R-0529 Projects

As-built report for the Bare Mitigation Site, Unnamed Tributary to Peak Creek, Ashe County

North Carolina Wildlife Resources Commission
Habitat Conservation Program

Joe Mickey and Staci Scott
Stream Mitigation Program

February 2002

CONTENTS

Introduction

This as-built plan is submitted as part of the fulfillment for the R-529 US 421 off-site stream mitigation agreement between the North Carolina Department of Transportation (DOT) and North Carolina Wildlife Resources Commission (WRC) in Watuaga County. Under this agreement, a total of 14,814 linear feet of stream mitigation is required by the United States Army Corps of Engineers (COE) and 7,407 linear feet of mitigation for the North Carolina Division of Water Quality (DWQ). The purpose of this report is to summarize 2,183 linear feet of stream enhancement at the Bare site on an unnamed tributary to Peak Creek, Ashe County.

Preconstruction Site conditions

The unnamed tributary is located on the Hazel Bare property in the Peak Creek watershed, New River drainage, Ashe County (Figure 1). The watershed area of the Bare project site is 2.2 square miles. Land use consists of small rural farms containing pastures and forested wood lots. Most of the flatter valleys are used to raise crops and cattle, with cattle grazing also occurring on steeper pastureland. Much of the forestland in the watershed has been converted to agricultural land, with a good portion used for Christmas tree farming. However, a significant portion of the watershed remains in secondary growth forest. There is some conversion of agricultural land to single family home sites. The unnamed tributary has suffered from past and ongoing land disturbing activities within the watershed. Old aerial photos and field observations show that the unnamed tributary and Peak Creek in the alluvial valley have been channelized to consolidate fields. Streambank instability from poor riparian zone management has continued for many years, causing adverse water quality impacts through increased sedimentation from eroding streambanks.

Soils at the Bare site are Toxaway soils. These soils consist of poorly drained and very poorly drained soils on flood plains. These soils formed in recent loamy alluvium. Slopes range from 0 to 0.2 percent. Toxaway soils have loamy horizons 40 to 60 inches thick. These soils are strongly acid or medium acid, except where the surface layer has been limed.

On the Bare property, the unnamed tributary flows through open grazing pastures in a broad alluvial valley to its confluence with Peak Creek. The stream drops approximately 17.96 feet in a 2150-foot reach (slope 0.0084). This slope is expected for an alluvial valley stream that has lost sinuosity, the result of past channelization. Prior to construction, the stream was composed of 93.3% riffles and 6.7% pools, again an indication of past channelization. Bank erosion was occurring at numerous locations, with the most severe bank erosion occurring along the right bank (looking downstream) at stations 1+56 to 3+62 and 5+85 to 7+81 (near Hwy 88). The majority of the stream channel was void of shrub/tree riparian vegetation due to past stream bank clearing and current livestock trampling of stream banks and grazing of riparian vegetation. There was little in-stream fish cover in the form of undercut banks, deep pools, deep riffles, and large woody debris. The combination of these factors provides poor to fair quality habitat for aquatic species, especially trout. This was confirmed by fish population data collected by the WRC (8/14/01); only one young-of-year brook trout was collected from two sample sites (44m and 49m). In comparison, the headwaters of Peak Creek with a similar drainage area and good habitat contains a healthy population of wild brook and brown trout (files, WRC District 7 data).

Bedrock outcroppings/ledges at some locations have resisted the erosive force of the stream, preventing further downcutting, widening of the stream channel, and steepening of the stream banks. Except for areas of bedrock and isolated large boulders, the channel substrate was composed primarily of gravel.

Two fords are located at stations 5+60 and 10+54. Three small spring seeps enter the stream at stations 0+10, 5+88, and 10+46.

Stream Classification

The Stream Restoration Plan (NCWRC 3/2001/DWQ/COE/WRC files) contains the summary of the existing condition survey (longitudinal profile, cross-sections, pebble counts, reach parameters). Bankfull was determined using field-identified indicators, primarily a scour line and point bar height, and evaluated using regional curve information (NCSU-Stream Restoration Institute). Two reference cross-sections were analyzed to obtain reference dimensional data. Reference information was taken from cross-sections 1 and 9 that exhibited stable conditions and Meadow Fork Creek in Alleghany County. These existing sites were used as the only reference data since no change in pattern was planned. Sinuosity is very low at this site, stream length/valley length = 1.1 or valley slope/stream slope = 1.1. Sinuosity is not a good criteria to use for typing this stream since it is was altered in the past and does not reflect natural conditions. An entrenchment ratio of approximately 1.4 would indicate that this would be a B type stream. However, high width/depth ratios indicate that the stream would be a C or F stream type. Slope indicates a C or F stream type. Medium to course gravel is the bed material in the reach (20 mm = D50) and cross-section (11.3 mm = D50). Water surface slope is .0084, which is more indicative of a C or F stream type. When taken together with the valley type and past channelization, this stream is in transition from a B4 stream type to a F4 or C4 stream type. Altered, unstable F4 and C4 stream types erosion without a well vegetated riparian zone are susceptible to accelerated stream bank. The presence and condition of riparian vegetation influence rates of lateral adjustment in these stream types. Sediment supply can be moderate to high, depending on stream bank erodibility conditions. Prior to construction, bank erosion pins at two locations indicated a stream bank erosion rate of 10 tons year from a 50' x 4.5 foot bank and 10.5 tons year from a 100' x 5' bank (Figure 2).

Project Objectives

Approximately 75% (1,614 feet) of the 2,150 feet surveyed (pre construction) were in need of enhancement. The following problem areas were noted during the survey:

Station #	Site condition
1+56 - 3+62	eroding right bank, meander needs to be reconstructed
3+62 - 4+20	braided channel and eroding left bank
4+20 - 4+81	eroding right bank
5+85 - 7+81	eroding right bank, about to take access road, meander needs to be reconstructed
7+35 - 8+76	eroding left bank (station 7+35 - 8+76 need step/pool design)
11+32 - 16+19	eroding left bank (steep)
16+29 - 18+00	eroding right bank
18+56 - 21+50	eroding in sections along both banks & at white pines

The objectives of the stream enhancement project on the unnamed tributary on the Bare property were:

1. Reconstruct the meander at stations 1+56 - 3+62 and 5+85 - 7+81 in order to reestablish proper dimension, pattern and profile to eliminate the severely eroding banks.

2. Slope and vegetate the banks at selected locations to reestablish a bankfull bench to make the banks more resistant to erosion and flooding.

3. Install rootwads and/or rock vanes or rock weirs where appropriate to provide long-term bank stability, fish habitat, and to narrow and deepen the stream channel.

4. Reestablish ground cover on all stream banks disturbed during construction with a native wildflower mix and annual wheat and rye. Plant native trees along the channel to provide long term bank stability, stream shading to reduce water temperatures, cover and food for wildlife.

5. Exclude livestock from the riparian zone through fencing and provide an alternate water source as specified in the plan developed by the Natural Resource Conservation Service. A 25-foot wide riparian buffer zone is recommended along each bank.

6. Improve the natural aesthetics of the stream corridor.

Conservation Easement

In order to ensure long term protection of the site, a conservation easement was signed by the landowner, DOT and WRC on August 3, 2001. The conservation easement area is shown as Conservation Easement No. 1, Conservation Easement No. 2 and Conservation Easement No. 3 of Parcel #704WM of Billie K. Perkins (Hazel R. Bare-Life Estate), being more particularly shown and described on a plat entitled Survey of Conservation Easement and being recorded in Plat Book 6 Page 031 of the Ashe County Registry. The conservation easement puts limitations and restrictions on 3.02 acres of land that includes the restoration site and riparian zone. There is a Permanent Access Easement of Ingress and Egress to the conservation easement over 0.07 acres. The conservation easement is perpetual and will be held by the WRC. **Copies of the conservation easement and survey plat have been attached to this report for DWQ, COE and DOT files.**

Channel Modifications

Construction at the site was carried out through an informal contract with Southern Highway Construction (Todd Hodges). The contractor provided a trackhoe and a dump truck. Access to the site was from Hwy 88 via the permanent 0.07 acre access easement. Stream work began on August 27, 2001 by hauling rootwads and large rock from the US 421 road construction project to the site. Some large riprap existing at the site from stations 0+00 to 1+00, placed there by the NC Dept. of Agriculture's Upper Mountain Research Station at the request of Mrs. Bare, was used for construction of rock vanes/weirs at this location. Stream enhancement construction began on August 28, 2001 and was completed on September 6, 2001.

Location of enhancement features (rock vanes, log vanes, rock weirs, root wads, large woody debris [LWD], bank sloping) are summarized in Table 1. At several locations a floodplain bench was constructed at the bankfull elevation to enhance and facilitate the natural meander of the stream. This did not involve filling the existing creek, but rather moving the slope of the streambank back away from the water for approximately 3 to 5 feet. Above this floodplain the stream bank was sloped to the top of the bank and vegetated. As banks were sloped, sod mats salvaged from the site were used to stabilize the new banks. In some areas a blanket of erosion control fabric was installed to provide temporary bank protection until vegetation could be established. Rock weirs and rock vanes were installed to prevent stream head cutting and create

pool habitat. Large footer rocks support all top boulders in the weirs and vanes. Holes were dug below the weir apex to accelerate and maintain pool formation by stream water velocities. Excess streambed materials were excavated at rock weirs and rock vanes and placed upstream of the structure near the bank where natural deposition would be expected. Rock vanes were used to divert water away from eroding banks and for habitat diversity. Root wads were used to improve bank stability, decrease width and improve aquatic habitat. At stations 5+60 and 10+54 stable ford crossings were constructed and a rock weir was built below each crossing to maintain ford stability.

Figures 3a-d and Figures 4a-d show pre and post-construction longitudinal profiles. The post longitudinal profile (Figure 4a-d) shows how the project increased pool and deep-water habitat. Pool habitat was increased from 6.7 % to 47%. The scour action of root wads, rock weirs, and rock and log vanes can be observed from the as-built profile. These structures are creating the desired deep-water aquatic habitat and sorting bed material in a way that will provide needed fish spawning gravel.

Figure 5 summarizes pre and post-construction pebble count data. Pre and post construction pebble count data show no major differences. The D50 is small gravel, D84 is very coarse gravel, and D95 is small cobble.

Figures 6-14 show post construction cross-sections of the new channel. These cross-sections will be used to monitor long-term channel stability.

Figures 15-22 show photos of before and after shots illustrating various stream enhancement methods used at the site. Methods pictured include bank sloping, rock weirs, root wads, LWD (large woody debris), watering tanks, stream crossings and fencing.

Riparian Improvements

During construction, sod mats salvaged from the site were used to provide instant bank stability and long term erosion control. Sod mats had the advantage of containing an established seed mix. On sites where sod mats were not used, the area was seeded with a native riparian mix and cover crop of winter wheat and rye. After seeding, an eight-foot wide straw erosion control blanket was used to cover the soil. These blankets were used to stabilize the soil surface until a vegetative cover could be achieved and to contribute to soil stability after vegetation is established. As the straw blankets decompose over a 2-year period, permanent vegetation should be well established.

Live stakes and bare root nursery trees were planted on the 3.02 acre site during February 2002. Live stakes, collected from nearby stream corridors, were silky dogwood (*Cornus amomum*), silky willow (*Salix sericea*), and black willow (*Salix nigra*). Bare root trees from the NC Forest Service were northern red oak (*Quercus rubra)*, black cherry (*Prunus serotina*), persimmon (*Diospyros virginiana*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), black walnut (*Juglans nigra*), river birch (*Betula nigra*), sycamore (*Platanus occidentalis*), and flowering dogwood (*Cornus florida*). We had hoped to plant tag alder (*Almus serrulata*) at the site but a source could not be located. The site will be monitored to ensure that a good stand of trees/shrubs is established at the rate of 320 per acre after 5 years.

