RACEY MITIGATION SITE ON LAXON CREEK, WATAUGA COUNTY

Monitoring Report

Prepared for the

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION PROGRAM

Transportation Improvement Project R-529 BA, BB, BD

Period Covered: July 30, 2002 - February 25, 2004

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Raleigh

2004

Abstract - This report summarizes the 2002 and 2003 monitoring of 1,150 linear feet of stream enhancement at the Racey site on Laxon Creek, Watauga County. This monitoring report is submitted as partial fulfillment of the off-site stream mitigation agreement between the North Carolina Department of Transportation and the North Carolina Wildlife Resources Commission for the R-529 US 421 road improvement project in Watauga County. The 2002 and 2003 monitoring surveys include longitudinal profile, cross-section, pebble count, vegetation survival, reference photographs, and temperature data comparisons. There has been little change in the post-construction longitudinal thalweg profile when compared to the 2002 and 2003 profiles. In-stream structures are functioning as designed. Four surveyed cross-sections have remained stable since construction, with the only exception being cross-section 1+88, which is developing a more recognizable inner berm and bankfull bench. The D50 pebble size has remained constant. Vegetation survival has been low due to beaver activity. Temperature data show that the average daily temperature at the lower end of the project was 2.0°C cooler in 2003 when compared with 2002 data and 0.9°C cooler when compared with 2001 data.

The purpose of this report is to summarize the July 30, 2002 and July 14, 2003 monitoring data collected from 1,150 linear feet of stream enhancement at the Racey site (Figure 1) along Laxon Creek, Watauga County. The stream enhancement construction project was completed on November 7, 2000. The as-built survey was completed and submitted to the North Carolina Department of Transportation (DOT), North Carolina Division of Water Quality (DWQ), and United States Army Corps of Engineers (USACE) in June 2001 (Mickey and Scott 2001). This monitoring report is submitted in partial fulfillment of the off-site stream mitigation agreement between the DOT and North Carolina Wildlife Resources Commission (WRC) for the R-529 (US 421) road improvement project in Watuaga County.

Drainage area at the site is 1,696 acres (2.65 mi^2). The lower end of the project begins at Laxon Creek's confluence with the South Fork New River. The 1,150 ft of stream enhancement work are located within a conservation easement totaling 1.42 acres. The watershed contains a low density of homes with agricultural operations being the primary land disturbing activity. Most of the hillsides and valleys are used for cattle grazing, hay production, and Christmas tree farming. A significant portion of the watershed remains in second growth forest. However, since the completion of US 421 from Deep Gap to Boone, there has been an increase in conversion of agricultural land to single family home sites. Sediment in the stream originates mainly from livestock pastures, new construction sites, and gravel roads. Pre-construction project objectives at the Racey mitigation site were to improve water quality, aquatic habitat, riparian area quality, and channel stability by:

1 Re-shaping the streambanks at selected locations to reestablish a bankfull bench making the banks more resistant to erosion.
2. Installing in-stream structures (root wads, rock vanes, and rock cross-vanes) where appropriate to provide long-term bank stability, fish habitat, and to deepen and narrow the channel.
3. Planting native trees, shrubs, and ground cover on all disturbed banks and along the channel to provide long-term bank stability, stream shading, and cover and food for wildlife.

Methods

Monitoring summarized in this report is based on WRC guidelines (Clemmons 2000), DWQ and Division of Land Resources (DLR) (2002) draft guidelines and USACE et al. (2003) stream mitigation guidelines. Monitoring data collected at this enhancement site includes channel morphology (stability analysis: cross-sections, longitudinal profile, and pebble counts), reference photographs, plant survival analysis, and water temperature.

Morphology

The longitudinal profile of the stream channel is measured from a known point downstream to the farthest extent of the reach. The locations of features measured include the heads of riffles and pools, water surface elevations, in-stream structures, bankfull elevation, top of bank elevation, and any other channel-forming feature (Harrelson et al.1994). Longitudinal profiles from previous years were plotted for comparison.

Permanent cross-sections were established at four locations (Mickey and Scott 2001) during the as-built survey by placing permanent pins in the ground so data points along the tape line up exactly from year to year. Data measurements were taken from left to right facing downstream, crossing through the channel up the bank, and into the floodplain. All breaks in slope are measured, within and outside of the channel. If potential problem areas develop, new cross-sections are established and assessed year to year. If bank instability occurs, the problem will be repaired.

Modified Wolman pebble counts (Rosgen 1996) were conducted pre-construction as a basis for comparison with the as-built and monitoring counts. These data are taken to assess changes in the bed composition pre- and post-construction and during the monitoring years. One hundred counts from pools and riffles were taken along a reach (in proportions equal to that of the overall reach pool/riffle ratio) and along a riffle cross-section.

Success or failure of restoration activities is based on a subjective review of the data. Minor changes in the cross-sectional areas, longitudinal profile, and substrate composition are expected. Major changes in these characteristics will be evaluated to determine if they represent a movement toward unstable stream channel conditions or are changes that represent an increase in stability.

Reference Photographs

Reference photograph locations were established at distinguishing points along the stream. Photographs were taken from the same location and during the same time of year to make accurate comparisons. Photographs were used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of in-stream structures. Photographs also are used to indicate if excessive bank erosion or bank instability is occurring. Where potential problem areas appear to be developing, additional photographs will be taken and a cross-section transect established. When channel or bank instability occurs, the problem will be repaired.

Vegetation

Vegetation was monitored by direct counts over the length of the reach. Due to the short length of the site, vegetation survival plots were not established. Numbers of live trees and livestakes were recorded and compared to the numbers planted.

Temperature

Temperature loggers were placed in the stream at the upper and lower ends of the project reach. Loggers were programmed to record temperature hourly and installed in July. Data was downloaded, edited, and plotted. Twenty degrees Celsius (68°F) was chosen as the generally accepted maximum water temperature that will sustain coldwater communities (USACE et al. 2003). The daily mean water temperatures were calculated by averaging all readings each day. The number of hours and days from July 26 through September 27 were determined, then the number of hours and days that 20°C was exceeded at the upper and lower ends of the site were calculated.

Results and Discussion

Stream flows were at all-time lows during 2001 and 2002 and few sediment flushing flows occurred during this period. Bankfull events did occur on March 30, 2001, February 22, 2002, and July 4, 2002 prior to the July 2002 monitoring survey. Prior to the July 2003 monitoring survey, a bankfull event occurred on March 16, 2003. As normal rain events returned to North Carolina during fall 2002 and winter 2003, several inner berm flow events occurred. No less than two bankfull flow events must be documented through the required five-year monitoring period and these events must occur during separate years.

Morphology

Longitudinal profile and cross-section data were collected on July 30, 2002 and July 14, 2003 Pebble count data were collected on July 30, 2002 and August 18, 2003.

Longitudinal profile data were collected from 963 linear feet of the 1,150 ft in the project site. Longitudinal profile data plots were overlaid to show changes in bed form from previous years (Figure 2). The as-built survey data showed there were 40% pools in 2001 (Mickey and Scott 2001), whereas in 2002 and 2003 pool habitat comprised 50% and 65% of the total reach. Three beaver dams were present at stations 2+40, 3+58, and 6+50 during the 2003 survey. A small debris jam consisting of beaver cuttings was located at station 3+62.

The longitudinal thalweg profile has shifted little since 2001 (Figure 2). There has been aggradation of materials at some locations and deepening at other locations; however, none of this activity indicates a migration towards an unstable stream channel. These changes appear to be normal adjustments to stream flow and weather conditions. From 2002 to 2003 pool habitat increased from 50% to 65%. This pool habitat increase is the direct result of three new beaver dams. These dams have backed water over traditional riffle habitats. There has been no shift in the meander pattern and in-stream structures are functioning as designed. No bank scour or erosion was evident and no problems were noted with any of the structures.

Overlay of data from four cross-sections, as shown in Figures 3.1-3.4, indicate few changes have taken place in the channel. The width/depth ratio, cross-sectional area, and entrenchment ratio have remained fairly constant (Table 1). The data indicate that both C4 and B4c stream channel types (Rosgen 1996) are present in the reach. There has been little change in the cross-section dimensions since completion of the as-built survey in 2001 (Figures 3.1-3.4). However, an inner berm bench is forming at cross-section 1+88 (Figure 3.1). Bankfull and inner berm storm events have deposited sediments on the constructed floodplain.

Pebble count data (Appendix 1) reveal the weighted D50 pebble size was 23.9 mm in 2001, 24.7 mm in 2002, and 23.7 mm in 2003 (Appendix 1). This places the D50 material towards the upper size for coarse gravel. The D84 material size was 148 mm in 2001, 90 mm in 2002, and 95 mm in 2003. The D84 material has dropped from the large cobble size class in 2001 to the medium cobble size class in 2002 and 2003. This slight drop in the D84 from large to medium cobble is probably the direct result of stream channel adjustment following construction in 2001 and to 2002 and 2003 stream flow conditions. It is expected that the D84 will remain in this range.

Reference Photographs

Reference photographs show a maturing riparian buffer. Photographs also show bank stability from year to year with no development of unstable depositional areas or bank erosion along the reach (Appendix 2). The goal of obtaining a conservation easement around this reach of stream was to reestablish a riparian corridor with mature vegetation. The photographs in Appendix 2 show that by restricting use of the riparian corridor the vegetation is growing and it will eventually improve the amount of shade over the stream. The reference photographs indicate that both the in-stream structures and stream channel are remaining stable throughout the reach.

