Badin Inn
Stream Restoration
Stanly County, North Carolina
Year 1 Monitoring Report

Monitoring Year: 2010
Measurement Year 1
As-Built Date 2009
NCEEP Project Number 92666

May 2010

BADIN INN STREAM RESTORATION
YEAR 1 MONITORING REPORT

CONDUCTED FOR THE NORTH CAROLINA DEPARTMENT
OF
ENVIRONMENT AND NATURAL RESOURCES

Table of Contents

LIST OF FIGURES

TABLES

APPENDICIES

I. EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Badin Inn project consists of 4,174 linear feet of Priority I stream restoration located on the golf course of the Badin Inn Golf Resort and Club in the Town of Badin, North Carolina. Construction on the site was completed in April of 2009. The following report provides the Year 1 monitoring information.

The project consists of a portion of an unnamed tributary to Little Mountain Creek (UT to Little Mountain Creek), a tributary to the Yadkin River. It is located entirely on land owned by the Badin Inn Golf Resort and Club and drains into Little Mountain Creek in Stanly County, North Carolina. The watershed area for this project is 0.5 square miles.

The project is located entirely west of Henderson Street (SR 1720) and begins approximately 100 feet south of Henderson Street's intersection with Boyden Street (SR 1717) and ends at the tributary's confluence with Little Mountain Creek.

UT to Little Mountain Creek is a 2nd order stream, as several small 1st order tributaries flow into it near the top of the watershed. As it passes through the town, the channel has uniform rectangular dimensions and is lined with concrete. As the primary drainage feature in the Town of Badin, it receives discharge from numerous stormwater pipes from houses and townhouse complexes. The channelization of this stream occurred during the development of Badin by ALCOA during the early 1920's, and has since served as the primary stormwater conveyance system for a portion of the town.

Prior to restoration, the stream entered a much larger, concrete-lined channel that traveled straight down the valley until joining with Little Mountain Creek. An intermittent tributary that was routed underground through a culvert entered the main channel approximately 500 feet downstream of the beginning of the project. The relict floodplain of the pre-restoration channel was covered by fairways of the Badin Inn Golf Resort and Club, and some modification to the valley had been done to create bunkers, greens and tee boxes. In addition, a network of drains, pipes and irrigation systems had been installed within the valley, and numerous stormwater outfalls discharged into the stream.

The stream was designated as a single reach (Reach 1) for the purposes of the design. Reach 1 was restored using a Priority 1 restoration that involved removal of the concrete channel and adjustment of the stream dimension, pattern, and profile to allow the stream to more fully transport its water and sediment load. A combination of bedform transformations, channel dimension adjustments, pattern alterations, and structure installations were used to accomplish this. The natural meander patterns were restored and rock grade control vanes were incorporated for aquatic habitat enhancement and bed and bank stability. The tributary was also restored using a Priority 1 restoration. The riparian area also underwent buffer restoration with plantings and is protected with a permanent easement.

Construction of the restored channel was completed in April 2009 and planting was completed in April 2009.

A monitoring baseline was established in the Year 0 monitoring effort, and was stationed from 10+00 to the end of the constructed portion of the project at the confluence with Little Mountain Creek. In order to facilitate efficient monitoring and to avoid confusion amongst different monitoring groups in future monitoring efforts, a baseline was established that stations the restored portion of UT Little Mountain Creek continuously from 10+00 to 50+22. All of the stations presented in this report are based on this monitoring baseline.

II. PROJECT BACKGROUND

A. Location and Setting

The UT Little Mountain Creek project site is located in the Town of Badin in northeast Stanly County. (Figure 1). The headwaters of the project originate approximately 0.8 miles to the northeast of the restoration site. From the headwaters, UT to Little Mountain Creek flows for approximately 1.5 miles before emptying into Little Mountain Creek. One tributary enters UT Little Mountain Creek along its project extent.

The watershed of the project stream is approximately 0.5 square miles (346 acres) and is oriented northeast to southwest. The project is located within a conservation easement that occurs on private land owned by Badin Inn Golf Resort and Club. The upper portions of the watershed are comprised of the western slope of a ridgeline in the Uwharrie Mountains chain. Further down, the watershed contains part of the Town of Badin, and includes residential areas, and the Badin Inn Golf Resort and Club, the golf course property on which the project is located. Although the town is small, it possesses a densely developed area of townhouse complexes and houses that were built as residences for the workers of ALCOA, the large aluminum manufacturer that built the Town of Badin in the early part of the twentieth century. Most of this densely developed area lies within the watershed of UT to Little Mountain Creek.

If traveling from the north (Raleigh, Greensboro, Winston-Salem), proceed southwest on NC 49 from Asheboro. After passing over the Yadkin River/Badin Lake, head south on NC 8 until reaching New London, where NC 8 merges with US Highway 52. Shortly after the merger, turn left onto NC 740 towards Badin. In Badin, after passing the ALCOA plant, turn left on Nantahala Street, then turn right on Henderson Street (SR 1720), which becomes Valley Drive. The beginning of the project is on the right, where the road passes through the fairways of the golf course.

If coming from the south (Charlotte), take NC 24/27 towards Albemarle, then in Albemarle proceed north on NC 740 towards Badin. In Badin, turn right on Nantahala Street, then right on Henderson Street (SR 1720), which becomes Valley Drive. The beginning of the project is on the right, where the road passes the fairways of the golf course.

B. Mitigation Structures and Objectives

The Priority 1 restoration involved removal of the concrete lining and construction of a stream with a proper dimension, pattern, and profile to allow the stream to more fully transport its water and sediment load. A combination of bedform transformations, channel dimension and pattern restoration, and structure installations were used to restore the stream. Natural meander patterns were added and rock grade control vanes were incorporated for aquatic habitat enhancement and bed and bank stability. The tributary was restored using Priority 1 restoration. The Priority 1 restoration involved converting the concrete-lined channel into a sinuous channel that meanders for a total of 4,174 linear feet of stream as measured along the centerline (Table I). A riparian buffer was planted in April 2009 and is protected by a Conservation Easement.

The project had the goal of accomplishing the following objectives:

1. Restore 3,994 linear feet of UT to Little Mountain Creek and 180 linear feet of a small unnamed tributary to Little Mountain Creek.
2. Provide a stable stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport its watershed's water and sediment load.
3. Improve water quality and reduce erosion by stabilizing the stream banks.
4. Reconnect the stream to its floodplain.
5. Improve aquatic habitat with the use of natural material stabilization structures such as root wads, rock vanes, woody debris, and a riparian buffer.
6. Provide aesthetic value, wildlife habitat, and bank stability through the creation or enhancement of a riparian zone.

Table I. Project Restoration Components Badin Inn Stream Restoration - EEP Project No. 92666								
Project Component or Reach ID	**Existing Feet/Acres**	**Type**	**Approach**	**Footage or Acreage**	**Mitigation Ratio**	**Mitigation Units**	**Stationing**	**Comment**
UT to Little Mountain Creek	3,540 feet	R	PI	3,994 feet	1.0	3,994	10+00 - 50+22	Construction started 28 feet from the start of stationing
Tributary	141 feet	R	PI	180 feet	1.0	180	10+00 - 11+80	
Mitigation Unit Summations								
Stream (lf)	Riparian Wetland (Ac)	Nonriparian Wetland (Ac)	Total Wetland (Ac)	Buffer (Ac)	Comment			
4,174	NA	NA	NA	0.0				

R = Restoration
P1 = Priority I

C. Project History and Background

The Badin Inn Stream Restoration Project is located in the Town of Badin in Stanly County, North Carolina and is situated entirely within the golf course of the Badin Inn Golf Resort and Club (Figure 1). The project site encompasses a perennial, unnamed tributary to Little Mountain Creek (UT to Little Mountain Creek) and a small, first-order intermittent tributary of UT to Little Mountain Creek (Tributary) and the associated floodplain through which these channels flow. Prior to restoration, the channel of UT to Little Mountain Creek consisted of approximately 3,700 feet of a concrete-lined and straightened perennial stream that had been in its altered state for nearly a century. The Tributary consisted of approximately 141 feet of an intermittent channel routed through a culvert from where it entered the golf course property until it's confluence with UT to Little Mountain Creek.

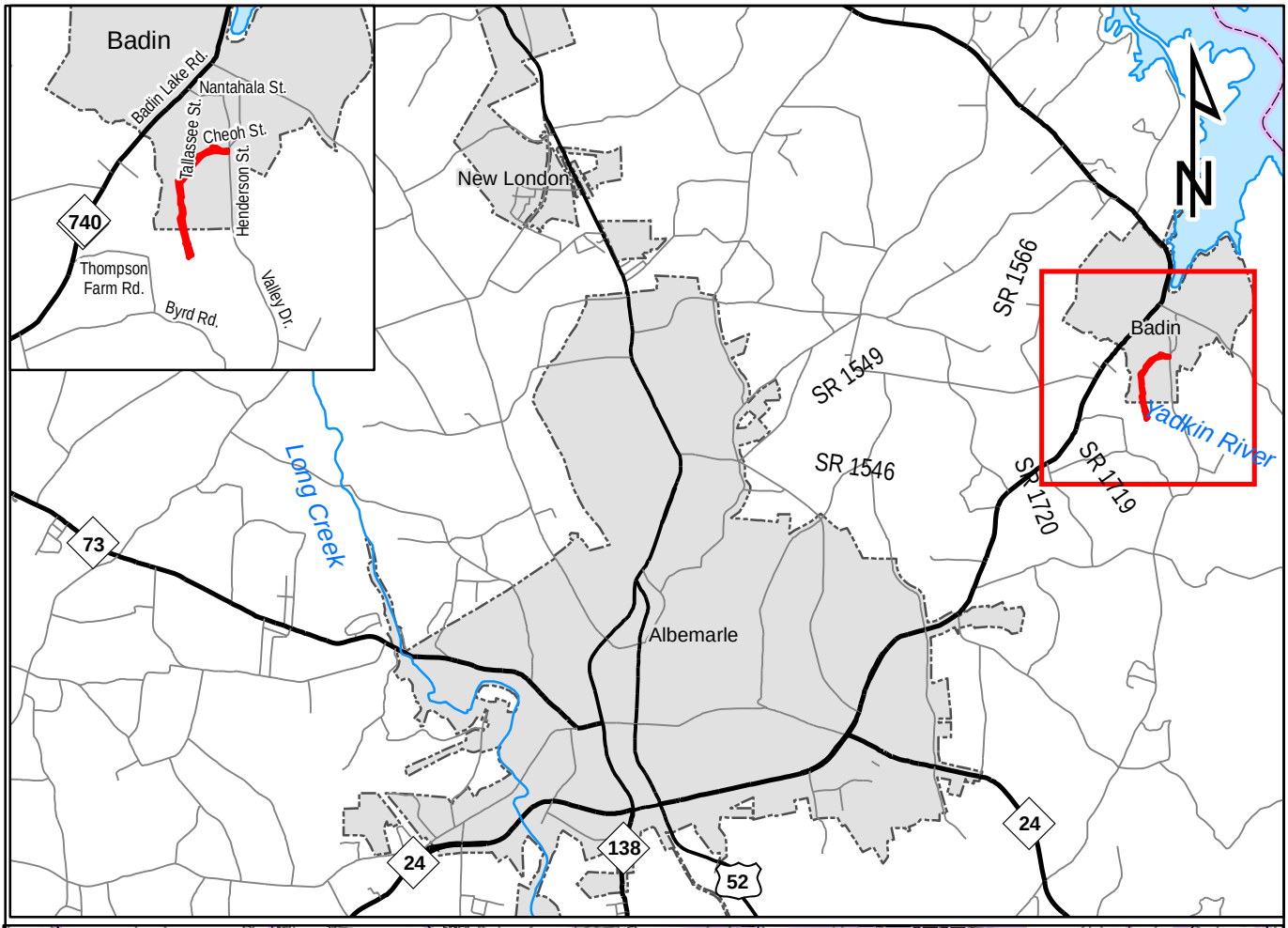
UT to Little Mountain Creek is a 2nd order stream, as several small 1st order tributaries flow into it near the top of the watershed. As it passes through the town, the channel has uniform rectangular dimensions and is lined with concrete. As the primary drainage feature in the Town of Badin, it receives discharge from numerous stormwater pipes from houses and townhouse complexes. The channelization of this stream occurred during the development of Badin by ALCOA during the early 1920's, and has since served as the primary stormwater conveyance system for a portion of the town. Where the stream enters the Badin Inn Golf Resort and Club golf course, the stream is confined to a narrow, stone-lined channel for roughly 700 feet. It continues in this form until reaching the conservation easement and the upstream end of the project reach, after passing through a 48" culvert under Henderson Street (State Road 1720).

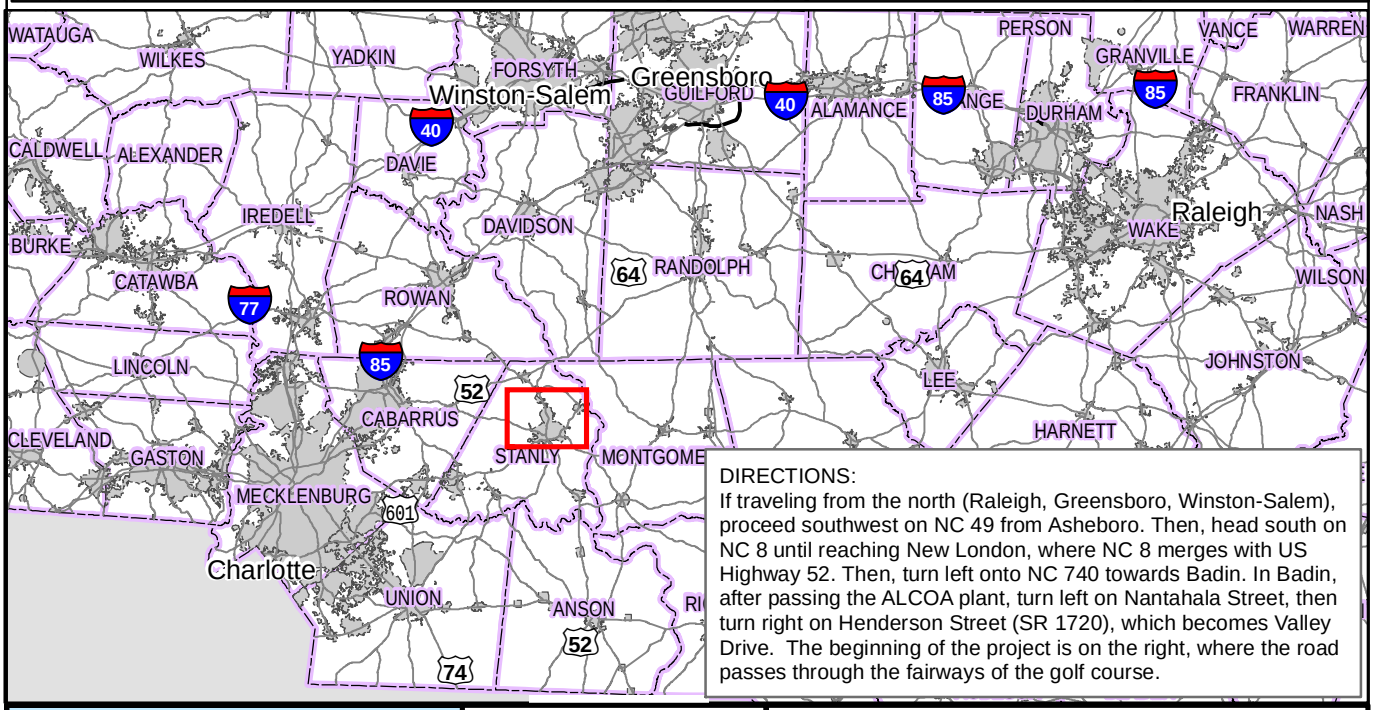
Prior to restoration, the stream entered a much larger, concrete-lined channel at this point, which traveled straight down the valley until joining with Little Mountain Creek. An intermittent tributary that was routed underground through a culvert entered the main channel approximately 500 feet downstream of the beginning of the project. The relict floodplain of the pre-restoration channel was covered by fairways of the Badin Inn Golf Resort and Club golf course, and some modification to the valley had been done to create bunkers, greens and tee boxes. In addition, a network of drains, pipes and irrigation systems had been installed within the valley, and numerous stormwater outfalls discharged into the stream.

The project is located in the Yadkin River Basin 8-digit Catalogue Unit 03040104 and the 14-digit hydrological unit 03040104010010. This watershed was identified by the NC Ecosystem Enhancement Program (EEP) as a Targeted Local Watershed and is also classified by the NC Division of Water Quality (NCDWQ) as a Water Supply Watershed (WSIV). The receiving stream, Little Mountain Creek, is listed on the 303(d) list for biological impairment (NCDENR, 2008).

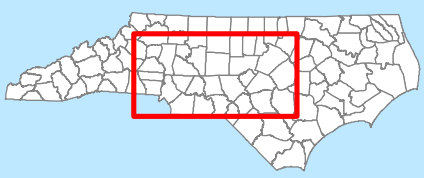
The project site is located in the Carolina Slate Belt ecoregion (Griffith *et. al*, 2002). The primary adjacent land use throughout the project watershed consists of managed herbaceous areas (which consists mainly of the Badin Inn golf course), developed areas, including much of the residential areas of the Town of Badin, and forested areas on the slopes above the town.

Table II. Project Activity and Reporting History Badin Inn Stream Restoration - EEP Project No. 92666		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	9/1/2007	July 2008
Final Design – 90%	July 2008	December 2008
Construction	NA	April 2009
Temporary S&E mix applied to entire project area	NA	4/1/2009
Permanent seed mix applied to entire project area	NA	4/1/2009
Containerized, B&B, and livestake plantings	4/1/2009	4/1/2009
Mitigation Plan / As-built (Year 0 Monitoring – baseline)	July 2009	August 2009
Year 1 Monitoring	January 2010	January 2010
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		
Year 5+ Monitoring		





DIRECTIONS:
If traveling from the north (Raleigh, Greensboro, Winston-Salem), proceed southwest on NC 49 from Asheboro. Then, head south on NC 8 until reaching New London, where NC 8 merges with US Highway 52. Then, turn left onto NC 740 towards Badin. In Badin, after passing the ALCOA plant, turn left on Nantahala Street, then turn right on Henderson Street (SR 1720), which becomes Valley Drive. The beginning of the project is on the right, where the road passes through the fairways of the golf course.



Ecosystem Enhancement Program

AECOM

FIGURE 1
VICINITY MAP

Badin Inn Mitigation Plan
Stanly County, North Carolina
EEP Project No. 92666
August, 2009

Not to Scale

Table III. Project Contacts Table Badin Inn Stream Restoration - EEP Project No. 92666	
Designer	Earth Tech | AECOM 701 Corporate Center Drive, Suite 475 Raleigh, NC 27607 Phone: (919) 854-6200
Construction Contractor	River Works, Inc. 8000 Regency Parkway, Suite 200 Cary, NC 27511 Phone: (919) 459-9001
Survey Contractor	Earth Tech | AECOM 701 Corporate Center Drive, Suite 475 Raleigh, NC 27607 Phone: (919) 854-6200
Planting Contractor	Efird Landscaping, Inc 42759 Greenview Dr. Albemarle, NC 28001 Phone: (704) 983-1970
Seeding Contractor	Efird Landscaping, Inc 42759 Greenview Dr. Albemarle, NC 28001 Phone: (704) 983-1970
Seed Mix Sources	Mellow Marsh Farm, Inc. 1312 Woody Store Rd. Siler City, NC 27344 Phone: (919) 742-1200
Nursery Stock Suppliers	Arborgen LLC 5594 Highway 38 Blenheim, SC 29516 Phone: (843) 528-9669 Carolina Wetland Services 550 E. Westinghouse Blvd. Charlotte, NC 28273 Phone: (704) 527-1177
Monitoring Performers	Earth Tech | AECOM 701 Corporate Center Drive, Suite 475 Raleigh, NC 27607
Stream Monitoring	Earth Tech | AECOM Phone: (919) 854-6200
Vegetation Monitoring	Earth Tech | AECOM Phone: (919) 854-6200

Table IV. Project Background Table Badin Inn Stream Restoration/ Project No. 92666		
	UT to Little Mountain Creek	Tributary
Project County	Stanly County	Stanly County
Drainage Area	0.5 sq miles	0.05 sq. miles
Drainage impervious cover estimate (%)	5%	15%
Stream order	2nd	1st
Physiographic Region	Piedmont	Piedmont
Ecoregion	Carolina Slate Belt	Carolina Slate Belt
Rosgen Classification of As-built	C4	C
Cowardin Classification	Riverine	Riverine
Dominant soil types	Oakboro/Kirksey Silt loams	Oakboro/Kirksey Silt loams
Reference site ID	Spencer Creek and UT Meadow Fork	Spencer Creek and UT Meadow Fork
USGS HUC for Project and Reference	03040104 (Project) 03040101 (UT Meadow Fork) 03040103 (Spencer Creek	03040104 (Project) 03040101 (UT Meadow Fork) 03040103 (Spencer Creek
NCDWQ Sub-basin for Project and Reference	NA	NA
NCDWQ classification for Project and Reference	WS-IV (UT Little Mountain Creek) C (Spencer Creek) B Tr+ (UT Meadow Fork)	WS-IV (UT Little Mountain Creek) C (Spencer Creek) B Tr+ (UT Meadow Fork)
Any portion of any project segment 303(d) listed?	No	No
Any portion of any project upstream of a 303d lsited segment	Yes	Yes
Reasons for 303d listing or stressor	Low dissolved oxygen and high conductivity	Low dissolved oxygen and high conductivity
% of project easement fenced	100	100

III. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

The final vegetative success criteria will be the survival of 260 5-year old planted trees per acre at the end of year 5 of the monitoring period. An interim measure of vegetation planting success will be the survival of at least 320 3-year old planted trees per acre at the end of year 3 of the monitoring period. Vegetation monitoring was performed using the CVS-EEP Level 2 protocol.

1. *Vegetative Problem Areas*

A few vegetation problem areas were noted during the Year 1 monitoring. As a whole the vegetation plantings have been very successful and only a few minor areas of concern were noted. The bulk of the problems were associated with sparse vegetative growth occurring on the floodplain in a few locations. This is likely a combination of soil compaction from

construction and scour resulting from frequent flooding along the stream. An instance of bare coir matting was noted but was relatively small in size and poses no perceptible threat to bank failure. Vehicle operation within the easement was noted in a few locations. In one instance a former stream crossing area has been slow to recover from construction and vegetation is noticeably lower at the crossing site. Another location near the most downstream bridge was disturbed when the permanent bridge was brought onto the site. None of the problems are major and all are easily remedied by additional plantings and installation of more exclusive fencing. Detailed descriptions and locations of each problem area and a representative photo of each problem type are located in Appendix A.

2. *Stem Counts*

Baseline vegetation plots were established in April 2009 after vegetative planting was completed. Nine (9) vegetation survival plots were staked out in the floodplain and terrace along UT Little Mountain Creek within the project area. Each plot measured 10m X 10m and had an area of $100m^2$. Stems were flagged and counted to establish baseline and yearly stem counts. Year 1 vegetation monitoring was performed on December 8, 2009.

Year 1 monitoring revealed an average of 607 woody stems per acre. This average is slightly below the baseline amount of 621 woody stems per acre. The range of stem densities encountered on the mitigation site varied from 283 to 850 stems per acre. Vegetation diversity was low in some individual plots. Species counts of 6 or fewer species occurred in 4 plots: Plots 2, 5, 7, and 9. Some dead stems were noted in the vegetation plots with an average of 1.3 dead stems per plot. Interestingly, some of the stems that were counted as dead during the baseline survey were apparently alive. Although they exhibited no signs of life at that point, a few are now actively growing and were counted as living during the Year 1 monitoring. Two stems were missing from the previous year's sampling and were likely trampled by golfers searching for wayward balls. Areas around plots 2 and 5 were at or below the minimum success criteria after three years of post construction monitoring. Approximately 2½ acres, encompassing these low density areas, have been replanted with 800 trees.