Livestock Exclusion

Mr. Glen Sullivan, Cost Share Technician, with the Ashe County Soil and Water Conservation District (ACSWCD) developed and supervised construction of the livestock exclusion plan for the site (Figure 22). In order for any stream restoration/enhancement project to be a success, livestock must be excluded from the recent construction and riparian zone and an alternate watering source other than the stream must be provided. This was accomplished by installation of one 500-gallon water reservoir, 5 watering tanks and associated lines, two stream crossings, and approximately 4,300 feet of conservation easement boundary fencing. Not included in the easement but also fenced from livestock were to small spring seeps totaling approximately 250 feet.

Temperature

One objective of a restoration/enhancement project in trout waters is to increase the quality of shade canopy over the stream, thereby reducing water temperatures to a more favorable condition for wild trout. The ability of planted vegetation to thermally stabilize enhancement site riparian zones may be sampled by recording thermometers. Water temperature was recorded at the site prior to and immediately following construction with *StowAway* recording thermometers made by Onset Computer Corporation. Upstream and downstream thermometers were installed at the site that recorded temperatures every hour from 7 August to 27 September 2001 (Figure 23). These were installed to monitor stream temperatures during the hot part of the year and for future comparisons. It is expected that as the riparian zone vegetation matures, the high temperature spikes experienced at the lower end of the site during the summer months will decrease or possibly go below upstream temperatures. It is anticipated that as water temperatures decrease over time and with the installation of habitat improvement structures, wild brook and brown trout will again utilize this section of stream.

Project Costs

Project costs for the Bare site are summarized in Table 2 (current through February 27, 2002). Total project cost for stream enhancement work is $60,023.65, or $27.50 per linear foot of stream enhancement (2183 lf). Project cost includes administrative cost, meetings with the landowner, meetings with NCDOT and NRCS personnel, field survey work, project conceptual, construction and as-built plans, tree purchase and planting, erosion control materials (seed, fertilizer, fabric), construction and livestock exclusion contracts, NRCS and WRC personnel costs. Salary costs for WRC personnel take into account past salary adjustments (1999 - 2000). Not included in this cost summary is future long term monitoring costs that will eventually increase project cost per foot. These costs will be added to the total once we have monitored the site for 5 years (DWQ requirement). Project costs do not take into account NCDOT Location and Survey and Right of Way personnel expenses. The NCDOT paid $15,450 for the 3.02-acre easement.

Conclusion

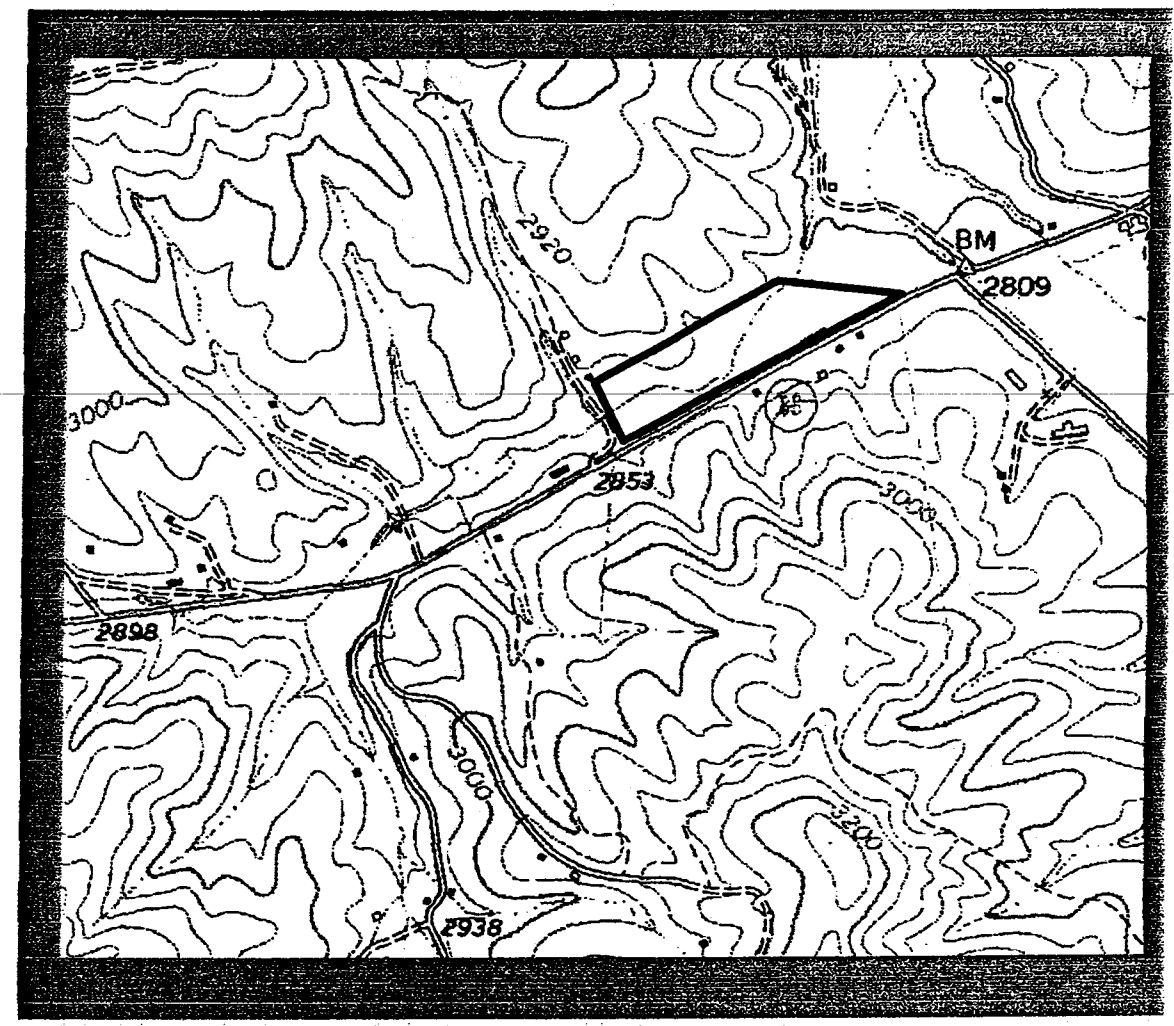
Through natural stream design, stream dimension and profile was improved at the Bare site. Water quality will be improved through reduced sedimentation from eroding banks and exclusion of livestock from the riparian zone. As the riparian zone matures, water temperatures should decrease, improving the likelihood that trout could once again inhabit the stream. In-stream habitat for fish and aquatic invertebrates has been increased with the installation of rock weirs, rock and log vanes and root wads. Both aquatic and terrestrial species will benefit with the return of a functioning riparian corridor and stream aesthetics have been improved.

Literature cited

Stream Restoration Plan, Bare Site, Unnamed Tributary to Peak Creek. NCWRC Habitat Conservation Program. March 2001. 42 pp.

Figure 1

Bare Project Site
UT to Peak Creek



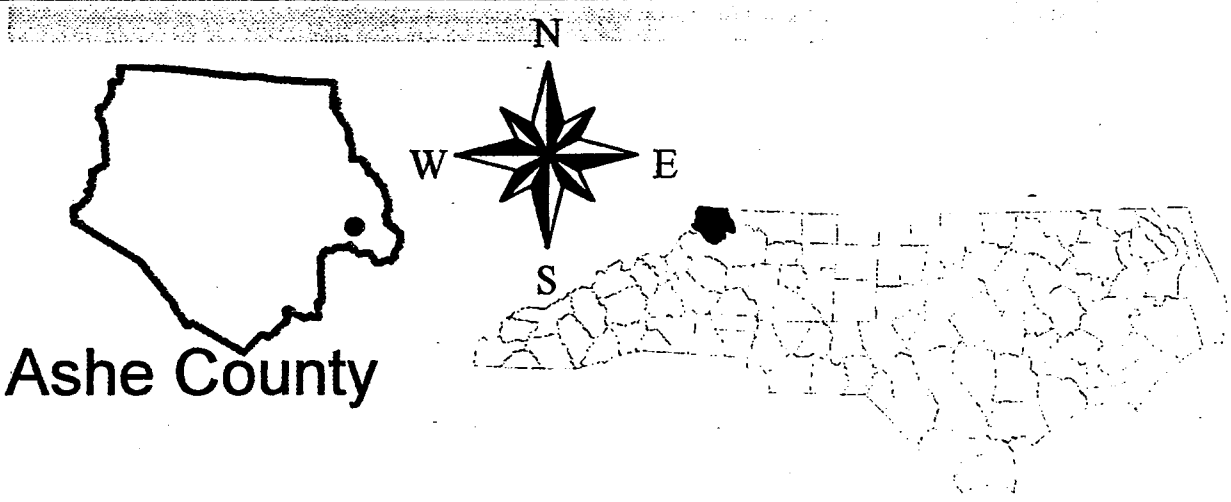


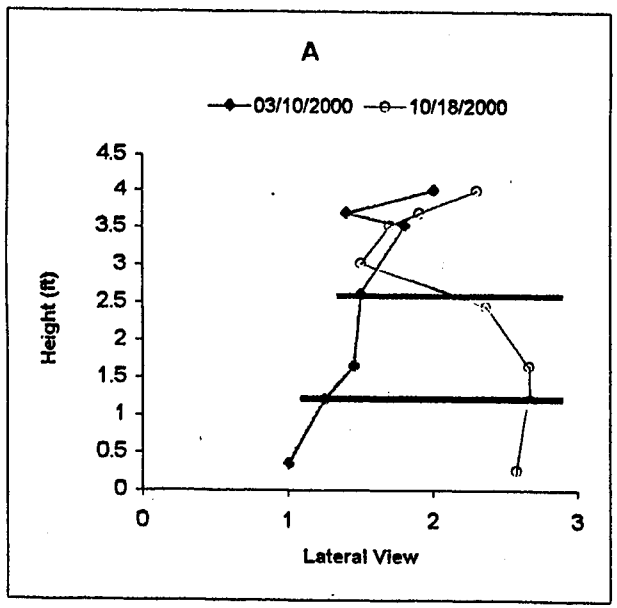
Figure 2 Bank Erosion Profile (pre-construction), Bare Site, Ashe Co.

Landowner : **Bare**
Project Site : **421 Mitigation**
Stream Name: **UT to Peak Creek**
Bank Profile

Bank Ht
Root Depth

STA	A				
Item	Vertical	3/10/00	Comment	10/18/00	Comment
1	0.26			2.57	ws
2	0.35	1	WS		
3	1.2	1.25	0.46 Pin	2.67	1.72 pin
4	1.65	1.45		2.66	
5	2.6	1.5	0.44 pin		0.48 pin
6	2.45			2.36	1.3 underneath
7	3.02			1.5	
8	3.52	1.8		1.7	
9	3.68	1.4		1.9	
10	4	2	TOB	2.3	TOB

STA	B				
Item	Vertical	3/10/00	Comment	10/18/00	Comment
1	0.49			1.6	ws
2	0.86			2.5	new point
3	0.59	1.74	WS	2.46	0.66 pin
4	1.26	2.24	0.4 pin		
5	2.03	2.6		2.54	
6	2.8	3	0.5 pin	2.74	0.46 pin
7	3.65	2.74		3.44	
8	3.98	2.3		3.38	
9	4.32	2.56		3.66	
10	4.55	3.06	TOB	3.5	