Vegetation

Since construction, all disturbed banks have become well vegetated. A total of 412 live stakes and bare root nursery trees were planted on the 1.42 acre site during 2001 and 2002 (Table 2). Attempts to determine survival of plantings were made at the time of the monitoring surveys in 2002 and 2003. However, these survival counts were abandoned due to dense thickets of blackberry *Rubus* spp., goldenrod *Solidago* spp., and other species that made visual sighting of the stems planted in 2001 nearly impossible. A survival count was conducted on February 25, 2004 with 133 stems being counted (Table 2) for a 32% survival rate. Based on USACE et al. (2003) criteria of 320 stems per acre through year three for mitigation sites, this 1.42-acre site should contain 454 planted trees/shrubs. However, fewer trees and shrubs were planted due to the numerous trees that had been planted by the landowner (14 white pine *Pinus strobus,* 7 black cherry *Prunus serotina,* and 18 walnut *Juglans nigra*) and trees that were naturally occurring along sections of the channel inside the conservation easement area. Since construction in 2001, naturally seeded tag alder *Alnus serrulatta* and black locust *Robinia pseudoacacia* have been observed at numerous locations along the new stream channel. These volunteer trees will provide additional shade and stability to the channel.

Three reasons can be given for the low number of stems counted on February 25, 2004. First, beavers had cut many of the stems planted at the site for dam construction. Second, a major flood occurred on November 19, 2003 covering many stems with debris. Third, several areas of streambank were covered with snow, limiting visual sighting of stems. The continued presence of beavers at this site could seriously limit survival of planted trees and the natural rejuvenation of woody species. In order to offset stem loss due to beaver impacts, an additional 215 silky willow *Salix sericea* cuttings were installed on February 25, 2004. Plant monitoring will continue to ensure that a good stand of shrubs and trees becomes established.

Temperature

Temperature was recorded hourly from July 26 - September 27 during 2001 and 2003 (Appendix 3). During 2002, temperatures were recorded at the upper end of the project from June 13 through July 5 and at the lower end of the project from June 13 - July 5 and July 26-September 27(Appendix 3). The average daily water temperatures between the upper and lower boundaries of Laxon Creek at the Racey were determined (Figure 4). The average daily temperatures at the upper Racey location were 17.7°C, 18.1°C, and 16.5°C in 2001, 2002, and 2003, whereas at the lower location they were 17.4°C, 18.5°C and 16.5°C. In order to understand temperature fluctuations at the site, 20°C (68°F) was selected as a threshold point where water temperatures might begin to negatively impact cold-water fish populations. In 2001, from a total of 1510 hours of data collected over 45 days at the upper end of the site. At A total of 328 hours (22%) exceeded 20°C. At the lower end of the site there were 72 hours (5%) that exceeded 20°C. In 2002, the upper temperature recorder failed and data was only collected from June 13 - July 5. During this period, 527 hours of data were recorded over 20 days, of which 140 hours (27%) exceeded 20°C at the upper site. At the lower site 131 hours (25%) exceeded 20°C. In 2002, water temperature recorders collected 1535 hours of data over 64 days at the lower end of the site. A total of 351 hours (23%) exceeded 20°C.

In 2003, 1535 hours of data was collected over 64 days at the upper end and lower ends of the project. At the upper site, there were 30 hours (2%) exceeding 20°C, while at the lower site 72 hours (5%) exceeded 20°C. The upper temperature recorder was moved to a location downstream and below the confluence with an unnamed tributary to Laxon Creek. This resulted in the temperature recorder being placed in an area of cooler water from the unnamed tributary. In hindsight, the recorder should have been placed further downstream from the confluence of the unnamed tributary to allow for better mixing of water from the two streams to occur before the temperature was recorded. It is assumed that the fewer number of days the water temperature was over 20°C at the upper location when compared to the lower location was a result of moving the temperature recorder. Data indicate that the average daily temperature at the lower Racey location was 2.0°C cooler in 2003 when compared with 2002 data and 0.9°C cooler when compared with 2001 data. The lower water temperatures recorded in 2003 at the lower end of the project when compared to 2001 and 2002 data is attributed to an increase in streamside vegetation, resulting in more shading and a narrowing of the channel, and a possible increase in stream flows due to the end of the 2001-2003 drought. As the riparian vegetation matures, the number of hours water temperatures exceed 20°C should decrease. This will make habitat conditions more favorable to coldwater fish species.

Summary

Through natural stream design concepts, a C4/B4c channel containing proper pattern, dimension, and profile has been constructed at the Racey site. This project has not experienced any in-stream habitat structure or bank failures since construction in 2000. Water temperatures at the lower end of the site appear to be decreasing as the riparian zone matures. The channel enhancement project is functioning as designed.

Recommendations

1. Continue monitoring channel morphology, vegetation survival, and taking photographic records for the duration of the required monitoring period.

2. Compile and plot channel morphology (cross-sections, longitudinal profiles, and pebble counts) data cumulatively and evaluate for indications of change towards increasingly unstable or stable conditions.

3. Expand site photographic records to show the site during winter and to document any channel or vegetation changes that occur during the year.

4. Inspect the site after potential bankfull storm events to document damage to the stream banks or structures.

5. Monitor potential problem areas with new cross-sections and photographs to determine if they are migrating towards an unstable condition.

6. Repair problem areas if it is determined that they are creating unstable channel conditions.

7. Move the upper temperature recorder back to the 2001 and 2002 location.

References

Clemmons, M. M. 2000. Mitigation site monitoring protocol for the NCWRC/NCDOT mitigation program. North Carolina Wildlife Resources Commission, Habitat Conservation Program, Raleigh.

Harrelson, C. C., C. L. Rawlins, and J. P. Potyondy. 1994. Stream reference sites: an illustrated guide to field technique. U. S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-245, Fort Collins, Colorado.

Mickey, J. H. and S. Scott. 2001. As-built report for the Racey mitigation site, Laxon Creek, Watauga County. North Carolina Wildlife Resources Commission, Raleigh.

Rosgen, D. L. 1996. Applied river morphology. Wildland Hydrology Books, Pagosa Springs, Colorado.

DWQ and NCDLR (North Carolina Division of Water Quality and North Carolina Division of Land Resources). 2000. "Draft internal technical guide for stream work in North Carolina". Raleigh.

USACE (U. S. Army Corps of Engineers), Wilmington District, U. S. Environmental Protection Agency, North Carolina Wildlife Resources Commission, and The North Carolina Division of Water Quality. 2003. "Stream mitigation guidelines". Wilmington, North Carolina.

FIGURE 1. Racey mitigation site, Laxon Creek, Watauga County, 2001-2003.

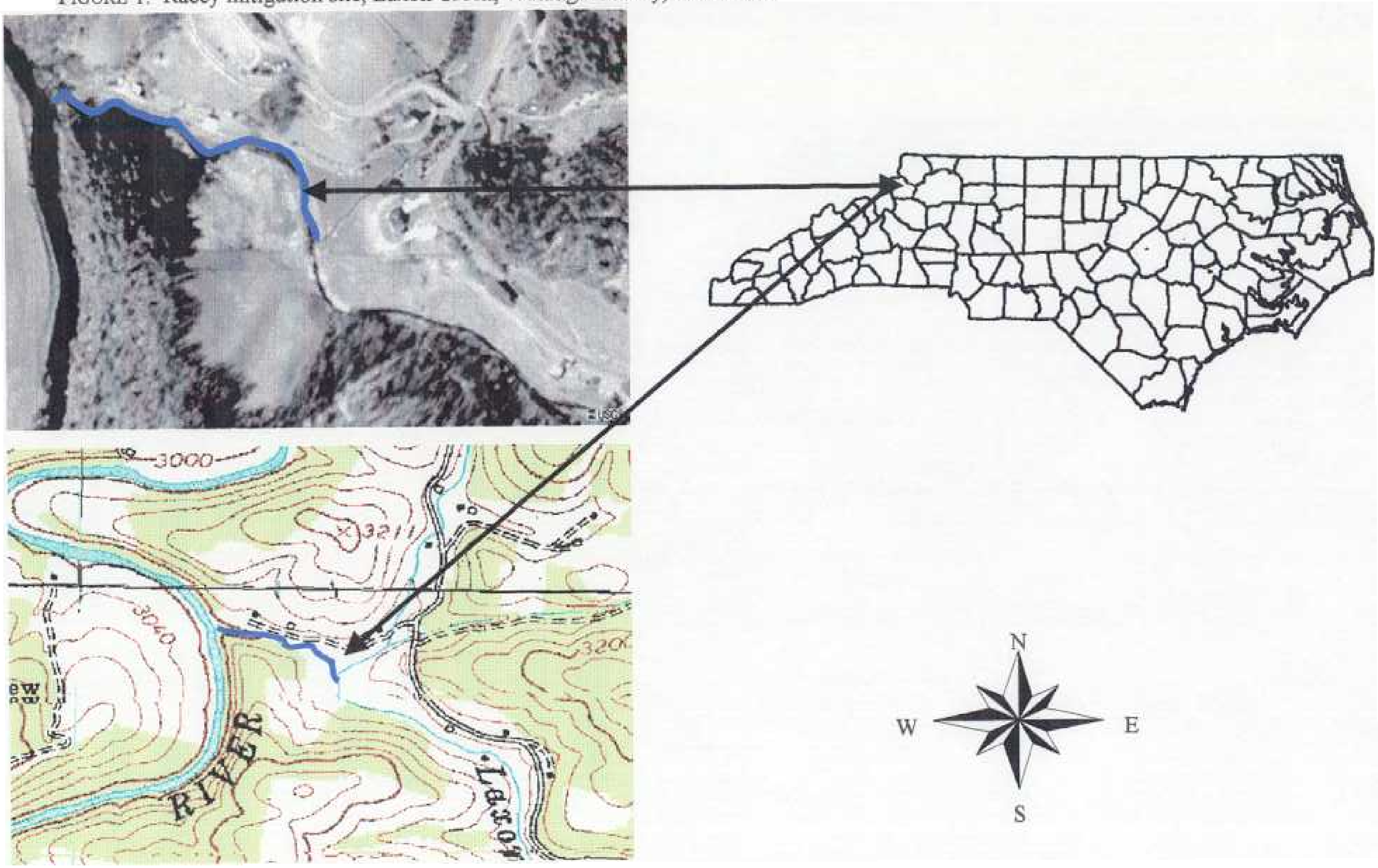


FIGURE 2. Longitudinal profile comparisons, Racey site, Laxon Creek, Watauga County, 2001-2003.