Physical damage was noted in most plots. Again the majority of damage was minor and consisted of broken stems or branches on the bare root plantings. Fifty percent of planted stems had what appeared to be remnant damage from the initial planting that was still influencing growth processes. Over 7% of the stems had damage that appeared to be a result of human trampling. This will be an ongoing problem in that golf balls were commonly found in the easement indicating that golfers frequently hit wayward shots and likely spend time searching for their ball. Slightly over 5% of the plants appeared to be stunted due to being planted in an area too wet for them to thrive. Deer activity was also present in the easement as numerous droppings were observed and it appears that some of the stems have been damaged by deer grazing. The deer activity will have to be watched closely since the increase in vegetation could attract deer more frequently resulting in an increasing problem. Currently levels of deer induced damage are not enough to warrant concern.

The *Juncus effusus* plugs and live stakes are growing well with little evidence of difficulty. The permanent seed mix germinated, and flowering occurred during the growing season in many of the species. Some individuals of *Bidens* reached heights of approximately 3 feet during the fall before dieback.

Table V. Vegetation Plot Stem Count Summary
Badin Inn Stream Restoration/ Project No. 92666

Species		Plots*									MY1 Total	Initial Total
Scientific Name	**Common Name**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**		
Shrubs												
Sambucus canadensis	Elderberry					1					***1***	***5***
Callicarpa americana	American Beautyberry	2	1			2	1	1	1	7	***15***	***16***
Prunus americana	American plum		1								***1***	***1***
	Total Shrubs	***2***	***2***	***0***	***0***	***3***	***1***	***1***	***1***	***7***	***17***	***22***
Trees												
Cercis canadensis	Redbud	1	3	2	1		10	4	2		***23***	***22***
Carpinus caroliniana	Ironwood	2			1						***3***	***4***
Quercus alba	White oak	3		1							***4***	***4***
Quercus nigra	Water oak	2									***2***	***2***
Quercus velutina	Black oak	1		4							***5***	***6***
Nyssa sylvatica	Black gum	1	1		2		1		1		***6***	***7***
Asimina triloba	Paw Paw	1								8	***9***	***10***
Quercus phellos	Willow oak		1	2	1			1			***5***	***3***
Cornus florida	Flowering dogwood			1	1			2			***4***	***6***
Castanea pumila	Chinquapin	1		7	6	2	1	12	5		***34***	***32***
Diospyros virginiana	American persimmon			3	3	2	1		2		***11***	***11***
Morus rubra	Red mulberry	3		1	1						***5***	***5***
Betula nigra	River birch						1		1		***2***	***3***
Fraxinus pennsylvanica	Green ash	1									***1***	***0***
Quercus sp.	Oak species					1			1		***2***	
Unknown							1		1		***2***	
	Total Trees	***16***	***5***	***21***	***16***	***5***	***15***	***19***	***13***	***8***	***118***	***116***
TABLE SUMMARY	*Total Stems of planted woody vegetation*	18	7	21	16	8	16	20	14	15	***135***	***138***
	% Shrubs	11%	29%	0%	0%	38%	6%	5%	7%	47%	***13%***	***16%***
	% Trees	89%	71%	100%	100%	63%	94%	95%	93%	53%	***87%***	***84%***
	Current Density											
	Shrubs per acre	81	81	0	0	121	40	40	40	283	76	99
	Shrubs per hectare	200	200	0	0	300	100	100	100	700	189	244
	Trees per acre	647	202	850	647	202	607	769	526	324	531	522
	Trees per hectare	1600	500	2100	1600	500	1500	1900	1300	800	1311	1289
	Total stem/acre	***728***	***283***	***850***	***647***	***324***	***647***	***809***	***567***	***607***	**607**	**621**
	Total stems/ hectare	***1800***	***700***	***2100***	***1600***	***800***	***1600***	***2000***	***1400***	***1500***	**1500**	**1533**

B. Stream Assessment

The stream remains in excellent condition. Only one small area of scour was observed during the Year 1 monitoring. Floodplain scour was noted in several locations and the possibility of a few overflow channels that were in the early stages of formation were the only problems observed along the stream and these problems were minor. Overall, the stream is remaining close to as-built morphology.

1. Morphometric Criteria

Considering the 5 year timeframe of standard mitigation monitoring, restored streams should demonstrate morphologic stability in order to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that is to also be expected. However, the observed change should not indicate a high rate or be unidirectional over time such that a robust trend is evident. If some trend is evident, it should be very modest or indicate migration to another stable form. Examples of the latter include depositional processes resulting in the development of constructive features on the banks and floodplain, such as an inner berm, slight channel narrowing, modest natural levees, and general floodplain deposition. Annual variation is to be expected, but over time this should demonstrate maintenance around some acceptable central tendency while also demonstrating consistency or a reduction in the amplitude of variation. Lastly, all of this must be evaluated in the context of hydrologic events to which the system is exposed over the monitoring period.

For channel dimension, cross-sectional overlays and key parameters such as cross-sectional area and the channel's width to depth ratio should demonstrate modest overall change and patterns of variation that are in keeping with above. For the channels' profile, the reach under assessment should not demonstrate any consistent trends in thalweg aggradation or degradation over any significant continuous portion of its length. Over the monitoring period, the profile should also demonstrate the maintenance or development of bedform (facets) more in keeping with reference level diversity and distributions for the stream type in question. It should also provide a meaningful contrast in terms of bedform diversity against the pre-existing condition. Bedform distributions, riffle/pool lengths and slopes will vary, but should do so with maintenance around design/As-built distributions. This requires that the majority of pools are maintained at greater depths with lower water surface slopes and riffles are shallow with greater water surface slopes. Substrate measurements should indicate the progression towards, or the maintenance of, the known distributions from the design phase.

Cross-section and longitudinal surveys were completed on January 8, 2010. Ten cross-sections and approximately 4,022 linear feet of UT Little Mountain Creek and 180 linear feet of the unnamed tributary was surveyed. A bed material analysis was performed on December 22, 2009 and January 5, 2010 and photographs were taken at all permanent photo points.

A monitoring baseline was established in the Year 0 monitoring effort, and was stationed from 10+00 at the culvert under Valley Drive to 50+22 at the end of the constructed portion of the project, in order to facilitate future monitoring efforts by different monitoring groups. The stationing of this baseline is used to identify locations along the restored portion of UT Little Mountain Creek throughout this report. Tributary stationing is the same in the monitoring as the construction documents.

The assessment included the survey of ten cross-sections, as well as the longitudinal profile. Cross-sections were marked with rebar. Cross sections are located at the following locations.

Cross-Section #1. UT Little Mountain Creek, Station 47+67, riffle
Cross-Section #2. UT Little Mountain Creek, Station 43+05, pool
Cross-Section #3. UT Little Mountain Creek, Station 38+26, riffle
Cross-Section #4. UT Little Mountain Creek, Station 33+72, riffle
Cross-Section #5. UT Little Mountain Creek, Station 29+78, pool
Cross-Section #6. UT Little Mountain Creek, Station 25+39, riffle
Cross-Section #7. UT Little Mountain Creek, Station 20+45, pool
Cross-Section #8. UT Little Mountain Creek, Station 16+50, pool
Cross-Section #9. UT Little Mountain Creek, Station 13+61, riffle
Cross-Section #10. Tributary, Station 12+85, Station 10+85, riffle

Survey data collected during future monitoring periods may vary depending on actual rod placement and alignment; however, from this point forward this information should remain similar in overall appearance.

2. Hydrologic Criteria

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. Therefore, one stream crest gauge was installed on UT Little Mountain Creek. One documented bankfull event occurred on December 25, 2009 following a heavy rainfall event.

Table VI. Verification of Bankfull Events
Badin Inn Stream Restoration/ Project No. 92666

Date of Data Collection	Date of Occurrence	Method	Photo # (if applicable)
2009	12-25-09	Photographed on-site	Photo 1


Photo 1. Photo of bankfull event on 12-25-09.

BEHI estimates are not applicable to the Year 1 Monitoring Report.

Table VII. Categorical Stream Feature Visual Stability Assessment Badin Inn Stream Mitigation Site/Project No. 92666					
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**
A. Riffles	100%	99%			
B. Pools	100%	100%			
C. Thalweg	100%	100%			
D. Meanders	100%	100%			
E. Bed General	100%	100%			
F. Vanes/J Hooks etc.	100%	100%			
G. Wads and Boulders	100%	100%			

IV. METHODOLOGY

The survey of the cross-sections and longitudinal profile were performed using RTK survey-grade GPS and/or total station survey equipment to detect thalweg, bankfull, and water surface elevations of the UT to Little Mountain Creek. A monitoring baseline was established in the Year 0 monitoring effort, and was stationed from the downstream end of the constructed portion of the project upstream to approximately station 10+00, in order to facilitate future monitoring efforts by different monitoring groups. The stationing of this baseline is used to identify locations along the restored portion of UT Little Mountain Creek throughout this report. The entire length of the tributary is surveyed annually as well. Baseline cross sections were established for ten cross sections. During monitoring year 1, it was found that one or more pins were "removed" from cross sections 5 and 8. These missing pins were reset and the monitoring year 1 data will be used as the new baseline data for these two cross sections.

Data was entered into the stream morphology applications program, Rivermorph, to obtain the dimensions of the cross sections and parameters applicable to the longitudinal profile. Reports generated by Rivermorph are used in this report to display and summarize stream survey data.

Table VIII. Baseline Stream Data Summary
Badin Inn Stream Restoration - EEP Project No. 92666
Reach I (4,174 feet)

Parameter	Gauge[2]	Regional Curve			Pre-Existing Condition			Reference Reach UT to Meadow Fork Creek			Reference Reach Spencer Creek			Design UT to Little Mountain Creek			Design Tributary			As-Built UT to Little Mountain Creek			As-Built Tributary		
Dimension and Substrate - Riffle		Min	Max	Med	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Bankfull Width (ft)	NA									11.81			12.3			10			5.6	9.37	11.63	10.914			6.29
Floodprone Width (ft)																				44.55	53.44	48.742			46.89
Bankfull Cross Sectional Area (ft^2)	NA									15.34			10.8			7			3.2	7.21	9	8.004			2.64
Bankfull Mean Depth (ft)	NA									1.3			0.88			0.7			0.57	0.65	0.8	0.734			0.42
Bankfull Max Depth (ft)	NA				2.5					2.11			1.8			1			0.7	1.04	1.25	1.196			0.56
Width/Depth Ratio	NA									9.08			13.98			14.3			9.82	12.17	17.89	14.99			14.98
Entrenchment Ratio	NA									28.11			>2.2			>2.2			>2.2	3.97	5.37	4.498			7.45
Bank Height Ratio	NA							**1.03**	**1.05**	**1.04**			**1.1**			**1**			**1**			**1**			**1**
Wetted Perimeter (ft)	NA																								
Hydraulic Radius (ft)	NA																								
Pattern																									
Channel Beltwidth (ft)								22	57.1	37.2	24	52	38	18.6	48.3	33.45	10.42	27.05	18.73	18.6	48.3	33.45	10.42	27.05	18.73
Radius of Curvature (ft)								18	42.8	25	5.4	22.1	12.9	22.1	42.3	32.2	12.38	23.69	18.03	22.1	42.3	32.2	12.38	23.69	18.03
Meander Wavelength (ft)								78.5	149.9	107.1	54	196	125	43.9	159.35	101.63	24.59	89.24	56.91	43.9	159.35	101.63	24.59	89.24	56.91
Meander Width Ratio								1.86	4.83	3.15	1.95	4.23	3.09	1.86	4.83	3.35	1.86	4.83	3.35	1.86	4.83	3.35	1.86	4.83	3.35
Profile																									
Riffle Length (ft)														14.32	154.43	49.04	18.93	28.54	24.84	18.24	121.02	54.01	17.17	22.51	20.96
Riffle Slope (ft/ft)								0.011	0.021	0.017	0.02	0.036	0.026	0.012	0.037	0.019	0.022	0.04	0.03	0.0053	0.0205	0.0143	0.0162	0.0505	0.0275
Pool Length (ft)								12.98	20.86	18.02	9.29	23.92	17.78	18.3	31	24.65	10.25	17.36	13.8	14.79	41.85	22.14	10.89	25.78	16.34
Pool Spacing (ft)								79.48	96.97	88.23	13	46.5	24.2	68.4	83.1	75.75	5.92	21.17	13.54	36.33	148.07	66.65	36.63	39.7	38.17
Substrate																									
d50(mm)	NA																								
d84 (mm)	NA																								
Additional Reach Parameters																									

NOT APPLICABLE-STREAM IS COMPLETELY MODIFIED

Valley length (ft)			3540	200	235	3820	157		
Channel length (ft)			3540	288	266	3994	180	3994	180
Sinuosity (ft)			1	1.4	1.1	1.33	1.03	1.33	1.03
Water Surface Slope (Channel) (ft/ft)	NA		0.0178	0.0122	0.0132	0.0134	0.0147	0.012	0.012
BF slope (ft/ft)	NA		0.0178	0.0122	0.0132	0.0134	0.0147	0.012	0.012
Rosgen Classification	NA		NA	E4	C4	C4	E4	C4	C4
Habitat Index			N/A	N/A	N/A				
Macrobenthos			N/A	N/A	N/A				

Table IX. Morphology and Hydraulic Monitoring Summary
Badin Inn Stream Restoration/ EEP Project No. 92666
Reach 1 (4,174 feet)

Parameter	Cross Section 1 Riffle						Cross Section 2 Pool						Cross Section 3 Riffle						Cross Section 4 Riffle						Cross Section 5 Pool					
Dimension	BASE	MY1	MY2	MY3	MY4	MY5	BASE	MY1	MY2	MY3	MY4	MY5	BASE	MY1	MY2	MY3	MY4	MY5	BASE	MY1	MY2	MY3	MY4	MY5	BASE	MY1*	MY2	MY3	MY4	MY5
BF Width (ft)	11.63	11.94					13.91	10.98					11.23	9.77					11.23	10.8					NA	10.02				
Floodprone Width (ft) (approx)	48.11	52.5					41.31	44.5					53.44	52.21					44.55	47					NA	52				
BF Cross-Sectional Area (ft^2)	7.62	9.52					9.78	8.48					7.87	5.88					9	9.25					NA	10.36				
BF Mean Depth (ft)	0.65	0.8					0.7	0.77					0.7	0.6					0.8	0.86					NA	1.03				
BF Max Depth (ft)	1.24	1.4					1.4	1.49					1.21	0.86					1.24	1.3					NA	2.02				
Width/Depth Ratio	17.89	14.93					19.87	14.26					16.04	16.28					14.04	12.56					NA	9.73				
Entrenchment Ratio	4.14	4.4					2.97	4.05					4.76	5.35					3.97	4.35					NA	5.19				
Wetted Perimeter (ft)	11.94	12.32					14.35	11.45					11.57	10.06					11.69	11.28					NA	10.85				
Hydraulic radius (ft)	0.64	0.77					0.68	0.74					0.68	0.58					0.77	0.82					NA	0.95				
Bank Height Ratio (ft/ft)	1	1					1	1					1	1					1	1					NA	1				
Substrate																														
d50 (mm)	21.4	29.18					11.3	9.65					5.46	8.73					17.8	1					0.83	0.63				
d84 (mm)	68.33	71.8					30.43	34.18					27.3	45					49.56	71.43					13.65	16				

Parameter	BASELINE			MY-01 (2009)			MY-02 (2010)			MY-03 (2011)			MY-04 (2012)			MY-05 (2013)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	18.6	48.3	33.45	18.6	48.3	33.45												
Radius of Curvature (ft)	22.1	42.3	32.2	22.1	42.3	32.2												
Meander Wavelength (ft)	43.9	159.35	101.63	43.9	159.35	101.63												
Meander Width Ratio	1.86	4.83	3.35	1.86	4.83	3.35												
Profile																		
Riffle Length (ft)	18.24	121.02	54.01	6.53	105.45	37.49												
Riffle Slope (ft/ft)	0.0053	0.0205	0.0143	0.0041	0.0516	0.0177												
Pool length (ft)	14.79	41.85	22.14	8.05	46.13	24.79												
Pool spacing (ft)	36.33	148.07	66.65	12.08	134.2	62.96												
Additional Reach Parameters																		
Valley Length (ft)	3820			3820														
Channel Length (ft)	3994			3994														
Sinuosity	1.33			1.33														
Water Surface Slope (ft/ft)	0.012			0.012														
BF Slope (ft/ft)	0.012			0.012														
Rosgen Classification	C4			C4														
Habitat Index																		
Macrobenthos																		

*MY1 will be the new baseline

Table IX. Morphology and Hydraulic Monitoring Summary
Badin Inn Stream Restoration/ EEP Project No. 92666
Reach 1 (4,174 feet)

Parameter	Cross Section 6 Riffle						Cross Section 7 Pool						Cross Section 8 Pool						Cross Section 9 Riffle						Cross Section 10 Riffle					
																									Tributary					
Dimension	BASE	MY1	MY2	MY3	MY4	MY5	BASE	MY1	MY2	MY3	MY4	MY5	BASE	MY1*	MY2	MY3	MY4	MY5	BASE	MY1	MY2	MY3	MY4	MY5	BASE	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	9.37	10					16.05	14.24					NA	12.01					11.11	10.6					6.29	8.51				
Floodprone Width (ft) (approx)	50.33	53					40.5	40.3					NA	62.5					47.28	48					46.89	43				
BF Cross-Sectional Area (ft^2)	7.21	8.54					14.18	17.27					NA	13.53					8.32	9.57					2.64	3.65				
BF Mean Depth (ft)	0.77	0.85					0.88	1.21					NA	1.13					0.75	0.9					0.42	0.43				
BF Max Depth (ft)	1.04	1.17					2.3	2.37					NA	2.58					1.25	1.6					0.56	0.64				
Width/Depth Ratio	12.17	11.76					18.24	11.77					NA	10.63					14.81	11.78					14.98	19.79				
Entrenchment Ratio	5.37	5.3					2.52	2.83					NA	5.2					4.25	4.53					7.45	5.05				
Wetted Perimeter (ft)	9.78	10.52					16.96	15.53					NA	13.38					11.5	11.31					6.54	8.76				
Hydraulic radius (ft)	0.74	0.81					0.84	1.11					NA	1.01					0.72	0.85					0.4	0.42				
Bank Height Ratio (ft/ft)	1	1					1	1					NA	1					1	1					1	1				
Substrate																														
d50 (mm)	26.71	31.37					0.79	0.06					NA	0.05					13.39	38.5					28.64	13.18				
d84 (mm)	57.67	62.54					39.8	18.93					NA	5.7					54.5	80.71					32	33.86				

Parameter		**MY-01 (2009)**				**MY-02 (2010)**				**MY-03 (2011)**				**MY-04 (2012)**				**MY-05 (2013)**				**MY+ (2014)**			
Pattern		Min	Max	Med		Min	Max	Med		Min	Max	Med		Min	Max	Med		Min	Max	Med		Min	Max	Med	
Channel Beltwidth (ft)																									
Radius of Curvature (ft)																									
Meander Wavelength (ft)																									
Meander Width Ratio																									
Profile																									
Riffle Length (ft)																									
Riffle Slope (ft/ft)																									
Pool length (ft)																									
Pool spacing (ft)																									
Additional Reach Parameters																									
Valley Length (ft)																									
Channel Length (ft)																									
Sinuosity																									
Water Surface Slope (ft/ft)																									
BF Slope (ft/ft)																									
Rosgen Classification																									
Habitat Index																									
Macrobenthos																									

*MY1 will be the new baseline

APPENDIX A

1. Vegetation Data Tables

   Table 1. Vegetation Metadata
   Table 2. Vegetation Vigor by Species
   Table 3. Vegetation Damage by Species
   Table 4. Vegetation Damage by Plot
   Table 5. Stem Count by Plot and Species
   Table 6. Vegetation Problem Areas Tables

2. Vegetation Problem Area Photos

3. Vegetation Monitoring Plot Photos

Table 1. Vegetation Metadata
Badin Inn Stream Restoration/ EEP No. 92666
Appendix A

Report Prepared By	Kevin Lapp
Date Prepared	12/21/2009 8:27
database name	AECOM-2008-0.mdb
database location	Q:\99255\Monitoring\Vegetation
computer name	USRAL3PC035
file size	45125632

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------

Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.

PROJECT SUMMARY----------

Project Code	92666
project Name	Badin Inn
Description	
River Basin	Yadkin-Pee Dee
length(ft)	4174
stream-to-edge width (ft)	42
area (sq m)	32570
Required Plots (calculated)	9
Sampled Plots	0

Table 2. Vegetation Vigor by Species Badin Inn Stream Restoration/ EEP No. 92666 Appendix A								
	Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
	Asimina triloba	8	1				1	
	Betula nigra	2				1		
	Callicarpa americana	3	9	2	1	1		
	Castanea pumila	4	22	6	2	1		
	Cornus florida	2	1	1		1	1	
	Diospyros virginiana	6	3	2				
	Fraxinus pennsylvanica	1						
	Nyssa sylvatica	2	4			2		
	Prunus americana	1						
	Quercus alba	3	1					
	Quercus nigra			2				
	Quercus phellos	4	1					
	Quercus velutina	1	3	1				
	Sambucus canadensis				1	4		
	Morus rubra		3	2				
	Carpinus caroliniana	1		1	1	1		
	Cercis canadensis	1	12	10		1		
	Quercus	1			1			
	Unknown		1	1				
TOT:	**19**	**40**	**61**	**28**	**6**	**12**	**2**	

Table 3. Vegetation Damage by Species
Badin Inn Stream Restoration/ EEP No. 92666
Appendix A

	Species	All Damage Categories	(no damage)	Enter other damage	Deer	Human Trampled	Site Too Wet	Unknown
	Asimina triloba	10	9	1				
	Betula nigra	3	2			1		
	Callicarpa americana	16	4	9	1	2		
	Carpinus caroliniana	4	2	1	1			
	Castanea pumila	35	4	28		2		1
	Cercis canadensis	24	2	18		1	3	
	Cornus florida	6	3	2		1		
	Diospyros virginiana	11	7	2			2	
	Fraxinus pennsylvanica	1	1					
	Morus rubra	5		5				
	Nyssa sylvatica	8	3	4		1		
	Prunus americana	1	1					
	Quercus	2	1			1		
	Quercus alba	4	3	1				
	Quercus nigra	2					1	1
	Quercus phellos	5	4	1				
	Quercus velutina	5	1	2	1		1	
	Sambucus canadensis	5	3			2		
	Unknown	2		1			1	

Table 4. Vegetation Damage by Plot
Badin Inn Stream Restoration/ EEP No. 92666
Appendix A

	plot	All Damage Categories	(no damage)	Enter other damage	Deer	Human Trampled	Site Too Wet	Unknown
	92666-01-0001-year:1	22	12	6	1		2	1
	92666-01-0002-year:1	8	3	5				
	92666-01-0003-year:1	21	7	12	1		1	
	92666-01-0004-year:1	17	6	9			1	1
	92666-01-0005-year:1	14	5	2		7		
	92666-01-0006-year:1	16	2	10			4	
	92666-01-0007-year:1	21	2	17		2		
	92666-01-0008-year:1	15	6	8		1		
	92666-01-0009-year:1	15	7	6	1	1		
TOT:	**9**	**149**	**50**	**75**	**3**	**11**	**8**	**2**

Table 5. Stem Count by Plot and Species
Badin Inn Stream Restoration/ EEP No. 92666
Appendix A

	Species	Total Planted Stems	# plots	avg# stems	plot 92666-01-0001-year:1	plot 92666-01-0002-year:1	plot 92666-01-0003-year:1	plot 92666-01-0004-year:1	plot 92666-01-0005-year:1	plot 92666-01-0006-year:1	plot 92666-01-0007-year:1	plot 92666-01-0008-year:1	plot 92666-01-0009-year:1
	Asimina triloba	9	2	4.5	1								8
	Betula nigra	2	2	1						1		1	
	Callicarpa americana	15	7	2.1	2	1			2	1	1	1	7
	Carpinus caroliniana	3	2	1.5	2			1					
	Castanea pumila	34	7	4.9	1		7	6	2	1	12	5	
	Cercis canadensis	23	7	3.3	1	3	2	1		10	4	2	
	Cornus florida	4	3	1.3			1	1			2		
	Diospyros virginiana	11	5	2.2			3	3	2	1		2	
	Fraxinus pennsylvanica	1	1	1	1								
	Morus rubra	5	3	1.7	3		1	1					
	Nyssa sylvatica	6	5	1.2	1	1		2		1		1	
	Prunus americana	1	1	1		1							
	Quercus	2	2	1					1			1	
	Quercus alba	4	2	2	3		1						
	Quercus nigra	2	1	2	2								
	Quercus phellos	5	4	1.3		1	2	1			1		
	Quercus velutina	5	2	2.5	1		4						
	Sambucus canadensis	1	1	1					1				
	Unknown	2	2	1						1		1	
TOT	**19**	**135**	**19**		**18**	**7**	**21**	**16**	**8**	**16**	**20**	**14**	**15**

Table 6. Vegetation Problem Areas
Badin Inn Stream Restoration/ EEP No. 92666
Appendix A

Feature/Issue	Station#/Range	Probable Cause	Photo #
Bare Bank	14+10	Vegetation having difficulty becoming established on coir matting	VPA 12
Bare Floodplain	23+20 to 23+90	Exposed soil and rocks from construction	VPA 2
	24+30	Exposed soil, Seed washed away by storm	
	27+50 to 28+00	Sparsely vegetated due to construction	
	29+70 to 30+10	Exposed soil, Seed washed away by storm	
	39+40 to 40+00	Exposed soil, Seed washed away by storm	
	40+70 to 41+40	Exposed soil, Seed washed away by storm	
	45+70 to 46+20	Exposed soil and rocks from construction	
	46+60 to 46+80	Sparsely vegetated floodplain due to construction	
Invasive/Exotic Populations	48+30 to 49+80	*Ligustrum sinense*: encroachment from outside	VPA 1
Vehicular Disturbance of Easement	21+40	Vehicle travel across stream	VPA3
	42+50 to 46+00	Bridge construction	

Badin Inn Stream Restoration Site
Year 1 Monitoring Report
Appendix A-2
Vegetation Problem Area Photos

This photolog displays a representation of the types of vegetative problem areas that are present along the restored reaches of UT Little Mountain Creek. Not all vegetative problem areas are depicted.


