeveloped parcels, which contribute less stormwater flow into the restored stream. In addition, the dimensions of the restored stream were not based on

those of the reference stream. The unchannelized bottomland hardwood reference site was chosen as a general control for groundwater hydrology. Site selection of the gauge placement was not based on similar cross-sectional profile data between the reference and the restored sites. Therefore, overbank flooding results are difficult to compare particularly when the four transects were selected at random with no pre-project elevation information.

Just like most coastal streams, Rowel Branch's stream bank heights show great variability and, therefore, overbank flooding events should not be referenced to one spot along an entire stream gradient. Rack lines, fresh sediment buildup, and compressed herbaceous plant stems are better indicators of flooding throughout the system. Further compounding the comparative results of random monitoring points is the braided nature of the coastal floodplain. In one instance, the reference gauge may be situated near a lower shelf braided branch of the main stream while the restoration gauge may be on a higher position on the floodplain. It is important to look at the entire system rather than at individual points. The requirement that all restored gauges must be within 10% of one sample reference transect is too restrictive and does not account for the high variability of the coastal bottomland hardwood stream system. A better solution would be to put more importance on achieving survivability of similar hydrophytic plants and maintaining wetland hydrology over the course of five years. Flooding events could be modeled with a design storm of a certain event (i.e. 10, 25 or 50-year) and then compare the extent of flooding over the four transects. In this manner one can project the flooding dissipation function of the floodplain in both reference and restored sites in a manner similar to FEMA and stormwater/sediment control models.

However, because the Rowel Branch gauges documented frequent flooding events and because wetland vegetation is flourishing throughout the site, it is achieving its overall goal of restoring a riverine floodplain system. As stated in previous monitoring reports, the riverine success criterion appears to be too restrictive and may need to be redefined by the commenting agencies.

The vegetation analysis determined a total of 469 trees within the surveyed plots (Table 4), a slight decrease from the 479 trees observed in 2003. This decrease was mostly a result of fewer red maple and alder trees, which are starting to thin out as individuals get older. After factoring in percentage requirements, the number of trees that were counted towards the vegetation success

criterion was 356.6 trees, or 3566 trees/acre. This was more than 10 times the minimum 320 trees/acre required by the mitigation plan and was an increase in number from monitoring performed in 2001 (205.6), 2002 (214.2), and 2003 (334.6). It should be noted that planted species continue to grow taller in each successive year, especially bald cypress. The mean height for cypress trees in 2004 was 6.8 feet, up from 5.5 feet observed in 2003. Therefore, vegetation met the success criterion during year four monitoring.

Based on the data analysis within this report, the conclusion of the year four monitoring is that the Rowel Branch tract has fulfilled the vegetation and hydrology success criteria established in the mitigation plan and that the wetland restoration of the tract is thus far successful.

Appendix A. Hydrographs

Appendix C. Vegetation Data by Transect

Table 1. Number and type of trees observed in Transect 1 in 2004.

Common Name	Scientific Name	Average Height (in)	# Observed
Atlantic White Cedar	*Chamaecyparis thyoides*	52.0	3
Bald Cypress	*Taxodium distichum*	82.13	32
Black Willow	*Salix nigra*	85.71	14
Common Alder	*Alnus serrulata*	73.50	48
Eastern Baccharis	*Baccharis halimifolia*	62.0	3
Green Ash	*Fraxinus pennsylvanica*	72.0	6
Loblolly Pine	*Pinus taeda*	34.29	21
Overcup Oak	*Quercus lyrata*	54.0	1
Red Maple	*Acer rubrum*	42.63	38
Sweetgum	*Liquidambar styraciflua*	52.40	15
Water Oak	*Quercus nigra*	36.0	1
Wax Myrtle	*Myrica cerifera*	49.43	21
Willow Oak	*Quercus phellos*	54.86	7
Winged Sumac	*Rhus copallina*	36.0	6
TOTAL			**216**

Table 2. Number and type of trees observed in Transect 2 in 2004.

Common Name	Scientific Name	Average Height (in)	# Observed
Bald Cypress	*Taxodium distichum*	79.06	17
Black Willow	*Salix nigra*	96.86	7
Common Alder	*Alnus serrulata*	63.0	66
Green Ash	*Fraxinus pennsylvanica*	79.0	6
Loblolly Pine	*Pinus taeda*	68.4	5
Overcup Oak	*Quercus lyrata*	18.0	1
Red Maple	*Acer rubrum*	57.69	148
Sycamore	*Platanus occidentalis*	39.0	2
Willow Oak	*Quercus phellos*	84.0	1
TOTAL			**253**

Appendix B. Pictures of Site