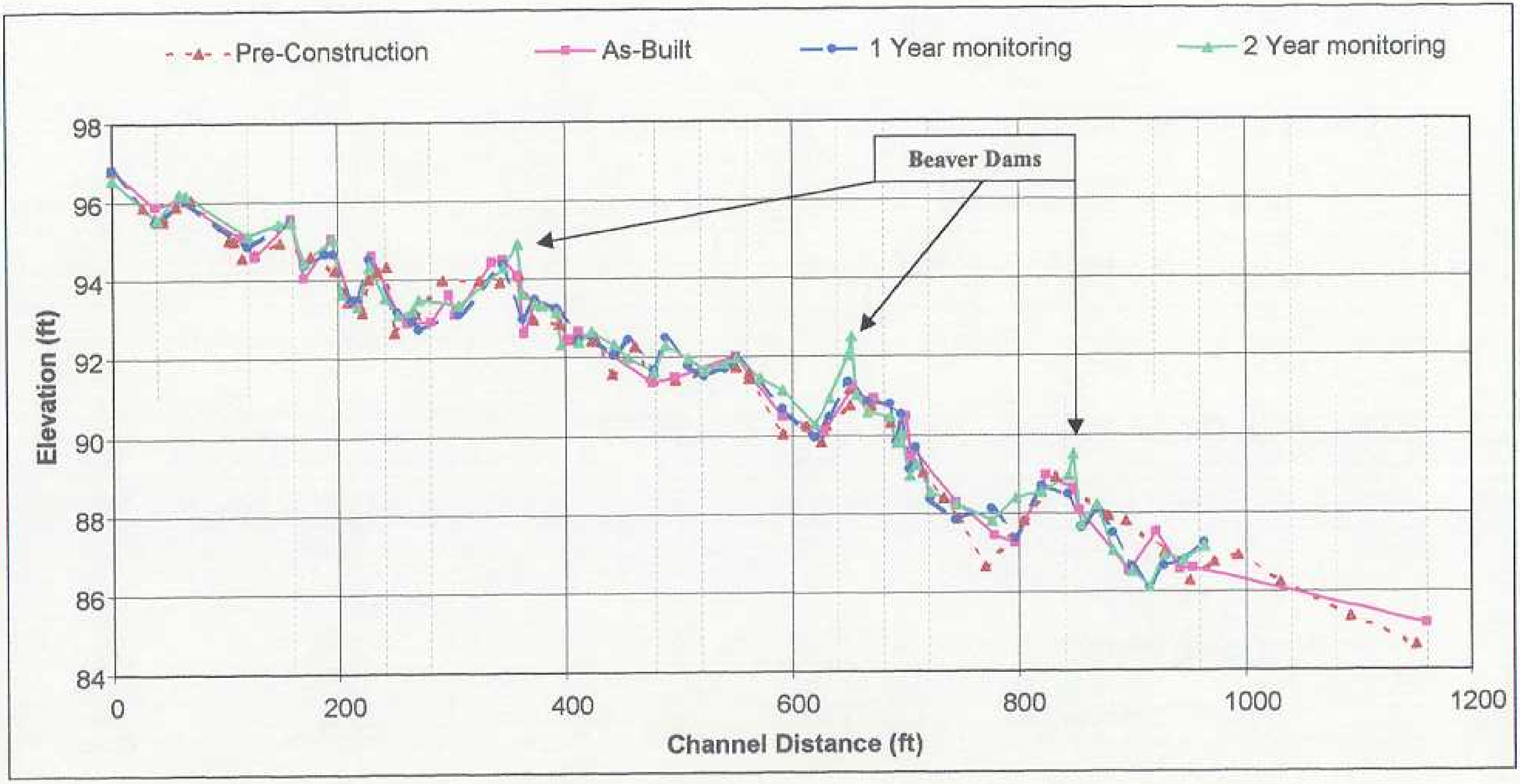


FIGURE 3. Cross-section comparisons, Racey site, Laxon Creek, Watauga County, 2001-2003.

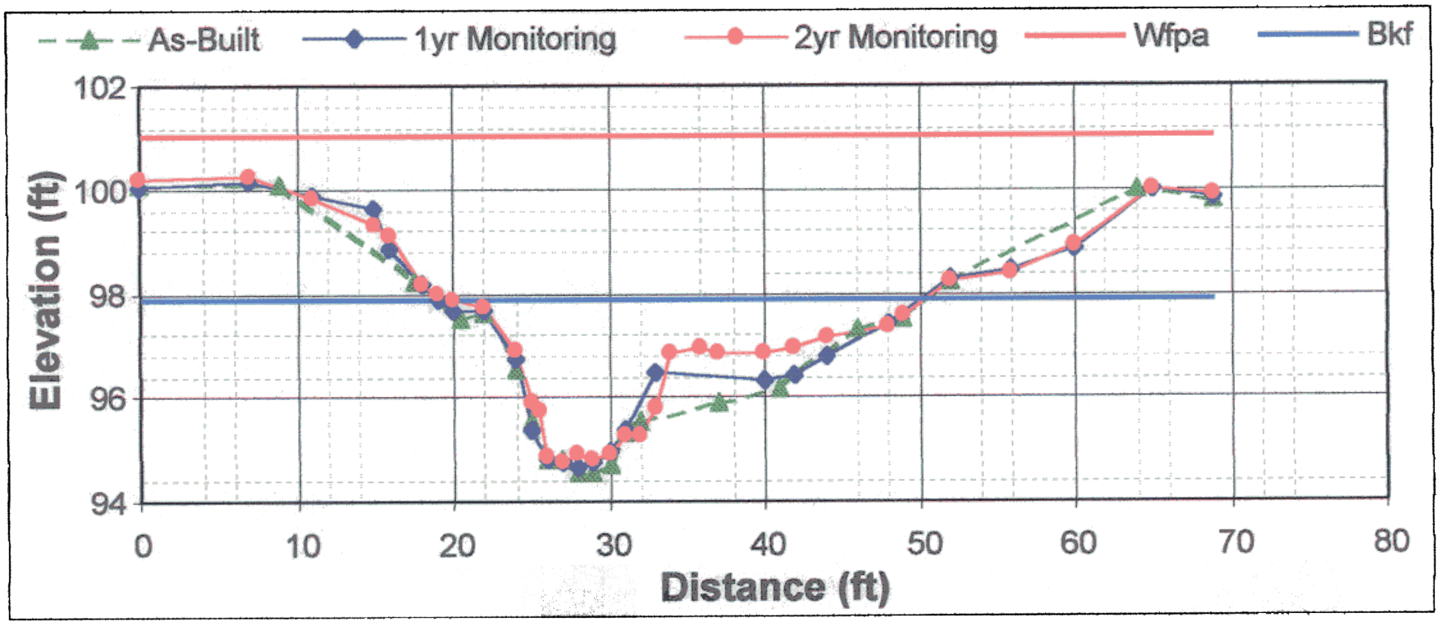


FIGURE 3.1. Cross section station 1+88, riffle.

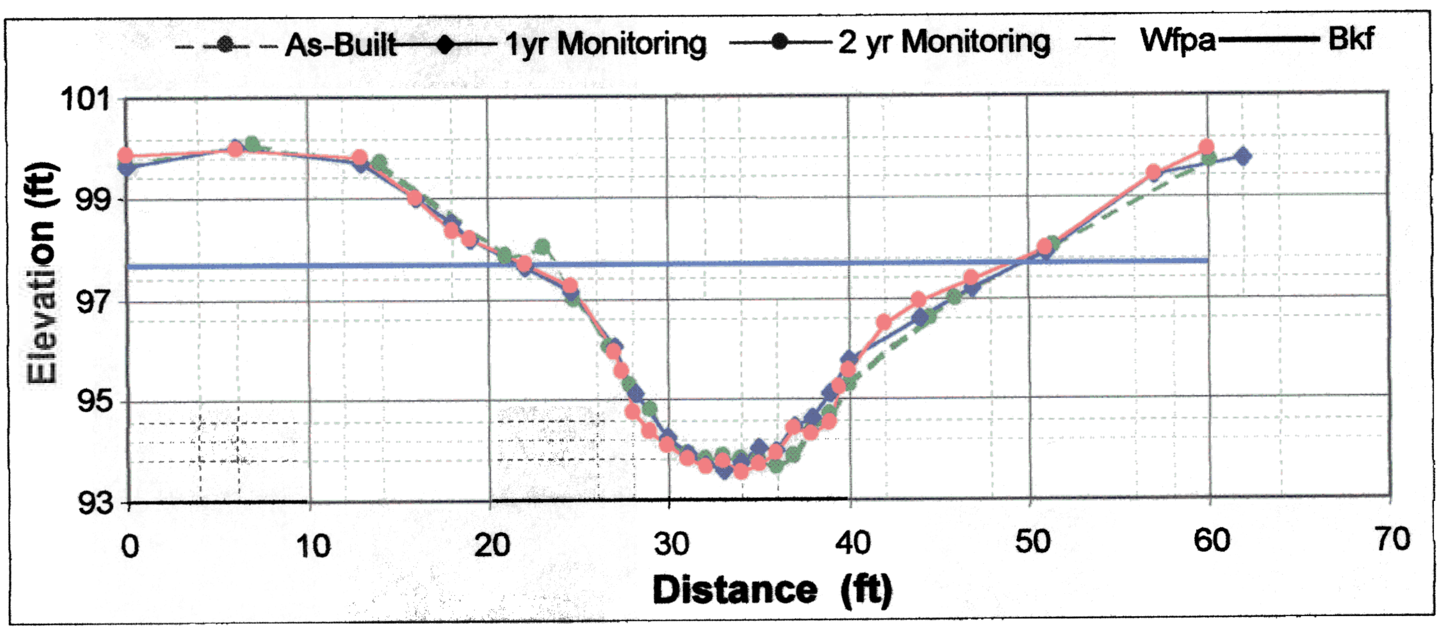


FIGURE 3.2. Cross section station 2+08, pool.