VPA 12. Sparsely vegetated coir matting along bank.


VPA 2. Sparsely vegetated floodplain from construction


VPA 5. Scoured floodplain with sparse vegetation.


VPA 1. Exotic Chinese privette establishing foothold in floodplain near confluence with Little Mountain Creek.


VPA 3. Mowed area in easement that receives vehicle traffic

Badin Inn Stream Restoration Site
Year 1 Monitoring Report
Appendix A-3
Vegetation Sampling Plot Photos


Vegetation Plot 1 facing 220˚.


Vegetation Plot 2 facing 160˚.


Vegetation Plot 3 facing 230˚.


Vegetation Plot 4 facing 155˚.


Vegetation Plot 5 facing 190˚.


Vegetation Plot 6 facing 285˚.


Vegetation Plot 7 facing 260˚.


Vegetation Plot 8 facing 300˚.


Vegetation Plot 9 facing 330˚.

APPENDIX B

1. Stream Problem Areas Plan View (not included, incorporated into Appendix C)

2. Table B.1. Stream Problem Areas Table

3. Representative Stream Problem Area Photos

4. Stream Photo Station Photos

5. Table B.2. Visual Morphological Stability Assessment

6. Annual Overlays of Cross Section Plots

7. Annual Overlays of Longitudinal Plots

8. Annual Overlays of Pebble Count Frequency Distribution Plots

B-1 Stream Problem Areas Plan View has been incorporated into Appendix C (Integrated Plan View)

Table B.1. Stream Problem Areas Badin Inn Stream Restoration/ EEP No. 92666 Appendix B			
Feature/Issue	**Station#/Range**	**Probable Cause**	**Photo #**
Overflow channel forming	12+60 to 13+90	Frequent flooding and steeper grade	SPA 3
Overflow channel forming	22+10 to 22+60	Frequent flooding and steeper grade	SPA 1
Bank scour	18+90	Lack of protection from coir matting	SPA 2

Badin Inn Stream Restoration Site
Mitigation Report
Appendix B-3
Stream Problem Area Photos

SPA 1. Stream overflow channel beginning to form.

SPA3. Stream overflow channel beginning to form.

SPA 2. Bank scour.

Badin Inn Stream Restoration Site
Mitigation Report
Appendix B-4
Stream Photo-Station Photos


Photo Point 1. Upstream From Cross Section #1.


Photo Point 1. Downstream from Cross Section #1.


Photo Point 2. Upstream from Cross Section 2.


Photo Point 2. Downstream from Cross Section #2.


Photo Point 3. Upstream from Cross Section 3.


Photo Point 3. Downstream from Cross Section #3.

Badin Inn Stream Restoration Site
Mitigation Report
Appendix B-4
Stream Photo-Station Photos


Photo Point 4. Upstream from Cross Section #4.


Photo Point 4. Downstream from Cross Section #4.


Photo Point 5. Upstream from Cross Section #5.


Photo Point 5. Downstream from Cross Section #5.


Photo Point 6. Upstream from Cross Section #6.


Photo Point 6. Downstream from Cross Section #6.

Photo Point 7. Upstream from Cross Section #7.

Photo Point 7. Downstream from Cross Section #7.

Photo Point 8. Upstream from Cross Section #8.

Photo Point 8. Downstream from Cross Section #9.

Photo Point 9. Upstream from Cross Section #9 Tributary.

Photo Point 9. Downstream from Cross Section #9 Tributary.

Badin Inn Stream Restoration Site
Mitigation Report
Appendix B-4
Stream Photo-Station Photos

Photo Point 10. Upstream from Cross Section # 10.

Photo Point 10. Downstream from Cross Section #10.

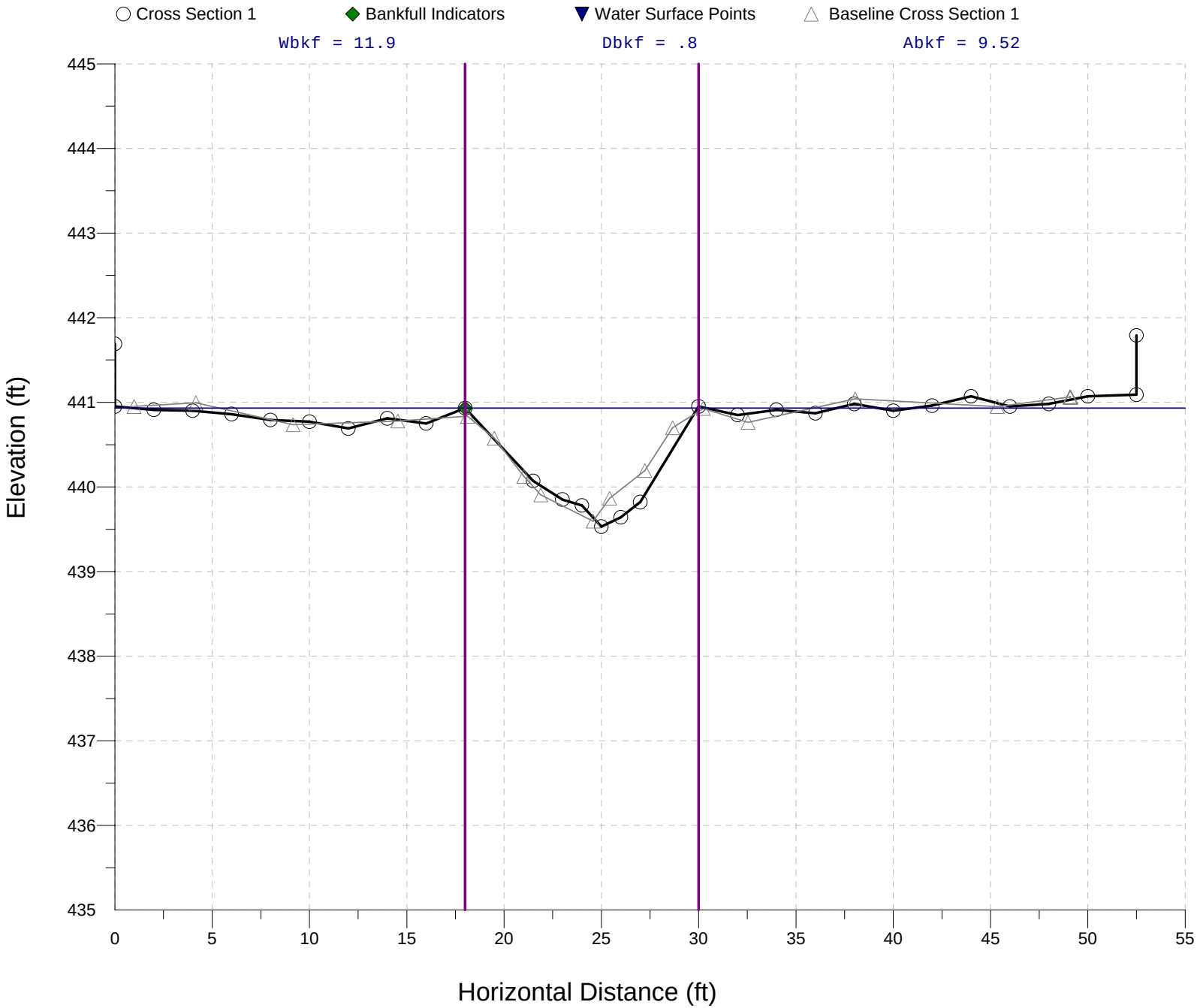
Table B2. Visual Morphological Stability Assessment
Badin Inn Stream Restoration/ EEP Number 92666
UT Little Mountain Creek/ 4,022 feet

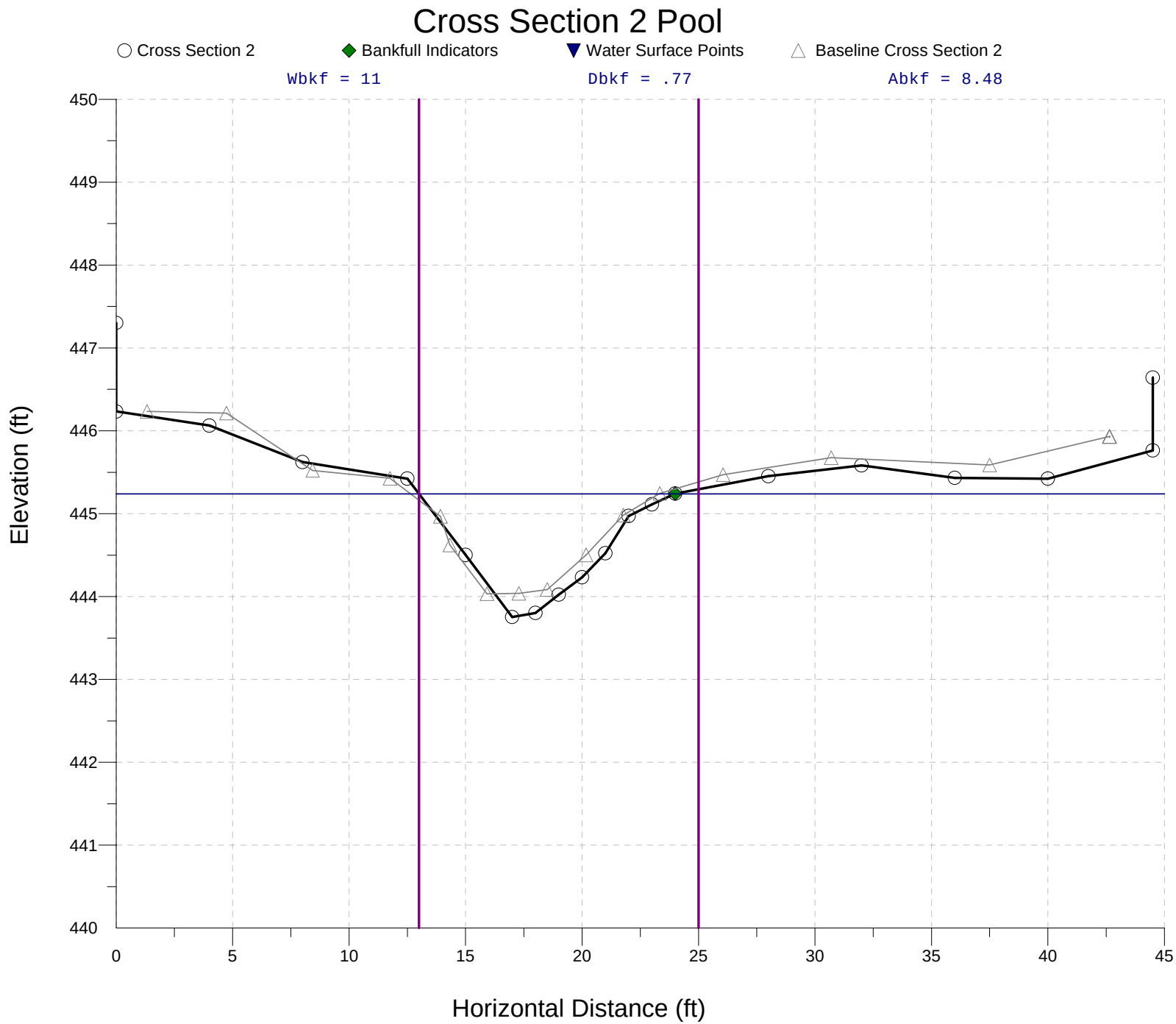
Feature Category	Metric (Per As-built and reference baselines)	# Stable Number Perform. as Intended	Total No. per As-built	Total Number/ feet in unstable state	% Perform. in stable condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	58	58	NA	100	100
	2. Armor stable (e.g. no displacement)	57	58	1	98	98
	3. Facet grade appears stable	58	58	NA	100	100
	4. Minimal evidence of embedding/fining	58	58	NA	100	100
	5. Length appropriate	58	58	NA	100	99
B. Pools	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	58	58	NA	100	100
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?	NA	NA	NA	NA	NA
	3. Length appropriate?	58	58	NA	100	100
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	NA	NA	NA	NA	NA
	2. Downstream of meander (glide/inflection) centering?	NA	NA	NA	NA	NA
D. Meanders	1. Outer bend in state of limited/controlled erosion?	44	44	NA	100	100
	2. Of those eroding, # w/concomitant point bar formation?	NA	NA	NA	100	100
	3. Apparent Rc within spec?	44	44	NA	100	100
	4. Sufficient floodplain access and relief?	44	44	NA	100	100
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA		100	100
	2. Channel bed degradation - areas of increasing down-cutting or headcutting	NA	NA		100	100
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA		100	100
G. Vanes	1. Free of back or arm scour?	17	17	NA	100	100
	2. Height appropriate?	17	17	NA	100	100
	3. Angle and geometry appear appropriate?	17	17	NA	100	100
	4. Free of piping or other structural failures?	17	17	NA	100	100
H. Wads/ Boulders	1. Free of scour?	NA	NA	NA	NA	NA
	2. Footing stable?	NA	NA	NA	NA	NA

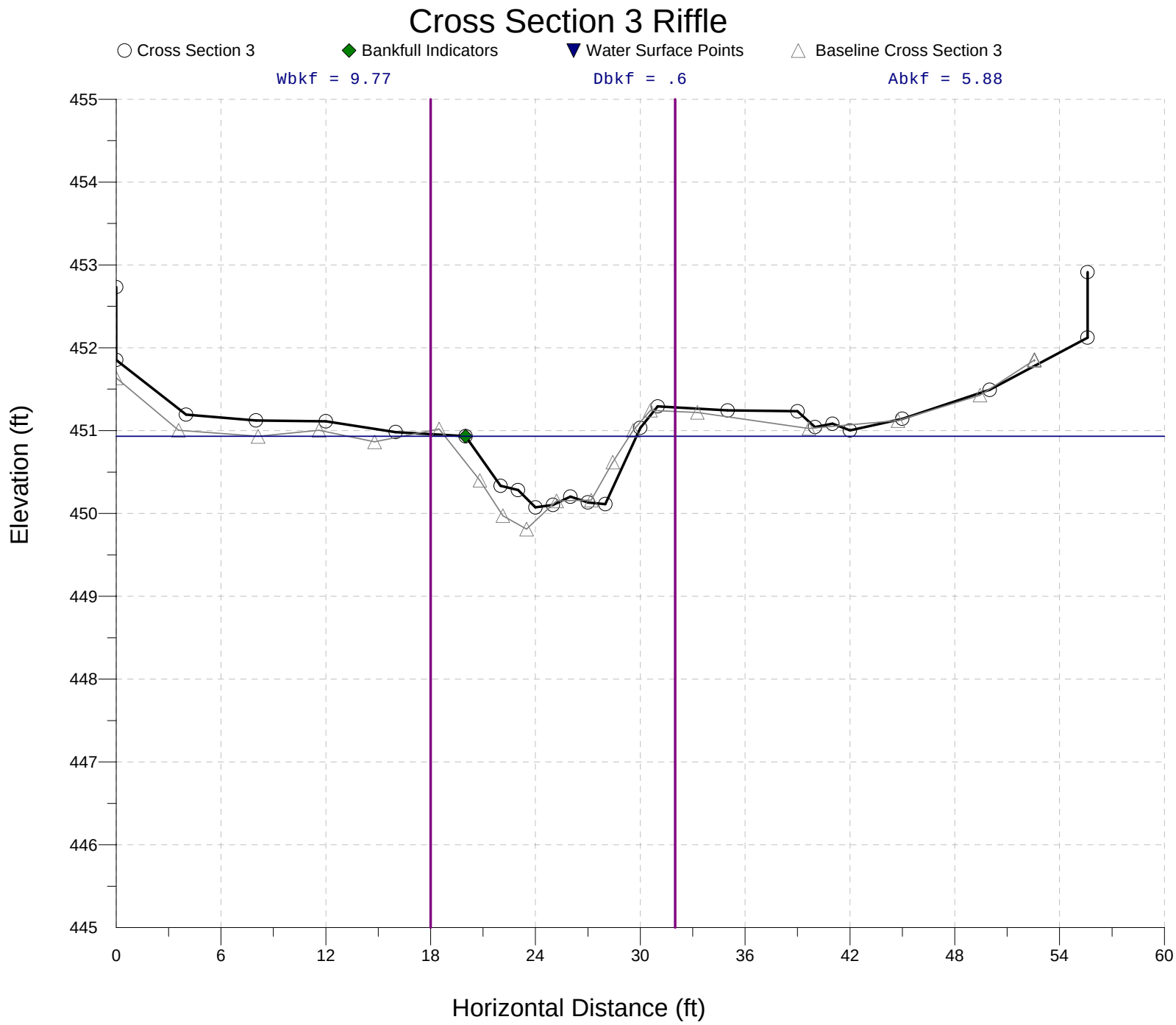
Table B2. Visual Morphological Stability Assessment
Badin Inn Stream Restoration/ EEP Number 92666
Tributary/ 180 feet

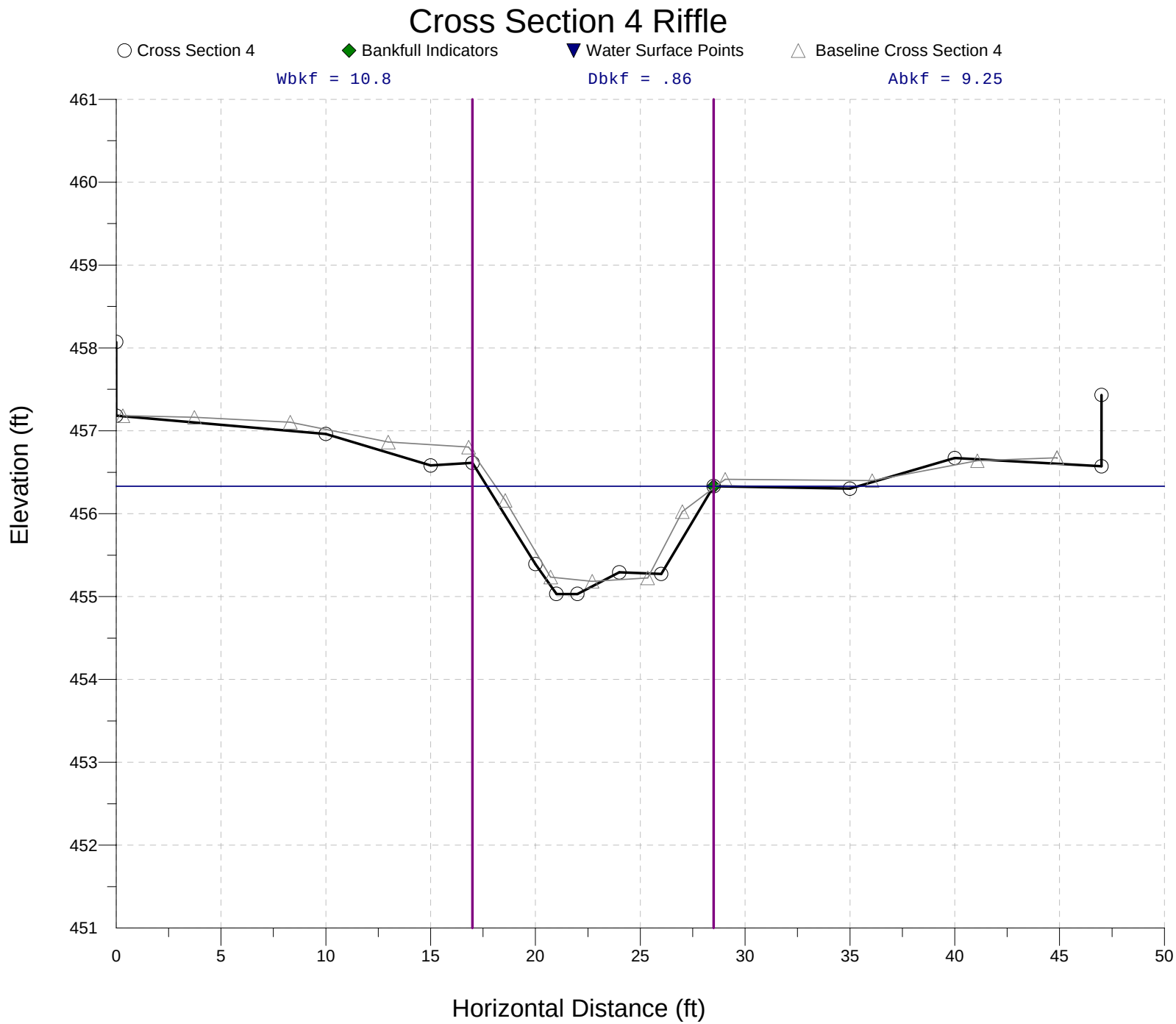
Feature Category	Metric (Per As-built and reference baselines)	# Stable Number Perform. as Intended	Total No. per As-built	Total Number/ feet in unstable state	% Perform. in stable condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	4	4	NA	100	100
	2. Armor stable (e.g. no displacement)	4	4	0	100	100
	3. Facet grade appears stable	4	4	NA	100	100
	4. Minimal evidence of embedding/fining	4	4	NA	100	100
	5. Length appropriate	4	4	NA	100	100
B. Pools	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	4	4	NA	100	100
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?	NA	NA	NA	NA	NA
	3. Length appropriate?	4	4	NA	100	100
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	NA	NA	NA	NA	NA
	2. Downstream of meander (glide/inflection) centering?	NA	NA	NA	NA	NA
D. Meanders	1. Outer bend in state of limited/controlled erosion?	4	4	NA	100	100
	2. Of those eroding, # w/concomitant point bar formation?	NA	NA	NA	100	100
	3. Apparent Rc within spec?	4	4	NA	100	100
	4. Sufficient floodplain access and relief?	4	4	NA	100	100
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	NA	100	100
	2. Channel bed degradation - areas of increasing down-cutting or headcutting	NA	NA	NA	100	100
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA	NA	100	100
G. Vanes	1. Free of back or arm scour?	NA	NA	NA	NA	NA
	2. Height appropriate?	NA	NA	NA	NA	NA
	3. Angle and geometry appear appropriate?	NA	NA	NA	NA	NA
	4. Free of piping or other structural failures?	NA	NA	NA	NA	NA
H. Wads/ Boulders	1. Free of scour?	NA	NA	NA	NA	NA
	2. Footing stable?	NA	NA	NA	NA	NA

