LITTLE PINE CREEK/BRUSH CREEK
2002 MONITORING REPORT

ALLEGHANY COUNTY, NORTH CAROLINA

HDR Project No. 09177-027-018

January 2003

2002 MONITORING REPORT

Prepared by:

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1.0 INTRODUCTION

1.1 Review

This report is intended for use by the North Carolina Department of Environment and Natural Resources (NCDENR) Wetland Restoration Program (NCWRP) for post-construction monitoring assessment on Little Pine Creek/Brush Creek, Alleghany County (County), North Carolina. This report was prepared pursuant to NCWRP's request to HDR Engineering, Inc. of the Carolinas (HDR), HDR Project No. 09177-027-018.

1.2 Purpose

HDR personnel conducted field reconnaissance to complete the first year of post-construction monitoring of the Little Pine Creek/Brush Creek project site. Field reconnaissance of the project site included surveying longitudinal profiles and cross-sections of Little Pine Creek and Brush Creek, photographing the streams at permanent photograph stations, and recording vegetation at the permanent vegetation plots. Methodology for the stream monitoring follows the Little Pine Creek/Brush Creek Monitoring Methodology Report (HDR, 2002).

2.0 SUMMARY

2.1 Site Characteristics

The project site is located in Alleghany County, in the Blue Ridge Province of the Appalachian Mountains. At this site, Little Pine Creek, a third-order perennial stream draining a watershed of 4.3 square miles, enters Brush Creek, a fourth-order perennial stream draining a watershed area of 26.3 square miles (Figure 1). Brush Creek is a tributary to the Little River. These streams are part of the New River watershed, United States Geologic Survey (USGS) Hydrologic Unit 05050001, and North Carolina Division of Water Quality (NCDWQ) Subbasin 05-07-03. Streams have been assigned a best usage classification by NCDWQ that reflects water quality conditions and potential resource usage. The classification for Brush Creek is C TR. Waters classified as C TR are used for secondary recreation and protected for the intent of trout propagation and survival (NCDENR, 2000).

In 1969, Little Pine Creek was channelized upstream of its confluence with Brush Creek. In the recent past, approximately 340 feet of Brush Creek stream bank, downstream of the Little Pine Creek confluence, experienced significant bank collapse. This collapse may be linked to a variety of factors, including the steep angle of the Little Pine Creek confluence, deflection of Brush Creek streamflow by point bar formation downstream of the confluence, the unconsolidated alluvial composition of the collapsing Brush Creek streambank, and limited riparian vegetation.

In response to landowner desires to restore Little Pine Creek and Brush Creek to a condition of natural stability, restoration of these streams occurred from April to July 2001, as shown in Figures 2 and 3. Riparian planting was completed in January 2002. Approximately 600 linear feet of altered Little Pine Creek channel were replaced with a new, 950-linear foot meandering

channel reconnected to the flood plain and designed to maintain stable dimension, pattern, and profile while effectively transporting anticipated streamflow and sediment load. A vegetated riparian corridor was established along Little Pine Creek in order to improve water quality and increase aquatic and terrestrial habitat resources. In addition, 340 linear feet of Brush Creek were stabilized to eliminate existing severe bank collapse problems. Another 2,300 feet of degraded Brush Creek riparian corridor were enhanced in an effort to stabilize unstable banks, increase instream aquatic habitat, and improve the riparian buffer.

The lower 700 feet of Brush Creek, which is included in the conservation easement, does not include cross-section or permanent photograph station establishment. No grading work or planting was performed in this stable reach. Two boulder clusters were placed in the stream in this section to augment existing riffle sections.

Lower 700 feet of Brush Creek

This project site must be monitored for a five-year period, or for two documented bankfull events, to determine restoration success. The morphology of the stream is to be monitored using the Rosgen classification system a minimum of once per year for five years after construction. Project construction was completed in 2001, with monitoring planned for 2002 through 2006. It is also recommended to survey the streams after bankfull, or greater, storm events during this monitoring period. This is the first monitoring event in a series of five and the first monitoring report in a series of three for this project site.

2.2 Stream Geomorphology

Cross-section geometry data were gathered during field reconnaissance. Three cross-sections have been established on each stream, capturing both riffles and pools. These locations are shown on Figure 2. The monitoring data from these cross-sections have been plotted over the baseline data for comparison. The figures for Little Pine Creek and Brush Creek are presented in Appendices A and B, respectively.

2.2.1 Dimension

Permanent cross-sections have been established, at one per 20 bankfull-width lengths, along the stream corridors of the restoration site. Little Pine Creek and Brush Creek each have three established cross-sections, as shown in Figure 2. Compared to the baseline data for Little Pine Creek, Cross-sections 1 and 2 have remained stable. Cross-section 3 has a slightly altered dimension compared to that from the baseline data. This could be caused by the animals using the banks as shelter. There is evidence of tunneling and burrowing, in addition to bank sloughing. In Brush Creek, all three cross-sections are similar to those produced from the baseline data. Cross-section 3 has slight differences in the terraced sand bar on the right bank (looking downstream). These differences are not significant and are most likely caused by the rock vanes pushing the thalweg closer to the center of the channel. Overall, the cross-sections show that the dimensions of Little Pine Creek and Brush Creek have not changed significantly compared to the baseline data.

Table 1 shows measurements that were taken while monitoring the cross-sections and longitudinal profiles of Little Pine Creek and Brush Creek. Calculations based on these

measurements include width to depth ratio, entrenchment ratio, and low bank height ratio. The cross-sections for Little Pine Creek are in Appendix A, while the cross-sections for Brush Creek are in Appendix B.

Table 1
Stream Attributes for Little Pine Creek and Brush Creek

Attribute	Little Pine Creek	Brush Creek
Bankfull width (ft)	20	56
Mean Bankfull depth (ft)	2.14	4.25
Belt width (ft)	20	
Meander width ratio	1.25	
Radius of curvature (ft)	50.5	
Sinuosity	1.7	
Pool-to-pool spacing (ft)	90.5	300-350
Flood prone area width (ft)	200	127
Average low bank height (ft)	4.69	7.71
Maximum bankfull depth (ft)	5.5	9.6
Low bank height ratio	0.85	0.80

2.2.2 Pattern

Based on the plan view of the project site, the following measurements were taken: sinuosity, meander width ratio, and radius of curvature. Radius of curvature is required only for the first year of monitoring of newly constructed meanders. The pattern of Little Pine Creek did not change compared to baseline data.

2.2.3 Profile

The longitudinal profiles were surveyed for Little Pine Creek and Brush Creek within the project site. These profiles capture the riffle and pool sequences of the stream. Data from these longitudinal profiles have been plotted over those of the previous year for comparison. In Little Pine Creek, the 2002 data show that the profile has not changed significantly. While there are some changes within the stream, the starting and ending elevations of the stream are within 0.15 feet of what they were during the baseline monitoring. Many of the changes in profile are due to bank failures, which are described in more detail in Section 6.0. Erosion of the banks allows water to move out of its intended path, which can cause changes in profile. The longitudinal profile for Brush Creek is similar to that taken during the baseline monitoring. In general, the instream structures were effective in keeping the flow in the middle of the channel. The longitudinal profile for Little Pine Creek is in Appendix A, while the longitudinal profile for Brush Creek is in Appendix B.

Longitudinal profile measurements include average slope, pool slope, and riffle slope. In addition, pool-to-pool spacing was measured. Pool-to-pool spacing in Little Pine Creek is calculated by taking the distance between the beginning of one pool and the beginning of the next pool. In Little Pine Creek, it is difficult to segregate between the runs and pools. Where runs are discernable, run slope was measured. For each stream, pool slope was measured by taking the attributes of the adjacent upstream and downstream features. For example, in Brush Creek, the slope of Pool 1 is calculated by using the attributes of the bottom of Riffle 1 and the top of Riffle 2.