FIGURE 3. Continued.

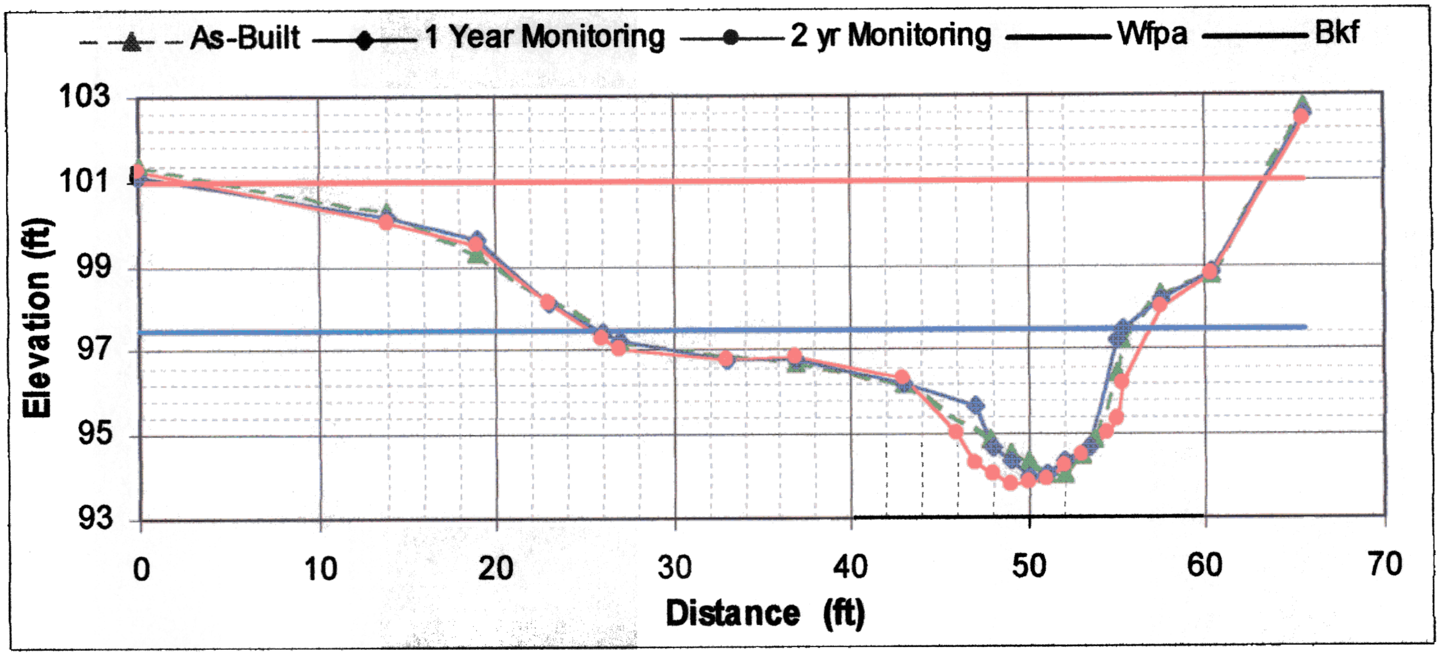


FIGURE 3.3. Cross section station 7+13, riffle.

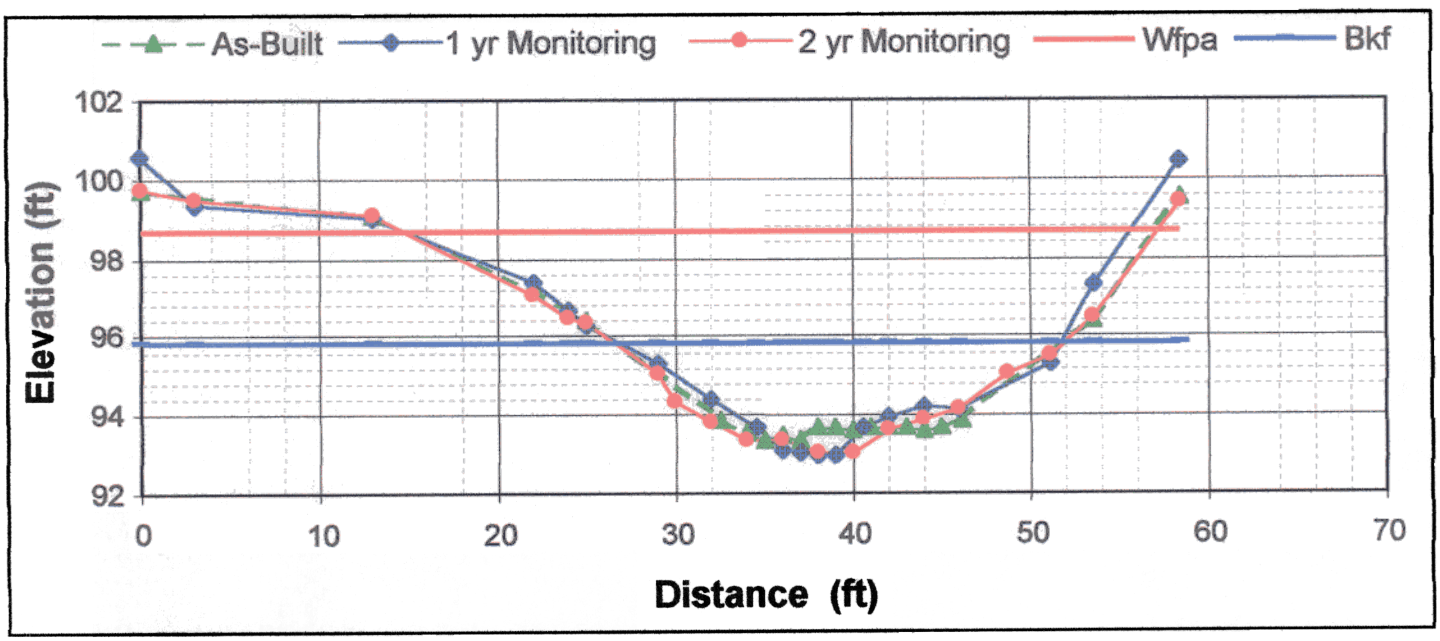
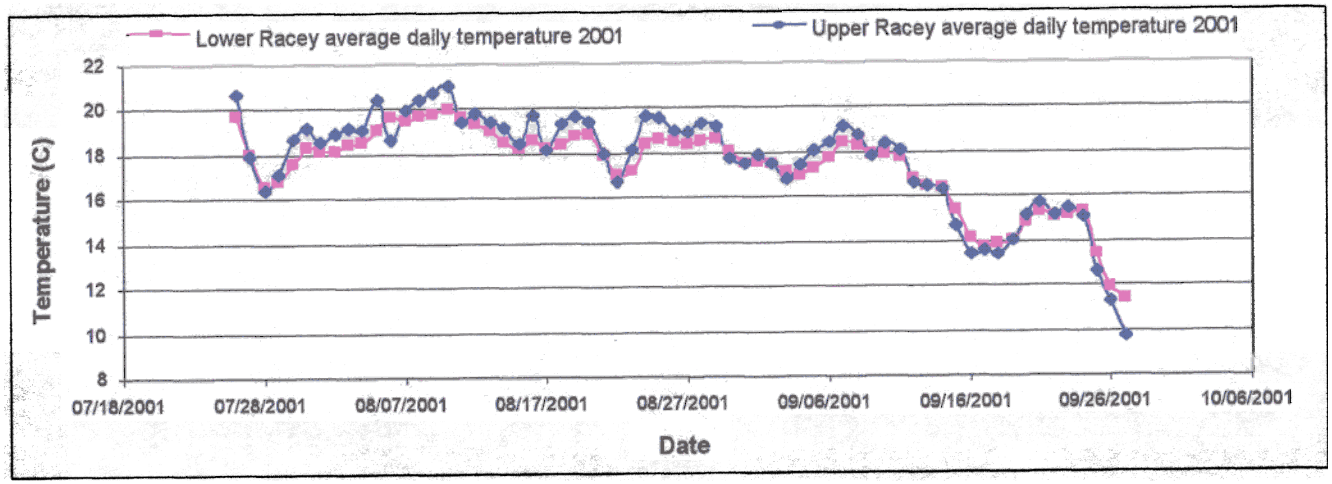
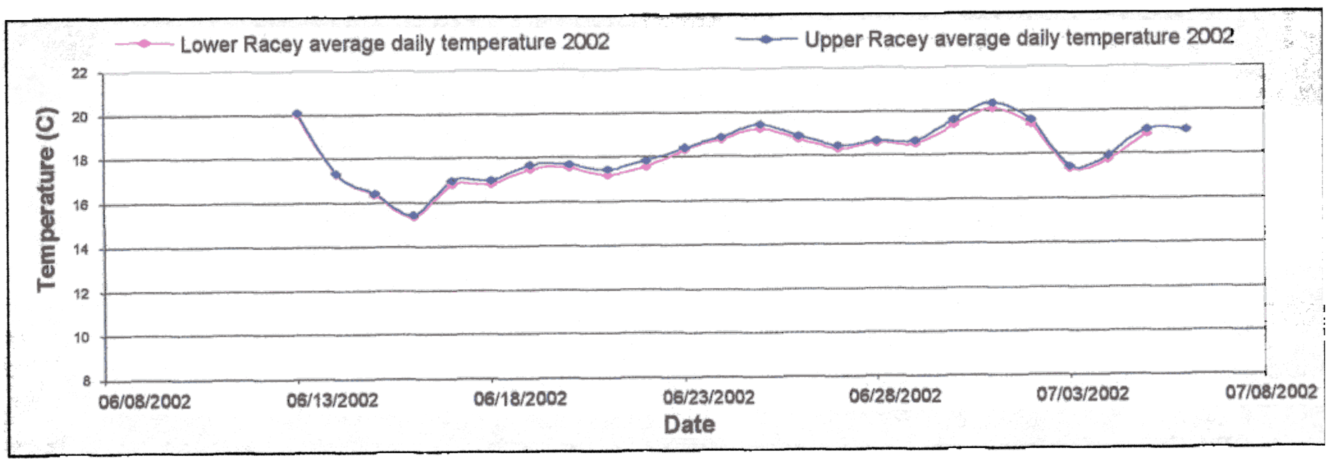


FIGURE 3.4. Cross section station 8+40, riffle.