Cross Section 1 Riffle

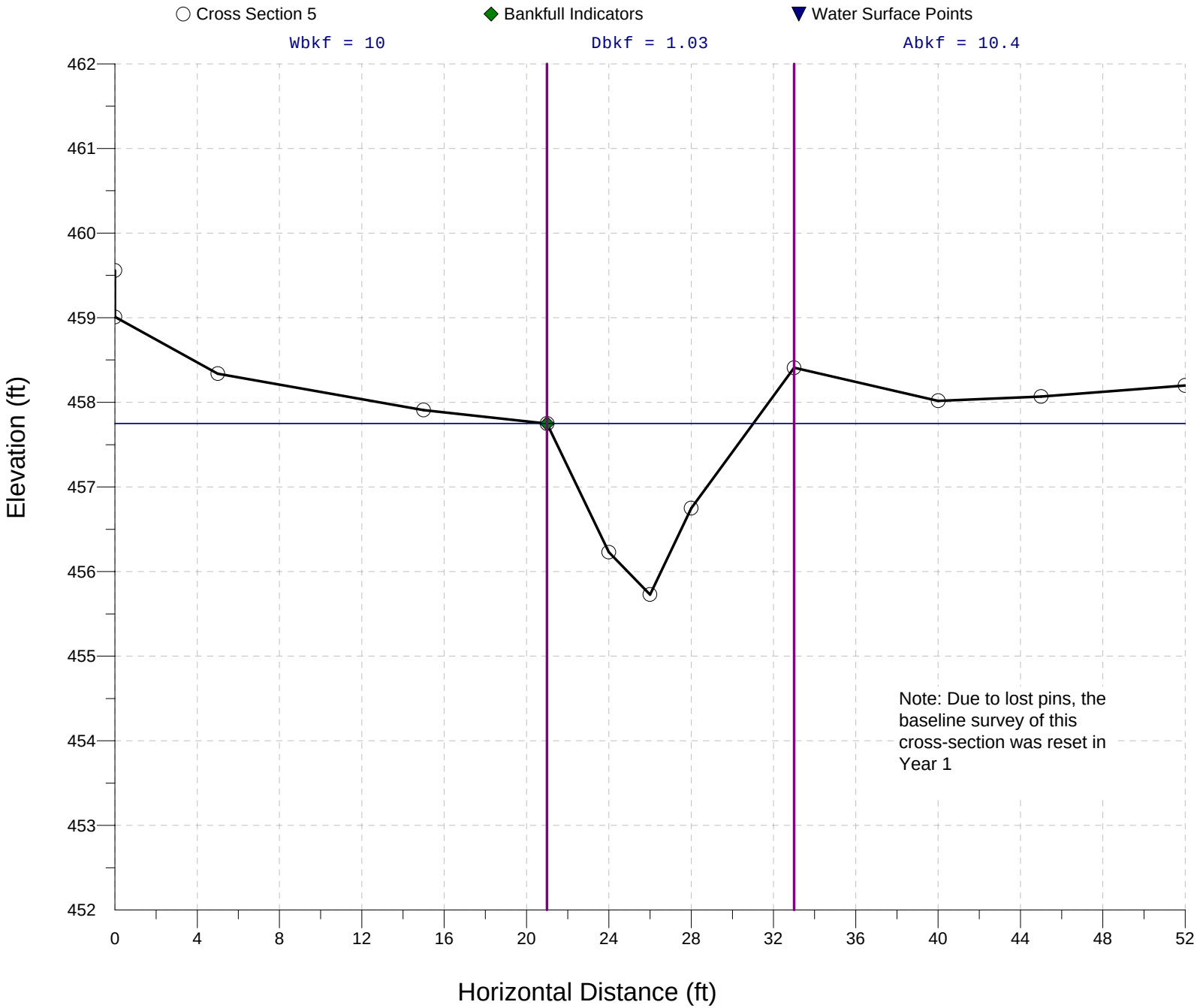



Cross Section 2 Pool
Cross Section 2
Bankfull Indicators
Water Surface Points
Baseline Cross Section 2
Wbkf = 11
Dbkf = .77
Abkf = 8.48
Elevation (ft)
Horizontal Distance (ft)
450
449
448
447
446
445
444
443
442
441
440
0
5
10
15
20
25
30
35
40
45

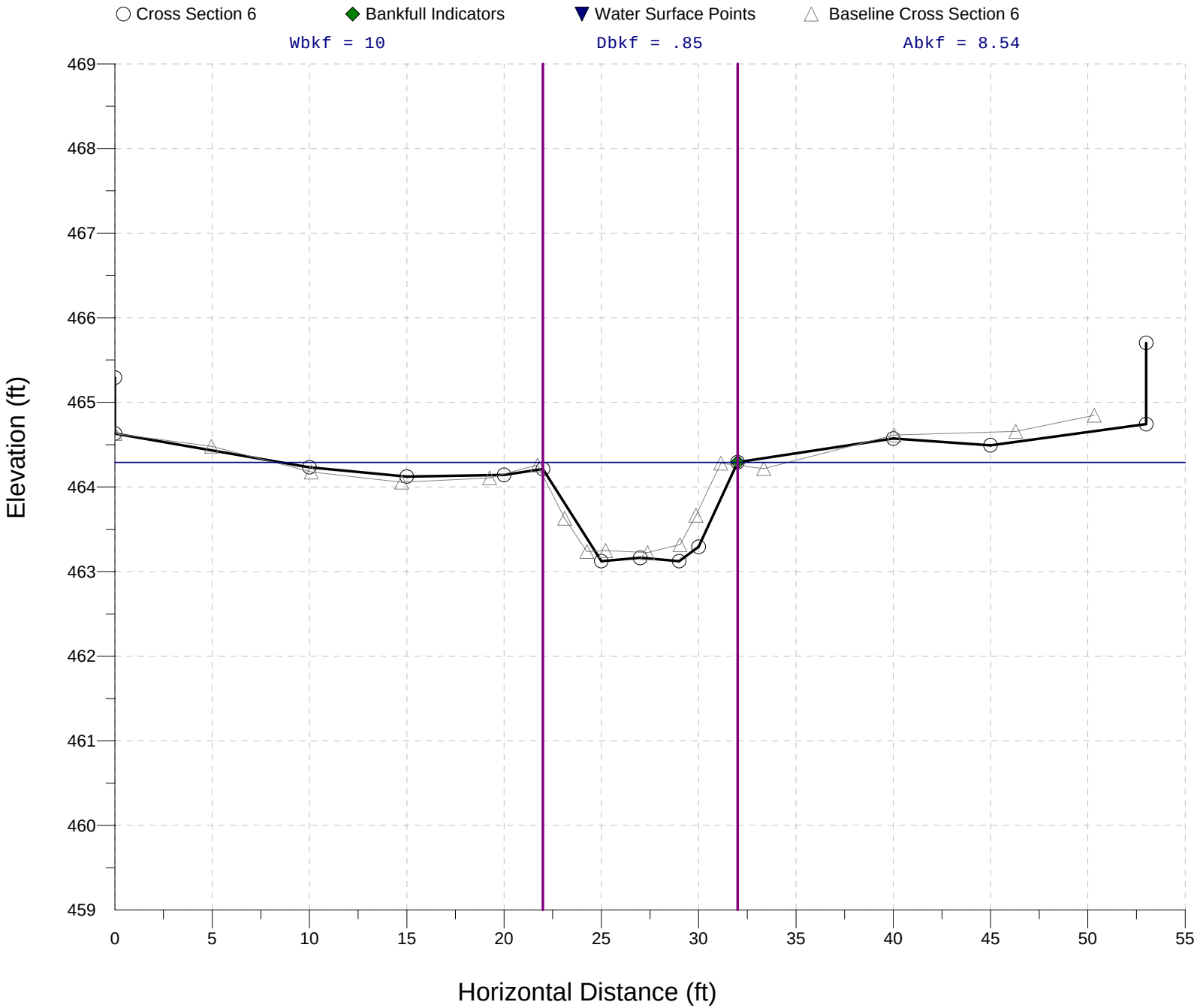

Cross Section 3 Riffle
Cross Section 3
Bankfull Indicators
Water Surface Points
Baseline Cross Section 3
Wbkf = 9.77
Dbkf = .6
Abkf = 5.88
Elevation (ft)
455
454
453
452
451
450
449
448
447
446
445
0
6
12
18
24
30
36
42
48
54
60
Horizontal Distance (ft)

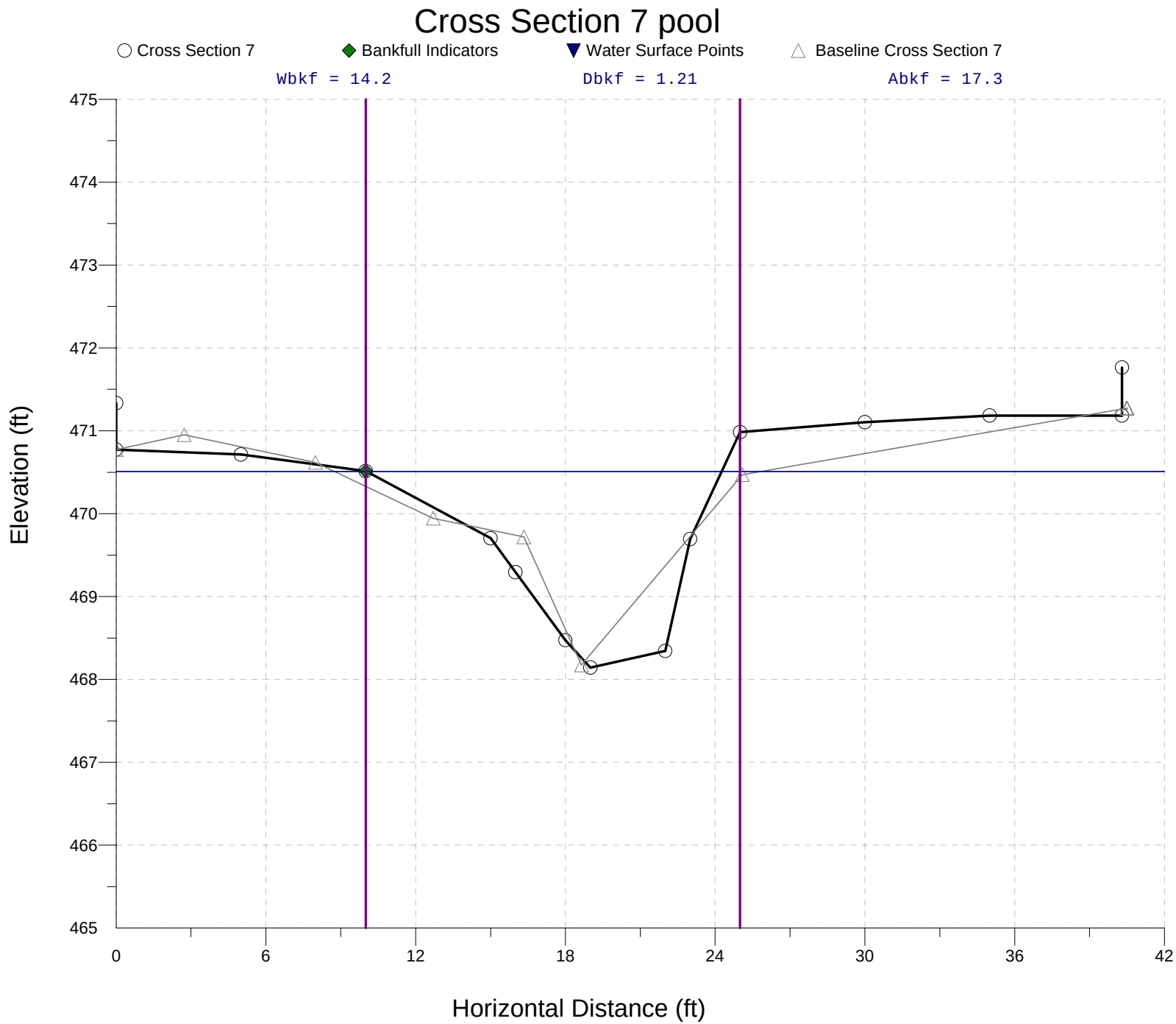

Cross Section 4 Riffle
Cross Section 4
Bankfull Indicators
Water Surface Points
Baseline Cross Section 4
Wbkf = 10.8
Dbkf = .86
Abkf = 9.25
Elevation (ft)
461
460
459
458
457
456
455
454
453
452
451
0
5
10
15
20
25
30
35
40
45
50
Horizontal Distance (ft)

Cross Section 5 Pool

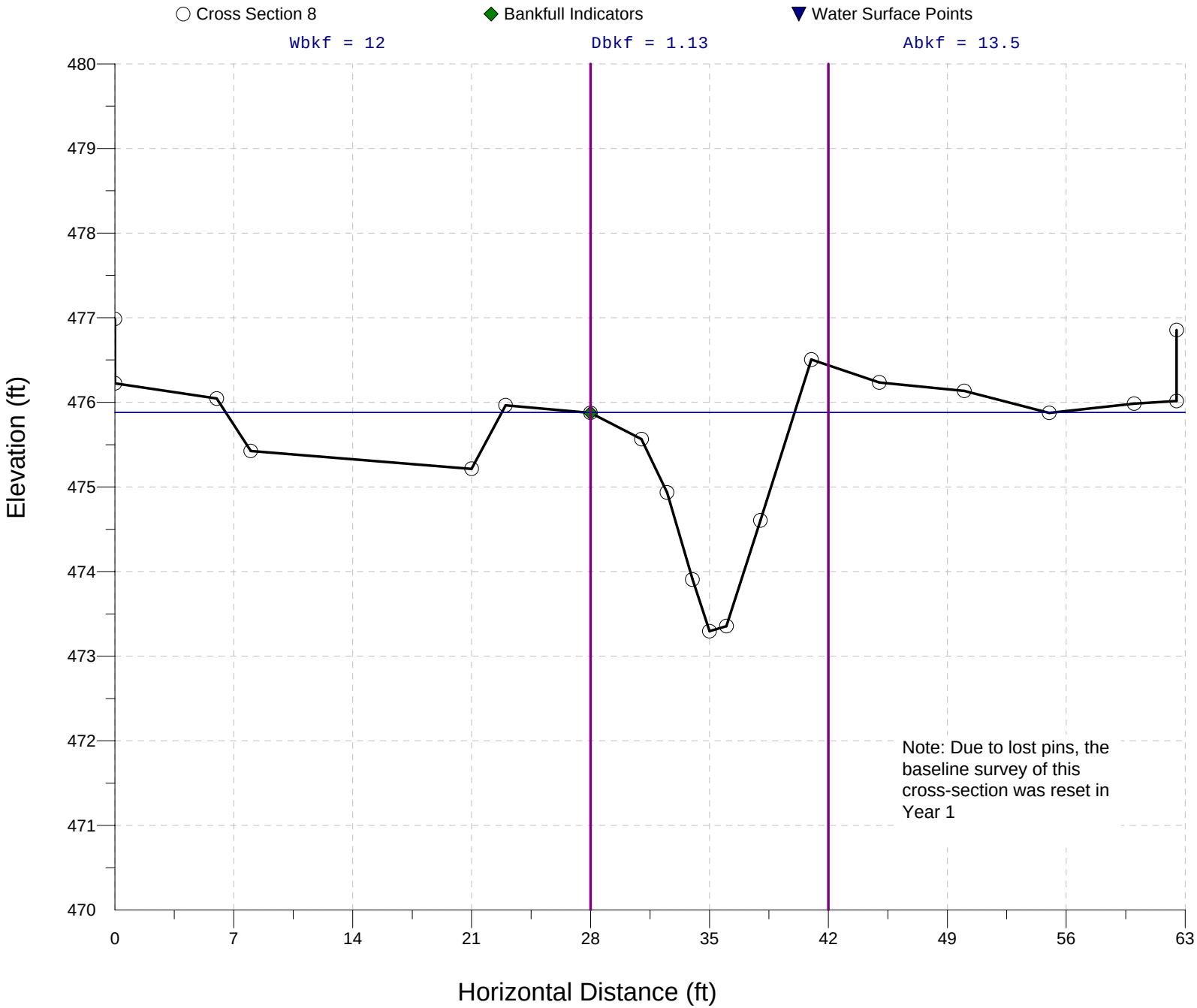


Cross Section 6 Riffle

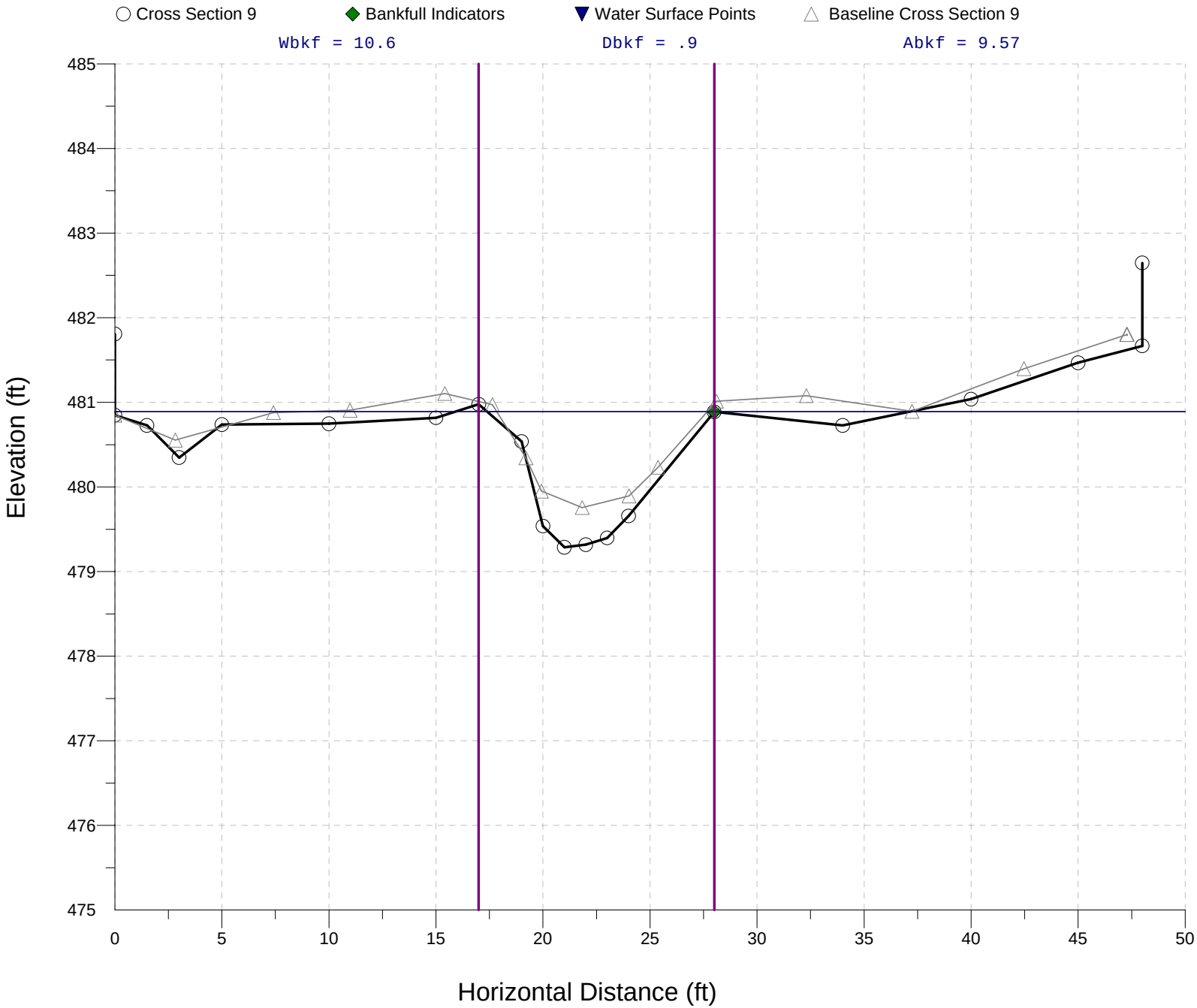



Cross Section 7 pool
Cross Section 7
Bankfull Indicators
Water Surface Points
Baseline Cross Section 7
Wbkf = 14.2
Dbkf = 1.21
Abkf = 17.3
Elevation (ft)
475
474
473
472
471
470
469
468
467
466
465
0
6
12
18
24
30
36
42
Horizontal Distance (ft)

