COPLAY CREEK
STREAM RESTORATION PROJECT

1999

Wildlands Conservancy

Funding Provided By:
Pa. Department of Environmental Protection
Watershed Restoration Assistance Program

INTRODUCTION

In January 1999, Wildlands Conservancy received a grant through the Pennsylvania Department of Environmental Protection's Watershed Restoration and Assistance Program (WRAP) in the amount of $5,001.00 to implement a stream restoration project on Coplay Creek. The objectives of the project were to address non-point source pollution, provide bank stabilization, improve overall water quality and restore degraded habitat for fish and aquatic macro-invertebrates. These objectives were achieved through the establishment of riparian buffers and through the construction of in-stream habitat improvement and bank stabilization devices.

Coplay Creek, a tributary of the Lehigh River, has a drainage area of 19.66 square miles and is located in North Whitehall and Whitehall Townships, Lehigh County (Appendix A). Pennsylvania Department of Environmental Protection's Chapter 93 Water Quality Standards designates Coplay Creek as a Cold Water Fishery and it is listed on the Section 303(d) list of impaired streams. Predominant land uses within the watershed include agriculture and residential development followed closely by commercial use. Siltation induced by agriculture, surface mining and urban storm water is the main source of impairment.

The project site is located on the properties of Donald Boyko (Boyko Petroleum) and Whitehall Township. During the in-stream habitat restoration phase of the project, a total of eight in-stream devices were constructed from stone, root wads, oak lumber and logs to stabilize 138 linear feet of stream bank and provide naturalistic habitat for fish and aquatic macro-invertebrates. During the riparian buffer enhancement phase of the project, a total of 153 native trees and shrubs, wetland meadow mix with annual ryegrass, perennial ryegrass and turf grass seed, and 892 square feet of jute matting were used to stabilize and re-vegetate 365 linear feet of stream bank. A forest opening of approximately 11,370 square feet in area was also re-vegetated with native trees and shrubs during the riparian enhancement phase of the project.

PRE-PROJECT DATA

Pre-project data consisting of a habitat assessment and aquatic survey were collected to aid in the development of an overall management strategy and to provide a comparison for evaluating the overall success of the stream restoration project. Pre-, during and post-project photographs were also used as a tool to evaluate the effectiveness of the project.

Aquatic Survey

On June 15, 1999 Lance Leonhardt, a licensed aquatic biologist, completed an aquatic survey of the project site using a 100-1100 V DC backpack electrofishing unit, block nets and dip nets. The aquatic survey was completed from the Chestnut Street Bridge downstream approximately 235M (705ft). Brown trout, brook trout and other high water quality dependant species were found in the sample.

From the baseline data collected in the sample, percent composition by individuals and percent composition by weight were calculated. Species collected in the sample were also classified based upon habitat tolerance, water quality tolerance and feeding guild, respectively (Appendix A).

A post-project aquatic survey is scheduled for June 2000 and will be used as a tool for evaluating the overall success of the stream restoration project. It is anticipated that the results of the post-project survey will indicate an increase in the number of high water quality dependant species and an increase in species diversity (number of different species), species richness (number of individuals within each species) and total biomass (weight).

Habitat Assessment

On August 2, 1999 Wildlands Conservancy staff completed a habitat assessment on a 460 foot reach within the project site using a version of US EPA's Rapid Bioassessment Protocols that had been modified by The Pennsylvania Fish and Boat Commission, Habitat Management Section. In the assessment, a series of physical habitat-related parameters were evaluated and numerically scored to identify specific habitat-related limiting factors existing within the riparian zone and stream channel. This assessment would ultimately be used to determine which parameters would be addressed through the stream restoration project. Depending upon the final numeric score, the reach would be classified as poor, marginal, sub-optimal or optimal in regard to the quality and quantity of desirable fish and aquatic macro-invertebrate habitat. The reach was assessed using a "glide/pool" type assessment form, meaning areas of low gradient and slow (less than 1meter/second) water velocities were most prevalent

Results of the 1999 habitat assessment yielded a total score of 85/200, placing the reach in the category of "marginal" in regard to fish and aquatic macro-invertebrate habitat. The primary limiting factor impacting the reach appeared to be large amounts of sediment (silt) deposition. Other limiting factors within the reach were a lack of epifaunal substrate/available cover, lack of pool substrate variability, lack in pool depth variability, lack of stream bank stability and a lack of riparian vegetation (Appendix A). These parameters would be addressed through in-stream habitat restoration and riparian buffer establishment.