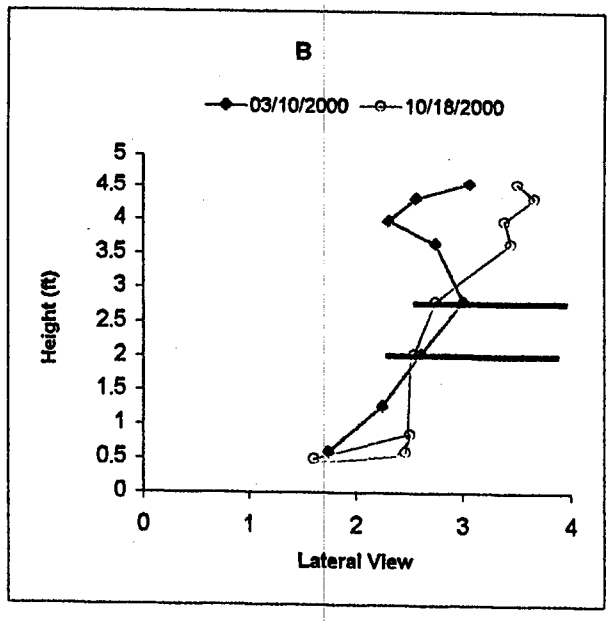


Figure 3a. Pre-Construction Longitudinal Profile

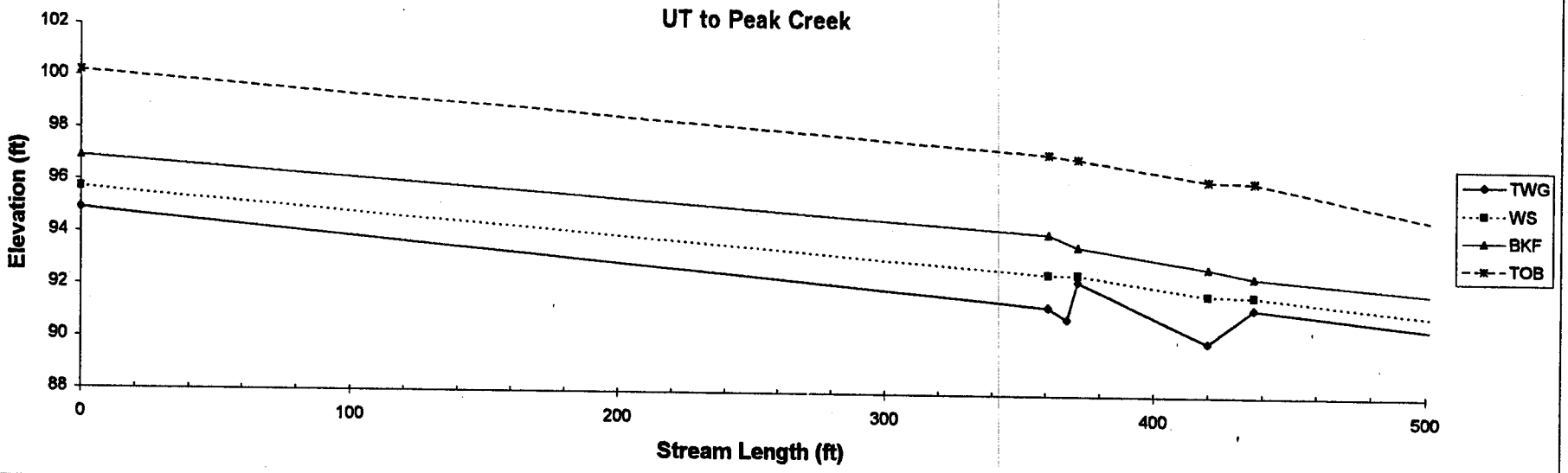


Figure 3b. Pre-Construction Longitudinal

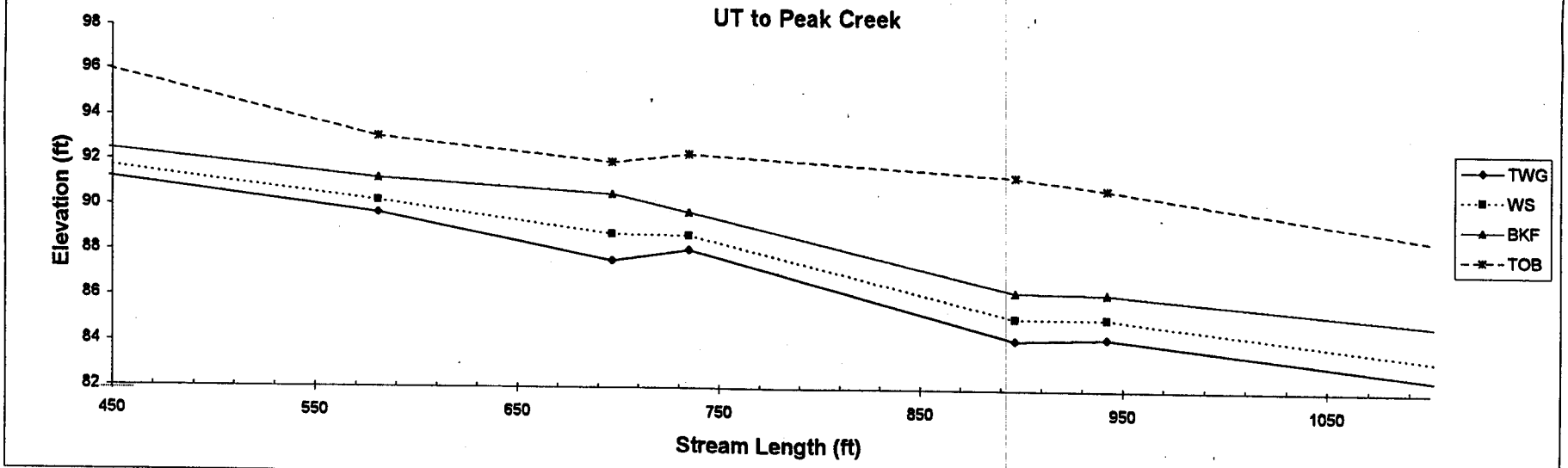


Figure 3c. Pre-Construction Longitudinal Profile

UT to Peak Creek

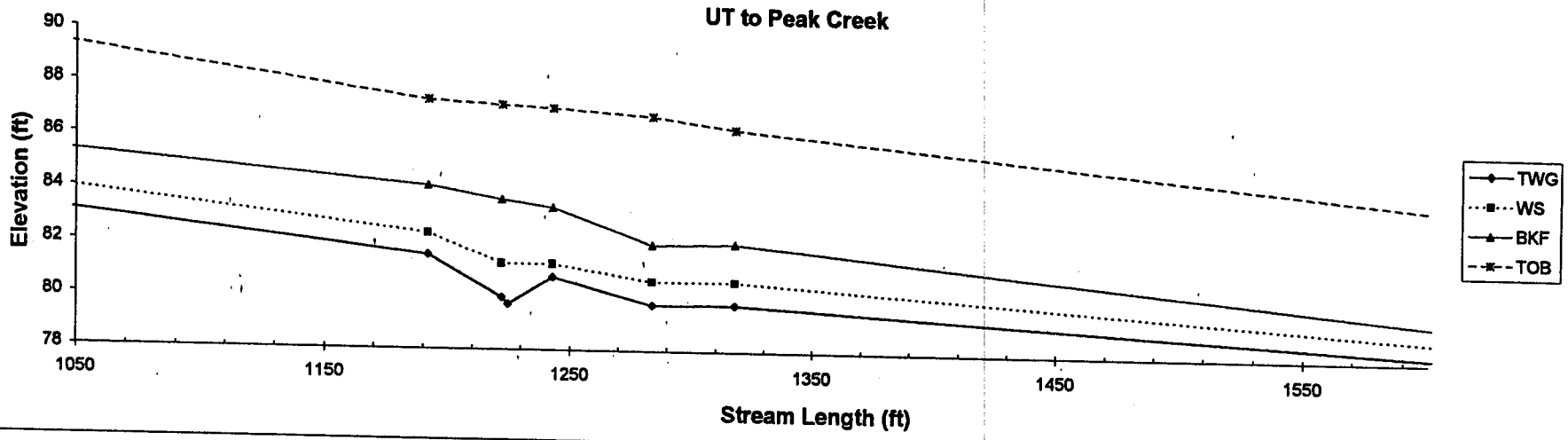


Figure 3d. Pre-Construction Longitudinal Profile

UT to Peak Creek

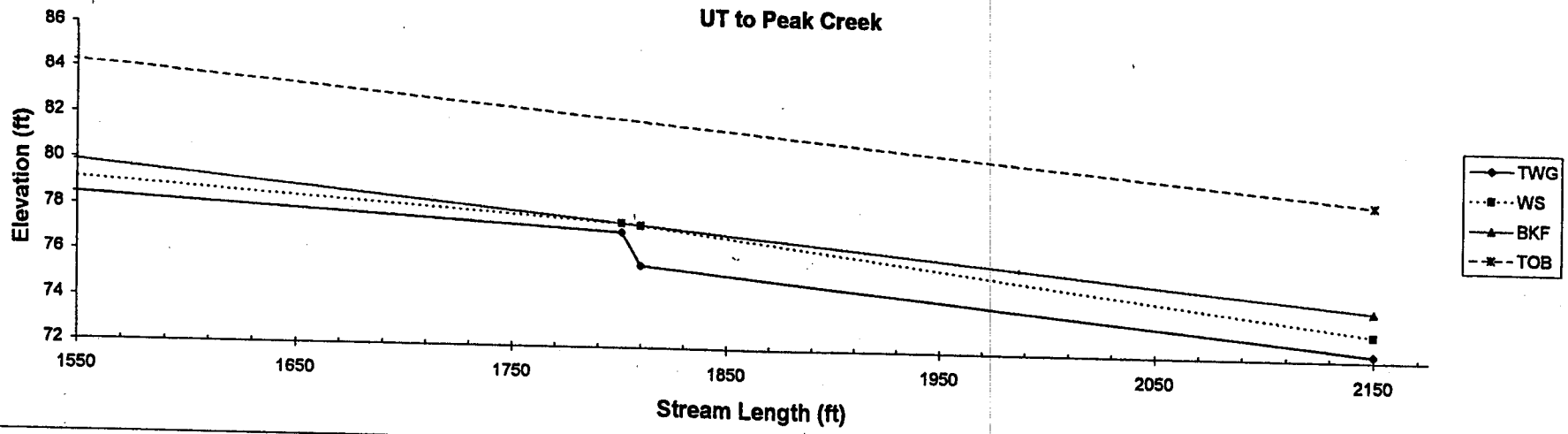


Figure 4a. Post-Construction Longitudinal Profile

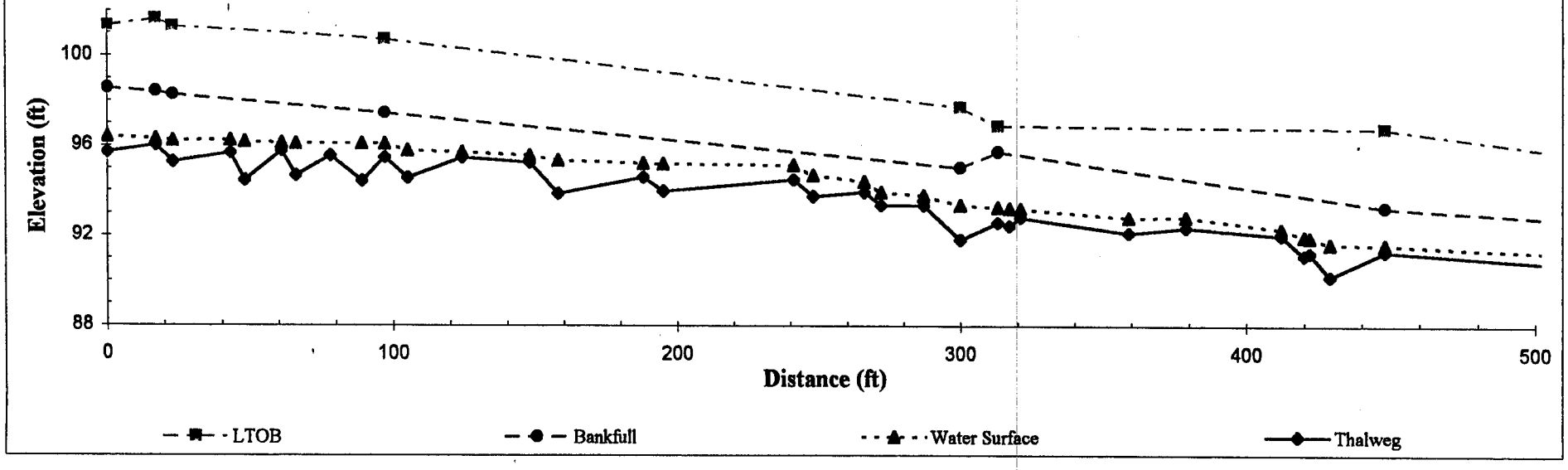