FIGURE 4. Comparisons of average daily water temperatures at the upper and lower boundaries of the Racey mitigation site 2001, 2003.





**Note: This is not the same time window of the 2001, 2003 graphs.

Figure 4. Continued

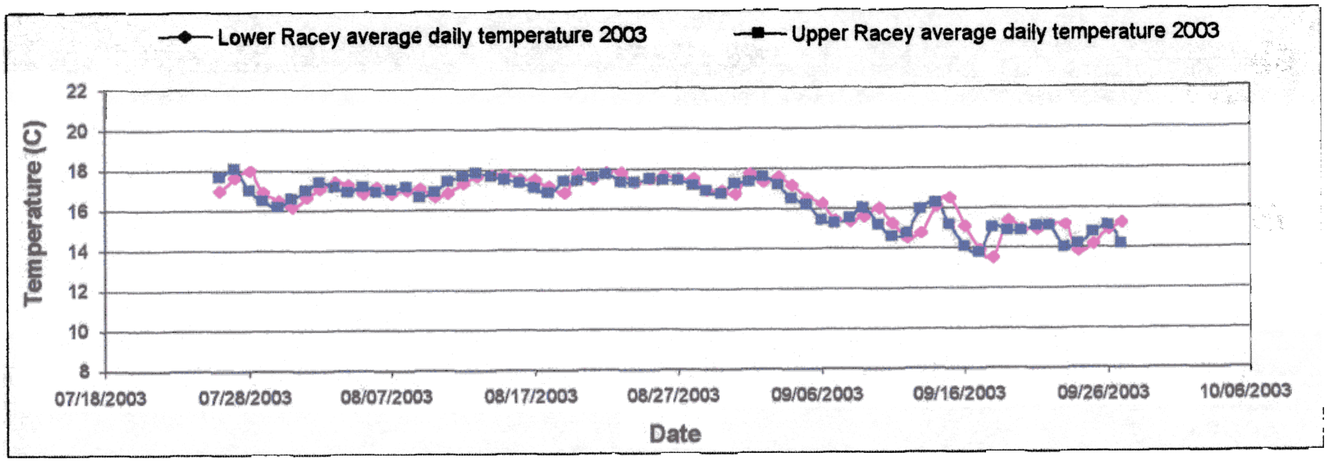


TABLE 1.—Stream channel characteristics from two riffle cross-sections at the Racey mitigation site, Laxon Creek, Watuaga County, 2001-2003.

	Cross-section at 1+88			Cross-section at 7+13		
	2001[a]	2002	2003	2001[a]	2002	2003
Area (m^2)	41.9	39.4	39.6	34	40.9	42.6
Bankfull width (m)						
Width/Depth ration (m)	20.2	21.8	23.4	23.7	21.6	22.1
Entrenchment ratio	2.7	3.4	3.3	1.8	2.2	1.9
D50 pebble count size[b] (mm)	23.9	24.7	23.7	23.9	24.7	23.7
Sinuosity	1.2	1.2	1.2	1.2	1.2	1.2
Water surface slope (%)	0.01	0.01	0.01	0.01	0.01	0.01
Stream type (Rosgen)	C4	C4	C4	B4c	B4c	B4c

[a] As-built survey.
[b] weighted D50.

TABLE 2. - Live stakes and trees planted at the Racey mitigation site, Laxon Creek, Watauga County, 2001 - 2002.

	No. planted		Survival Count				
Live stakes	2001	2002	2002[a]	2003[a]	2004[b]	2005	2006
Silky Willow *Salix sericea*	30				31		
Silky dogwood *Cornus amomum*	157				29		
Black Willow *Salix nigra*	13				2		
Bare root nursery stock							
Red oak *Quercus rubra*	25				6		
Black cherry *Prunus serotina*	50				15		
Persimmon *Diospyros virginiana*	25	7			1		
White ashe *Fraxinus americana*	25				2		
White pine *Pinus strobus*	20				5		
Locust *Robinia pseudoacacia*		10			10[c]		
Tag alder *Alnus serrulata*		45			30		
Black walnut *Juglans nigra*		5			2		
Total	345	67			133[d]		

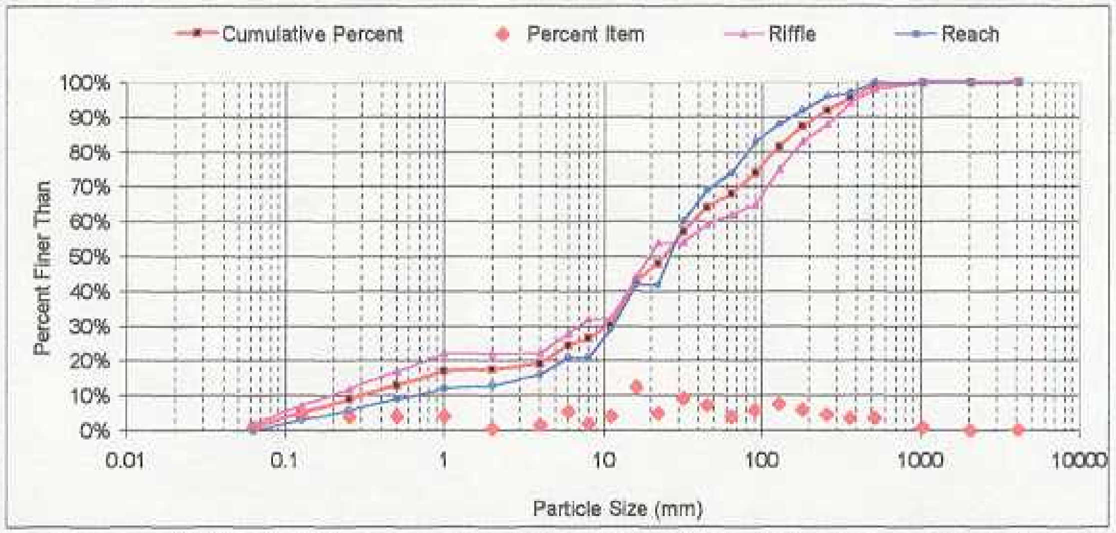
[a]No count conducted, existing vegetation too dense to be able to do an accurate count.
[b]Count made on February 24, 2004.
[c]Counts were actually higher due to natural germination of these species.
[d]Total does not include 14 white pine, 18 black walnut, and 7 black cherry planted by the landowner along the riparian corridor prior to construction of the project in 2000.

Appendix 1. Weighted pebble counts for the Racey mitigation site, Laxon Creek, Watauga County, 2001-2003.

Percent Riffle:	50		Percent Run:	
Percent Pool:	50		Percent Glide:	

Pebble Count,
--Laxon Creek
--South Fork New River
--Racey site
Note:

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	1.0	# #
very fine sand	0.062	0.13	4.0	# #
fine sand	0.13	0.25	4.0	# #
medium sand	0.25	0.5	4.0	# #
coarse sand	0.5	1	4.0	# #
very coarse sand	1	2	0.5	# #
very fine gravel	2	4	1.5	# #
fine gravel	4	6	5.5	# #
fine gravel	6	8	2.0	# #
medium gravel	8	11	4.0	# #
medium gravel	11	16	12.5	# #
coarse gravel	16	22	5.0	# #
coarse gravel	22	32	9.0	# #
very coarse gravel	32	45	7.0	# #
very coarse gravel	45	64	4.0	# #
small cobble	64	90	6.0	# #
medium cobble	90	128	7.5	# #
large cobble	128	180	6.0	# #
very large cobble	180	256	4.5	# #
small boulder	256	362	3.5	# #
small boulder	362	512	3.5	# #
medium boulder	512	1024	1.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
Weighted Count:			100	
True Total Particle Count:			200	



Size percent less than (mm)				
D16	D35	D50	D84	D95
0.841	12.59	23.9	148	345

Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
1%	17%	51%	24%	8%	0%

A.1.1. Weighted pebble count, 2001.

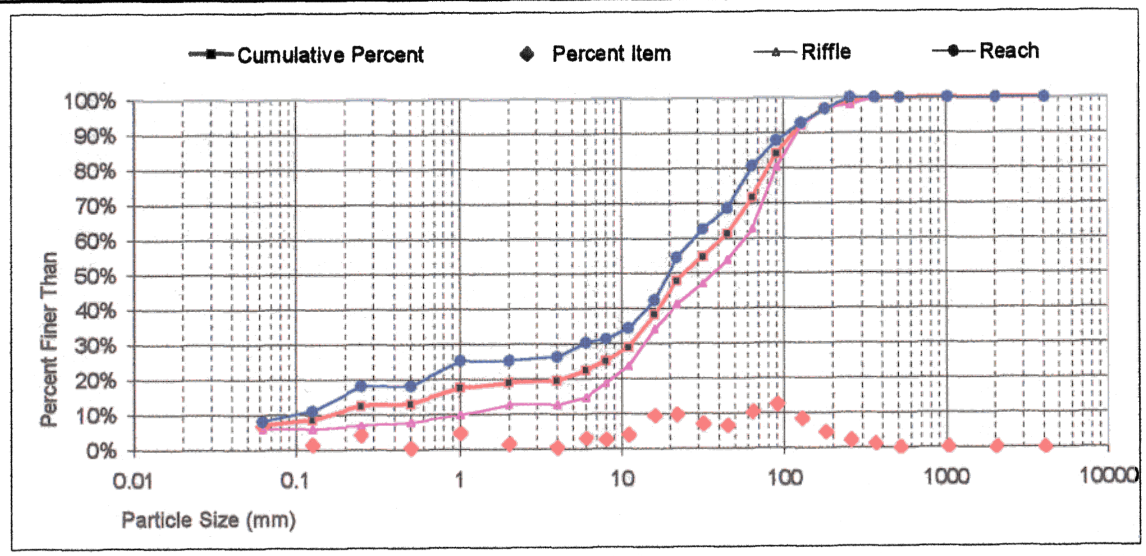
Appendix 1 Continued.