A post-project habitat assessment is scheduled for August 2000. It is anticipated that the results of the post-project habitat assessment will yield an increase in total score, reflecting an improvement in the quality and quantity of desirable fish and macro-invertebrate habitat.

IN-STREAM HABITAT RESTORATION

The in-stream phase of this restoration project was designed by Wildlands Conservancy staff, and was implemented with the cooperation of Boyko Petroleum, Inc., Whitehall Township and several other participants (refer to list of participants). The Pennsylvania Fish and Boat Commission Habitat Management Section provided on-site technical assistance in the construction of two "J-hook" vanes.

This phase of the project addressed sources of non-point source pollution through the construction of several devices placed within the immediate stream channel. These devices were designed from natural materials to achieve bank stabilization, while providing diverse and immediate habitat benefits for fish and aquatic macro-invertebrates. The location, components, function and long term expectations of each device are individually explained. For further explanation of each individual device, refer to standard drawings (Appendix A).

"J-Hook" Vanes

To create pool diversity and provide stability to a length of severely eroded stream bank (Figure 1), two "J-Hook" vanes were constructed using large stone ranging from 24" to 48" in diameter (Appendix A). These devices were constructed at the 60' and 130' marks along the left stream bank on the Boyko property. Each of these devices will function independently to re-direct high water away from the stream banks and into a scour pool, in which the energy of the water will dissipate. Since the large stones within the device were spaced and trenched low relative to the stream bottom, these devices will allow for both fish passage and sediment transport (Figure 2). The area that was disturbed during the construction of these devices was seeded with perennial turf grass seed, since Boyko Petroleum, Inc. was managing this portion of the property as mowed lawn.

Figure 1- A section of eroded stream bank adjacent to Boyko Petroleum, Inc.

Figure 2 – Two "J-Hook" vanes were installed along the eroded section of stream bank shown in Figure 1. These devices will direct the flow of high water into a scour pool where the energy of the water will dissipate. The scour pool will also add pool diversity and provide habitat for fish. (View is looking downstream)

Modified Bank Cribbing

Beginning at the 327' mark, modified bank cribbing was constructed to provide habitat and protect an eroded section of the left stream bank (Boyko property) from future erosion. Constructed from logs and oak lumber, the cribbing was designed to provide a stable undercut bank that would enhance the habitat within the existing pool. This cribbing (approximately 40 feet in length and 6 feet in width) was filled with stone, which was tapered into the existing stream bank at an approximate 3:1 grade (Figure 3). The interior of this device is expected to vegetate as sediment is deposited there during high flow episodes. Perennial ryegrass and approximately 240 square feet of jute matting were used to stabilize and re-vegetate the area that had been disturbed during the construction of this device (Figure 4).

Figure 3 – Modified bank cribbing after construction. The cribbing will stabilize the eroded stream bank and provide habitat similar to that of an undercut bank.

Figure 4 – Jute matting and ryegrass seed was used to re-vegetate this area behind the bank cribbing. The ryegrass will provide further bank stability during high flow episodes.

Root Wads

As an alternative to using stone riprap, three root wads were used to provide stability and naturalistic woody habitat along a severely eroded section of the right stream bank (Whitehall Township property). Erosion along this bank was particularly serious since it was located downstream from a sharp bend and at an area where an abrupt change in gradient occurred (Figure 5). Root wads are the intact root system and lower trunk portion of downed trees (Appendix A). The stem portions of these root wads were trenched into the stream bank at an upstream angle between the 275' and 308' marks. Stone was used to anchor the root wads within these trenches, and the bank behind the root wads was re-graded. This area was also seeded and jute matted (specific techniques used to re-vegetate this immediate area are discussed in more detail in the riparian buffer establishment section of this report). The root wads will provide a stable surface to direct the flow of high water away from the banks, and toward the center of the stream channel. These devices will not only provide erosion protection to the stream bank, but will also provide woody habitat for fish and aquatic insects (Figures 6 and 7).