Figure 4b. Post-Construction Longitudinal Profile

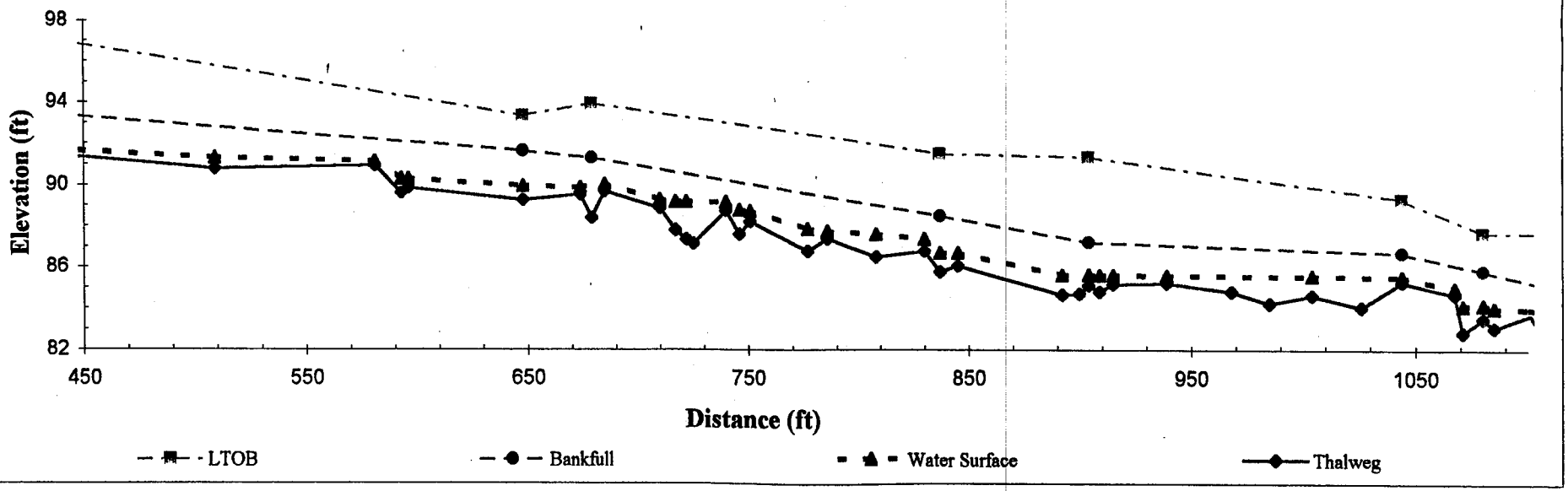


Figure 4c. Post-Construction Longitudinal Profile

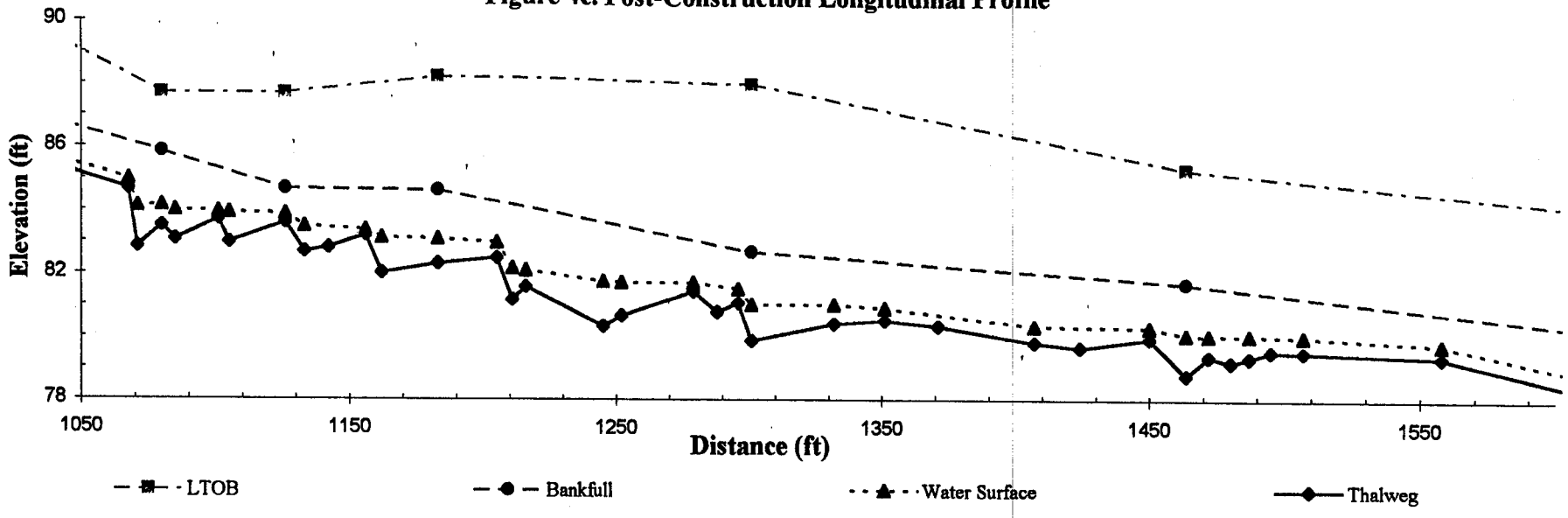


Figure 4d. Post-Construction Longitudinal Profile

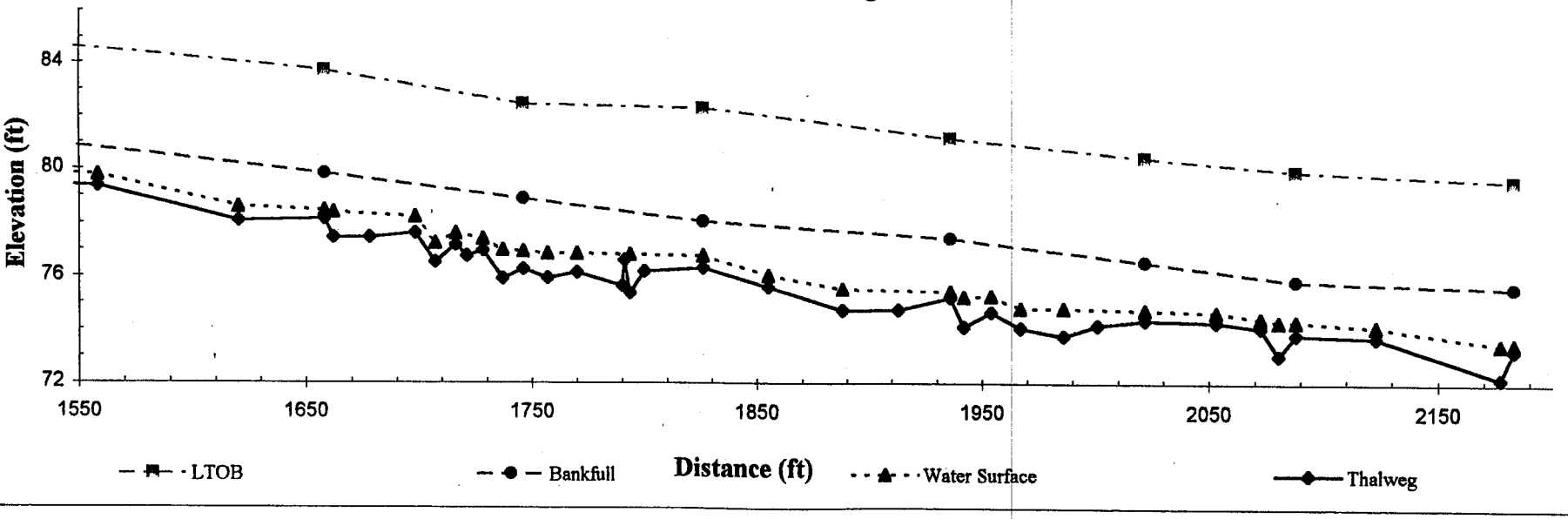
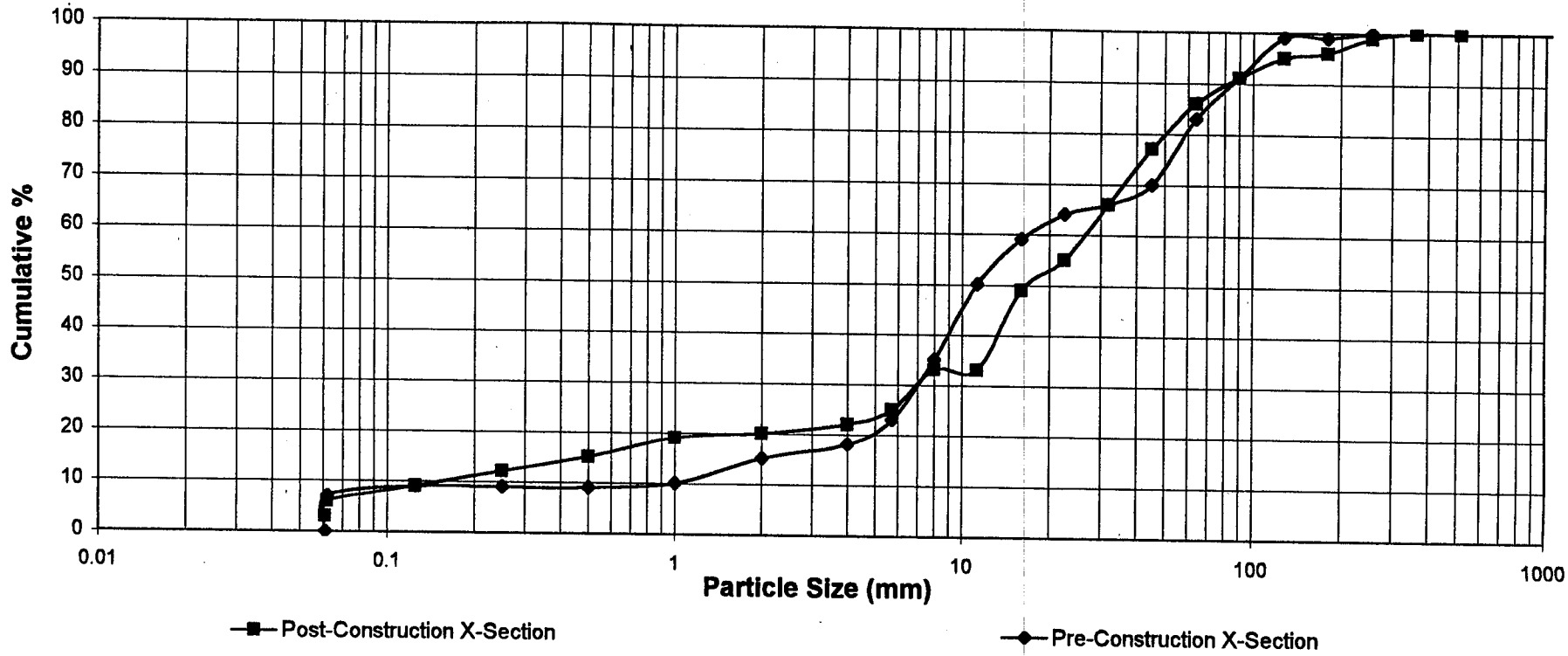


Figure 5. Pre- and Post Construction Pebble Count Comparison
Bare Site



X-SECTION, riffle
Post-Construction 18+42
Particle Sizes (mm):

D16	2.1
D35	8
D50	11.3
D84	70
D95	120

X-SECTION, riffle
Pre-Construction 6+91
Particle Sizes (mm):