Percent Riffle:	50	Percent Run:		
Percent Pool:	50	Percent Glide:		

Pebble Count,

Note: Laxon Creek
South Fork New River
Racey site

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	6.9	# #
very fine sand	0.062	0.13	1.5	# #
fine sand	0.13	0.25	4.0	# #
medium sand	0.25	0.5	0.5	# #
coarse sand	0.5	1	4.5	# #
very coarse sand	1	2	1.5	# #
very fine gravel	2	4	0.5	# #
fine gravel	4	6	3.0	# #
fine gravel	6	8	2.5	# #
medium gravel	8	11	4.0	# #
medium gravel	11	16	9.4	# #
coarse gravel	16	22	9.4	# #
coarse gravel	22	32	6.9	# #
very coarse gravel	32	45	6.4	# #
very coarse gravel	45	64	10.4	# #
small cobble	64	90	12.3	# #
medium cobble	90	128	8.4	# #
large cobble	128	180	4.5	# #
very large cobble	180	256	2.0	# #
small boulder	256	362	1.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.5	#
		Weighted Count:	100	
		True Total Particle Count:	202	



Size percent less than (mm)				
D16	D35	D50	D84	D95
0.795	14.01	24.7	90	154

Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
7%	12%	53%	27%	1%	1%

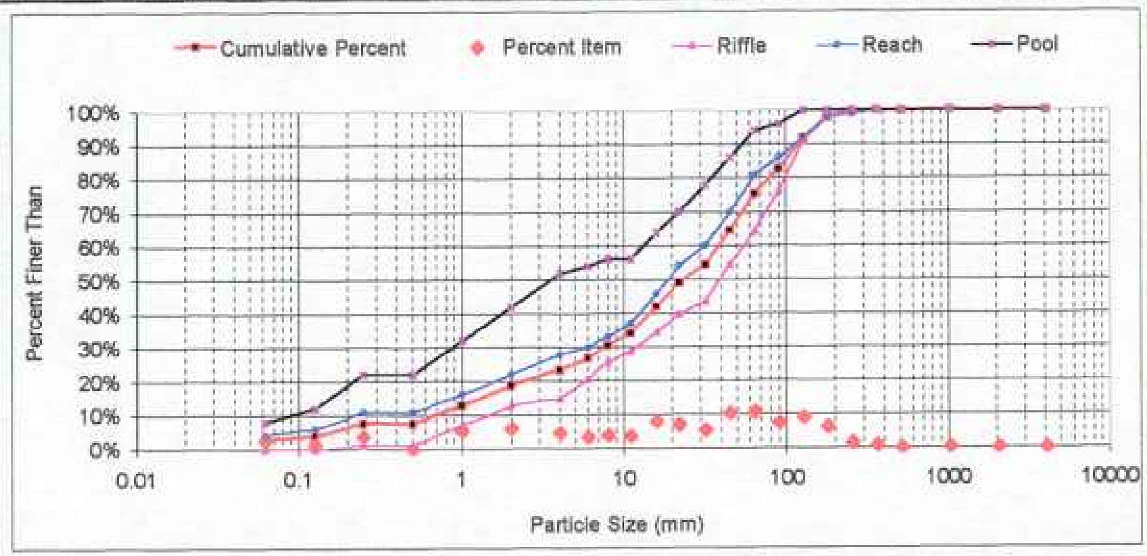
A.1.2. Weighted pebble count, 2002.

Appendix 1 Continued

Percent Riffle:	35		Percent Run:	
Percent Pool:	65		Percent Glide:	

Material	50		Total #	
silt/clay	0	0.062	2.6	# #
very fine sand	0.062	0.13	1.3	# #
fine sand	0.13	0.25	3.6	# #
medium sand	0.25	0.5	0.0	# #
coarse sand	0.5	1	5.3	# #
very coarse sand	1	2	6.0	# #
very fine gravel	2	4	4.6	# #
fine gravel	4	6	3.4	# #
fine gravel	6	8	3.7	# #
medium gravel	8	11	3.6	# #
medium gravel	11	16	7.9	# #
coarse gravel	16	22	6.9	# #
coarse gravel	22	32	5.3	# #
very coarse gravel	32	45	10.3	# #
very coarse gravel	45	64	10.6	# #
small cobble	64	90	7.4	# #
medium cobble	90	128	9.1	# #
large cobble	128	180	6.3	# #
very large cobble	180	256	1.3	# #
small boulder	256	362	0.7	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	251	

Pebble Count,
Laxon Crk
South Fork New River
Racey site
Note:



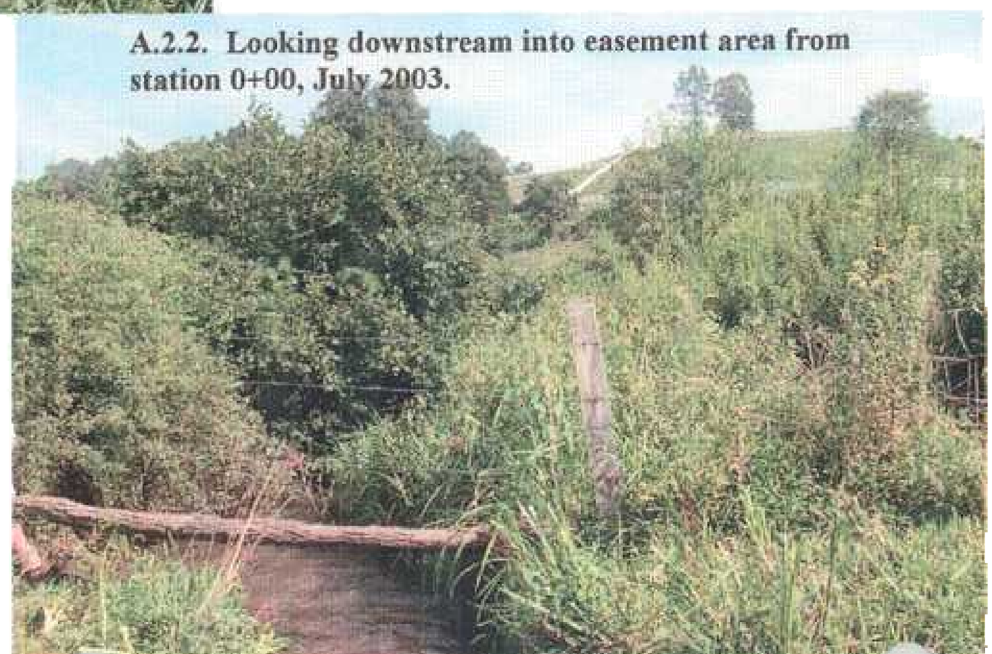
Size percent less than (mm)				
D16	D35	D50	D84	D95
1.445	11.48	23.7	95	153

Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
3%	16%	56%	24%	1%	0%

A.1.3. Weighted pebble count, 2003

Appendix 2. Photos of the Racey mitigation site, Laxon Creek, Watauga County, 2001-2003.

A.2.1. Looking upstream from upper easement boundary, outside easement, July 2003. This area is grazed by cattle.



A.2.2. Looking downstream into easement area from station 0+00, July 2003.

A.2.3. Looking upstream from station 2+40, May 200

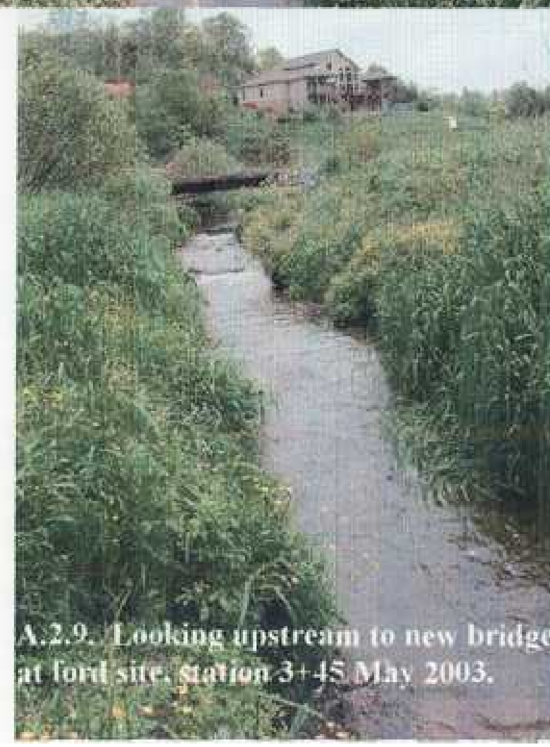
A.2.4. Looking upstream from station 2+40, July 2002.

A.2.5. Looking upstream from station 2+40, May 2003.

A.2.6. Looking upstream to ford, station 3+45, November 2000.