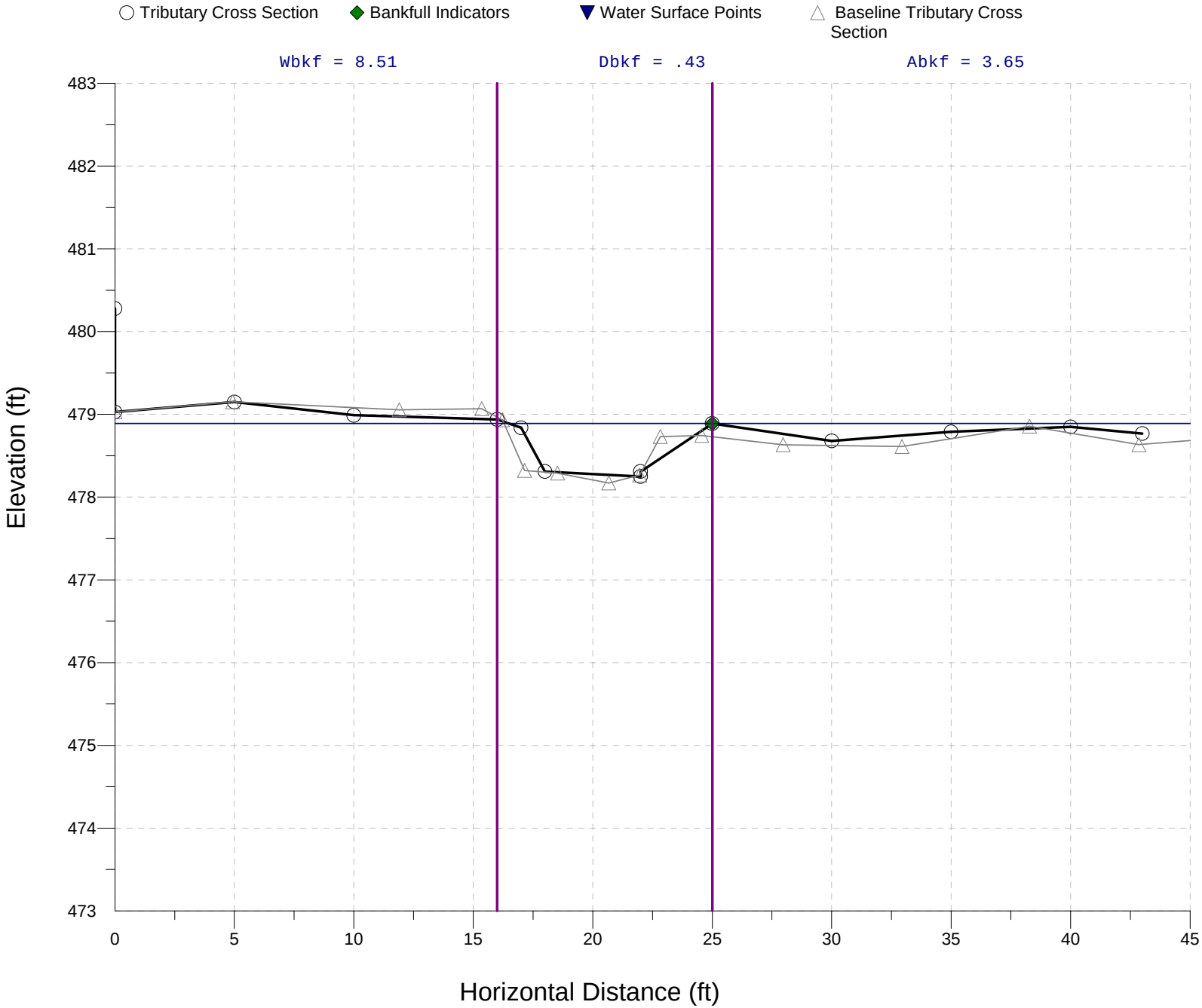
Cross Section 8 Pool

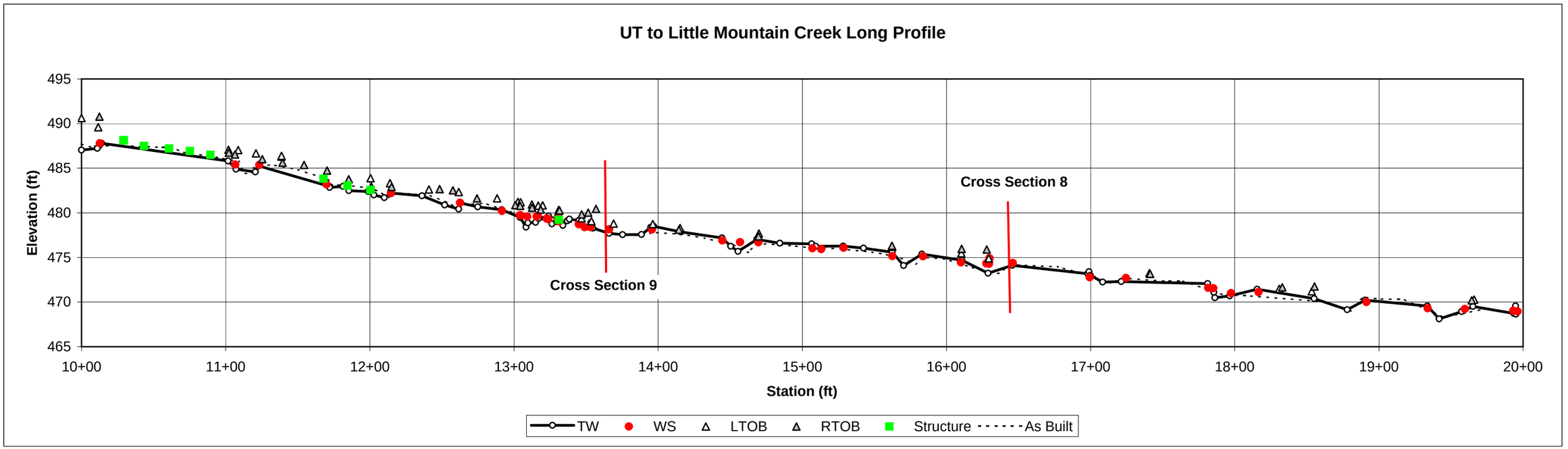


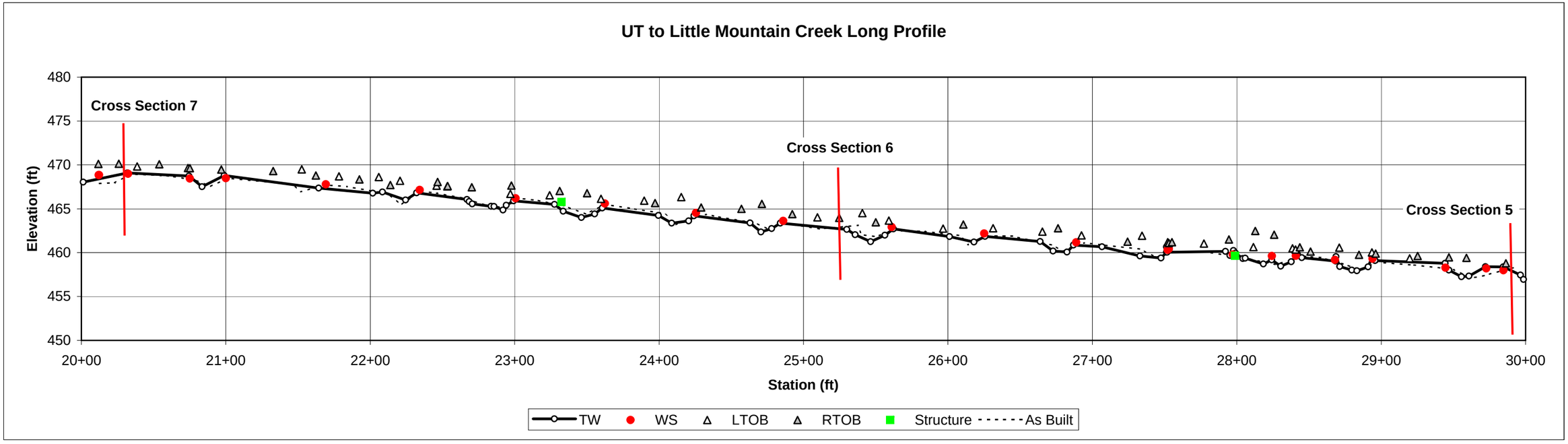
Cross Section 9 Riffle

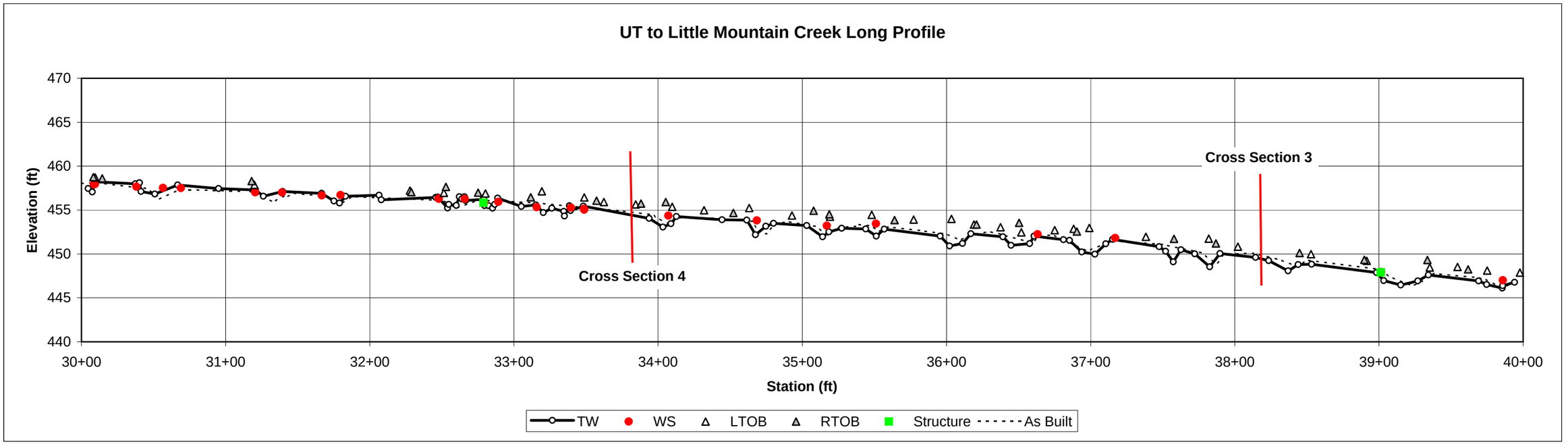


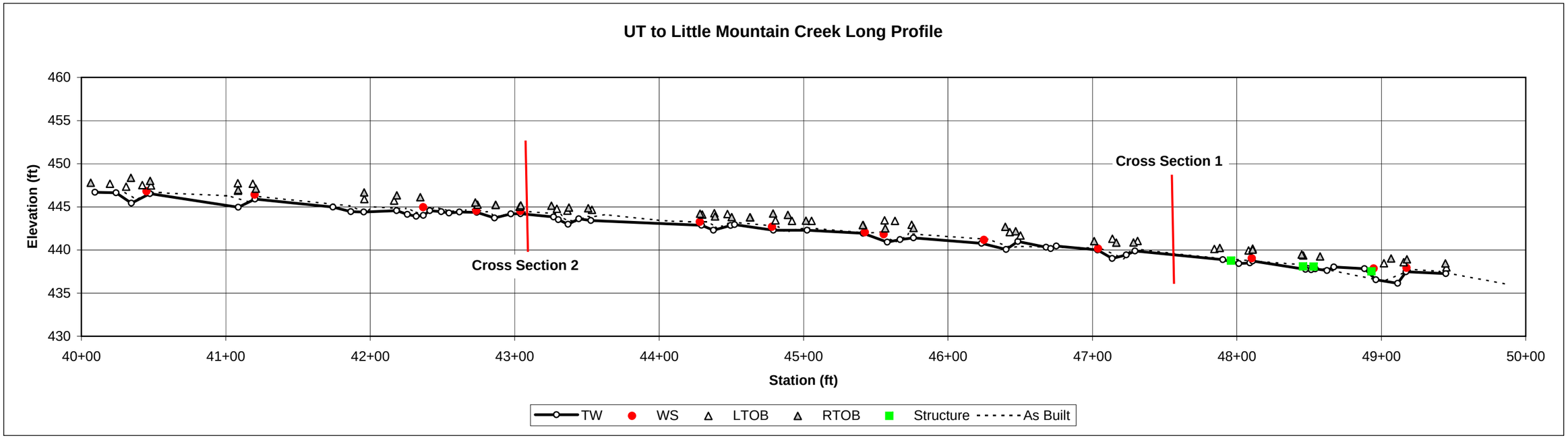
Tributary Cross Section Riffle

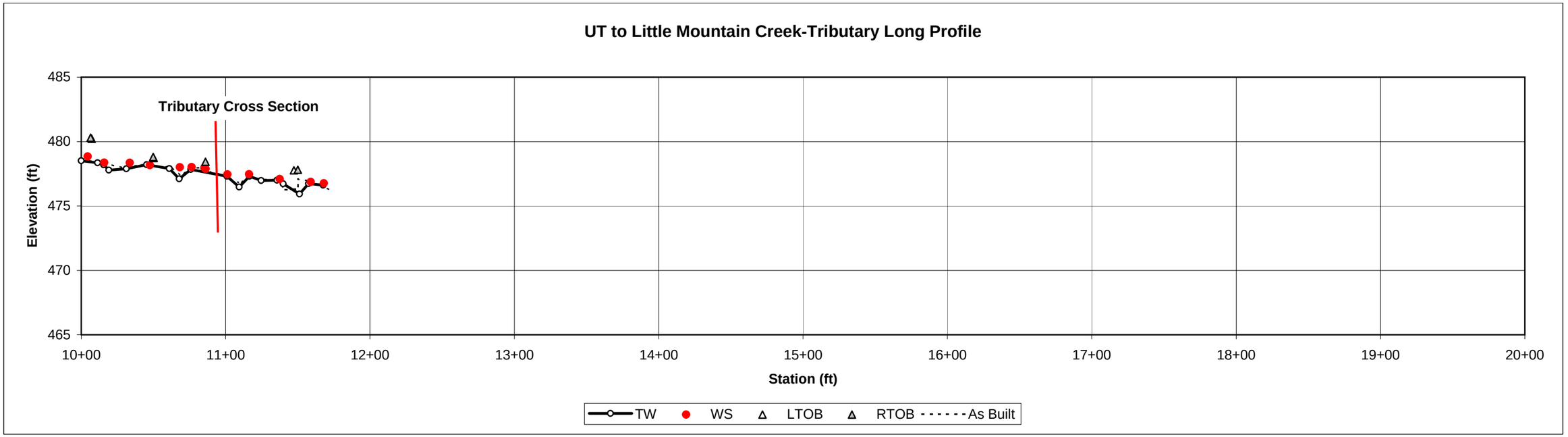



UT to Little Mountain Creek Long Profile
Elevation (ft)
495
490
485
480
475
470
465
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
Station (ft)
Cross Section 8
Cross Section 9
TW
WS
LTOB
RTOB
Structure
As Built

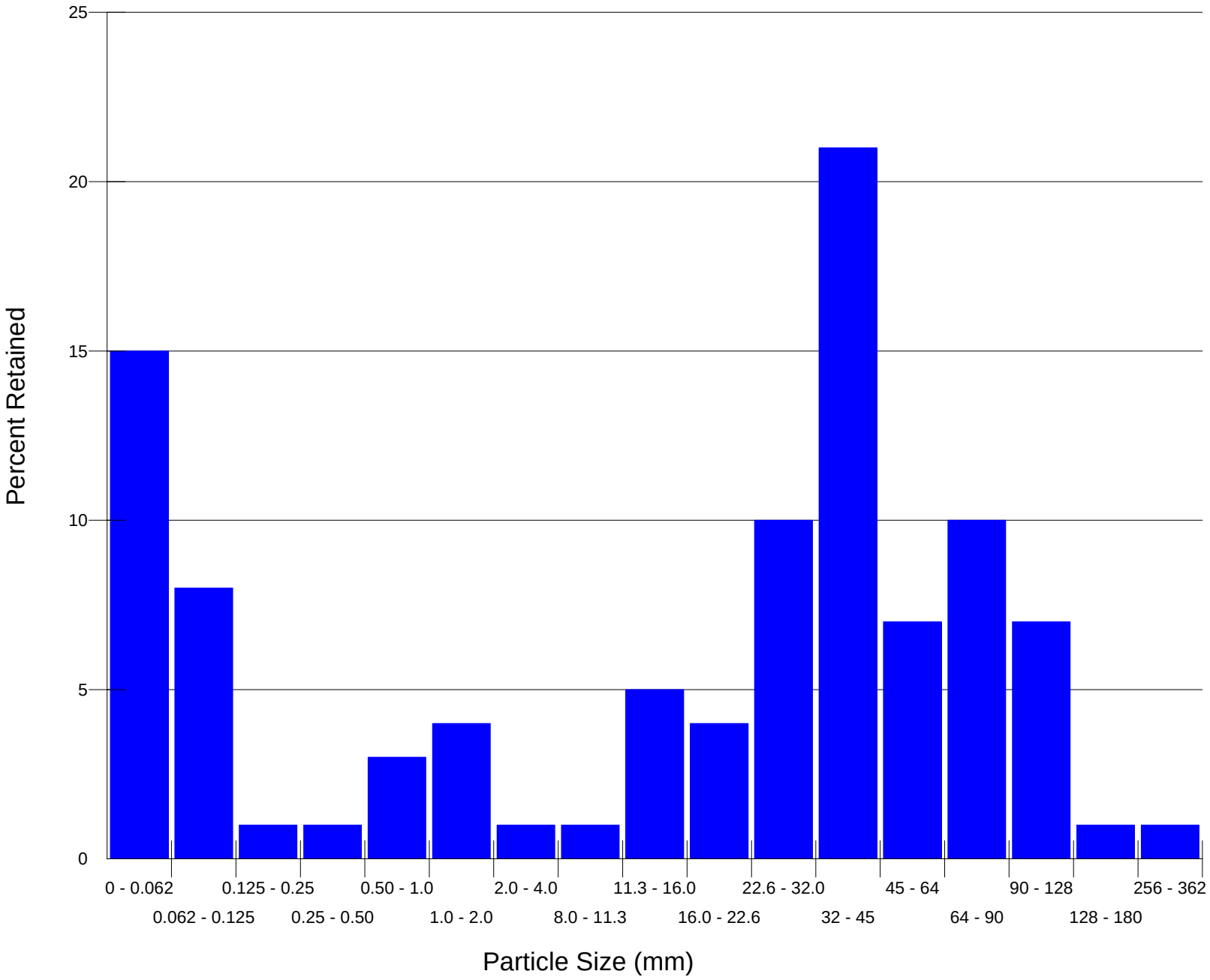

UT to Little Mountain Creek Long Profile
Elevation (ft)
480
475
470
465
460
455
450
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
30+00
Station (ft)
Cross Section 7
Cross Section 6
Cross Section 5
TW
WS
LTOB
RTOB
Structure
As Built


UT to Little Mountain Creek Long Profile
Elevation (ft)
470
465
460
455
450
445
440
30+00
31+00
32+00
33+00
34+00
35+00
36+00
37+00
38+00
39+00
40+00
Station (ft)
Cross Section 4
Cross Section 3
TW
WS
LTOB
RTOB
Structure
As Built

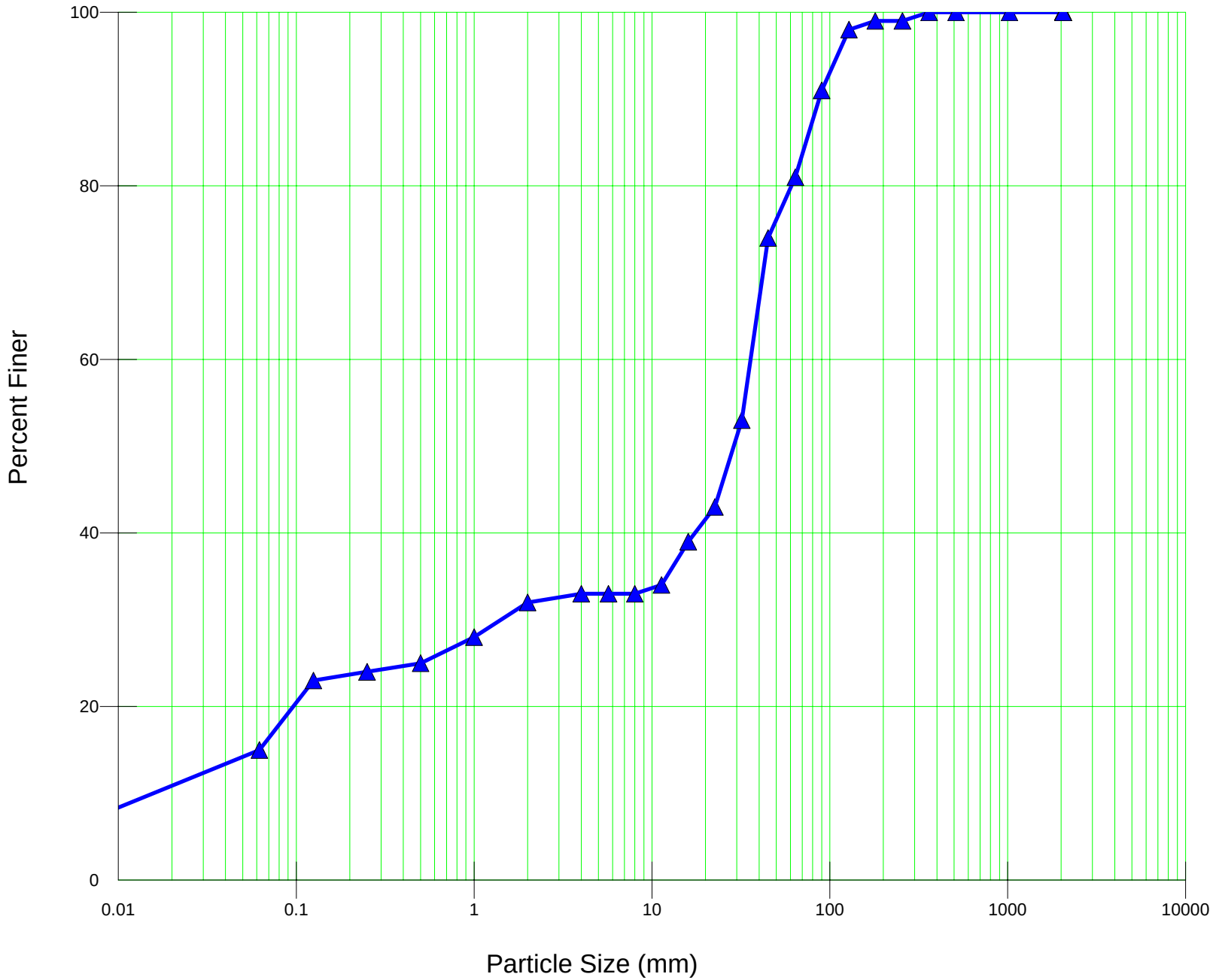

UT to Little Mountain Creek Long Profile
Elevation (ft)
460
455
450
445
440
435
430
40+00
41+00
42+00
43+00
44+00
45+00
46+00
47+00
48+00
49+00
50+00
Station (ft)
Cross Section 2
Cross Section 1
TW
WS
LTOB
RTOB
Structure
As Built


UT to Little Mountain Creek-Tributary Long Profile
Tributary Cross Section
Elevation (ft)
485
480
475
470
465
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
Station (ft)
TW
WS
LTOB
RTOB
As Built