D16	0.7
D35	13
D50	16
D84	64
D95	128

Figure 6. Cross Section STN 1+78

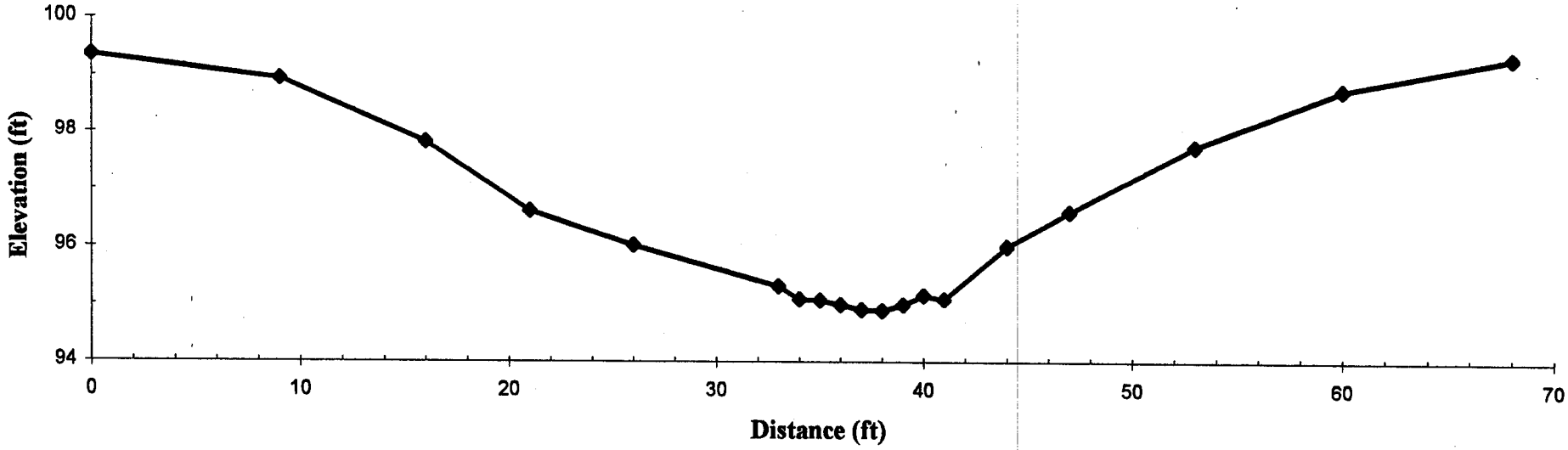


Figure 7. Cross Section STN 2+90, Pool

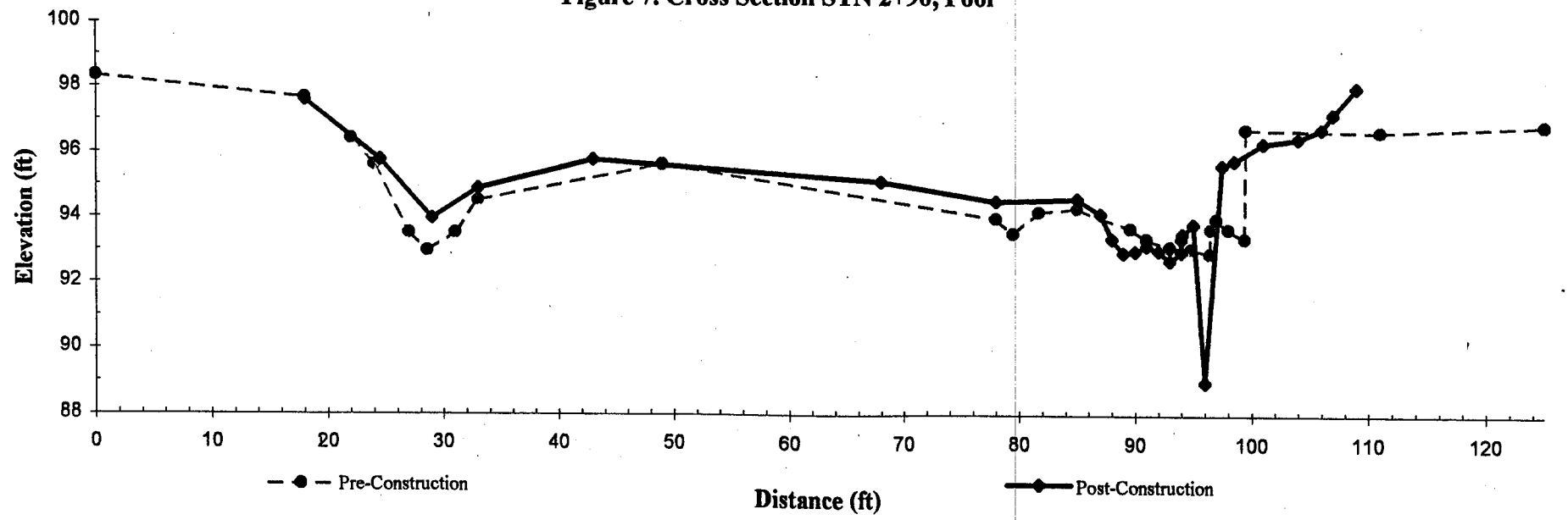


Figure 8. Cross Section STN 7+19, Pool

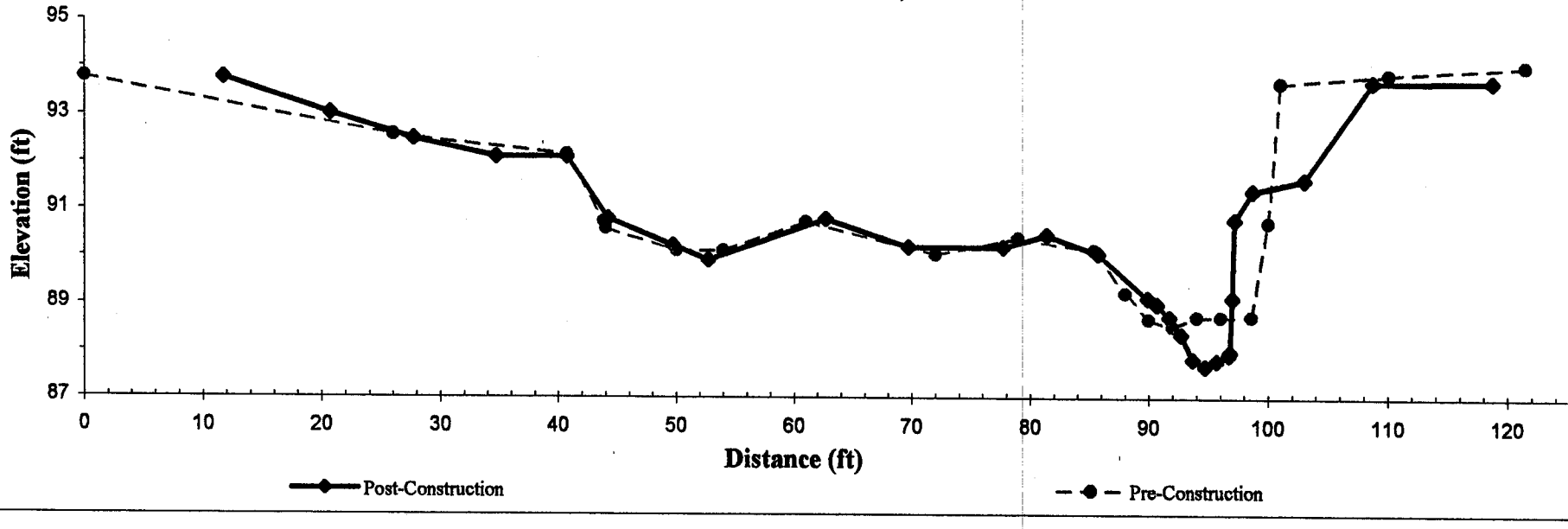


Figure 9. Cross Section STN 10+35, Wide Pool

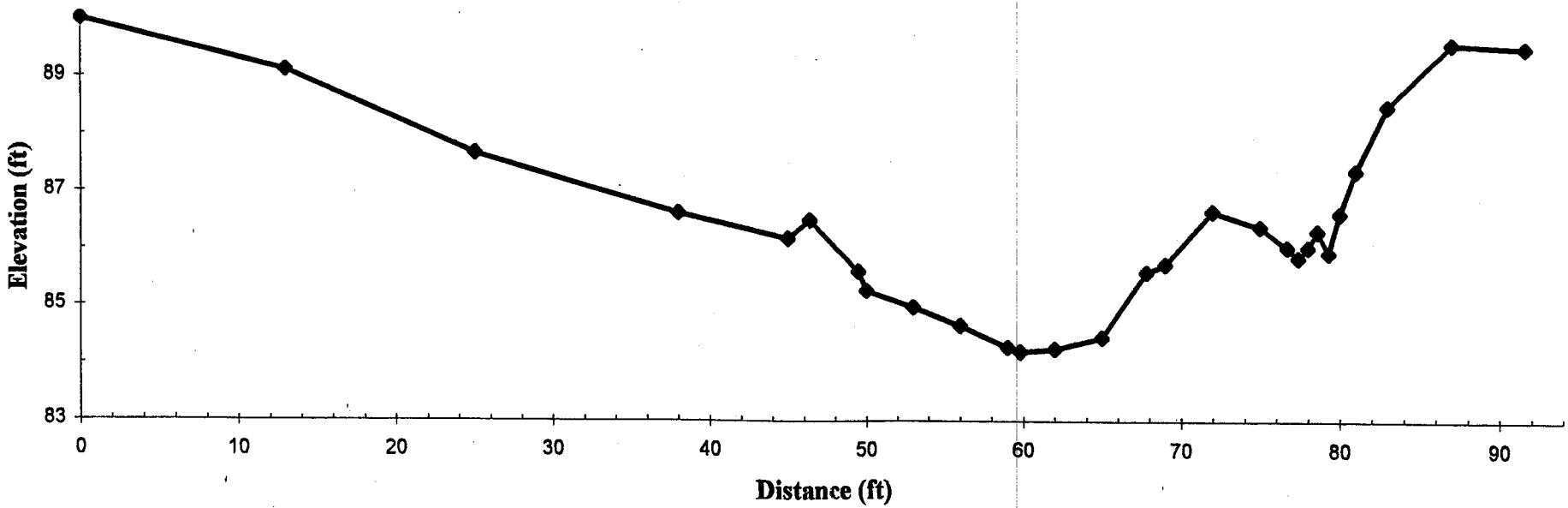


Figure 10. Cross Section STN 11+68

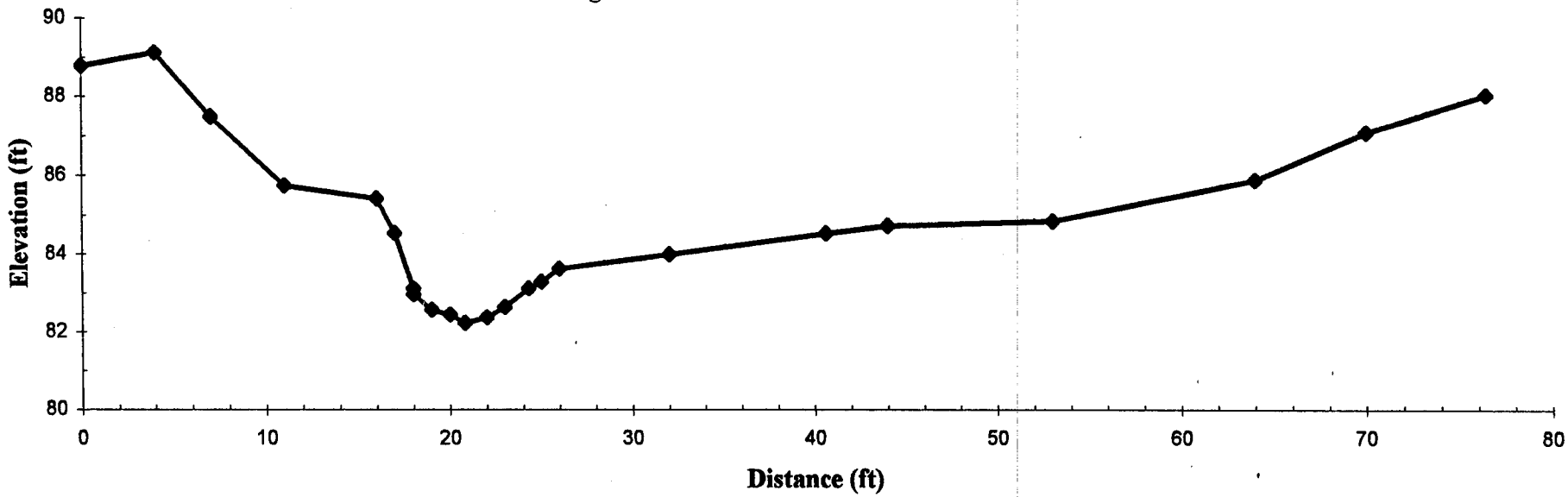


Figure 11. Cross Section STN 16+81, Pool at Root Wad Bend

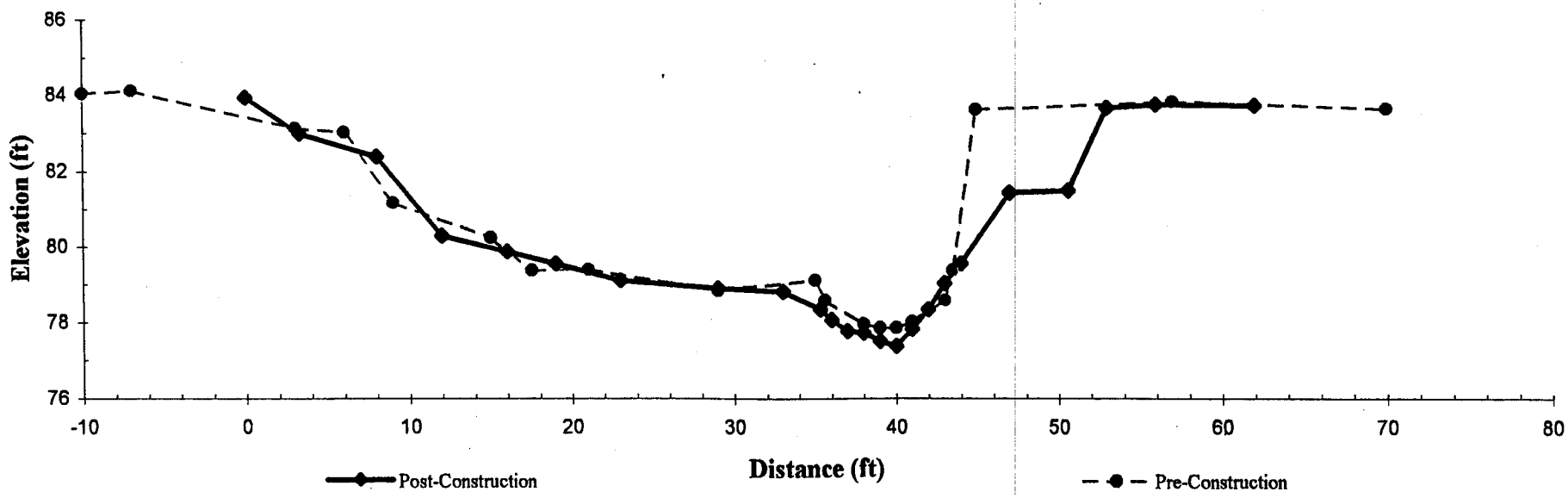


Figure 12. Cross Section STN 17+57, Pool/Deep Run

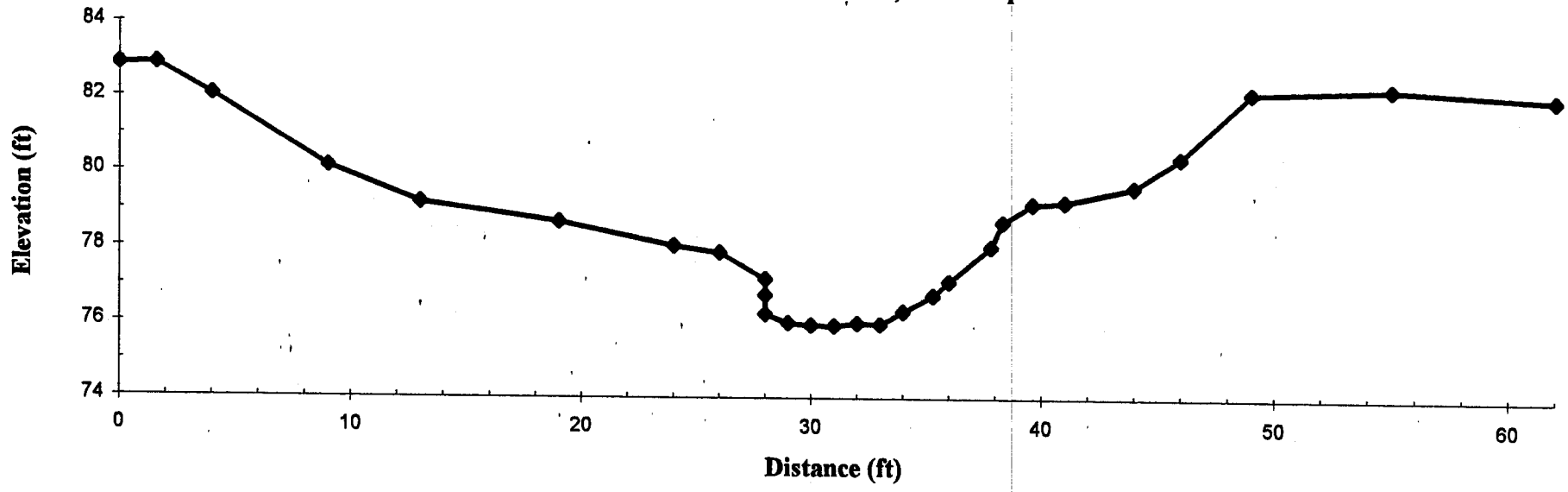