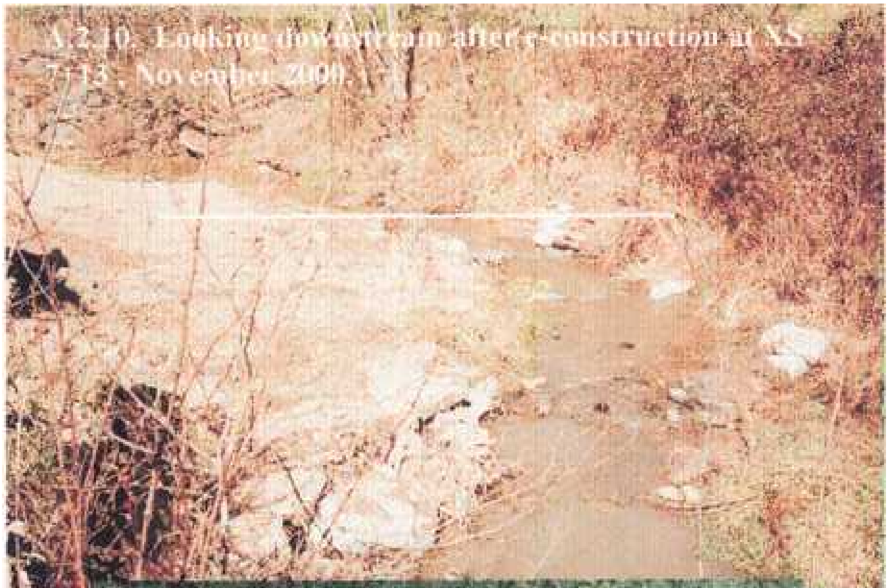
A.2.7. Looking upstream to ford, station 3+45, October 2001

A.2.8. Looking upstream to new bridge at ford site, station 3+45, July 2002.

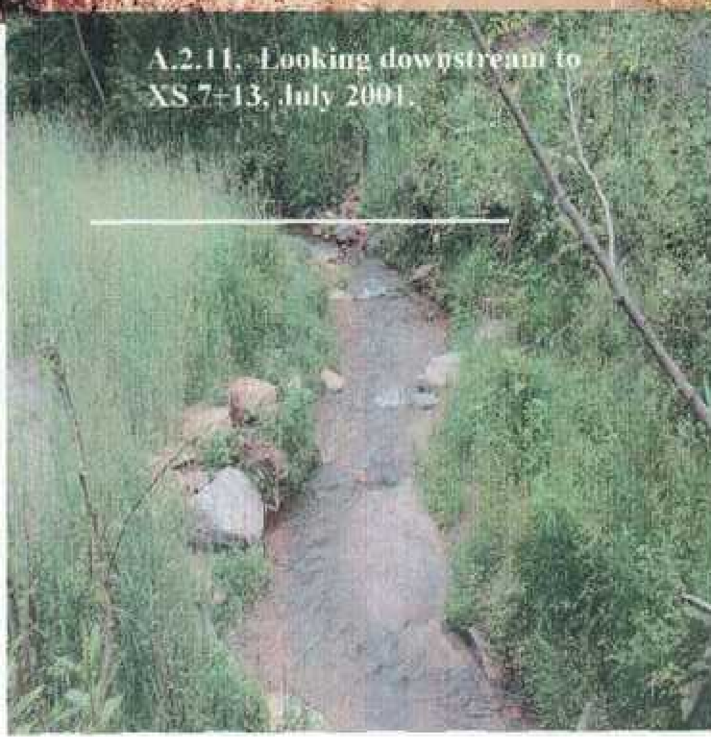


A.2.9. Looking upstream to new bridge at ford site, station 3+45 May 2003.

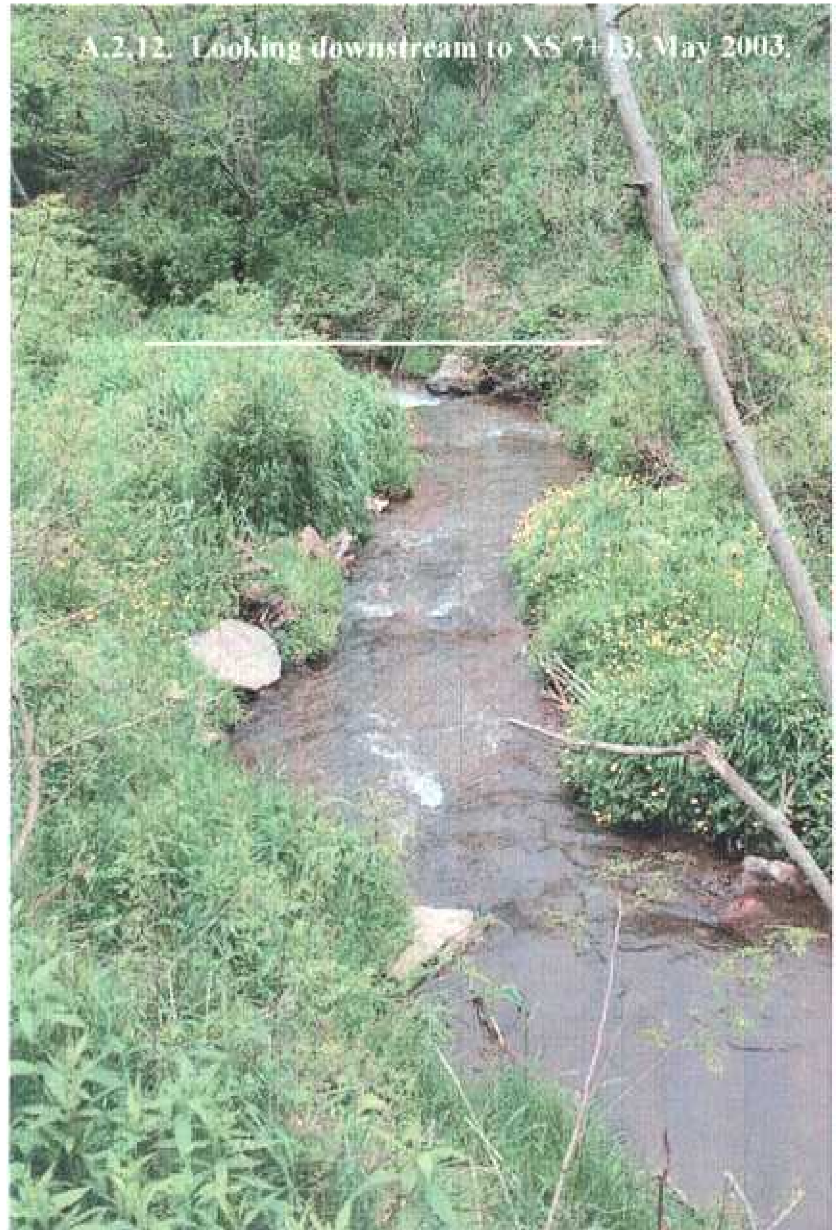
Appendix Continued.



A.2.10. Looking downstream after re-construction at XS 7+13, November 2000.



A.2.11. Looking downstream to XS 7+13, July 2001.



A.2.12. Looking downstream to XS 7+13, May 2003.

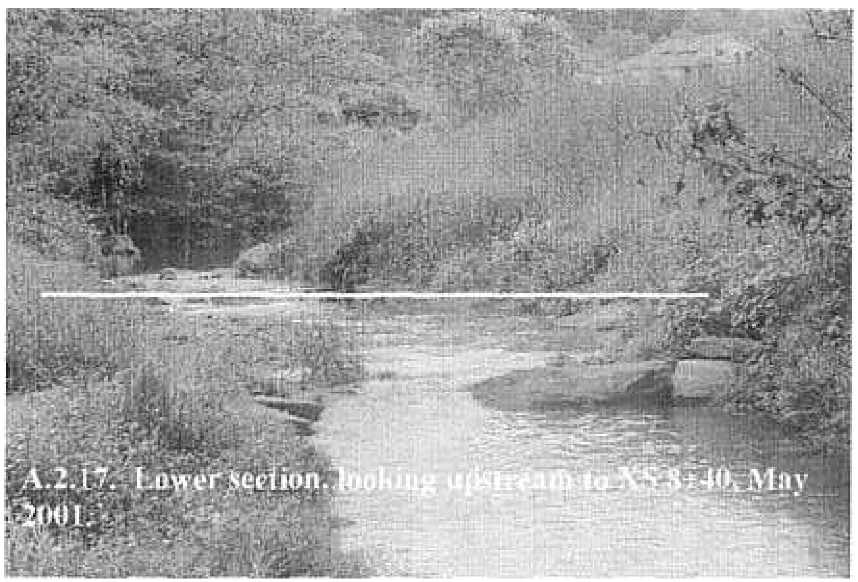
Appendix 2. Continued

A.2.13. Looking upstream at XS 7+13, May 2001.

A.2.14. Looking upstream at XS 7+13, July 2002.

A.2.15. Looking upstream at XS 7+13, May 2003.

A.2.16. Lower section, looking upstream to XS 8+40, September 2000.