In Little Pine Creek, the average riffle slope is 0.0309 for baseline and 0.0355 for 2002, with average pool slopes of -0.0085 and -0.0047 for the baseline and 2002 measurements, respectively. The overall slope of Little Pine Creek is 0.0125 for the baseline data and 0.0139 for the 2002 monitoring data, which indicates that the profile of the stream has not changed significantly.

In Brush Creek, the average riffle and pool calculations are skewed by measuring one incomplete riffle and one incomplete pool. Removing Riffle 1 from the calculation yields an average riffle slope of 0.0220 for the baseline data and 0.0117 for the 2002 monitoring data. In addition, removing Pool 4 from the calculations yields an average pool slope of –0.0005 for the baseline data and 0.0003 for the 2002 monitoring data. Removing both of these numbers from the calculation of overall average slope gives a slope of 0.0073 for the baseline data and 0.0056 for the 2002 monitoring data. This indicates that the slope of Brush Creek has not changed drastically from the baseline data.

While pool-to-pool spacing remained consistent in Brush Creek, compared to baseline, pool-to-pool spacing did increase in Little Pine Creek. The average distance between pools in Little Pine Creek was 90.5 feet, compared with 73 feet during the baseline sampling. Some of the features in the stream have changed from pools to runs, and this can account for the difference in distance. There are two fewer pools in Little Pine Creek than there were immediately after construction.

2.2.4 Materials

A pebble count provides a quantitative characterization of streambed material. This composition information is used as an indicator of changes in stream character, channel form, hydraulics, erosion rates, and sediment supply. Pebble counts were performed at each of the three cross-sections along Little Pine Creek and Brush Creek. Each pebble count consisted of 100 counts at each location along the streams.

Pebble counts were completed following the basic steps for the Modified Wolman Pebble Count (Rosgen, 1996). The data for the pebble counts have been plotted over those of the previous year for comparison. Table 2 shows d50 and d85 from the baseline monitoring and the 2002 monitoring for each stream. Data from pebble counts for Little Pine Creek are in Appendix A, while pebble count data for Brush Creek are in Appendix B.

The 2002 data show that substrate sizes for Little Pine Creek and Brush Creek are similar to those measured during the baseline reconnaissance. In Little Pine Creek, substrate size at Cross-sections 1 and 2 are very similar. Substrate size at Cross-section 3 is somewhat different. The data show that much of the very fine sand has been flushed out of this area. There is a more even distribution of sand and gravel in 2002, when compared to the baseline. In Brush Creek, data from Cross-section 1 show the greatest change from baseline conditions. Both d50 and d85 sizes decreased, yet the maximum particle size increased. The decrease in d50 and d85 can be attributed to a small sand bar forming in front of one of the boulders placed in the stream. Data from Cross-sections 2 and 3 show only slight differences in d50 and d85.

Table 2 Pebble Count Data				
Stream	**Cross Section**	**Attribute**	**Baseline**	**2002 Monitoring**
Little Pine Creek	XS-1	d50 (mm)	29.1	25.0
		d85 (mm)	77.5	79.0
	XS-2	d50 (mm)	38.9	34.1
		d85 (mm)	82.3	88.9
	XS-3	d50 (mm)	< 2	3.3
		d85 (mm)	5.8	11.3
Brush Creek	XS-1	d50 (mm)	26.5	18.8
		d85 (mm)	57.6	96.0
	XS-2	d50 (mm)	15.3	10.8
		d85 (mm)	52.6	49.6
	XS-3	d50 (mm)	29.8	26.7
		d85 (mm)	192.0	192.0

2.2.5 Reference Photographs

Photograph stations have been established at all cross-section locations and at distinguishing points, including all instream structures, along Little Pine Creek and Brush Creek. All photograph stations are labeled on Figure 2, and station number and compass bearing are shown in Table 3.

Table 3 Permanent Photograph Stations		
Stream	**Station Number**	**Bearing (° from N)**
Little Pine Creek	1	105, 180
	2	40, 80, 120
	3	20, 60, 100
	4	0, 280, 320
	5	260
Brush Creek	1	235, 275
	2	10, 310, 330
	3	0, 80, 120, 160
	4	55, 95, 145
	5	40
	6	5, 55, 115, 150
	7	90, 335
	8	140, 180, 220
	9	130, 170, 230, 270, 310, 340
	10	30, 50, 85, 120

Photographs of Little Pine Creek are in Appendix A, while photographs of Brush Creek are in Appendix B. Comparison of these photographs to those taken when the permanent photograph stations were established indicated vegetation growth along the stream banks of Little Pine Creek. Overall, the channel of Little Pine Creek looks the same, compared to

baseline. The only major difference is shown at Photograph Station 4, 40º from north. Comparison of the photographs shows the bank sloughing off into the channel. The baseline photograph shows a small sandbar in the channel, while the 2002 photograph shows that the bank and the sandbar have become connected.

Overall, photographs from Brush Creek show vegetation growth along the stream banks, channel stability, and stability of structures placed in the stream. The photograph at Station 3, bearing north, shows deposition of more sand on the floodplain bench. Other features along the channel look similar to those depicted in the baseline photographs.

2.2.6 Vegetation

Vegetation planting included a seed mix, live stakes, and bare root trees. The seed mix (Table 4) was spread throughout the buffer area. Live stakes (Table 5) were planted from the edge of water to the top of slope on the banks of Little Pine Creek. Approximately 11,275 square feet of Little Pine Creek banks were planted. Additional live stakes were planted on the flood plain bench, along the rock vane area, and throughout various areas of Brush Creek. These areas comprise approximately 11,150 square feet of live staking. Bare root plantings (Table 5) occurred in the buffer areas from the top of slope out 50 feet. Woody vegetation will be monitored for five years, or for two bankfull events, before success or failure is assessed.

Table 4
Riparian Seed Mix (Ernst Seeds)

Common Name	Scientific Name	Percent
Annual rye	*Lolium multiflorum*	25
Blue vervain	*Verbena hastata*	5
Bur-marigold	*Bidens aristosa*	10
Deertongue "Tioga"	*Dichanthelium clandestinum*	15
Eastern gamma grass	*Tripsacum dactyloides*	5
Partridge pea	*Chamaecrista fasciculata*	10
Pennsylvania smartweed	*Polygonum pennsylvanicum*	10
River oats	*Chasmanthium latifolium*	5
Soft rush	*Juncus effusus*	5
Virginia wild rye	*Elymus virginicus*	10

Table 5 Live Stake and Bare Root Trees		
Common Name	**Scientific Name**	**Planting Type**
River birch	*Betula nigra*	Bare root
Black walnut	*Juglans nigra*	Bare root
Tulip poplar	*Liriodendron tulipifera*	Bare root
White oak	*Quercus alba*	Bare root
Persimmon	*Diospyros virginiana*	Bare root
Sycamore	*Platanus occidentalis*	Bare root
Sugar maple	*Acer saccharum*	Bare root
Silky dogwood	*Cornus amomum*	Live stake
Silky willow	*Salix sericea*	Live stake
Virginia willow	*Itea virginica*	Live stake
Elderberry	*Sambucus canadensis*	Live stake
White alder	*Clethra acuminata*	Live stake
Ninebark	*Physocarpus opulifolius*	Live stake

Survival of vegetation within the riparian buffer was evaluated using survival plots and photograph documentation of the length of the corridor in which buffers were planted (Figure 2). In addition to evaluating survival of live stakes along Little Pine Creek, woody vegetation was monitored in two vegetation plots along Little Pine Creek and one plot on the atop the bankfull bench of Brush Creek.

Each vegetation plot is 1/50 of an acre, with a radius of 16.7 feet from the center point shown on Figure 2. Vegetation survival of target dominant species and herbaceous cover should be incorporated into the plot; however, due to sampling after the 2002 growing season, dominant species and percent cover were not monitored.