Figure 13. Cross Section STN 18+42, Stable Reach

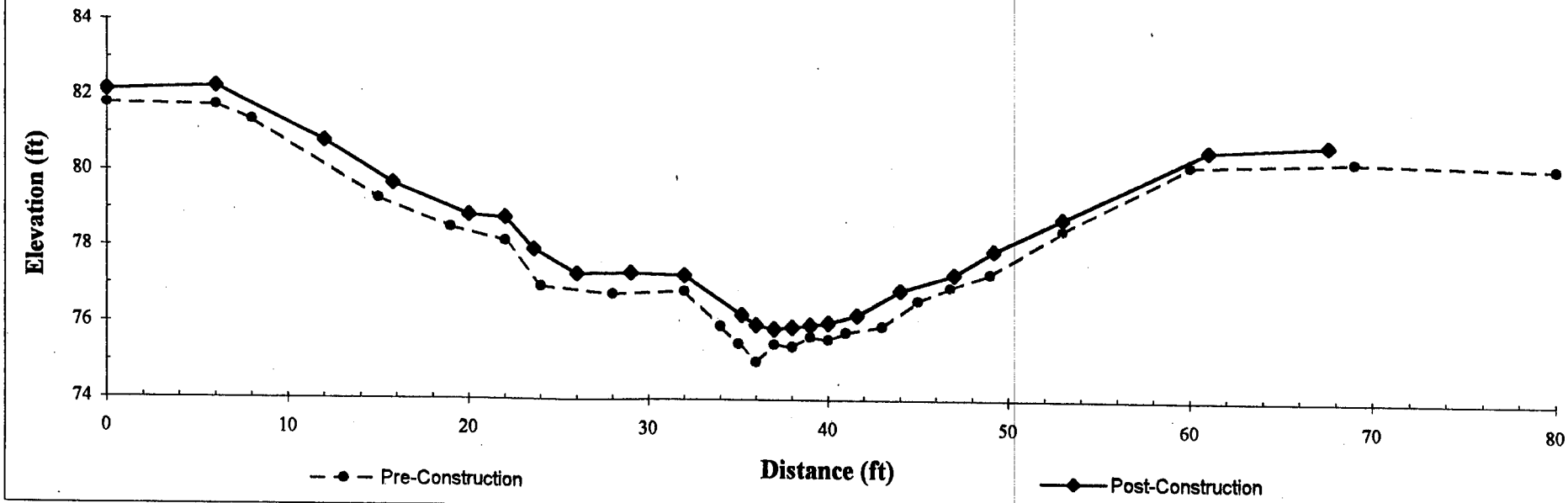


Figure 14. Cross Section STN 20+80, Pool

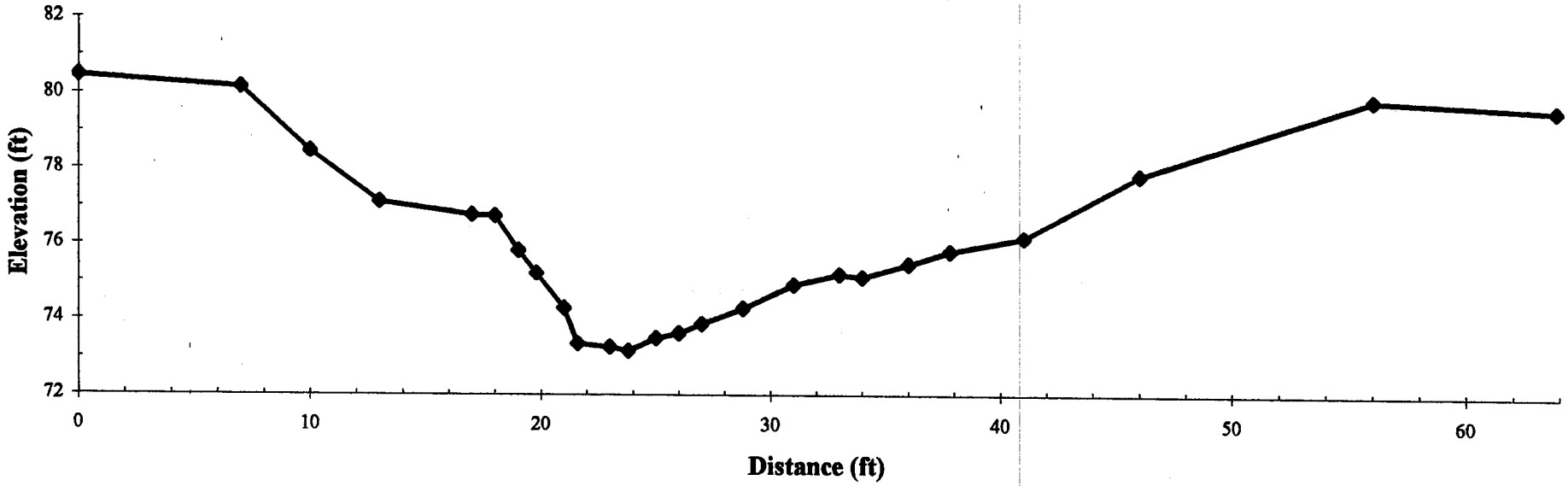


Figure 15. Bank Sloping and Root Wad Installation, STN 1+56 - 3+62

Pre-Construction

Post-Construction

Figure 16. Long Eroding Bank

STN 7+35 - 8+76

Pre-Construction

Post-Construction

Figure 17. Bank Sloping and LWD Installation STN 16+58 - 18+26, looking upstream

Pre-Construction

Post-Construction

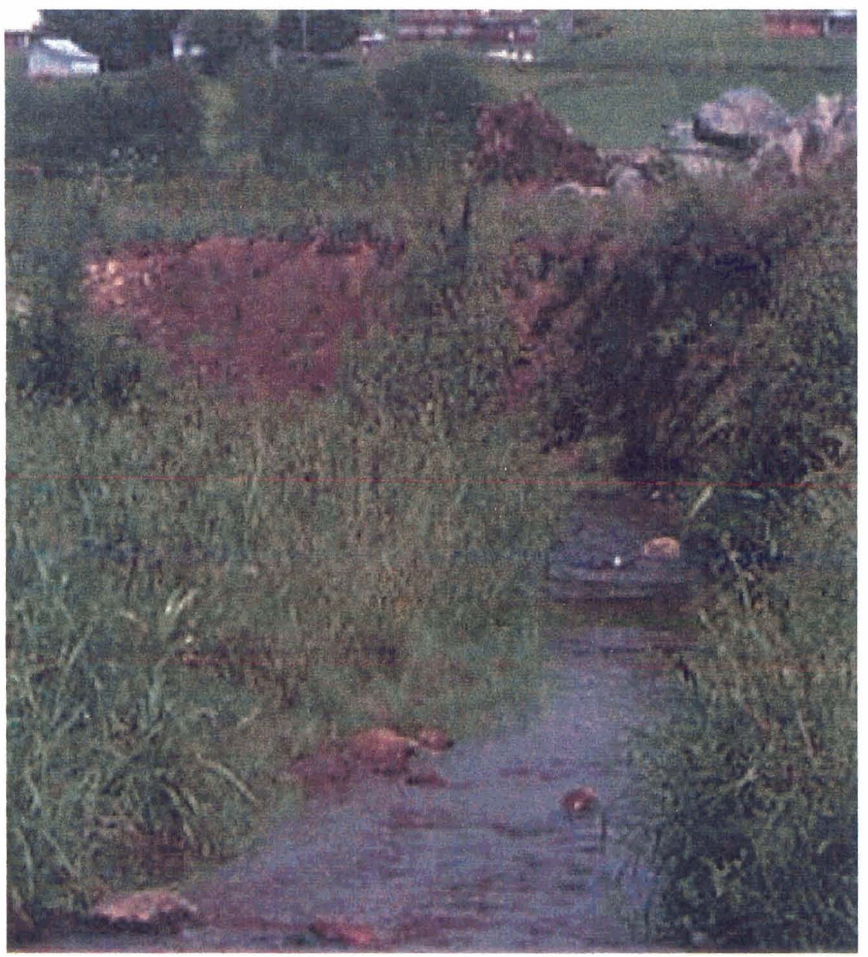
Figure 18. Bank Sloping and Rock Weir Installation STN 16+58 - 18+26, looking downstream