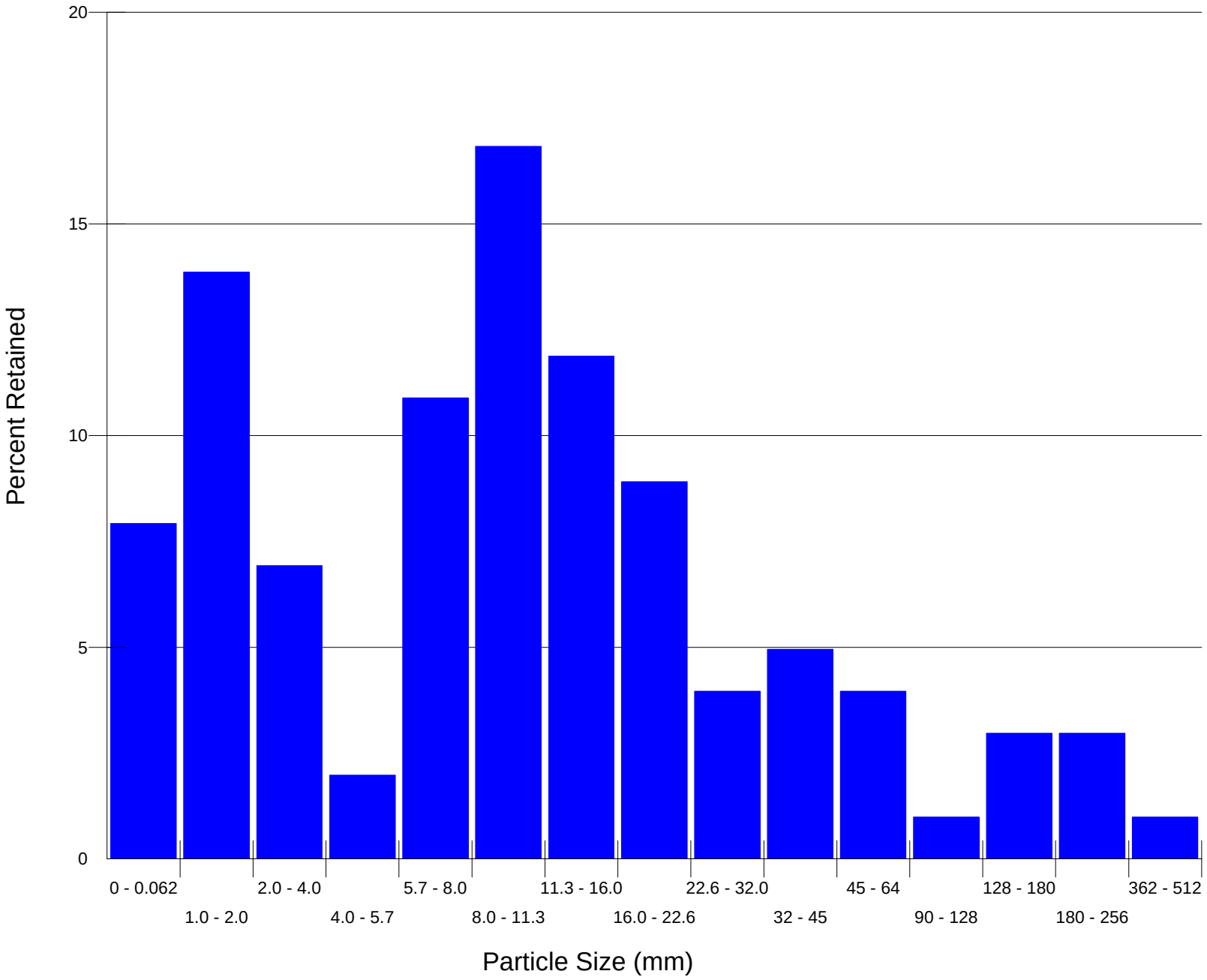
Pebble Count 1 Riffle



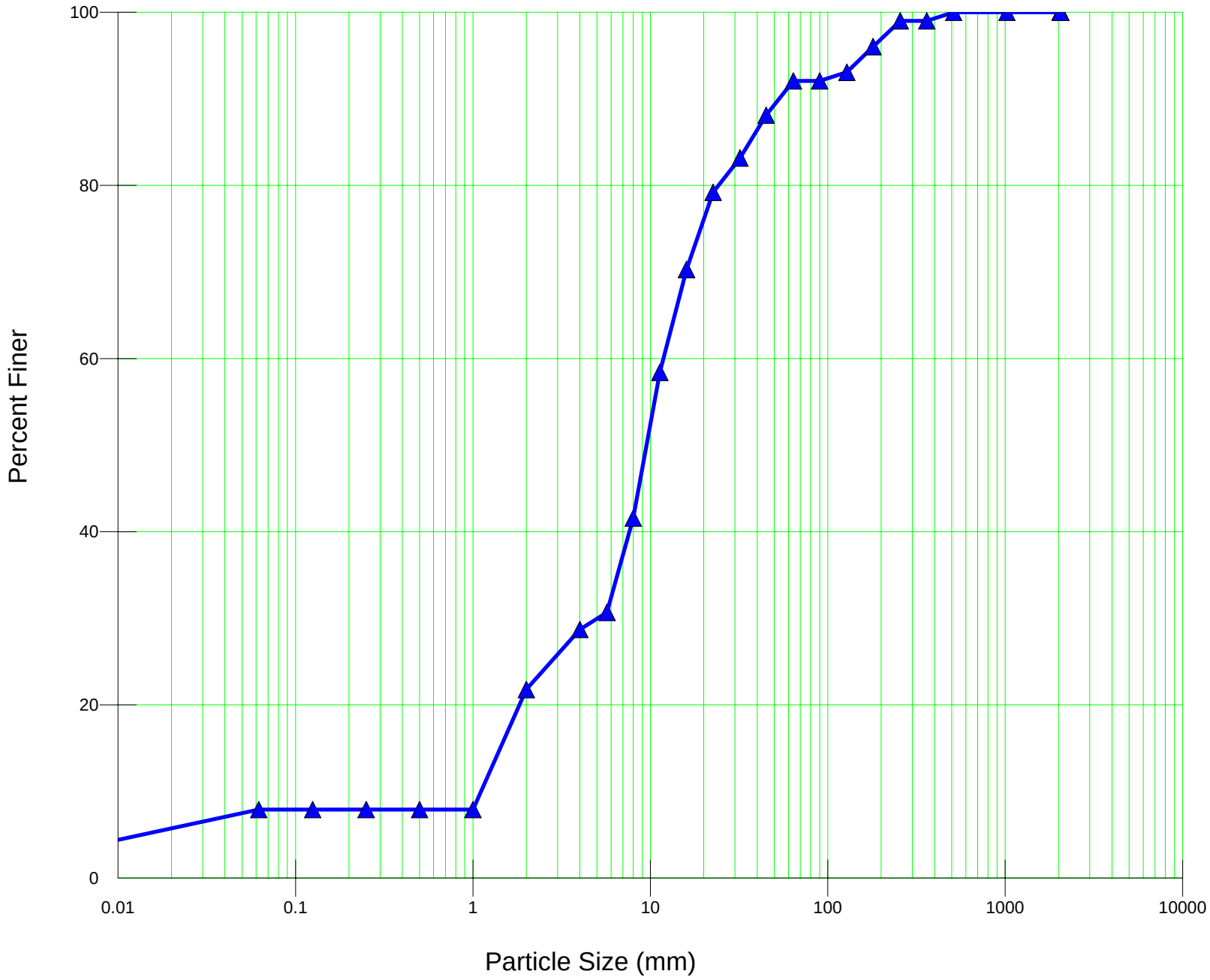
Pebble Count 1 Riffle



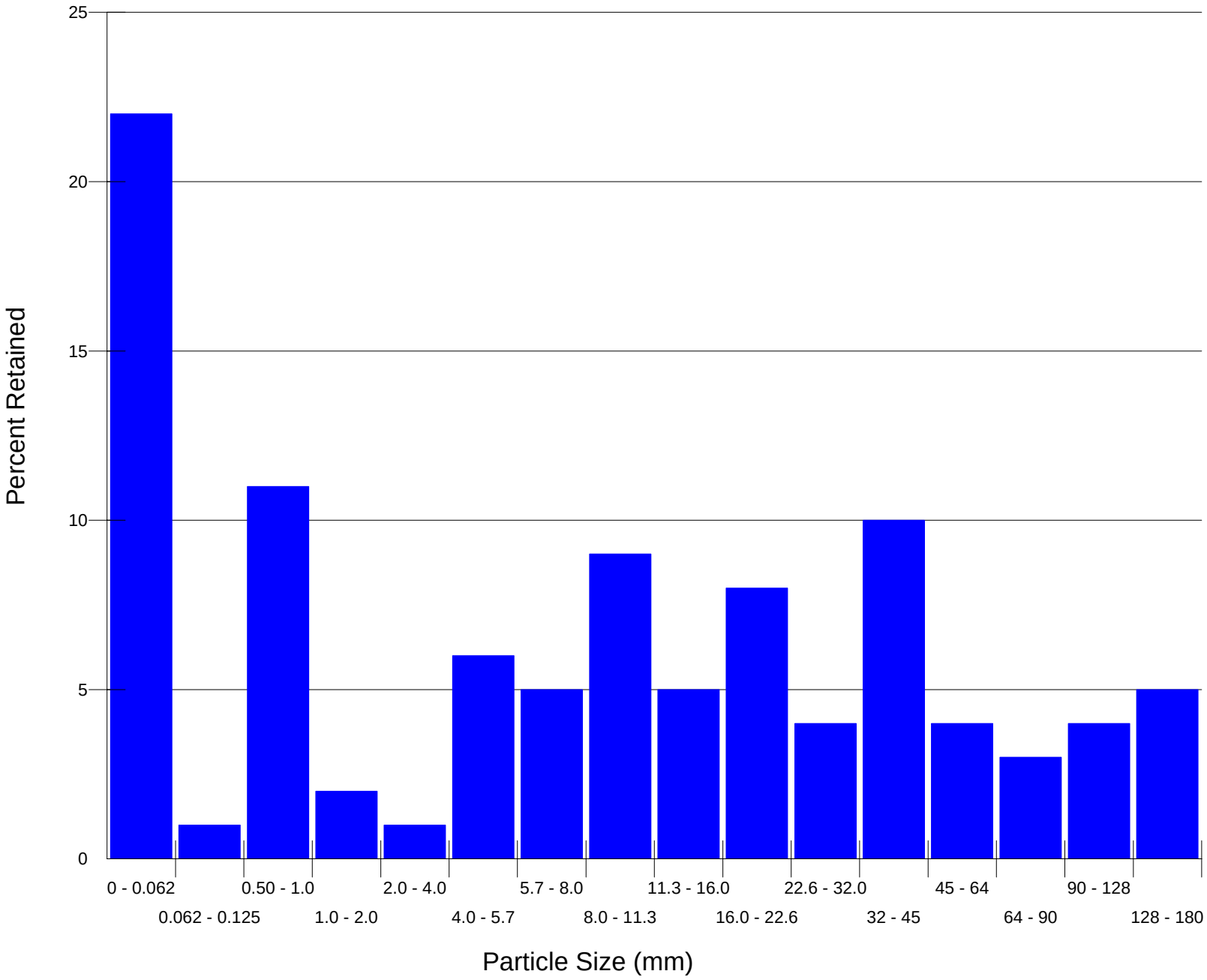
Pebble Count 2 Pool



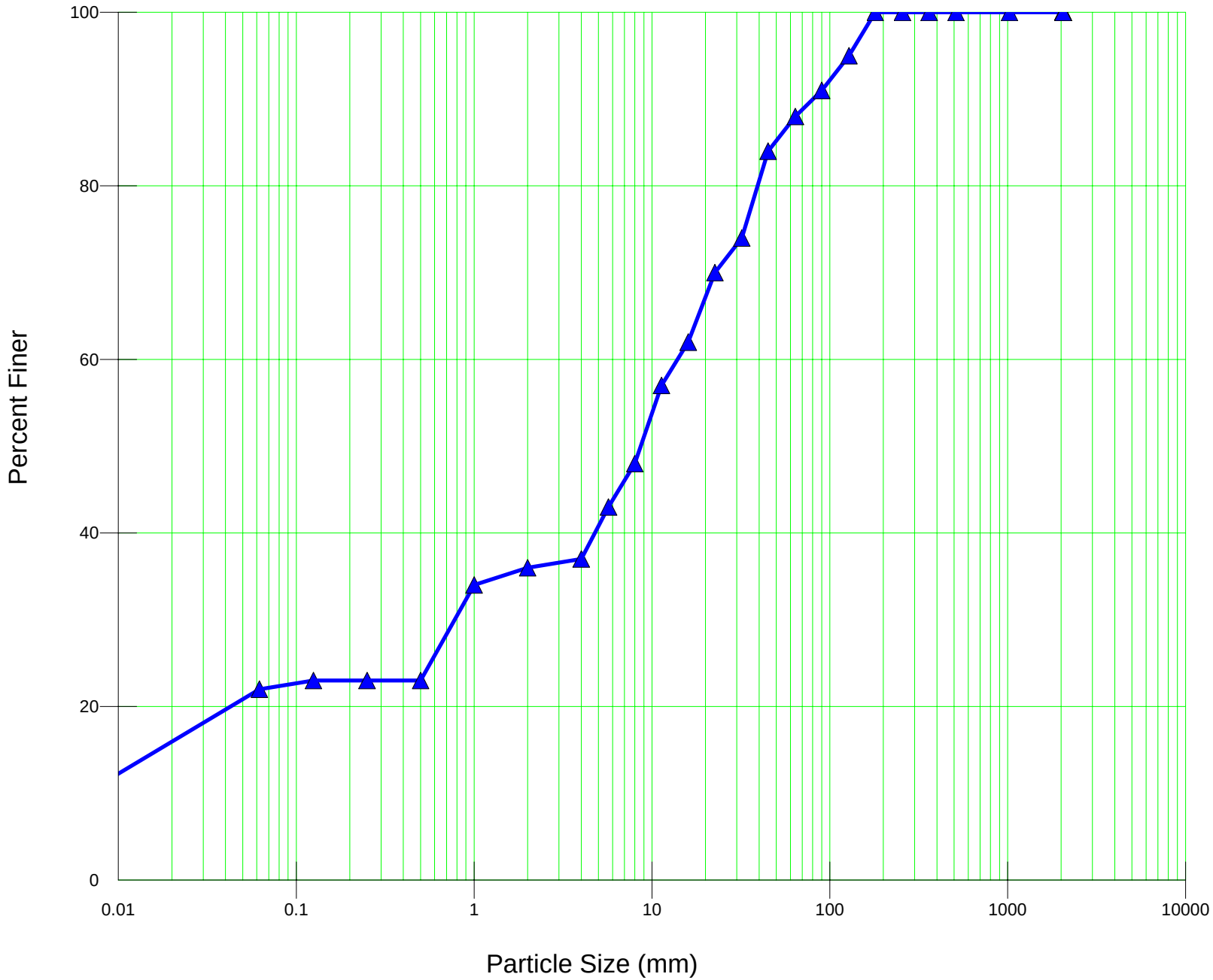
Pebble Count 2 Pool



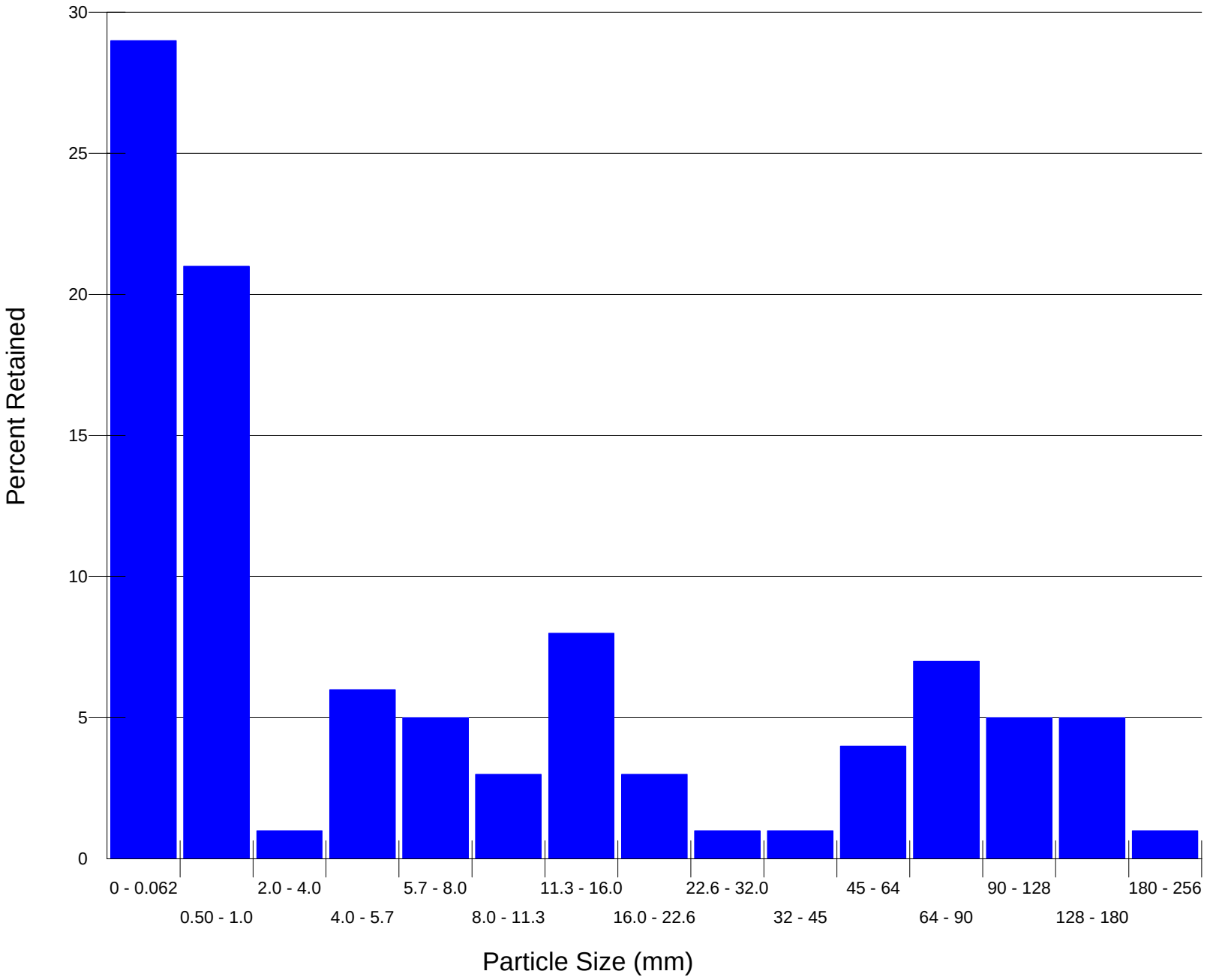
Pebble Count 3 Riffle



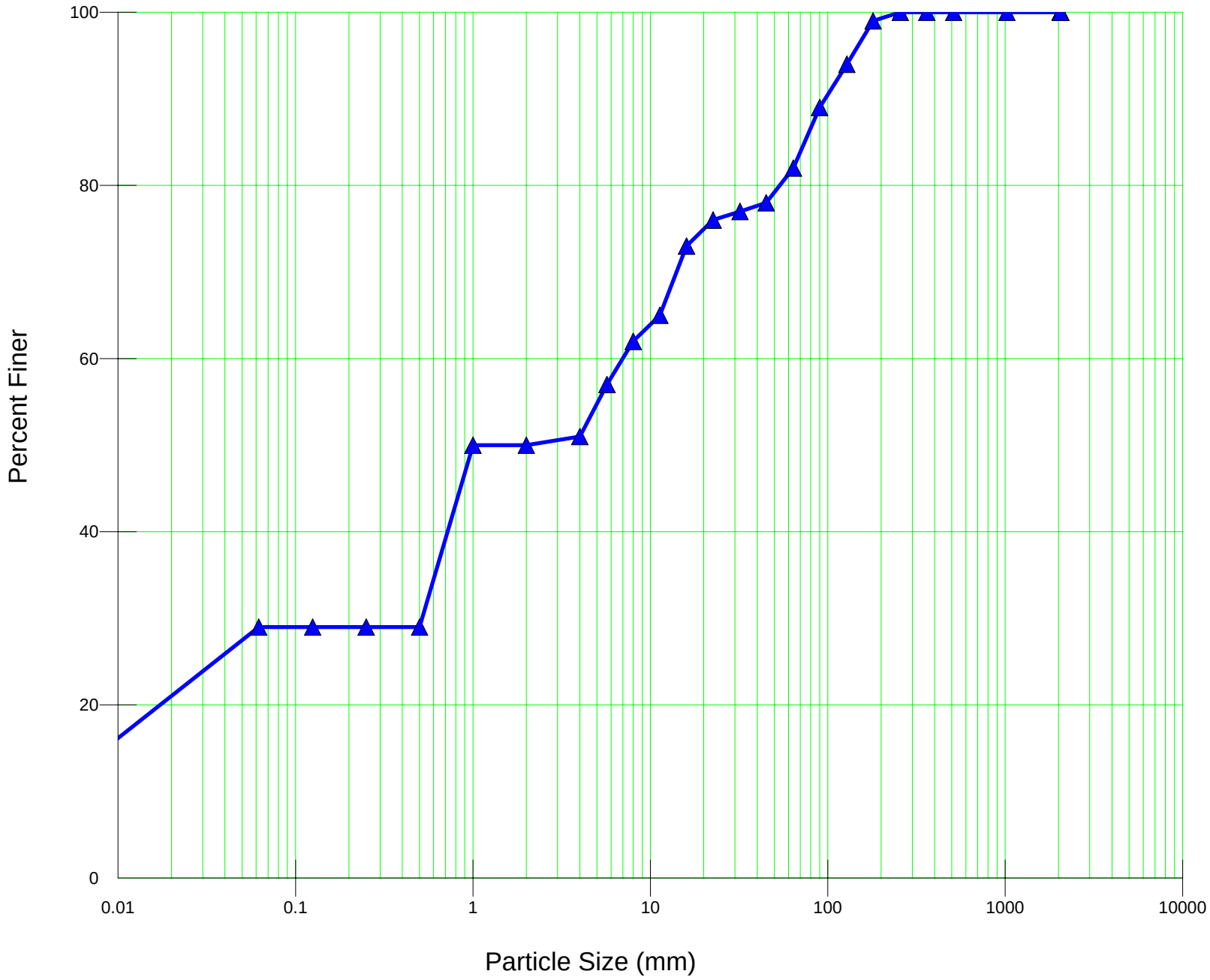
Pebble Count 3 Riffle



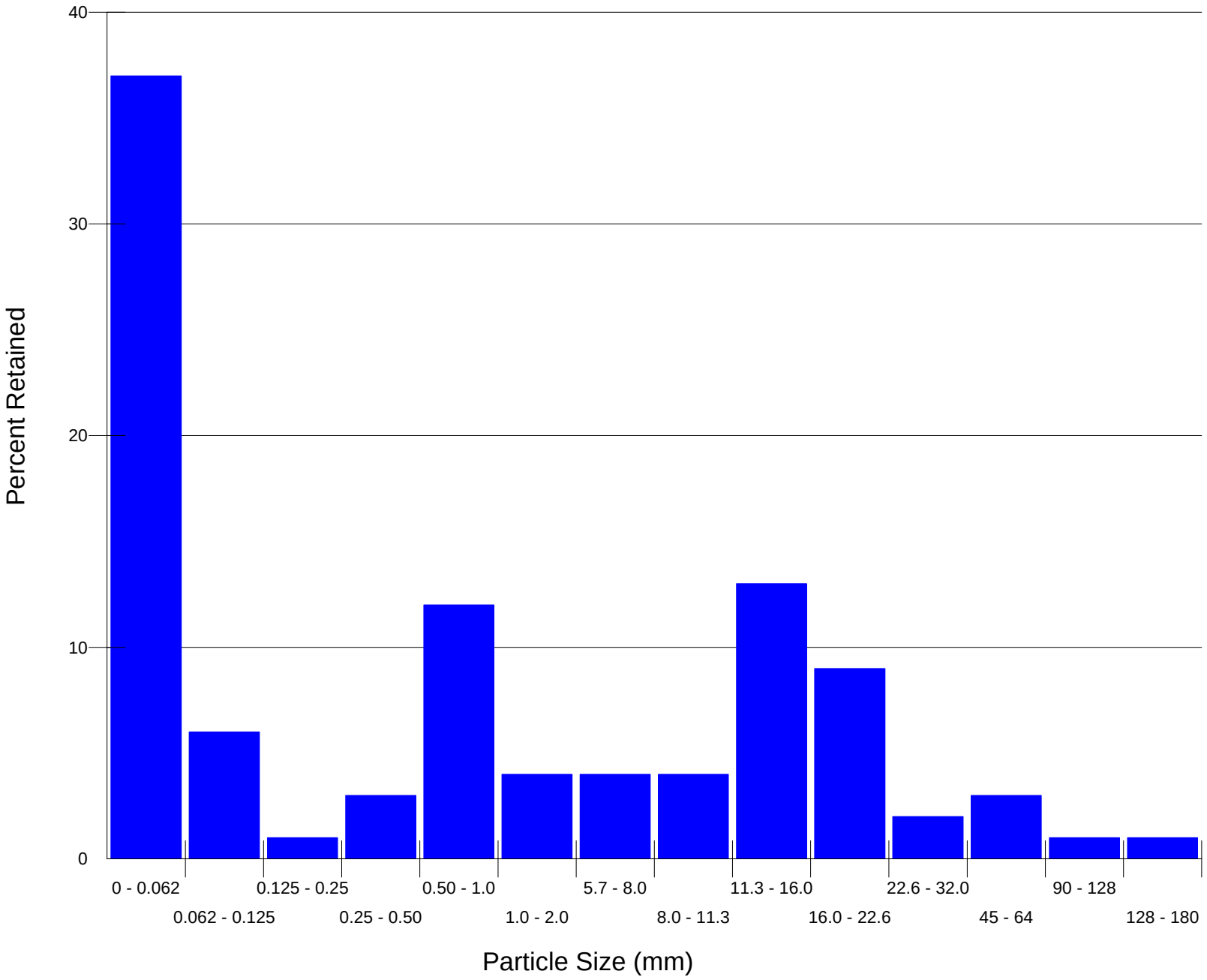
Pebble Count 4 Riffle



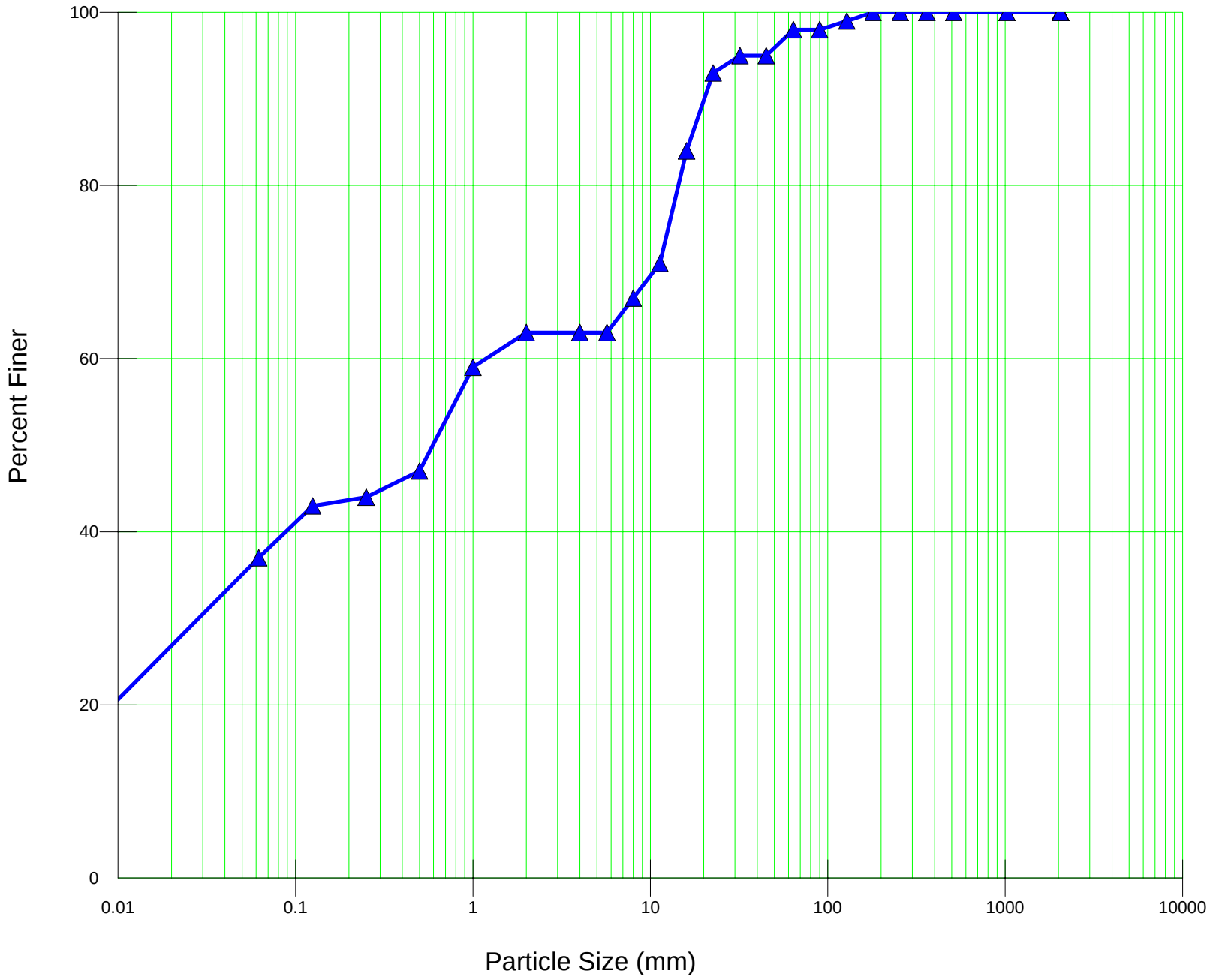
Pebble Count 4 Riffle



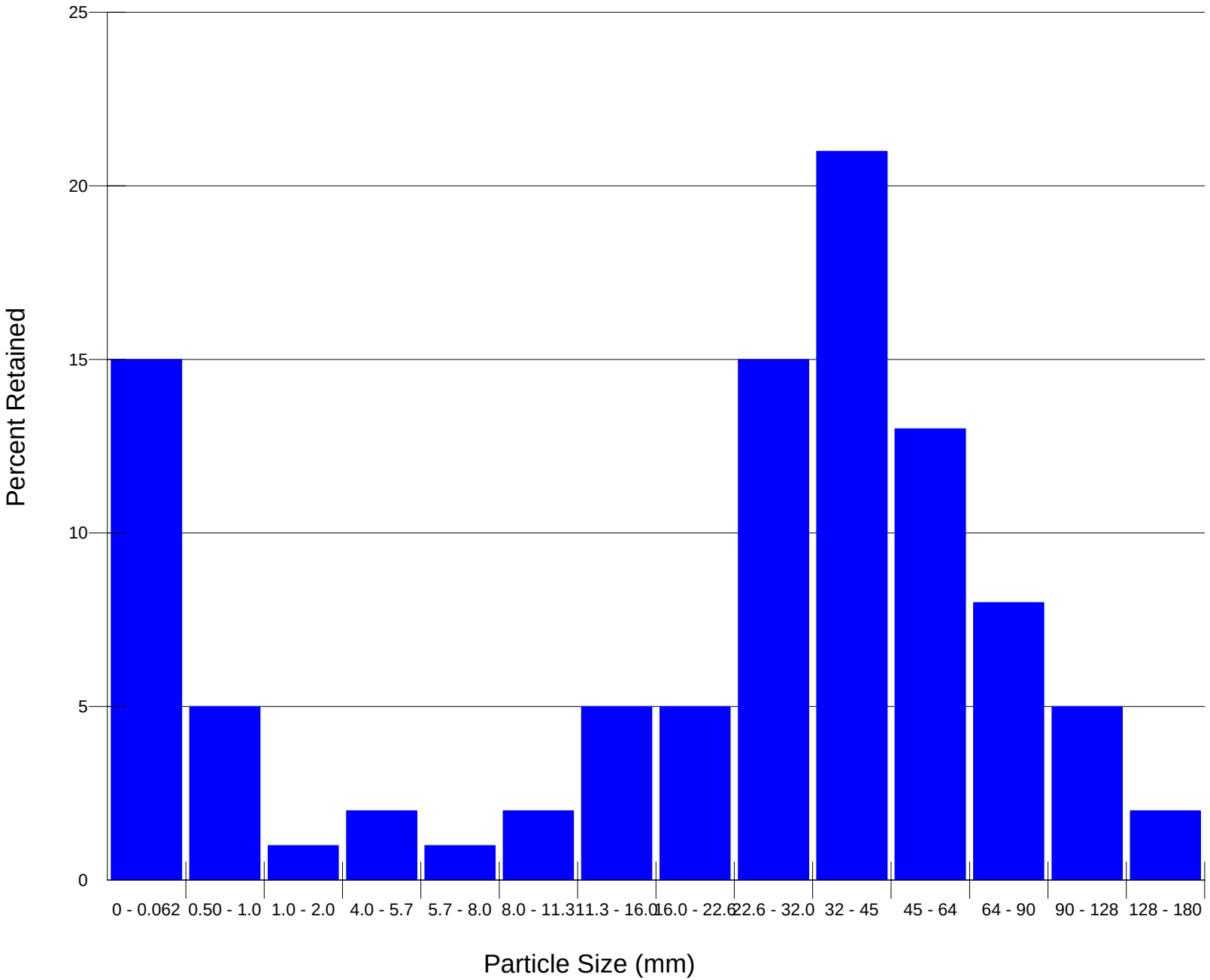
Pebble Count 5 Pool



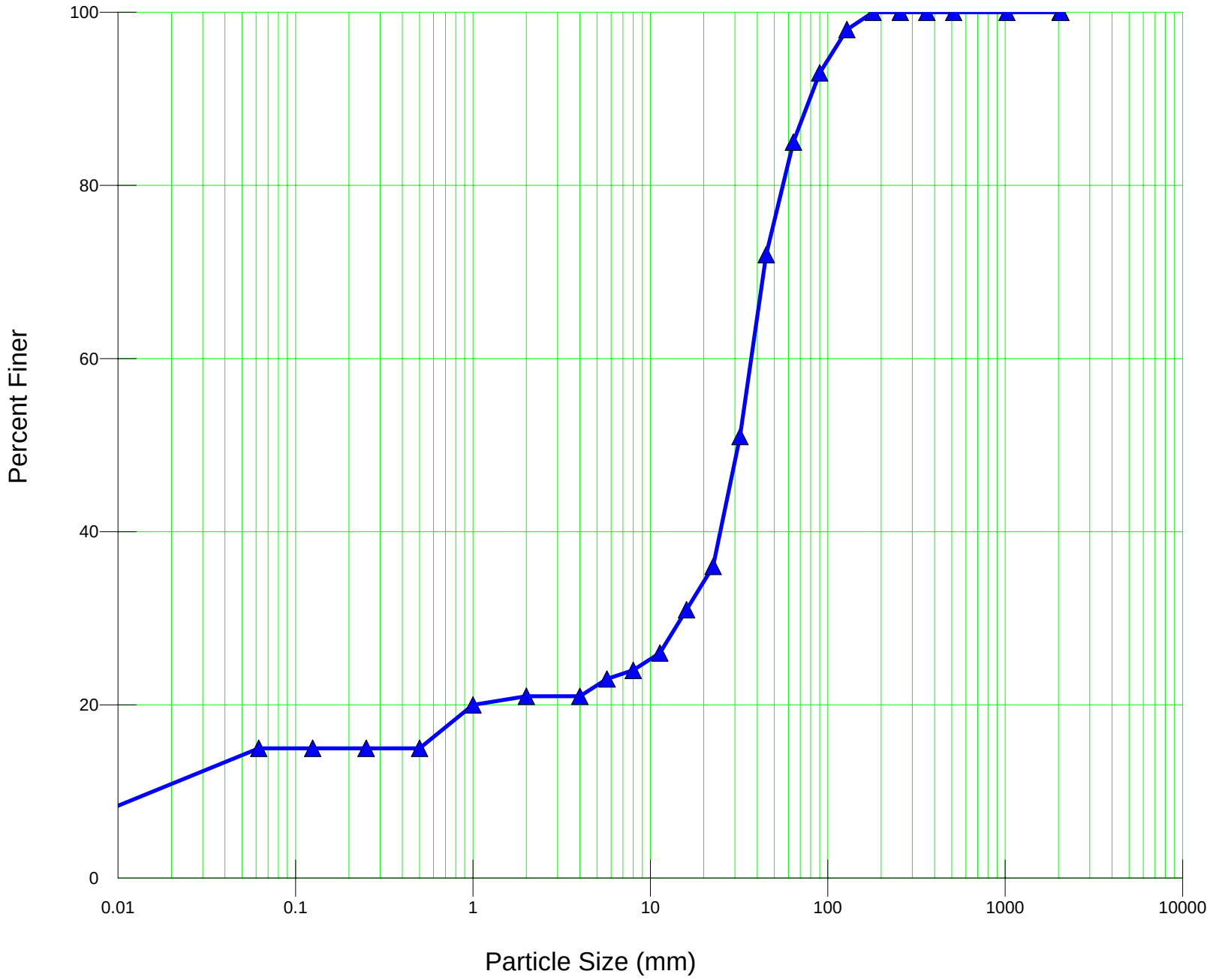
Pebble Count 5 Pool



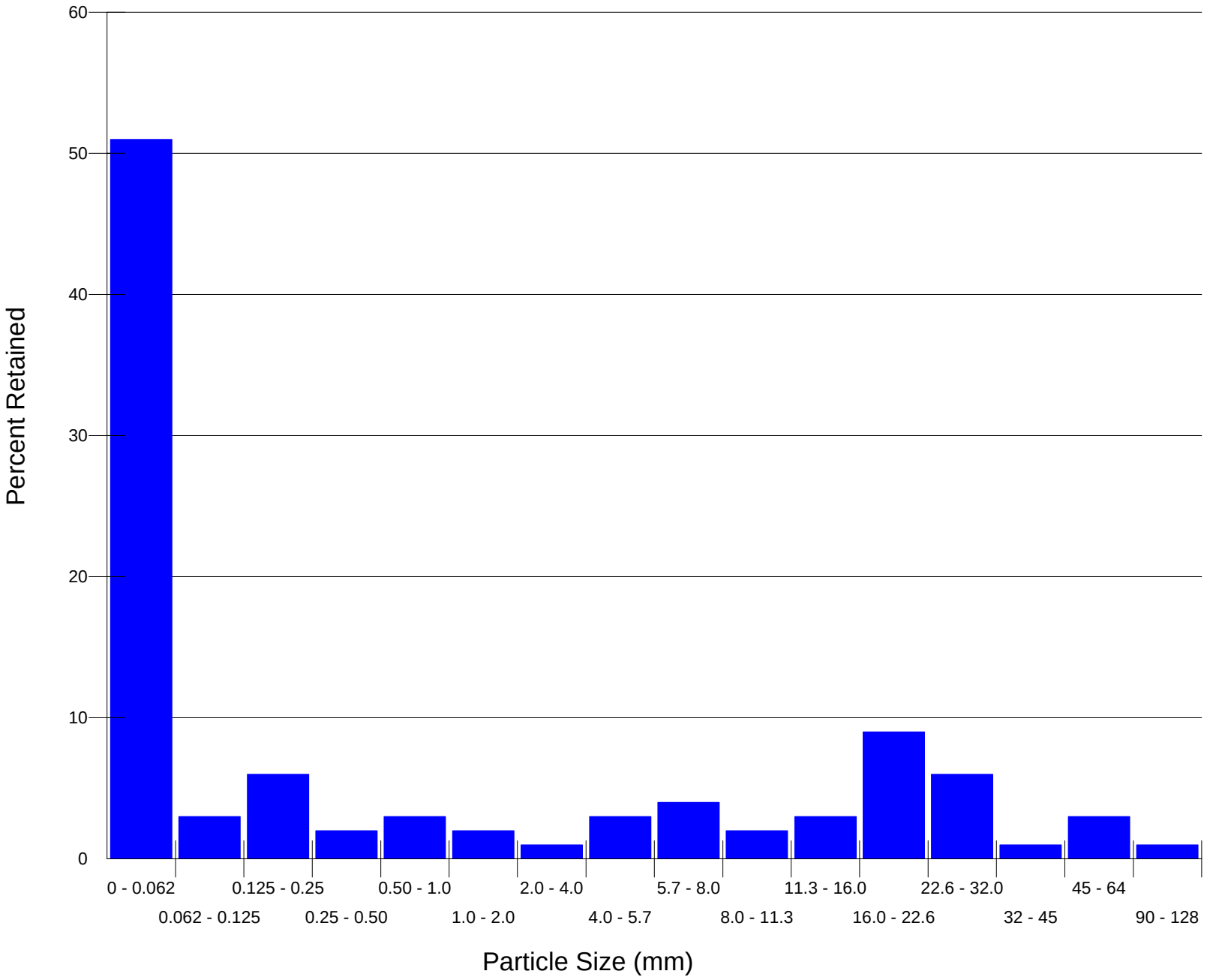
Pebble Count 6 Riffle



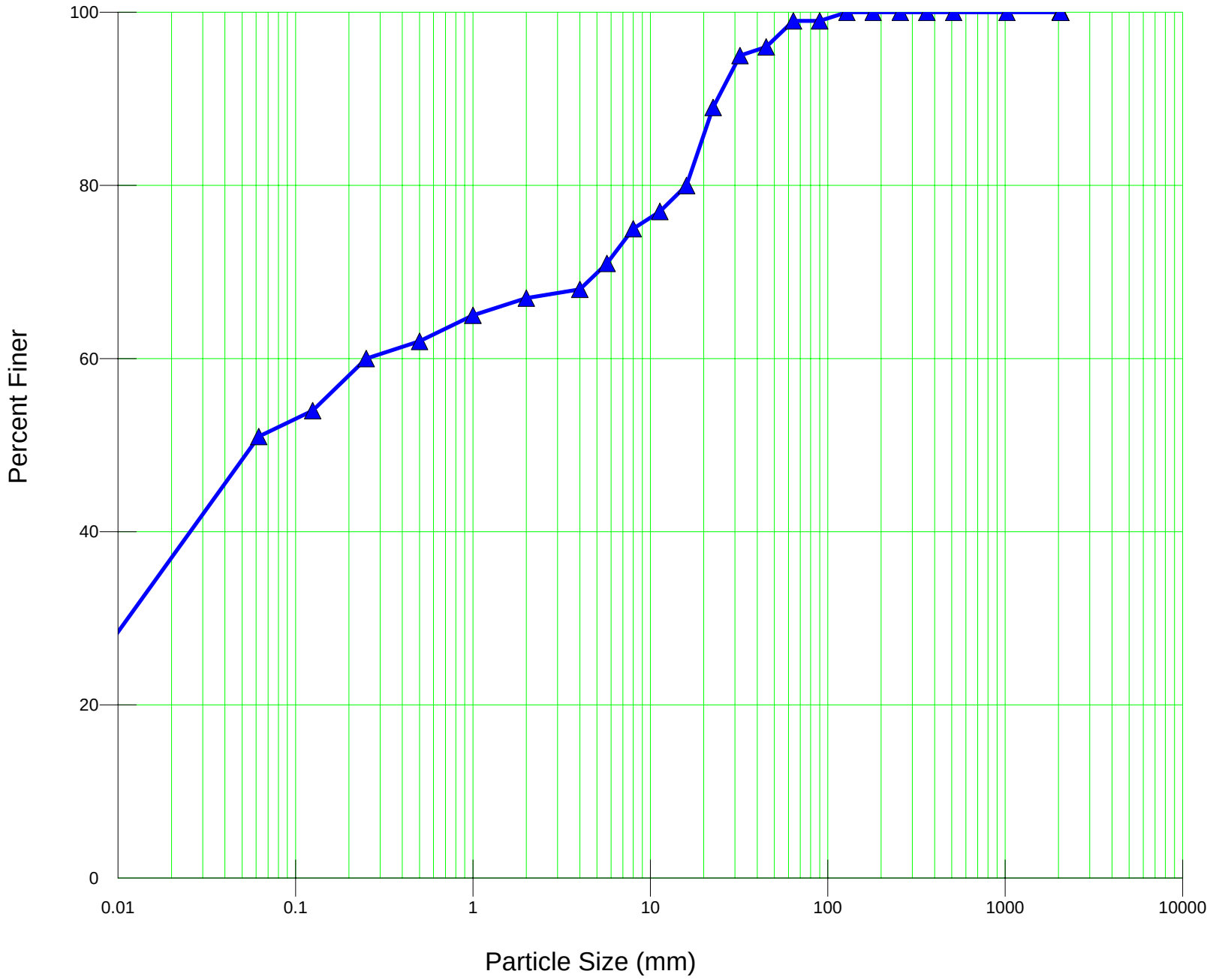
Pebble Count 6 Riffle



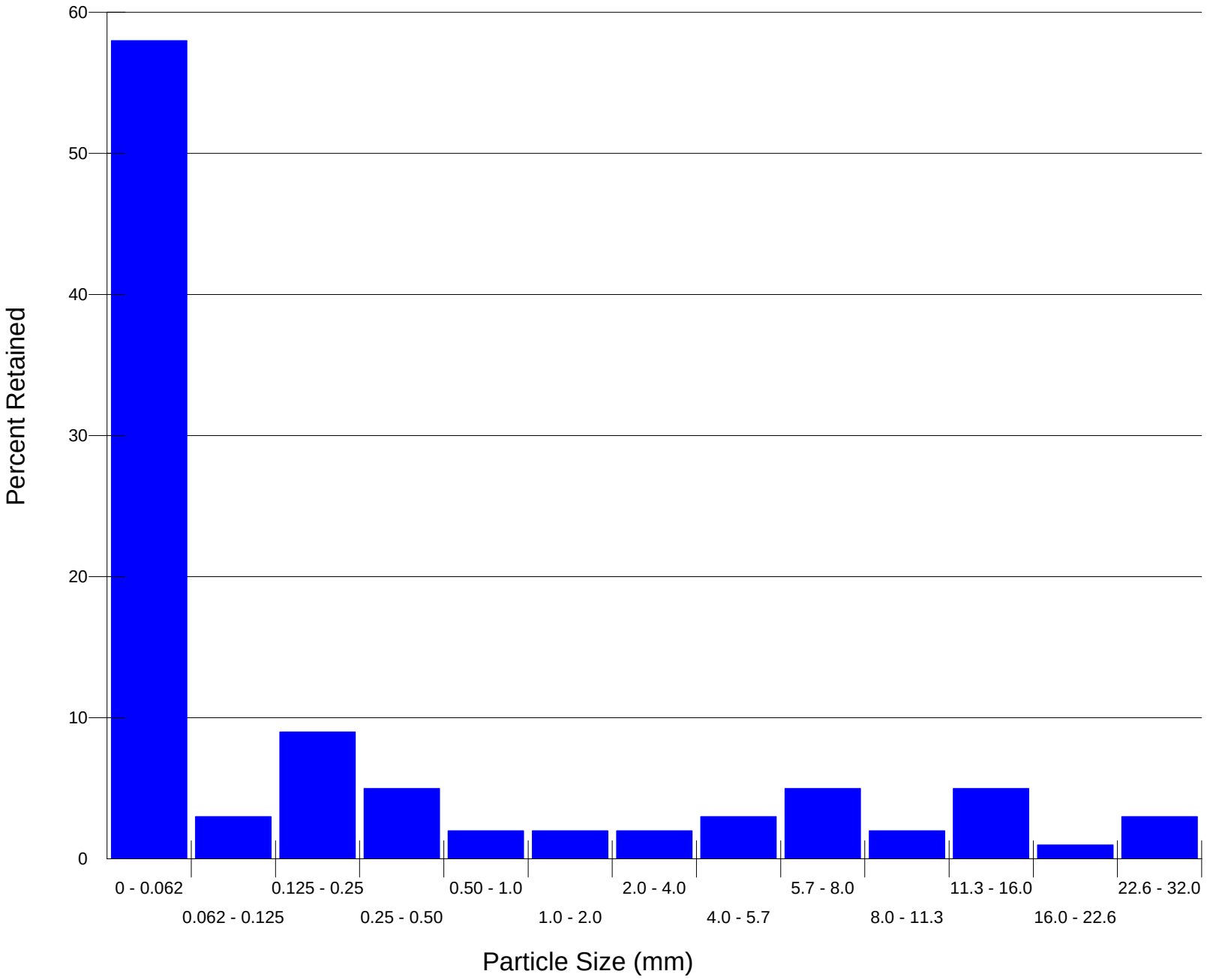