Overall, survival of the vegetation was good. However, growth has been severely delayed by a late hard freeze shortly after planting. The majority of the bare root plantings were alive because of secondary growth from the root crown, not from the woody stems. The Silky willow live stakes along the Little Pine Creek corridor exhibited significant growth. The lower half of the stream banks along Little Pine Creek has a dense cover of Rush (*Juncus* sp.), which provides additional bank stability. For many plants, the upcoming growing season may provide a more accurate representation of vegetation success.

3.0 SUCCESS CRITERIA

Restoration of Little Pine Creek and Brush Creek will be determined a success after the monitoring period is complete and the following criteria are met. The stream channels should maintain their dimension, pattern, and profile over time. Additionally, instream structures should remain secure and stable during the monitoring period.

Judgments on success or failure of restoration activities using these data will be subjective. It is expected that there will be some minimal changes in the cross-sections, profile, and/or substrate composition. Changes that may occur during the monitoring period will be evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting, deposition, and/or erosion) or if they are minor changes that represent an increase in stability (e.g., settling, vegetative changes, and/or decrease in

width/depth ratio). Unstable conditions that require remediation will indicate failure of restoration activities.

3.1 Dimension

Cross-section changes can indicate changes in the width to depth ratio of a stream. Some change is expected over time; however, cross-section changes should not show excessive erosion or degradation of the channel dimensions over time. Bank slopes should remain stable. Photographs can also provide visual references to channel cross-section changes.

3.2 Pattern

The plan view of the project site should remain consistent with the designed Rosgen valley and stream type. Success of the design is indicated by no change in sinuosity.

3.3 Profile

Comparison of longitudinal profiles during the monitoring period will indicate excessive changes in channel slope, riffle and pool sequences, and developing bars within the channel. Channel aggradation or degradation can be analyzed from longitudinal profile information. Longitudinal photographs can also document stream channel changes over time.

3.4 Materials

Pebble count data can be used to interpret the movement of materials in the stream channels. Established d50 and d85 sizes should increase in coarseness in riffles and increase in fineness in pools.

3.5 Photographs

Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of in-stream structures and erosion control measures. A series of photographs can also indicate channel or bank erosion problems over time. If necessary, actions can be taken to remedy these problems.

3.6 Vegetation

Review of photograph documentation should make evident the establishment and maturation of vegetated riparian buffer zones (Figure 4). Native vegetation, as determined by reference reach vegetation inventories, was planted at the project site. Five years after project construction completion, tree species comparable to those at the reference site must have a survival rate of 320 stems per acre.

4.0 MONITORING SCHEDULE

Annual monitoring is required for a five-year period beginning in 2002 and ending in December 2006. Reports will be submitted in 2002, 2004, and 2006 to U.S. Army Corps of Engineers, NCDWQ, and North Carolina Wildlife Resources Commission (NCWRC). This report fulfills the monitoring requirement for 2002.

5.0 RESULTS

The cross-section data show that the dimensions of Little Pine Creek and Bruch Creek have remained stable compared to the baseline data. The only evidence of altered channel dimension is shown at Cross-section 3 for Little Pine Creek. The dimension has most likely been altered by the presence of animals using the stream bank as shelter, as evidenced by numerous burrows perforating the banks.

Although, the data show that the longitudinal profile of Little Pine Creek has not changed significantly, there are areas that have been affected by bank failure. Overall, the stream does not show any trend other than stability. There is no evidence of head cutting or of becoming shallower. The data for Brush Creek suggest that there are no significant differences in profile. There are two areas that are different in 2002, compared to the baseline data. The first is near the confluence of Little Pine Creek. In this area, there seems to be some fractured bedrock, which has caused scouring in this area of the stream. The second area is downstream where the instream structures have pushed the thalweg more toward the center of the stream. Because the rock vanes are effective in moving the flow toward the center of the channel, additional pool scouring can occur during high flows. This accounts for the differences seen in depth between the baseline and 2002 measurements.

The 2002 data show that substrate sizes for Little Pine Creek and Brush Creek are similar to those measured during the baseline reconnaissance. At this time, there are not enough data to suggest any trends; however, similar substrate size at the cross-sections indicates channel stability.

Overall, photographs of the channel of Little Pine Creek look the same, compared to baseline. The only major difference is shown at Photograph Station 4, 40º from north. Comparison of the 2002 and baseline photographs shows the bank sloughing into the channel. Photographs from Brush Creek show vegetation growth along the stream banks, channel stability, and stability of structures placed in the stream.

Although survival of the vegetation was good, growth has been severely delayed by a late hard freeze shortly after planting. There is new growth on the root crowns of the bare root plantings, but the frost caused many of the woody stems to die. There is sufficient vegetation along the stream banks of Little Pine Creek and Brush Creek.

6.0 RECOMMENDATIONS

There are four areas along Little Pine Creek in need of repair. Near the upstream-most section of the restoration area, beavers had built a dam in the summer months, which backed up water and flooded land above the bridge. In addition, this caused severe erosion along the right bank (looking downstream). Local landowners destroyed the beaver dam; however, this eroded bank needs to be repaired. In addition, there is an all-terrain vehicle (ATV) crossing near the beaver dam remnants, which affects both stream banks. Following repair of the stream banks in this area, landowners need to be discouraged from using vehicles to cross the stream.

Bank erosion, right bank, near Cross-section 1

There is a bank failure near Cross-section 1. This area failed during the first storm event after construction. Although the bank has become partially revegetated, it needs to be repaired.

Near cross-section 3 on Little Pine Creek, there is evidence of animals burrowing into the banks. This could account for some of the bank sloughing into the stream. In addition, there are tunnels and dens in the stream banks. The photograph shows tunneling in the stream bank. Additional evidence is provided in the photograph taken from Station 4, 40º from north and in the stream dimensions at Cross-section 3. The dimension of Cross-section 3 different than that of the baseline, and it is possible that the animal impacts in the stream banks caused this change. Measures need to be taken to repair this area as well as to exclude wildlife from using the stream banks as shelter.

Tunneling in left bank near cross-section 3

Finally, there has been some erosion on the left bank of Little Pine Creek at the confluence with Brush Creek. Although the area has been somewhat revegetated, the stream bank has been undercut. In this area, the bank needs to be rebuilt and may need to have a less severe side slope in order to prevent such severe erosion in the future. Providing toe protection in this area is advised to slow erosion.

The stream banks of Brush Creek are in good condition. There are no areas that are visibly eroded. The instream structures seem to be working correctly to direct current into the middle of the channel. There are no areas along the enhanced portion of Brush Creek that need to be repaired.