Pre-Construction

Post-Construction

Figure 19. Bank Sloping, Root Wad Installation, and Weir Placement, STN 16+98 - 17+07

Pre-Construction



Post-Construction

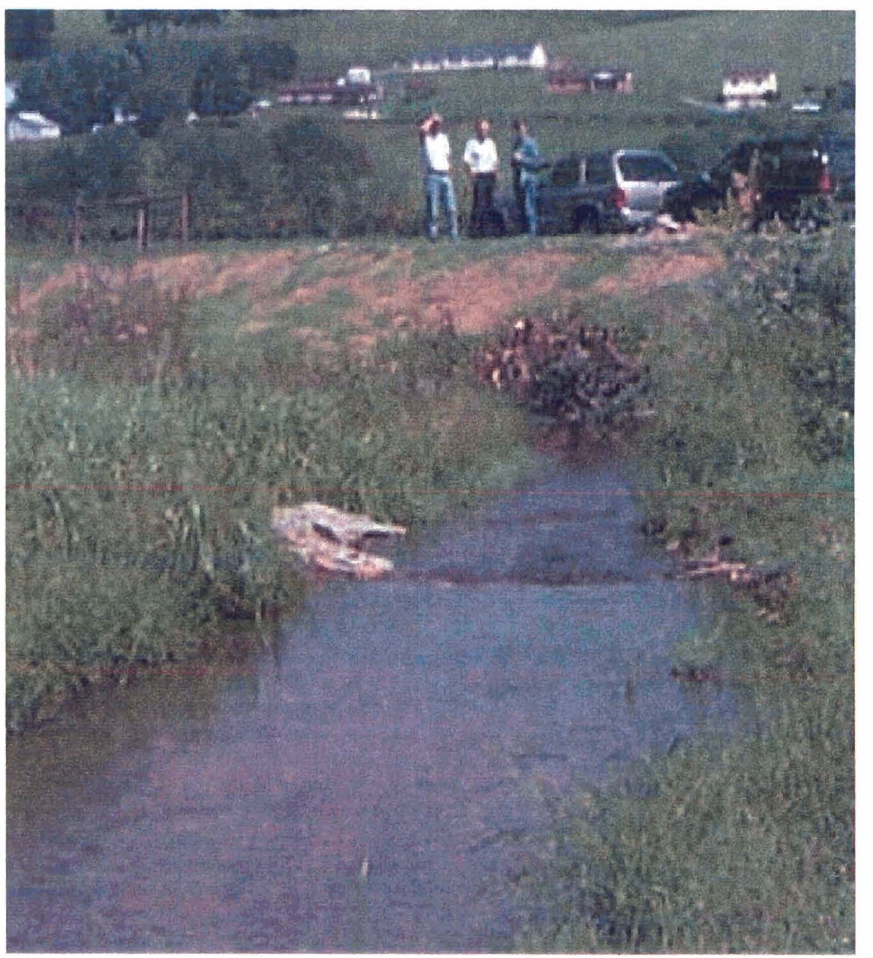


Figure 20. Large Woody Debris Installed During Construction

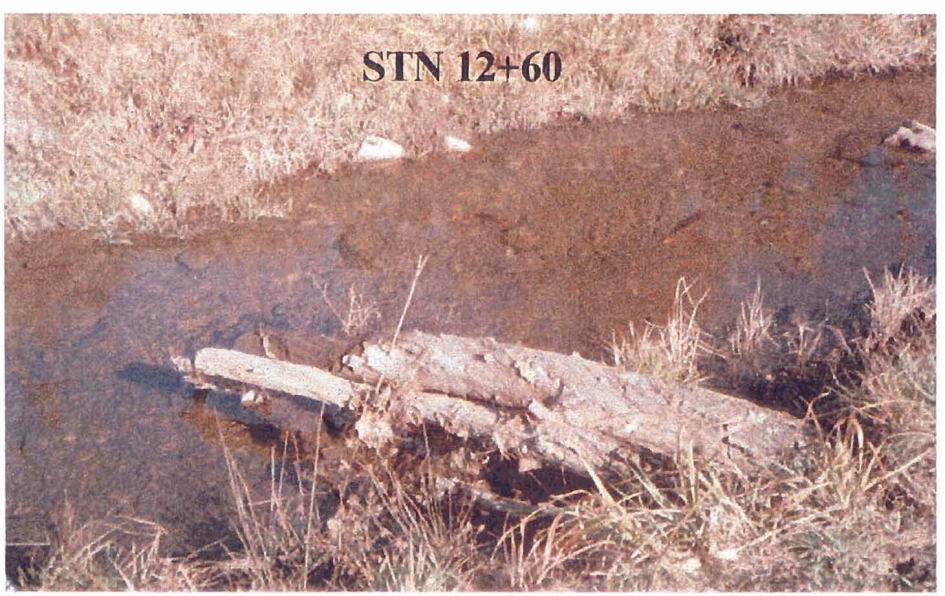
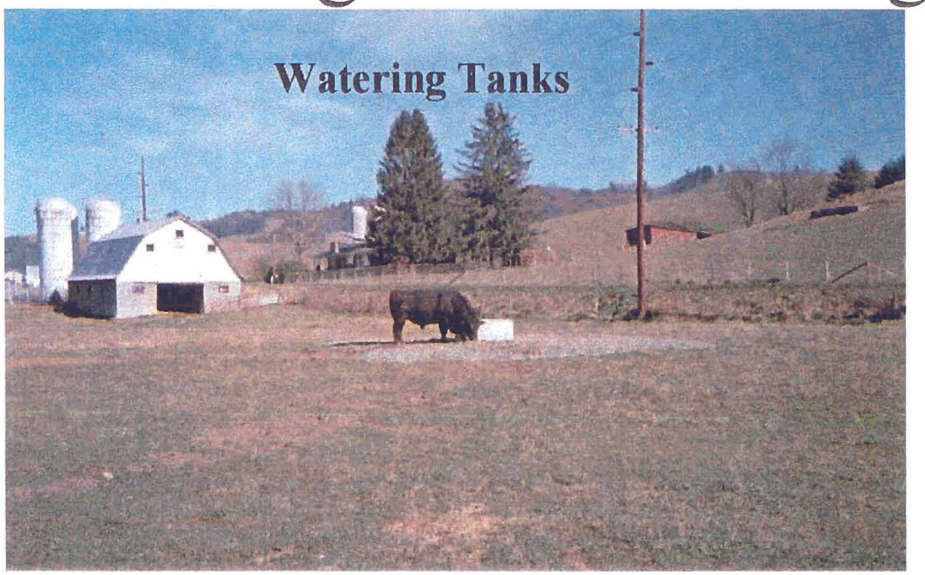
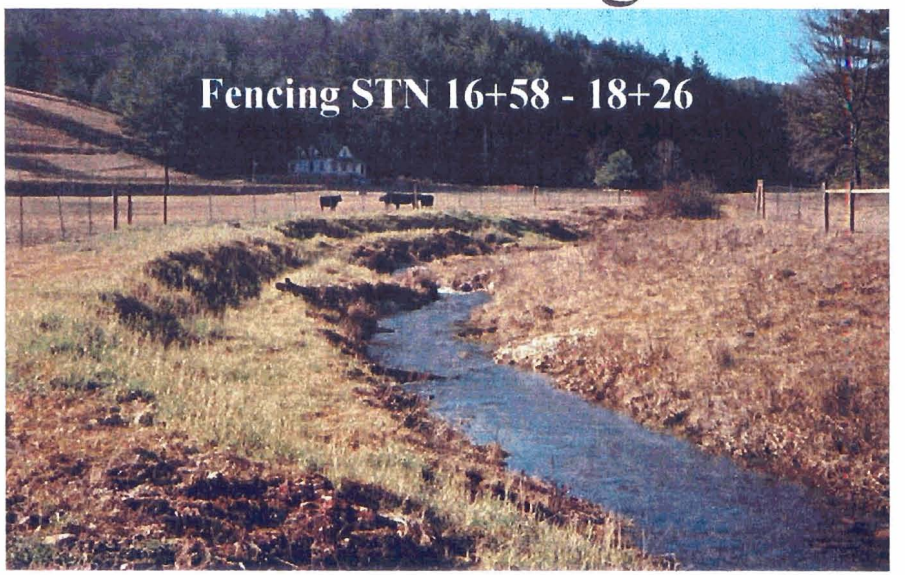
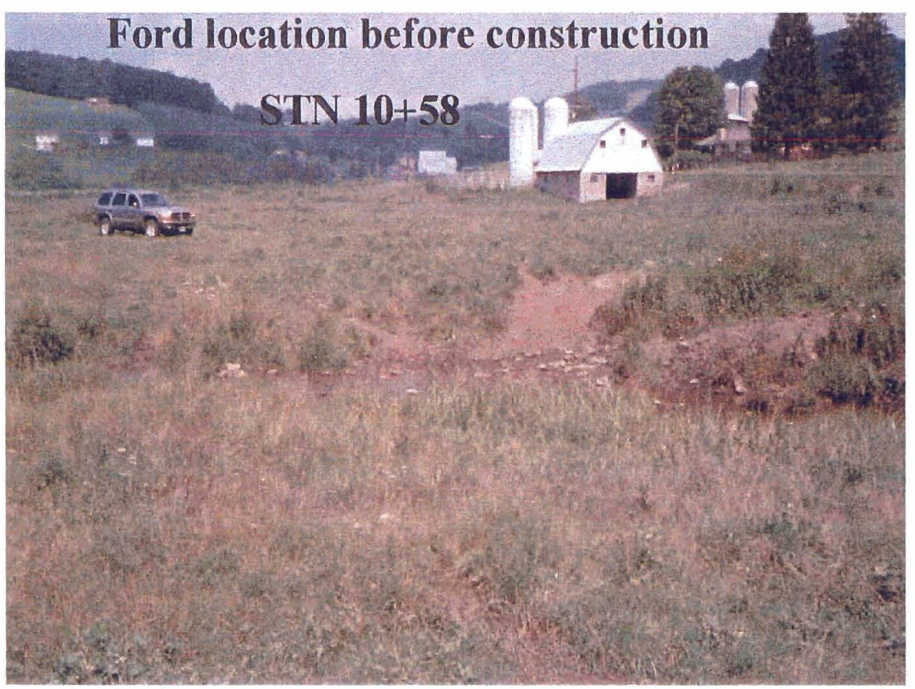