Pebble Count 7 Pool

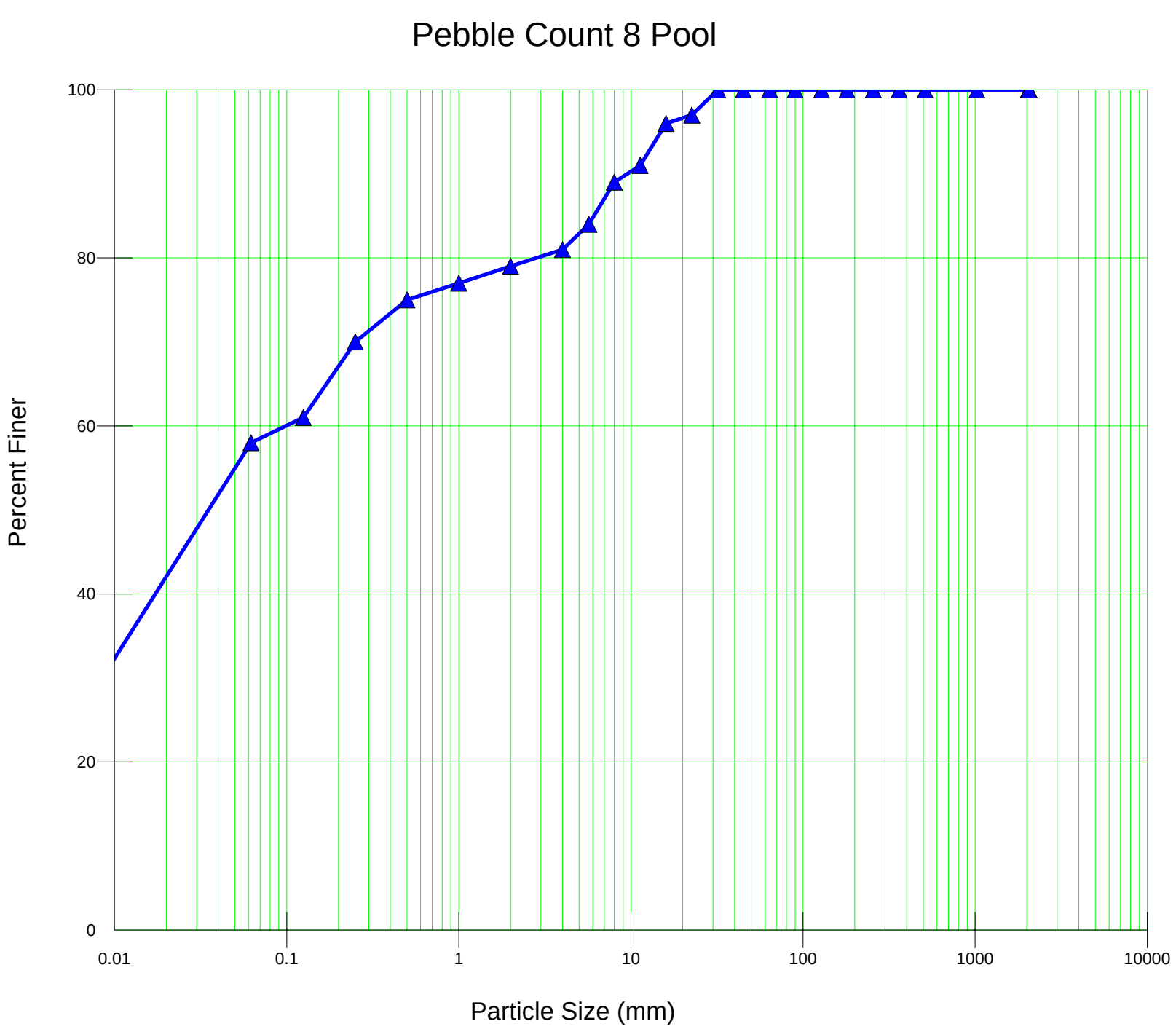


Pebble Count 7 Pool

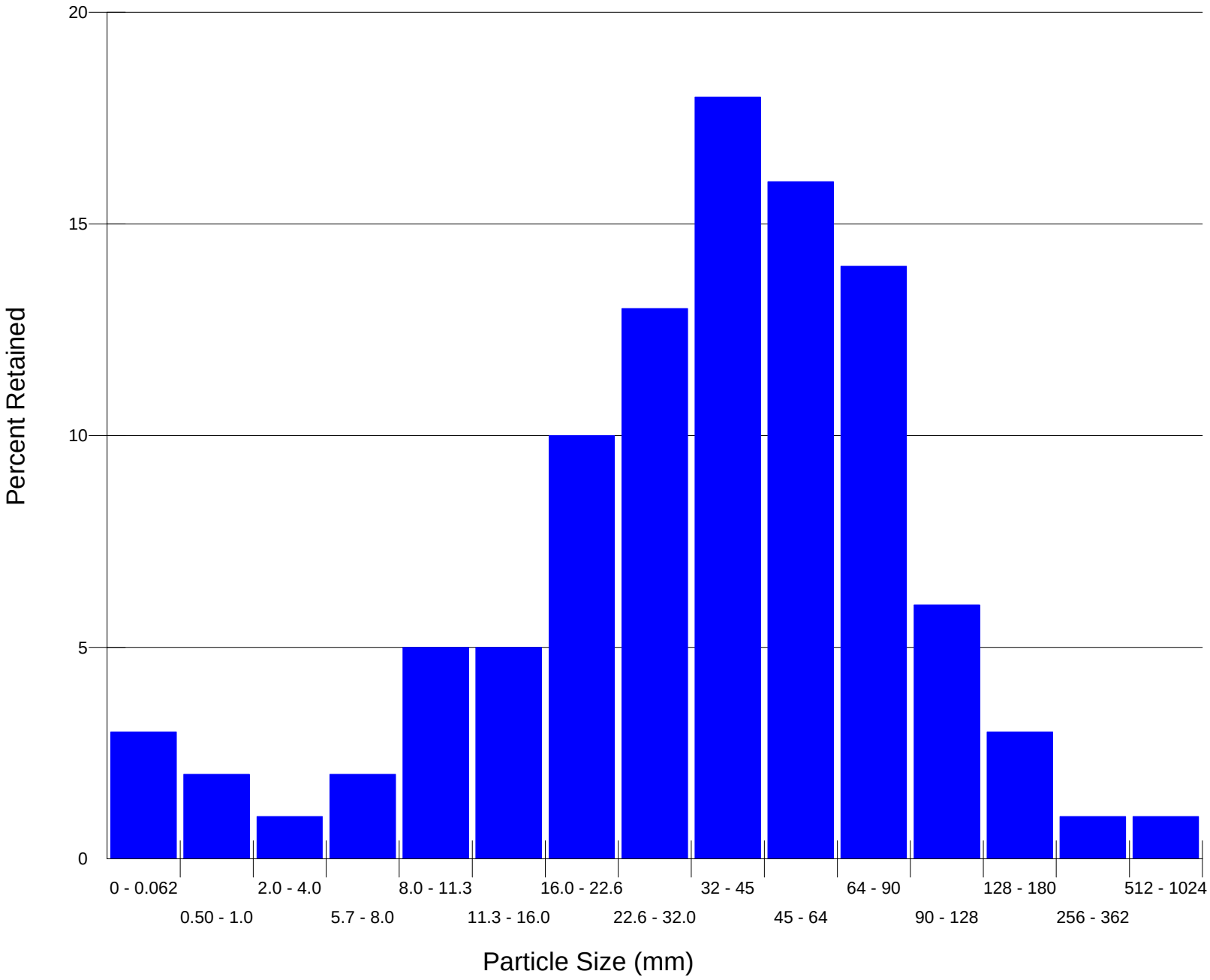


Pebble Count 8 Pool

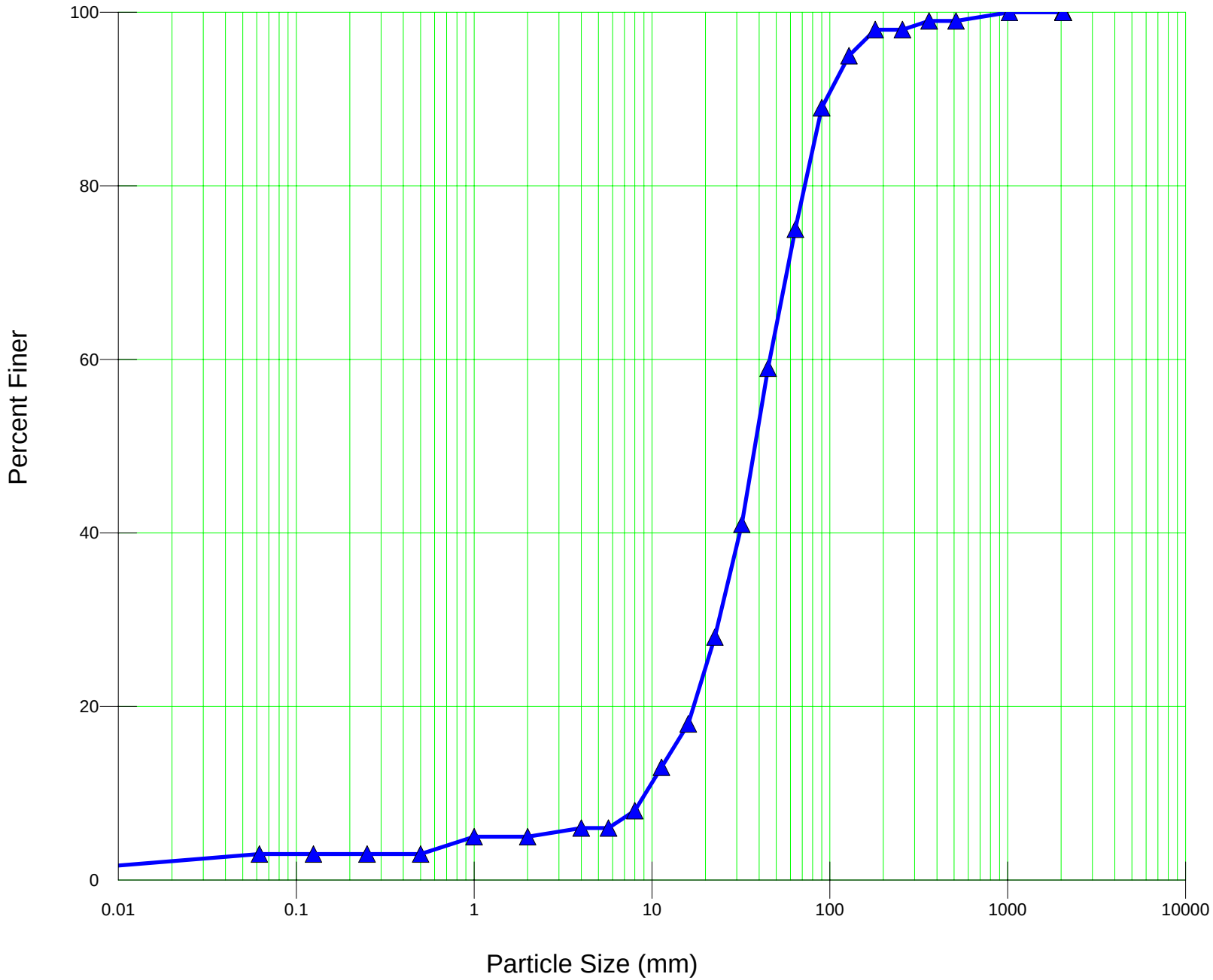


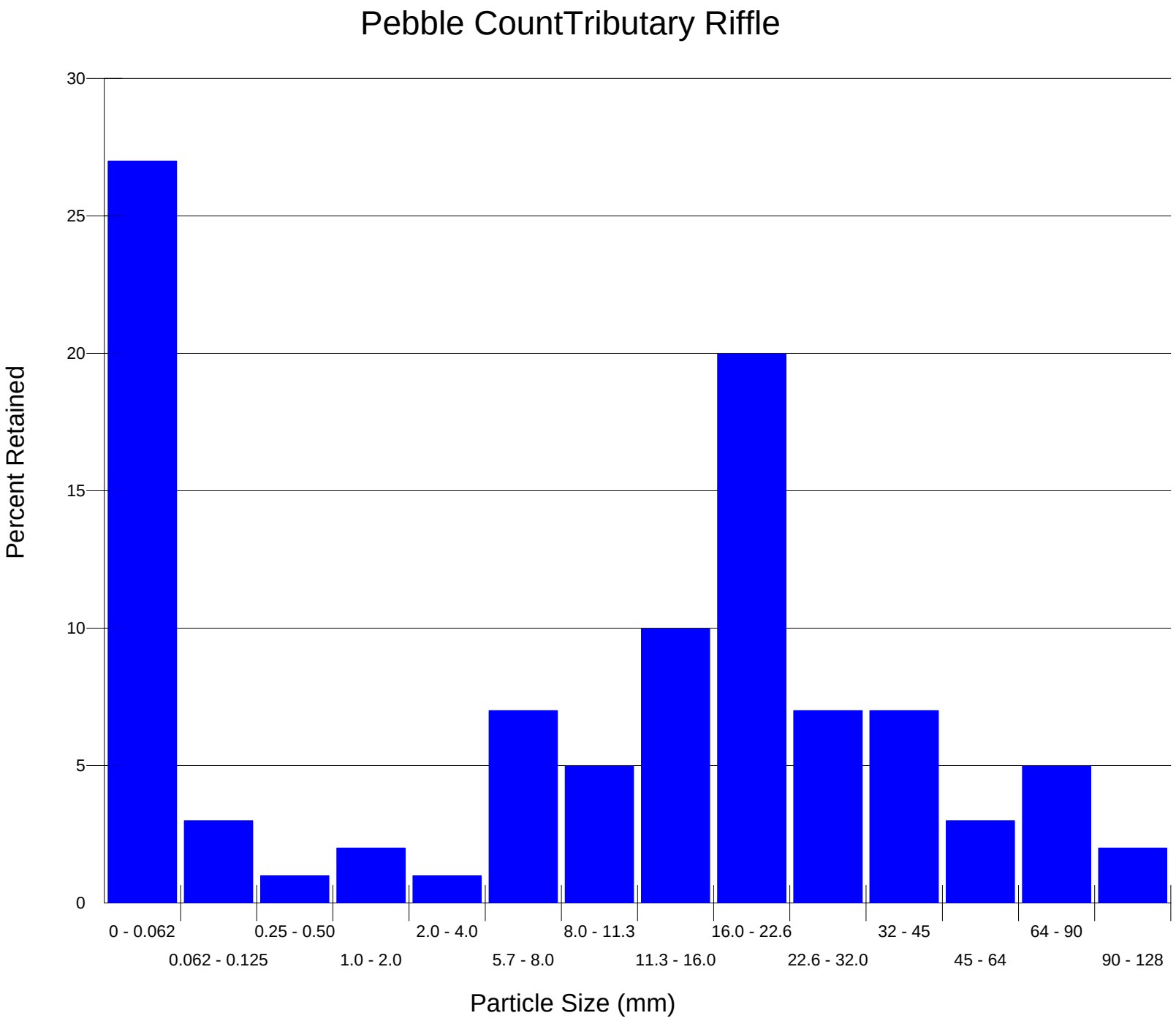

Pebble Count 8 Pool
Percent Finer
100
80
60
40
20
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)

Pebble Count 9 Riffle

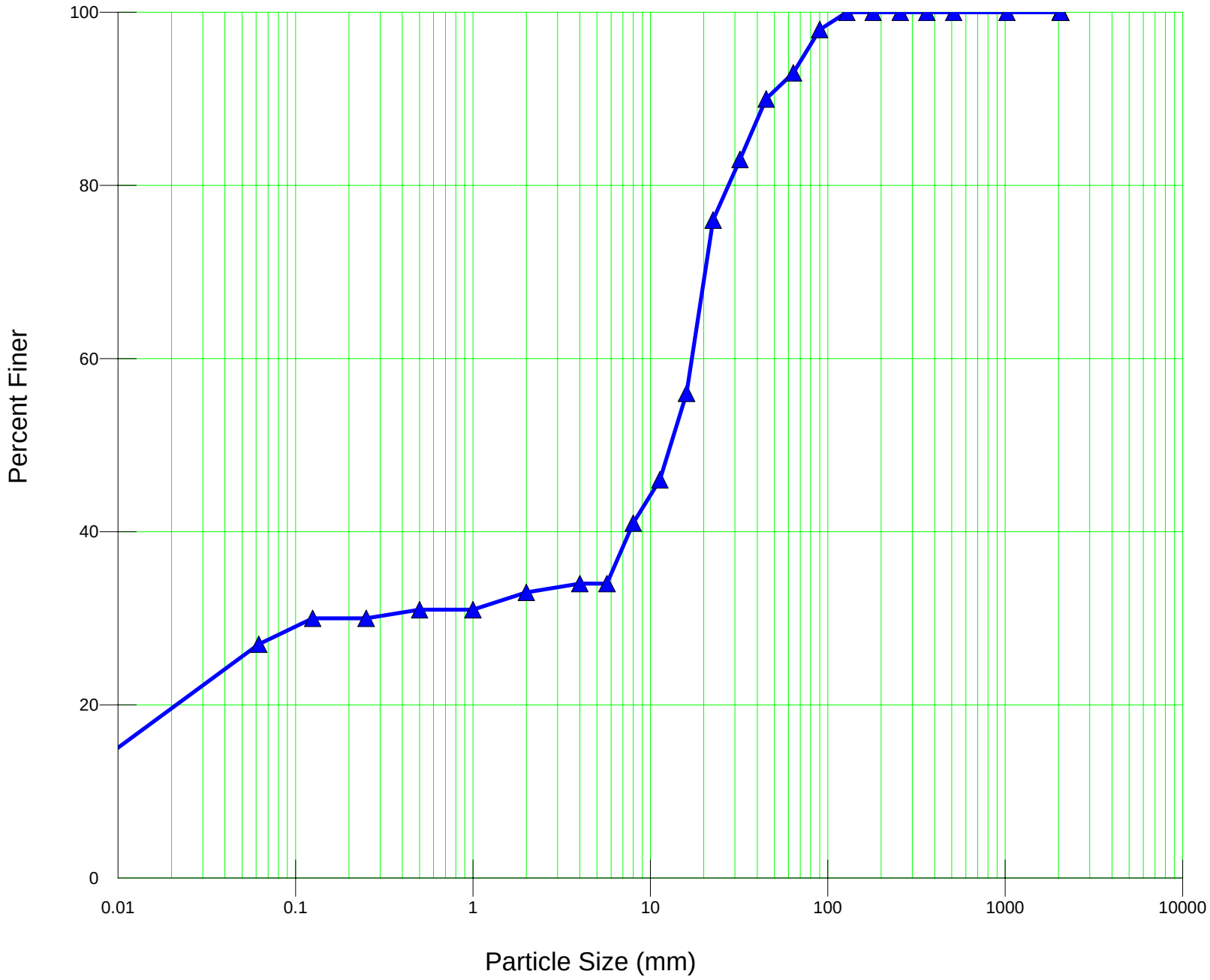


Pebble Count 9 Riffle



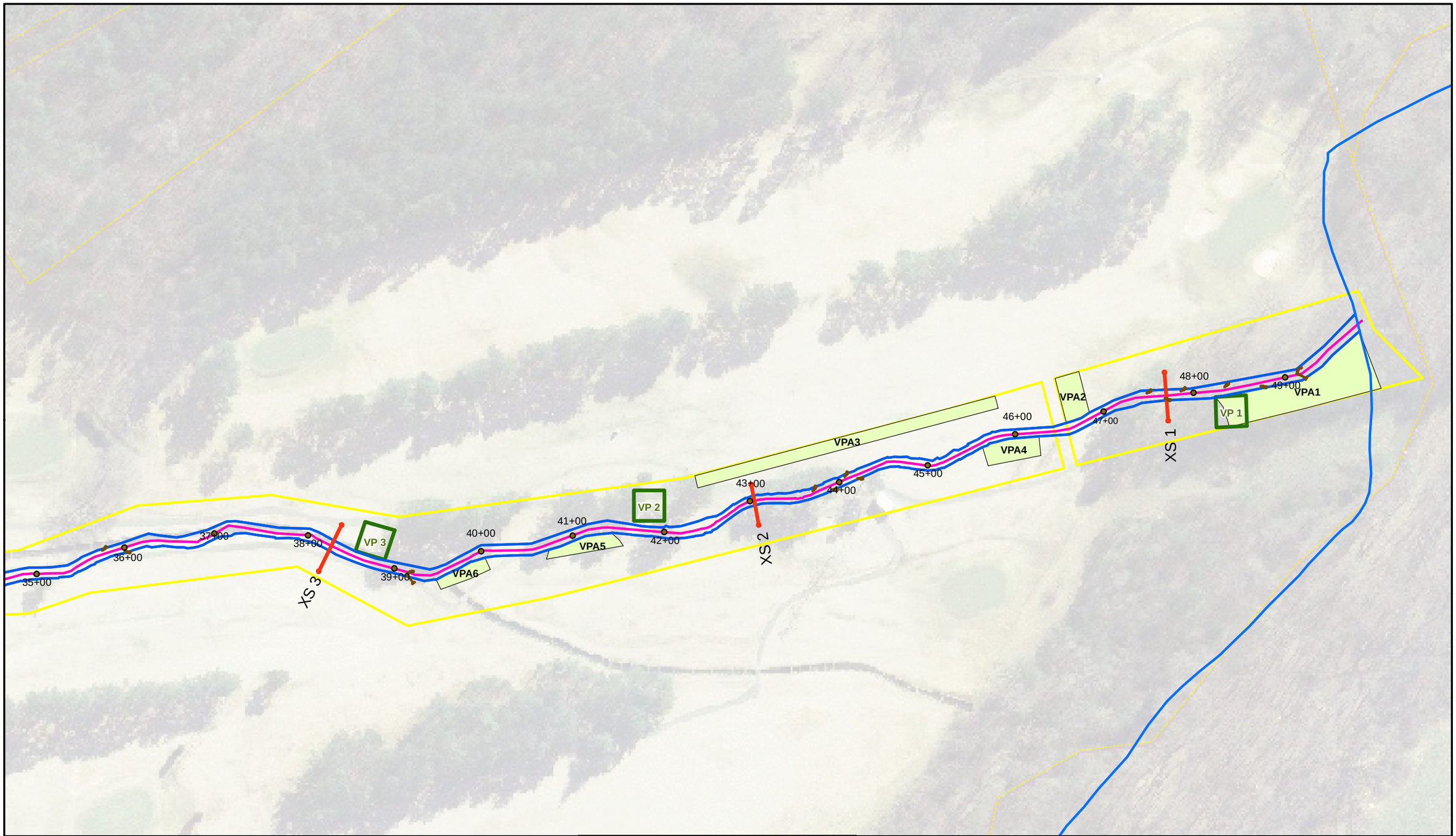

Pebble CountTributary Riffle
Percent Retained
30
25
20
15
10
5
0
0 - 0.062
0.062 - 0.125
0.25 - 0.50
1.0 - 2.0
2.0 - 4.0
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
Particle Size (mm)

Pebble Count Tributary Riffle



APPENDIX C

1. Integrated Plan View



Ecosystem Enhancement Program

APPENDIX C-1
Integrated Plan View

Date		Project No.