Undercut left stream bank at the confluence with Brush Creek

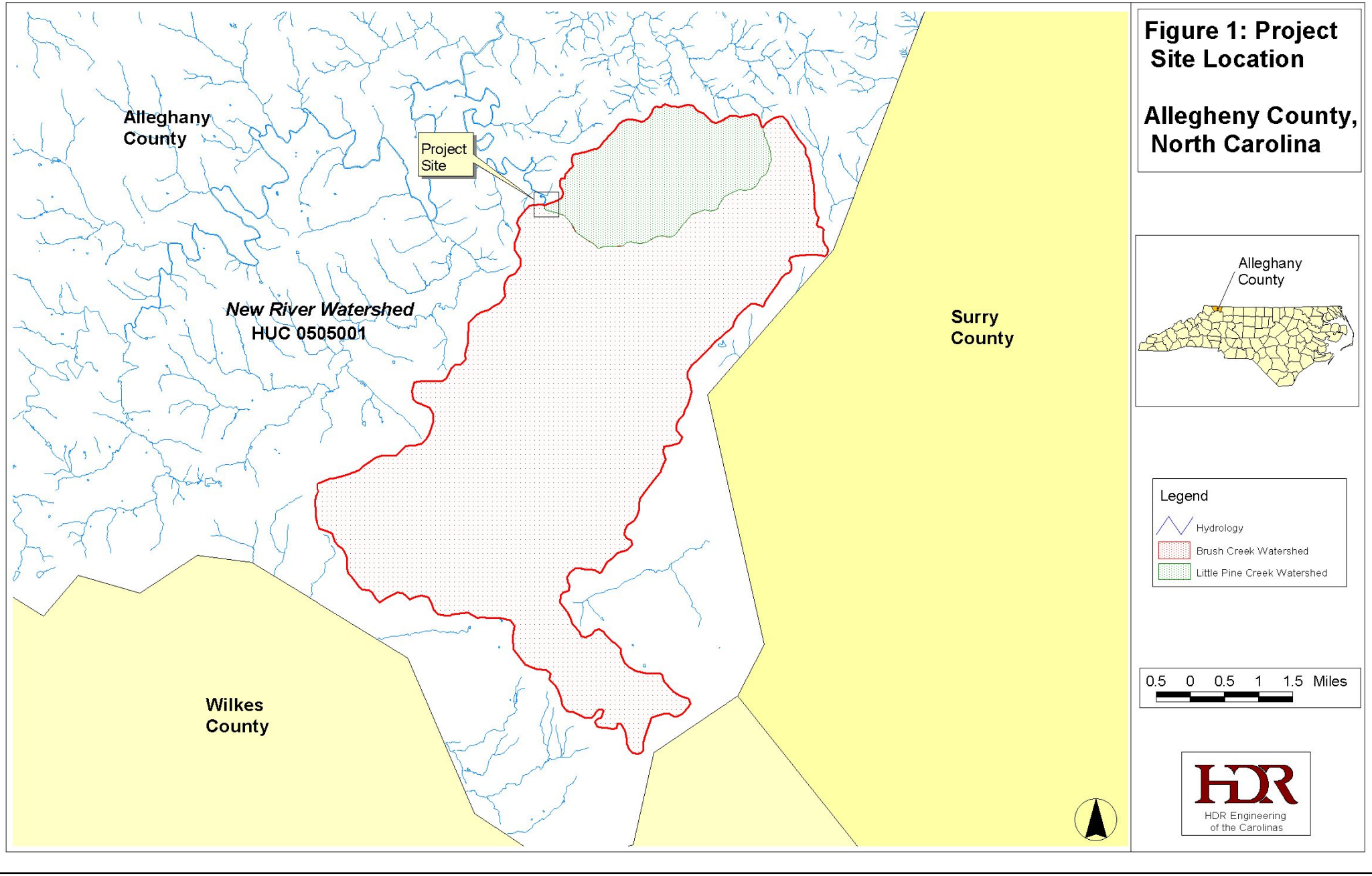
For many plants, the upcoming growing season may provide a more accurate representation of vegetation success. A mid-summer vegetation assessment is recommended to determine which and how many plants need to be replaced. Plants should be replaced per the contract documents.

7.0 REFERENCES

HDR. 2002. Little Pine Creek/Brush Creek Monitoring Methodology Report.

North Carolina Department of Environment and Natural Resources. 2000. *New River Basinwide Water Quality Plan*. Division of Water Quality. Raleigh, NC.

Rosgen, David L. 1996. *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, CO.


Alleghany
County
Project
Site
New River Watershed
HUC 0505001
Surry
County
Wilkes
County
Figure 1: Project
Site Location
Allegheny County,
North Carolina
Alleghany
County
Legend
Hydrology
Brush Creek Watershed
Little Pine Creek Watershed
0.5 0 0.5 1 1.5 Miles
HDR
HDR Engineering
of the Carolinas

LITTLE PINE CREEK

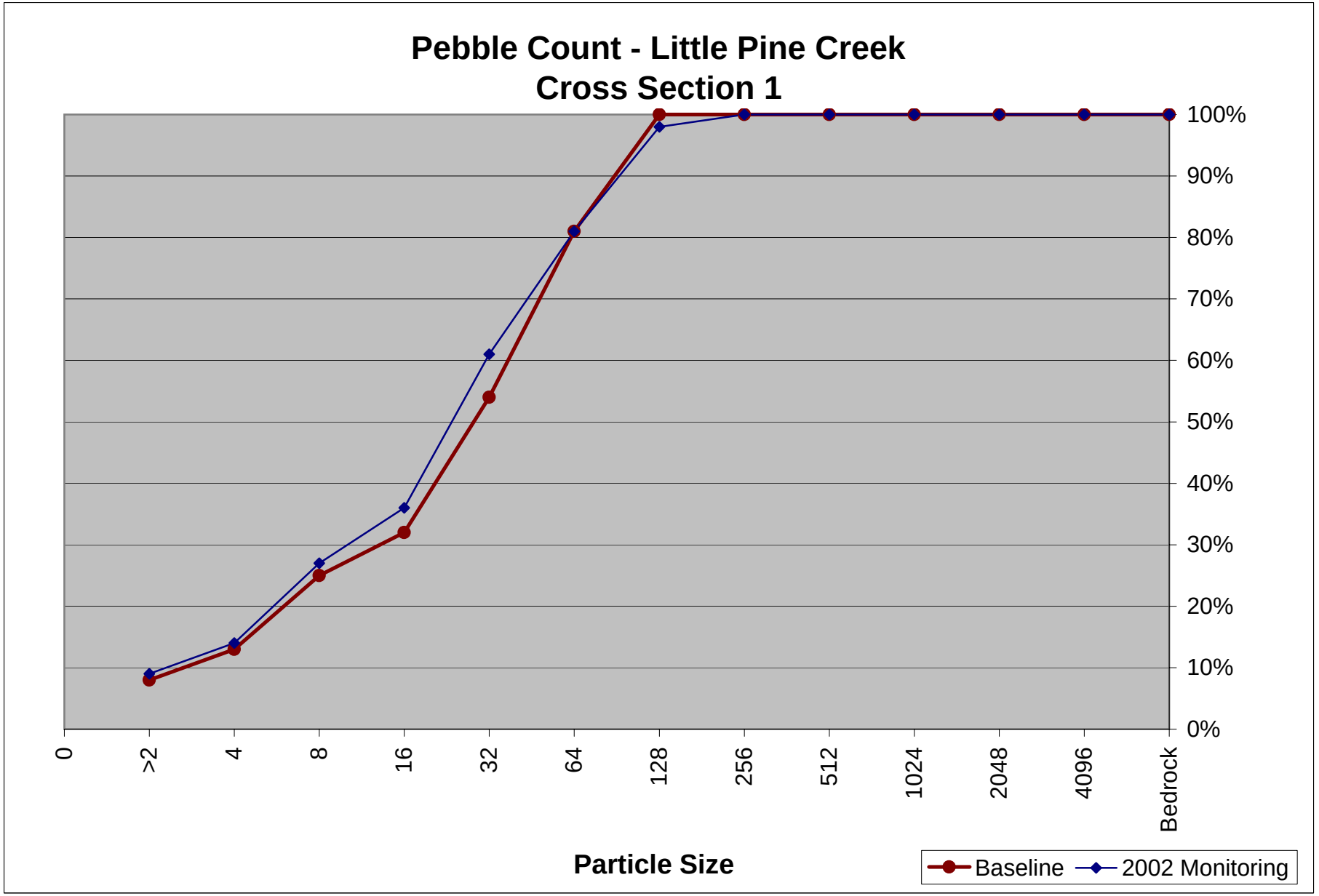
LONGITUDINAL PROFILE

Slope and Maximum Water Depth - Little Pine Creek Alleghany County, North Carolina Baseline Monitoring		
Feature	**Slope**	**Max. H2O depth (ft)**
Riffle 1	0.0030	0.86
Riffle 2	0.0176	0.65
Riffle 3	0.0194	0.48
Riffle 4	0.0459	0.45
Riffle 5	0.0207	0.50
Riffle 6	0.0288	0.75
Riffle 7	0.0425	0.80
Riffle 8	0.0587	0.92
Riffle 9	0.0032	0.84
Riffle 10	0.0518	1.00
Riffle 11	0.0472	0.88
Riffle 12	0.0634	1.54
Riffle 13	0.0184	0.58
Riffle 14	0.0123	0.90
Average Riffle	**0.0309**	
Pool 1	-0.0008	1.72
Pool 2	-0.0025	1.22
Pool 3	-0.0045	0.86
Pool 4	0.0002	1.10
Pool 5	-0.0067	1.34
Pool 6	-0.0036	1.72
Pool 7	-0.0082	1.25
Pool 8	0.0085	1.00
Pool 9	-0.0058	1.05
Pool 10	-0.0080	1.56
Pool 11	-0.0065	0.90
Pool 12	-0.0238	1.54
Pool 13	0.0006	0.85
Average Pool	**-0.0047**	
Run 1	-0.0057	1.00
Run 2	0.0063	0.65
Run 3	0.0029	0.70
Average Run	**0.0012**	
Average Slope	**0.0125**	