Figure 21. Watering Tanks and Fencing







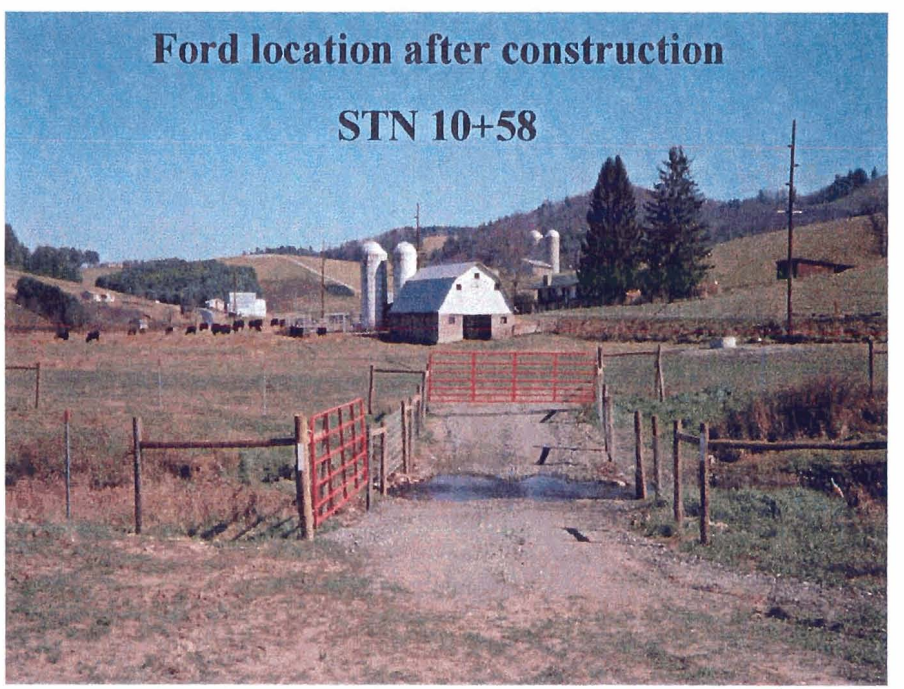


Figure 22 Livestock Exclusion Plan, Bare Site, Ashe Co.

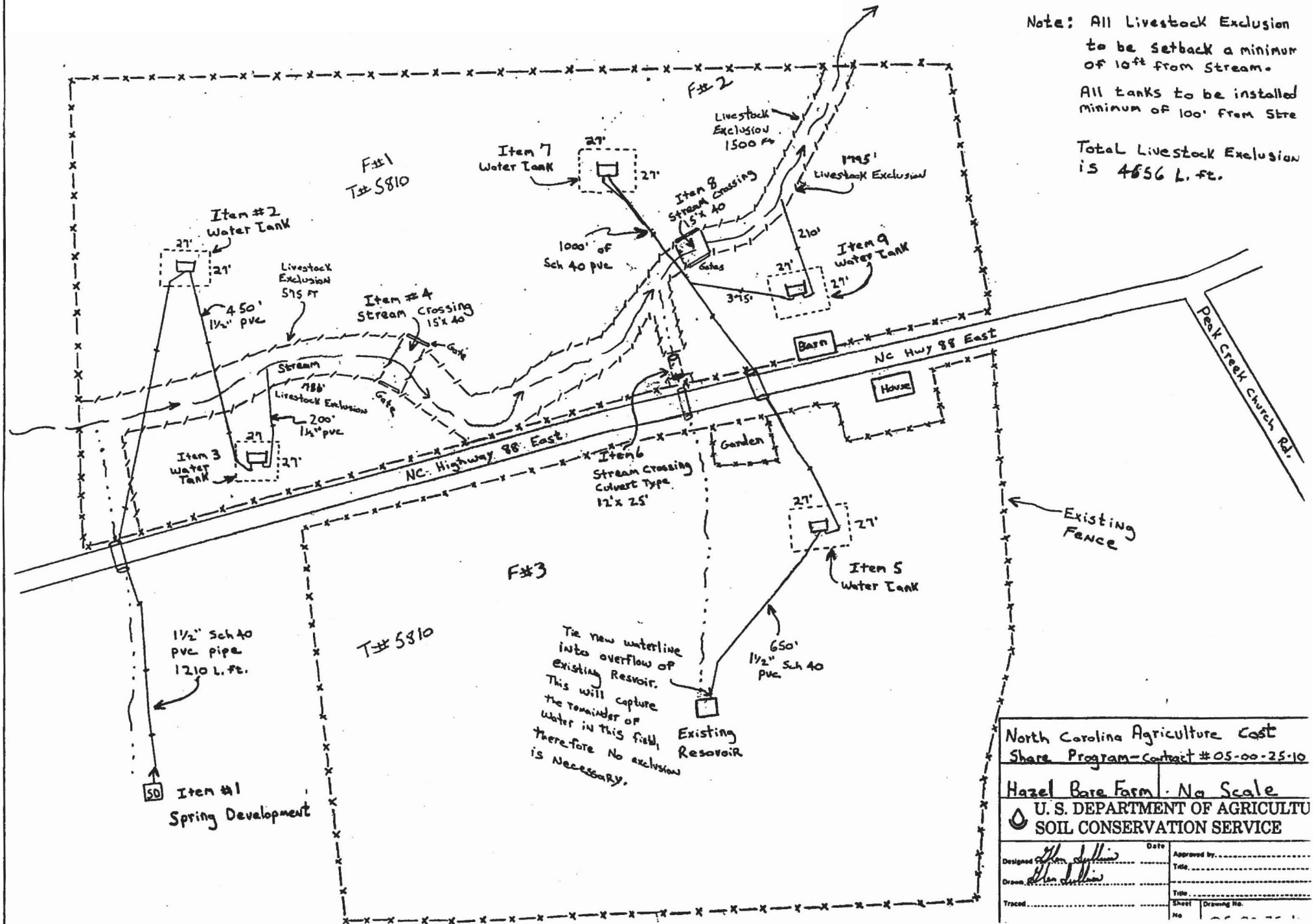


Figure 23. Upper and Lower Temperature Logger Comparison 8/7-9/27/01

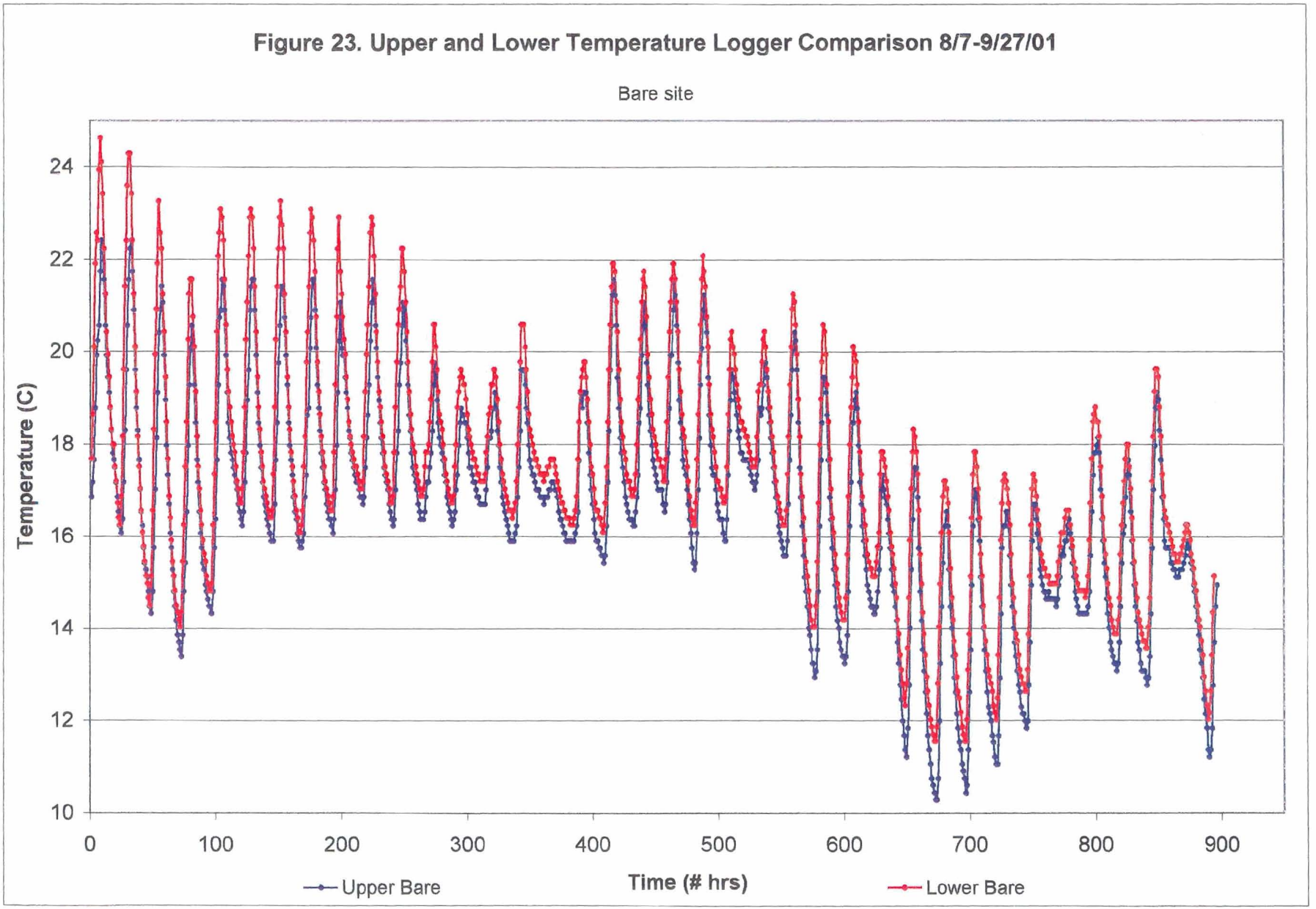


Table 1: Location and type of enhancement structure, Bare site, Ashe Co.

Station location	Structure type
0+17	rock weir
0+43	rock weir
0+61	rock weir
0+89	J-hook vane & LWD structure
0+97	rock vane
1+48	J-hook vane
1+58	LWD structure
1+56 - 3+62	bank sloping/BKF bench
1+88	rock weir
2+41	rock weir
2+66	rock weir
2+87	rock weir
3+00	root wads
3+13	rock weir
3+62 - 4+20	bank sloping
4+12 - 4+75 (approx.)	bank sloping
5+60	livestock crossing
5+81	rock weir
6+74	rock weir
7+00	rock weir
7+17	root wads
7+35 - 8+76	bank sloping/BKF bench
7+40	rock weir
8+30	rock/log weir
10+54	livestock crossing
10+67	rock weir
11+01	rock side channel block
11+26	rock weir
11+56	rock weir
11+56 - 12+16 (approx.)	bank sloping/BKF bench
12+05	rock weir at log
12+52	LWD structure
12+60	LWD structure
12+96	rock weir
14+72	rock vane
14+87	rock vane
15+07	rock weir
16+58	rock weir
16+58 - 18+26	bank sloping/BKF bench
16+98	rock weir
17+07	root wads
17+46	rock weir
17+91	LWD structure
19+36	rock weir at white pines
19+54	rock weir at white pines
19+81	rock vane at white pines
19+81 - 20+88	bank sloping/BKF bench
20+72	rock weir
20+80	root wads

Table 2. Project Costs as of 2/28/02
Bare Site

WRC Administration		
hours	$	785.63
mileage	$	41.61
WRC Pre-Planning		
hours	$	3,426.67
mileage	$	348.84
WRC Construction		
hours	$	5,355.23
mileage	$	799.90
WRC As-Built		
hours	$	2,363.04
mileage	$	184.68
WRC Tree Planting		
hours	$	1,475.20
mileage	$	269.42
WRC Monitoring		
hours	$	-
mileage	$	-
Construction Contract	$	5,459.00
Construction Materials	$	816.30
Livestock Exclusion Contract	$	31,121.53
NRCS Administrative Cost	$	1,007.62
Tree Purchase	$	912.00
Livestake Purchase	$	125.00
WRC Overall 421 Project Administration		
hours	$	2,668.38
mileage	$	45.37
project equipment / office expenses / supplies	$	2,818.24
Total Project Cost as of 2/28/02	**$**	**60,023.65**
Cost per foot (2183ft)	$	27.50
DOT Easement Payment	$	15,450.00