01-10	Badin Inn Stream Restoration Stanly County, North Carolina	92666

SPA2
19+00
VP 7
20+00
XS 7
21+00
VPA11
22+00
SPA1
23+00
VPA10
24+00
VPA9
XS 6
25+00
26+00
VP 6
27+00
VPA8
28+00
29+00
VPA7
30+00
VP 5
XS 5
31+00
VP 4
32+00
33+00
XS 4
34+00
35+00

N

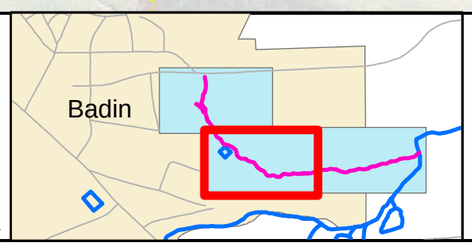
0 100 200 Feet

Legend

- Stations
- Structures
- Roads
- Cross Sections
- Restored Thalweg
- Restored Bankfull
- Vegetation Plots

Problem Area Type

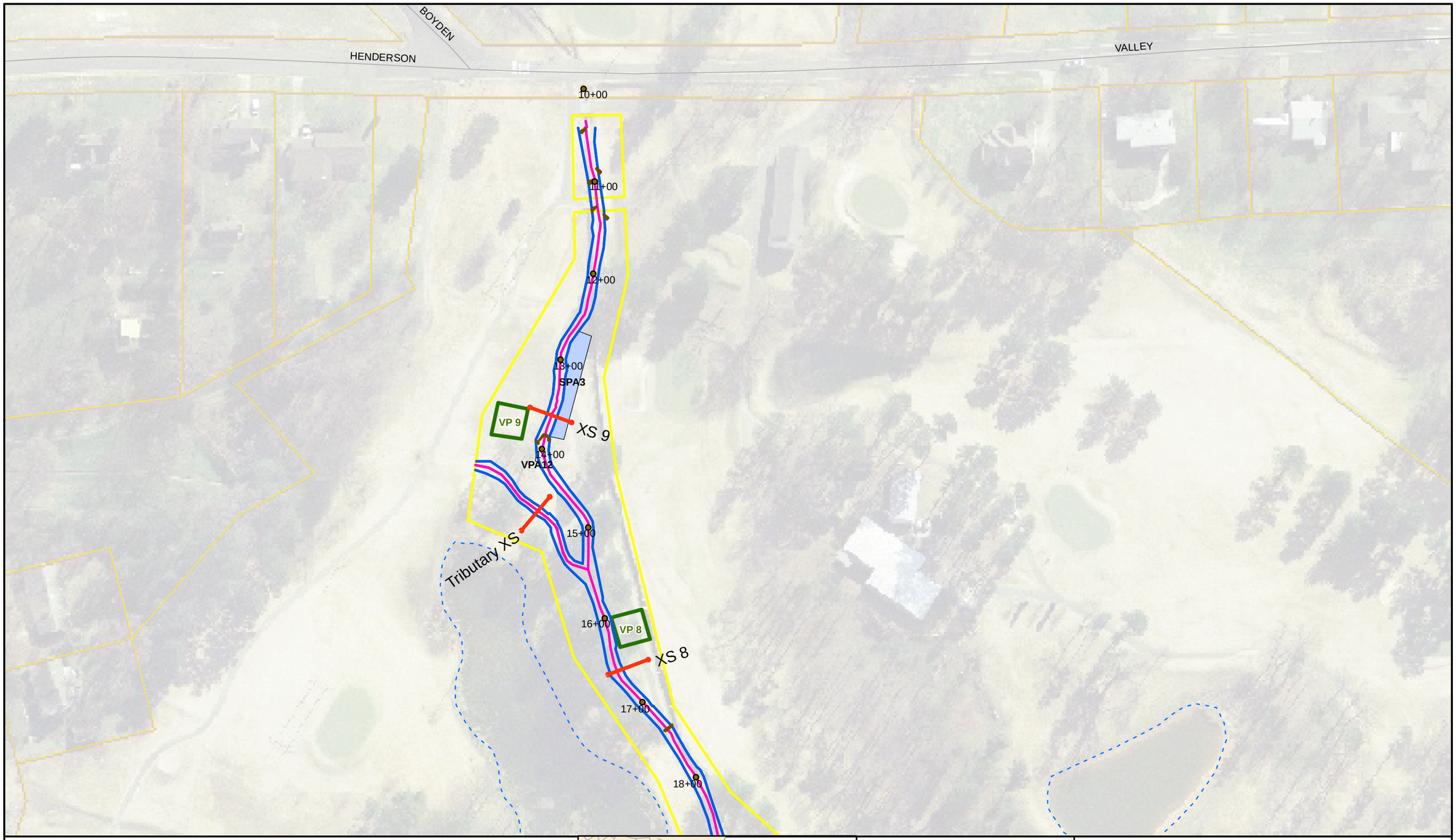
- Stream Problem Area
- Vegetation Problem Area



Ecosystem Enhancement Program

APPENDIX C-2
Integrated Plan View

Date		Project No.
01-10	Badin Inn Stream Restoration Stanly County, North Carolina	92666



APPENDIX C-3
Integrated Plan View

Date		Project No.
01-10	Badin Inn Stream Restoration Stanly County, North Carolina	92666