Slope and Maximum Water Depth - Little Pine Creek Alleghany County, North Carolina 2002 Monitoring		
Feature	**Slope**	**Max. H2O depth (ft)**
Riffle 1	0.0181	1.00
Riffle 2	0.0163	0.80
Riffle 3	0.0417	1.40
Riffle 4	0.0237	0.85
Riffle 5	0.0190	0.60
Riffle 6	0.0006	0.80
Riffle 7	0.0308	0.90
Riffle 8	0.0794	0.90
Riffle 9	0.0622	1.50
Riffle 10	0.0519	1.30
Riffle 11	0.0348	1.35
Riffle 12	0.0476	1.20
Average Riffle	**0.0355**	
Pool 1	-0.0118	1.65
Pool 2	-0.0103	1.10
Pool 3	-0.0031	0.90
Pool 4	-0.0219	1.25
Pool 5	-0.0090	1.55
Pool 6	0.0011	1.35
Pool 7	-0.0106	1.10
Pool 8	-0.0080	2.10
Pool 9	-0.0032	1.60
Pool 10	-0.0110	1.30
Pool 11	-0.0059	2.30
Average Pool	**-0.0085**	
Run 1	0.0135	1.30
Run 2	0.0065	1.00
Run 3	0.0097	0.80
Run 4	-0.0101	1.40
Run 5	0.0011	1.55
Average Run	**0.0041**	
Average Slope	**0.0139**	

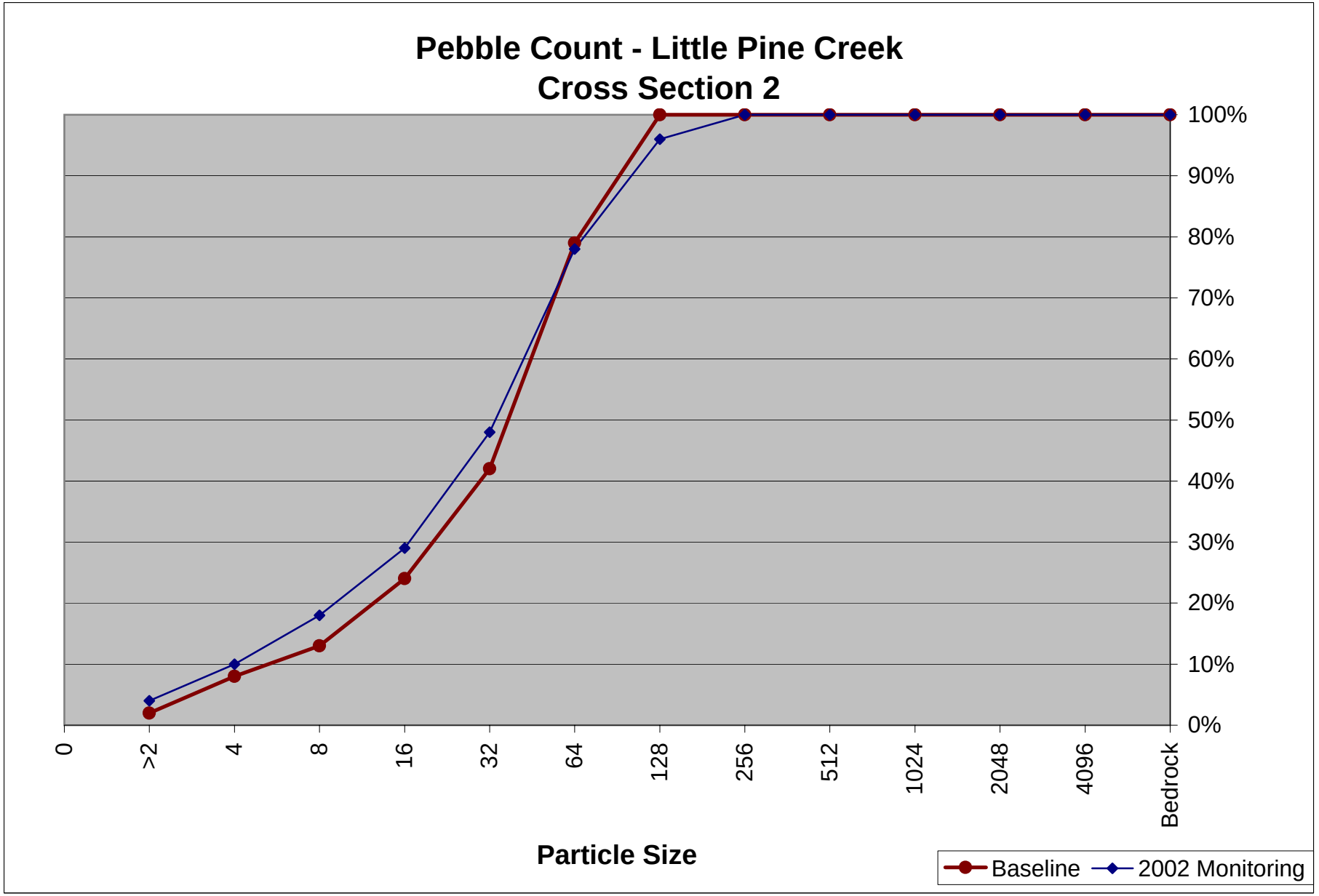
CROSS-SECTIONS

PEBBLE COUNT DATA


Pebble Count - Little Pine Creek
Cross Section 1
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
>2
4
8
16
32
64
128
256
512
1024
2048
4096
Bedrock
Particle Size
Baseline
2002 Monitoring