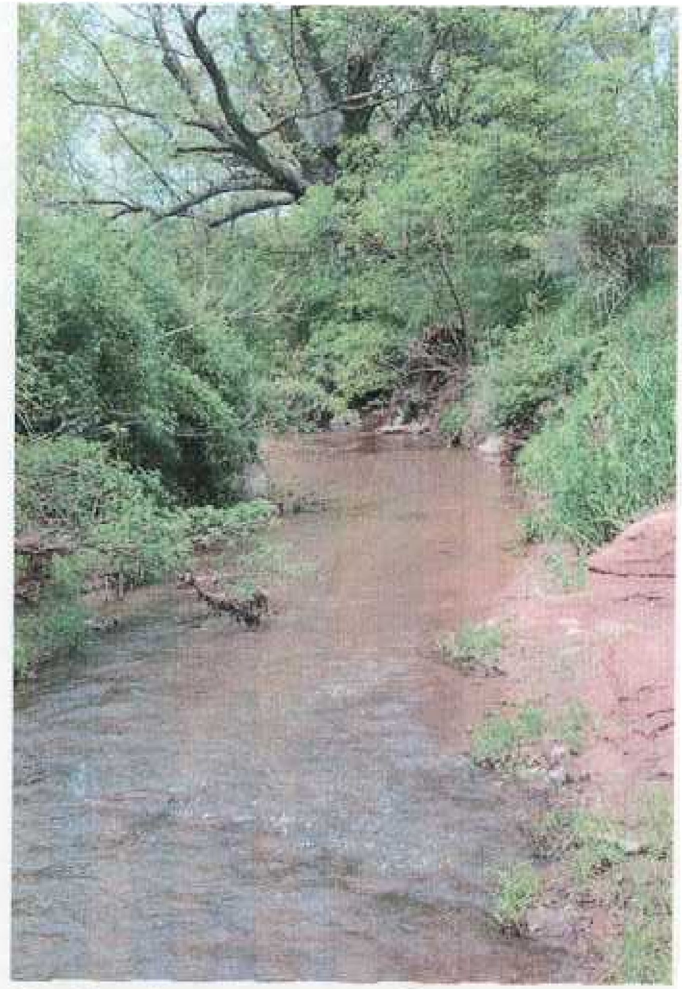
A.2.17. Lower section, looking upstream to XS 8+40, May 2001.

A.2.18. Lower section, looking upstream to XS 8+40, July 2002

A.2.19. Lower section, looking upstream to XS 8+40, May 2003.

Appendix 2. Continued.

A.2.20. Looking downstream to confluence with S. Fk. New River, Oct. 2001.

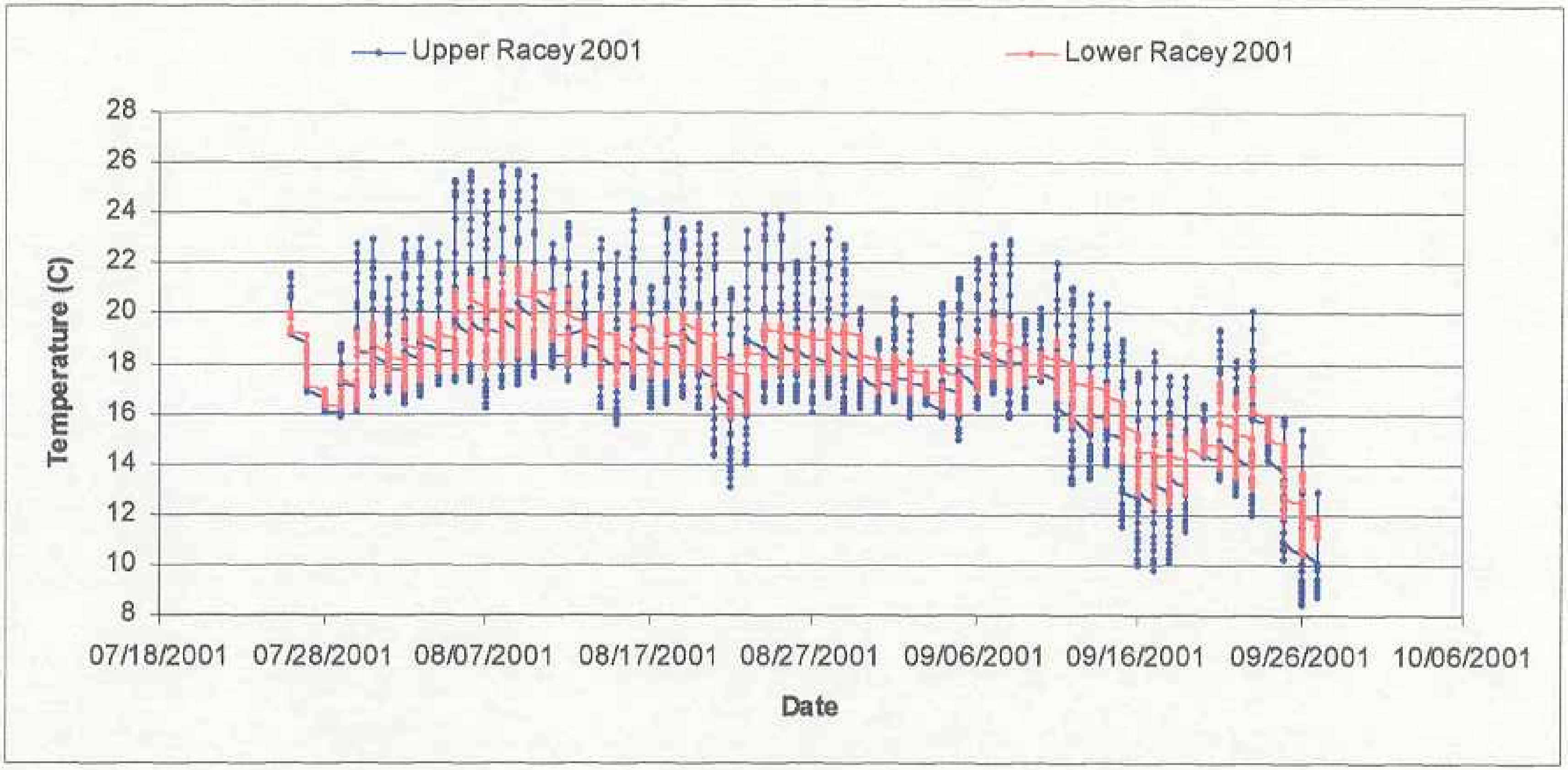


A.2.21. Looking downstream to confluence with South Fork New River, 7/02.

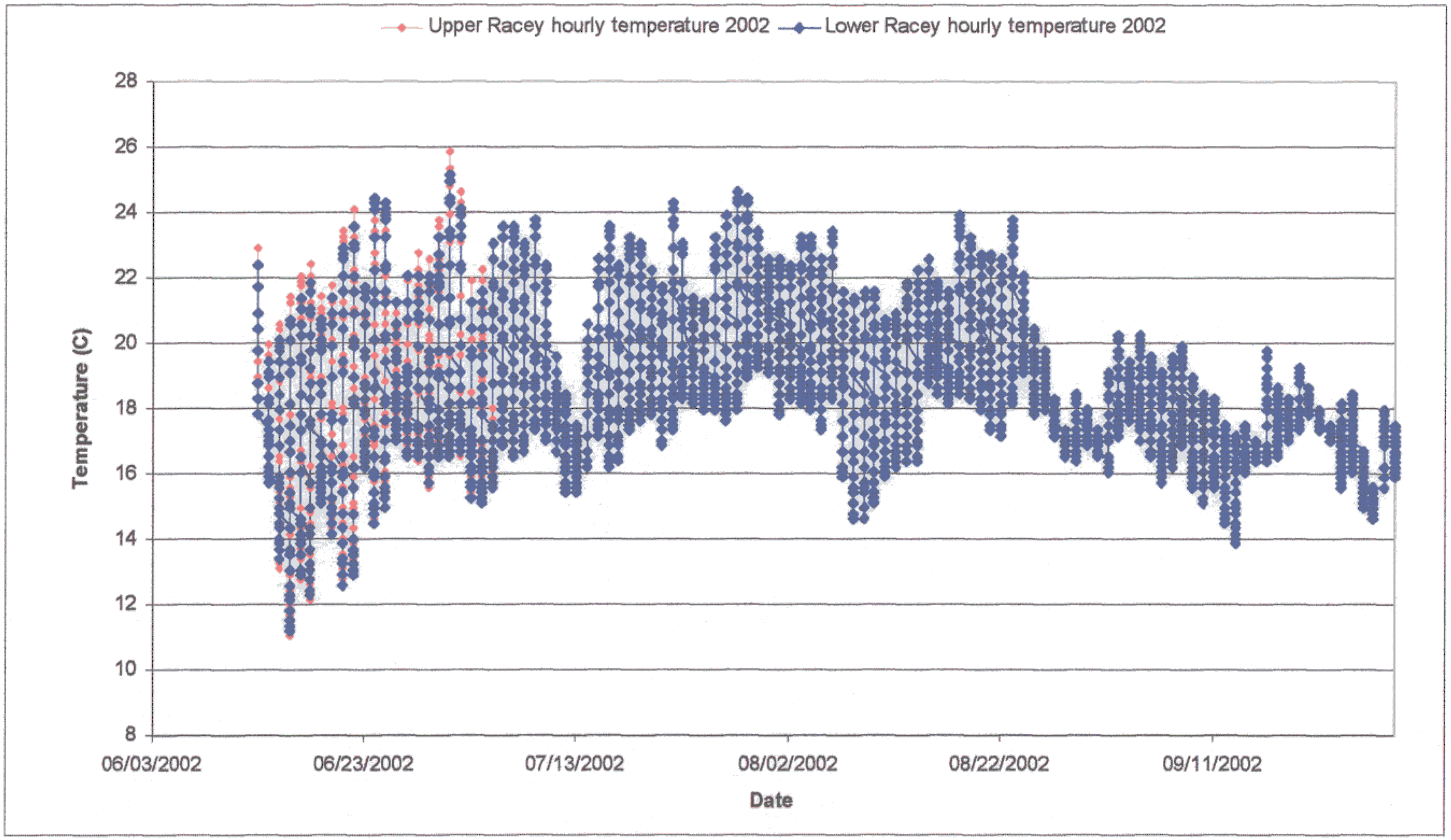
A.2.22. Looking downstream to confluence with South Fork New River, May 2003.

A.2.23. On of th bea 'er dam located within the mitigation site during th July 2003 monitoring ey station 8+48.

Appendix 3. Hourly recorded water temperatures taken at the upper and lower boundaries of the Racey mitigation site, Laxon Creek, Watauga County, 2001, 2003.



Appendix 3. Continued.



Appendix 3. Continued.