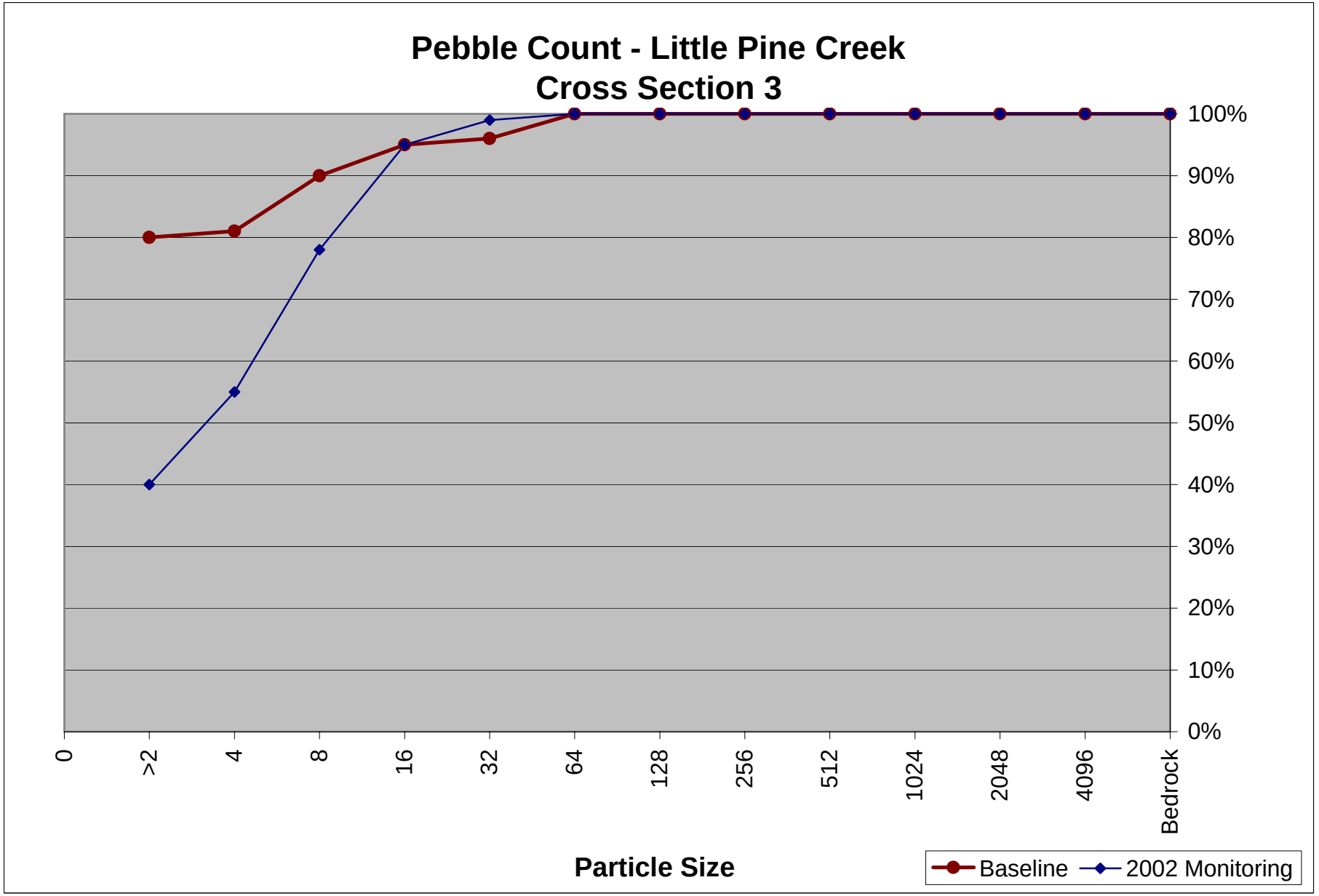
Little Pine Creek			
Cross Section 1			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	8	8.0%	8%
2-4	5	5.0%	13%
4-8	12	12.0%	25%
8-16	7	7.0%	32%
16-32	22	22.0%	54%
32-64	27	27.0%	81%
64-128	19	19.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 29.1 mm, d85 = 77.5 mm			

Little Pine Creek			
Cross Section 1			
2002 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	9	9.0%	9%
2-4	5	5.0%	14%
4-8	13	13.0%	27%
8-16	9	9.0%	36%
16-32	25	25.0%	61%
32-64	20	20.0%	81%
64-128	17	17.0%	98%
128-256	2	2.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 25.0 mm, d85 = 79.0 mm			


Pebble Count - Little Pine Creek
Cross Section 2
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
>2
4
8
16
32
64
128
256
512
1024
2048
4096
Bedrock
Particle Size
Baseline
2002 Monitoring

Little Pine Creek			
Cross Section 2			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	2	2.0%	2%
2-4	6	6.0%	8%
4-8	5	5.0%	13%
8-16	11	11.0%	24%
16-32	18	18.0%	42%
32-64	37	37.0%	79%
64-128	21	21.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 38.9 mm, d85 = 82.3 mm			

Little Pine Creek			
Cross Section 2			
2002 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	4	4.0%	4%
2-4	6	6.0%	10%
4-8	8	8.0%	18%
8-16	11	11.0%	29%
16-32	19	19.0%	48%
32-64	30	30.0%	78%
64-128	18	18.0%	96%
128-256	4	4.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 34.1 mm, d85 = 88.9 mm			


Pebble Count - Little Pine Creek
Cross Section 3
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
>2
4
8
16
32
64
128
256
512
1024
2048
4096
Bedrock
Particle Size
Baseline
2002 Monitoring

Little Pine Creek			
Cross Section 3			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	80	80.0%	80%
2-4	1	1.0%	81%
4-8	9	9.0%	90%
8-16	5	5.0%	95%
16-32	1	1.0%	96%
32-64	4	4.0%	100%
64-128		0.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 < 2 mm, d85 = 5.8 mm			

Little Pine Creek			
Cross Section 3			
2002 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	40	40.0%	40%
2-4	15	15.0%	55%
4-8	23	23.0%	78%
8-16	17	17.0%	95%
16-32	4	4.0%	99%
32-64	1	1.0%	100%
64-128		0.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 3.3 mm, d85 = 11.3 mm			

PHOTOGRAPHS

Little Pine Creek Photograph Station 1

260º from North

Little Pine Creek Photograph Station 2

North

Little Pine Creek Photograph Station 2

320º from North

Little Pine Creek Photograph Station 2

320º from North

Little Pine Creek Photograph Station 2

280º from North

Little Pine Creek Photograph Station 3

100º from North

Little Pine Creek Photograph Station 3

60º from North

Little Pine Creek Photograph Station 3

60º from North

Little Pine Creek Photograph Station 3

20º from North

Little Pine Creek Photograph Station 4

120º from North

Little Pine Creek Photograph Station 4

80º from North

Little Pine Creek Photograph Station 4

80º from North

Little Pine Creek Photograph Station 4

40º from North

Little Pine Creek Photograph Station 5

180º from North

Little Pine Creek Photograph Station 5

105º from North

BRUSH CREEK

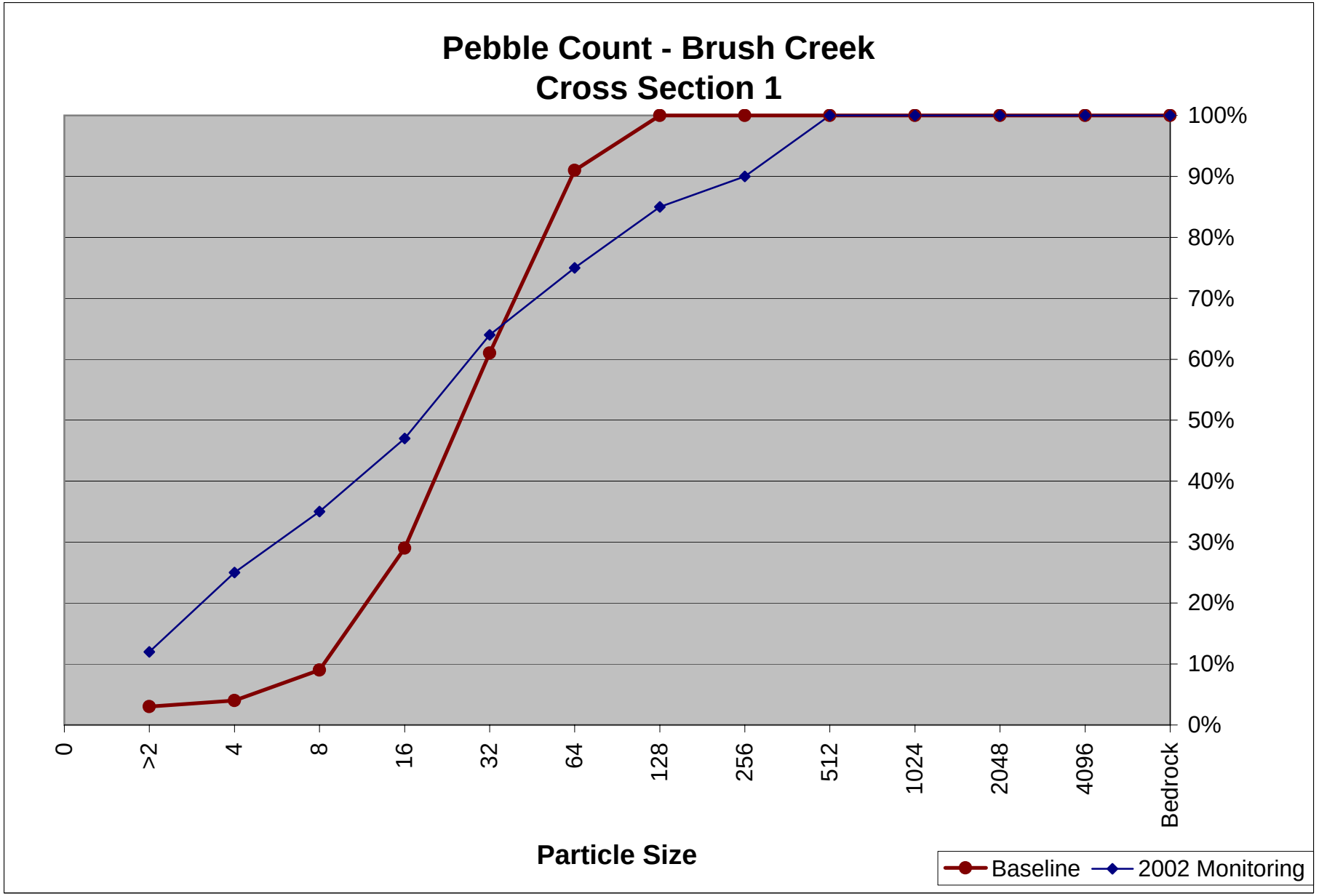
LONGITUDINAL PROFILE

Slope and Maximum Water Depth - Brush Creek Alleghany County, North Carolina Baseline Monitoring		
Feature	**Slope**	**Max. H2O depth (ft)**
Riffle 1	0.0380	0.96
Riffle 2	0.0256	1.05
Riffle 3	0.0024	0.85
Riffle 4	0.0203	0.75
Average Riffle	**0.0216**	
Pool 1	0.0007	1.80
Pool 2	-0.0001	2.30
Pool 3	-0.0022	2.90
Pool 4	0.0143	1.60
Average Pool	**0.0032**	
Run 1	0.0042	1.50
Average Slope	**0.0115**	

Slope and Maximum Water Depth - Brush Creek Alleghany County, North Carolina 2002 Monitoring		
Feature	**Slope**	**Max. H2O depth (ft)**
Riffle 1	0.0070	0.90
Riffle 2	0.0135	2.00
Riffle 3	0.0012	2.10
Riffle 4	0.0204	1.70
Average Riffle	**0.0105**	
Pool 1	0.0033	4.00
Pool 2	-0.0002	2.80
Pool 3	-0.0020	4.10
Pool 4	0.0218	1.30
Average Pool	**0.0057**	
Run 1	0.0034	2.50
Average Slope	**0.0076**	

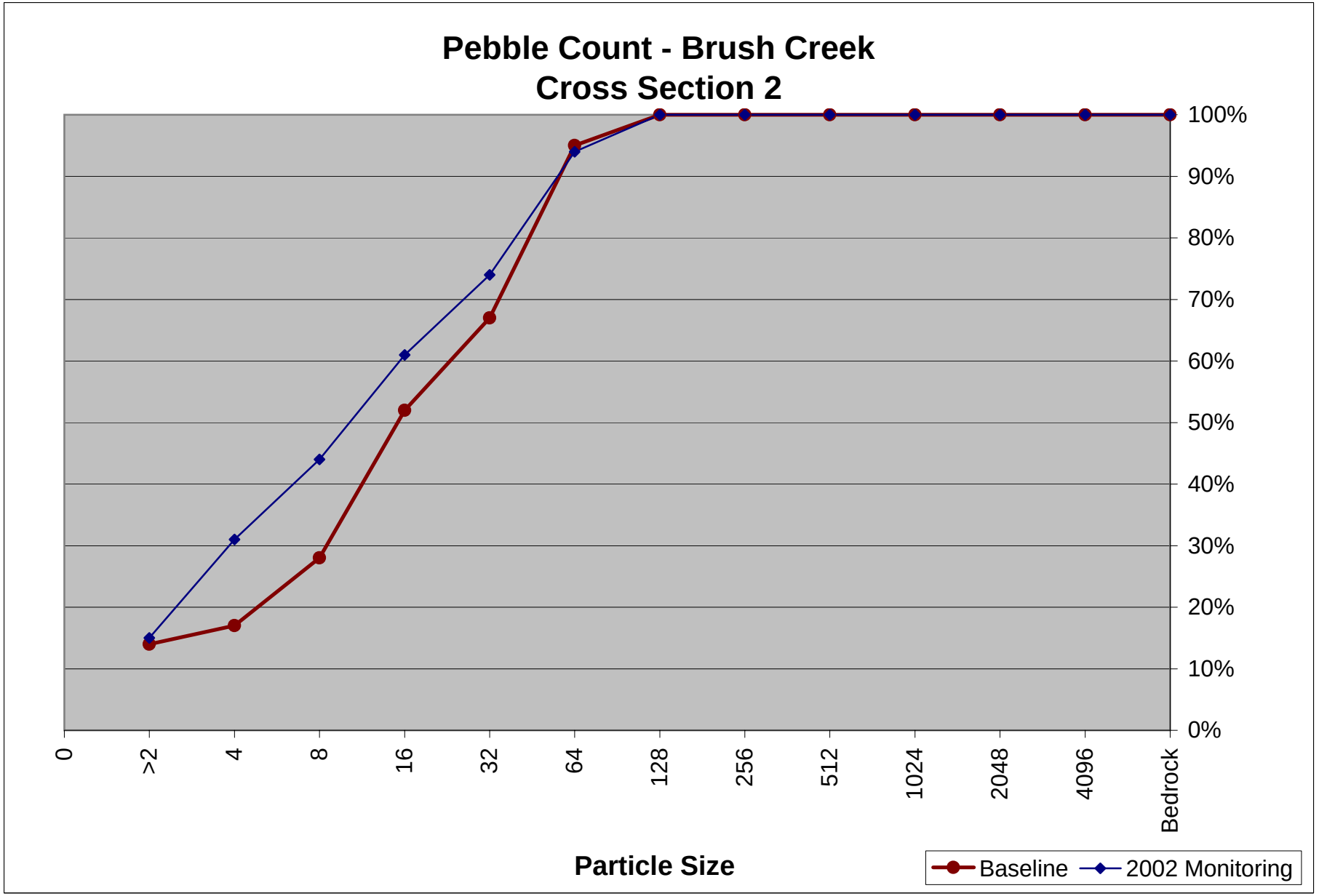
CROSS-SECTIONS

PEBBLE COUNT DATA


Pebble Count - Brush Creek
Cross Section 1
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
>2
4
8
16
32
64
128
256
512
1024
2048
4096
Bedrock
Particle Size
Baseline
2002 Monitoring

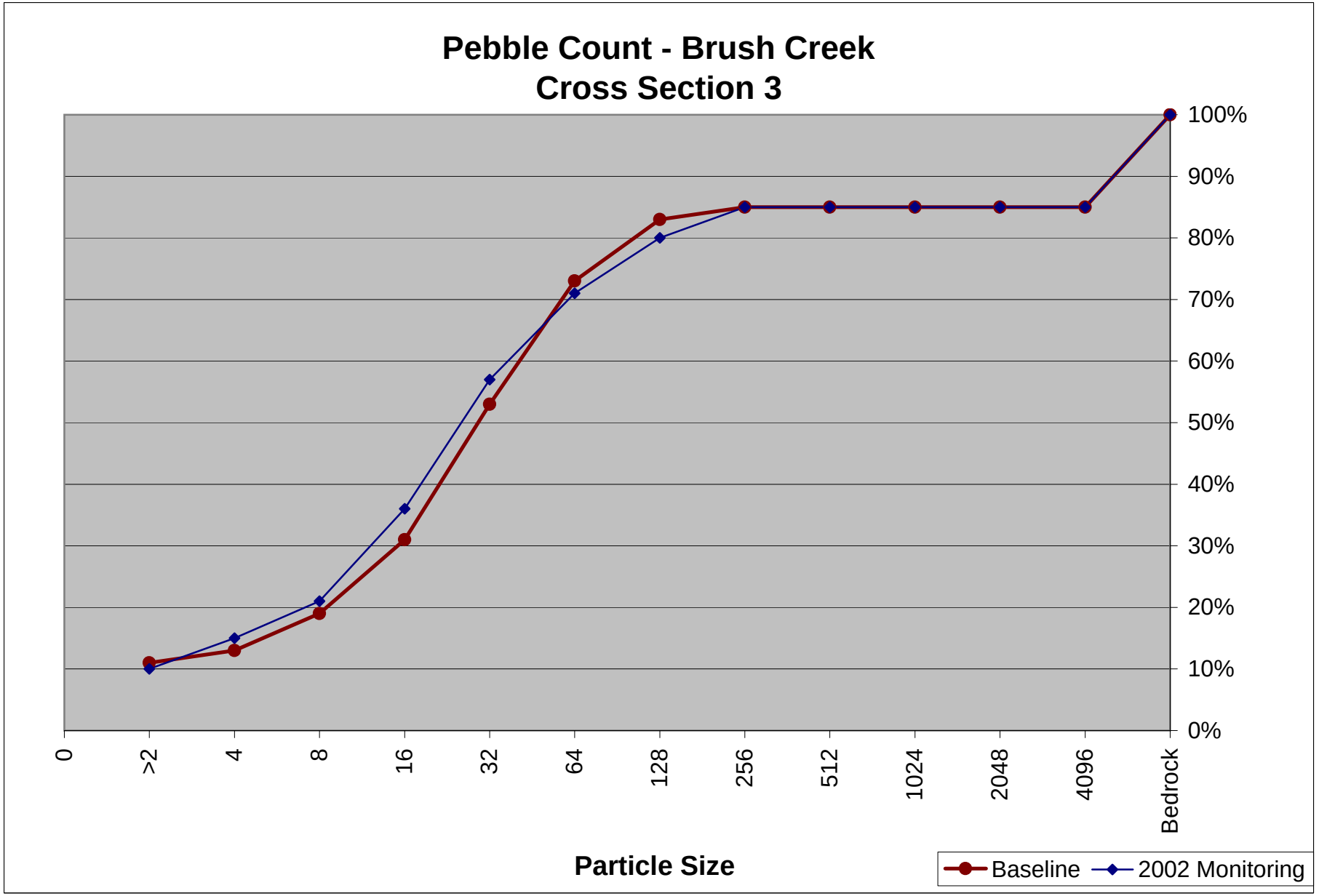
Brush Creek			
Cross Section 1			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	3	3.0%	3%
2-4	1	1.0%	4%
4-8	5	5.0%	9%
8-16	20	20.0%	29%
16-32	32	32.0%	61%
32-64	30	30.0%	91%
64-128	9	9.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 26.5 mm, d85 = 57.6 mm			

Brush Creek			
Cross Section 1			
2002 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	12	12.0%	12%
2-4	13	13.0%	25%
4-8	10	10.0%	35%
8-16	12	12.0%	47%
16-32	17	17.0%	64%
32-64	11	11.0%	75%
64-128	10	10.0%	85%
128-256	5	5.0%	90%
256-512	10	10.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 18.8 mm, d85 =96 mm			


Pebble Count - Brush Creek
Cross Section 2
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
>2
4
8
16
32
64
128
256
512
1024
2048
4096
Bedrock
Particle Size
Baseline
2002 Monitoring

Brush Creek			
Cross Section 2			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	14	14.0%	14%
2-4	3	3.0%	17%
4-8	11	11.0%	28%
8-16	24	24.0%	52%
16-32	15	15.0%	67%
32-64	28	28.0%	95%
64-128	5	5.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 15.3 mm, d85 = 52.6 mm			

Brush Creek			
Cross Section 2			
2002 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	15	15.0%	15%
2-4	16	16.0%	31%
4-8	13	13.0%	44%
8-16	17	17.0%	61%
16-32	13	13.0%	74%
32-64	20	20.0%	94%
64-128	6	6.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 10.8 mm, d85 = 49.6 mm			


Pebble Count - Brush Creek
Cross Section 3
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
>2
4
8
16
32
64
128
256
512
1024
2048
4096
Bedrock
Particle Size
Baseline
2002 Monitoring

Brush Creek			
Cross Section 3			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	11	11.0%	11%
2-4	2	2.0%	13%
4-8	6	6.0%	19%
8-16	12	12.0%	31%
16-32	22	22.0%	53%
32-64	20	20.0%	73%
64-128	10	10.0%	83%
128-256	2	2.0%	85%
256-512		0.0%	85%
512-1024		0.0%	85%
1024-2048		0.0%	85%
2048-4096		0.0%	85%
Bedrock	15	15.0%	100%
Total	**100**	**100%**	**100%**
d50 = 29.8 mm, d85 = 192 mm			

Brush Creek			
Cross Section 3			
2002 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	10	10.0%	10%
2-4	5	5.0%	15%
4-8	6	6.0%	21%
8-16	15	15.0%	36%
16-32	21	21.0%	57%
32-64	14	14.0%	71%
64-128	9	9.0%	80%
128-256	5	5.0%	85%
256-512		0.0%	85%
512-1024		0.0%	85%
1024-2048		0.0%	85%
2048-4096		0.0%	85%
Bedrock	15	15.0%	100%
Total	**100**	**100%**	**100%**
d50 = 26.7 mm, d85 = 192 mm			

PHOTOGRAPHS

Brush Creek Photograph Station 1

235° from North

Brush Creek Photograph Station 1

275° from North

Brush Creek Photograph Station 2

310º from North

Brush Creek Photograph Station 2

330º from North

Brush Creek Photograph Station 2

330º from North

Brush Creek Photograph Station 2

10º from North

Brush Creek Photograph Station 3

160º from North

Brush Creek Photograph Station 3

120º from North

Brush Creek Photograph Station 3

80º from North

Brush Creek Photograph Station 3

North

Brush Creek Photograph Station 4

145º from North

Brush Creek Photograph Station 4

95º from North

Brush Creek Photograph Station 4

55º from North

Brush Creek Photograph Station 5

40º from North

Brush Creek Photograph Station 6

150º from North

Brush Creek Photograph Station 6

115º from North

Brush Creek Photograph Station 6

55º from North

Brush Creek Photograph Station 6

5º from North

Brush Creek Photograph Station 7

90º from North

Brush Creek Photograph Station 7

335º from North

Brush Creek Photograph Station 8

140º from North

Brush Creek Photograph Station 8

180º from North

Brush Creek Photograph Station 8

220º from North

Brush Creek Photograph Station 9

130º from North

Brush Creek Photograph Station 9

170º from North

Brush Creek Photograph Station 9

230º from North

Brush Creek Photograph Station 9

270º from North

Brush Creek Photograph Station 9

310º from North

Brush Creek Photograph Station 9

340º from North

Brush Creek Photograph Station 10

120º from North

Brush Creek Photograph Station 10

85º from North

Brush Creek Photograph Station 10

50º from North

Brush Creek Photograph Station 10

30º from North