Figure 5 – Root wad placement was proposed along this severely eroded section of the right stream bank. Erosion along this bank was particularly serious since it was located downstream from a sharp bend and at an area where an abrupt change in gradient occurred.

Figure 6 – Placement of root wads will direct the flow of water away from the eroded bank and toward the center of the stream channel. Stone was used to stabilize the toe of the bank and to prevent water from undercutting of the root wads.

Figure 7 – This stream bank was re-graded after root wads were installed. Jute matting, wetland meadow mix, perennial ryegrass and native trees and shrubs were used to establish a riparian buffer. Note the outlet pipe and clearing to the top right. A portion of this clearing was re-vegetated using native trees and shrubs.

Multi-Log Deflector

In the construction of the multi-log deflector at the 425' mark, two logs were crossed and pinned to one another using 2' re-bar and were secured to the stream banks using stone, which stabilized approximately 20 linear feet of stream bank. The top log was angled upstream and tilted downward from the stream bank to the tip of the log to direct the flow of high water toward the center of the stream channel during storm events. The stream bank was then re-graded to an approximate 3:1 slope, seeded and covered with jute matting (Figure 8).

The re-directed flow created by this device should scour a well-defined channel and deposit sediment along the same stream bank downstream of the device, where vegetative establishment should follow. From the placement of the multi-log deflector, reduction of non-point source pollution, stream narrowing and immediate habitat benefits for fish and aquatic macro-invertebrates will result.

Figure 8 – A multilog deflector was installed to provide naturalistic woody habitat, direct the flow of high water away from the bank and narrow the stream channel. The bottom log was trenched low and submerged, making it difficult to see in this photo. Stone was used to secure the logs and provide toe protection, and the bank behind this device was re-graded, jute matted and seeded. Grass seed has begun to sprout through the jute matting just two weeks after construction.

Upstream Single Log

At the 453’ mark, an upstream single log was used to redirect the flow of high water, provide habitat and narrow the stream channel by depositing sediment along the banks. This log was trenched into the stream bank at a slight upstream angle and tilted to allow the tip of the log to rest on the stream bottom (Appendix A). By placing the log in this fashion, the log will direct water toward the center of the stream channel and away from the stream bank, as would a multi-log deflector. A scour pool should also form around the tip of the log, providing naturalistic habitat for fish and aquatic insects. Stone was used to secure the log, and the stream bank was graded to an approximate 3:1 slope. The graded bank was then seeded and covered with jute matting. The installation of this device stabilized approximately 10 linear feet of stream bank (Figure 9).

Figure 9 – Upstream single log placement. During storm events, high water will flow over the log and will be directed toward the center of the stream channel (stream flow is right to left). A sediment bar will develop against the bank downstream of the log, where vegetative establishment and channel narrowing will occur.

RIPARIAN BUFFER ESTABLISHMENT

The riparian planting phase of the Coplay Creek Stream Restoration Project was planned by Wildlands Conservancy Staff and Eagle Scout Tom Hays of Boy Scout Troop 431, who assisted in developing a list of native trees and shrubs to be used to re-vegetate the project site. The implementation of this plan was completed with the cooperation of several other participants (refer to list of project participants).

During this phase of the project, reduction of non-point source pollution was accomplished through the establishment of two separate riparian areas. The first site was located upstream of the Chestnut Street Bridge (and the two J-Hook vanes). This site is under the ownership of Boyko Petroleum, Inc and was being managed as a mowed clearing, with the exception of a narrow (approximately 10' in width) buffer strip consisting of herbaceous vegetation. In this mowed clearing, a total of 33 native trees and shrubs were planted along the left stream bank to create a riparian buffer zone of approximately 187 feet in length. Boyko Petroleum, Inc. has agreed to modify their management practices within the clearing to allow for the growth of grasses and other vegetation within this zone, which varied from 10 to 30 feet in width. (Figure 10).

Figure 10– Wildlands Conservancy staff watering the trees and shrubs planted at the Boyko Petroleum, Inc. site. The newly established riparian zone will minimize non-point source pollution and provide wildlife habitat.

The following is a list of native trees and shrubs that were planted at the Boyko Petroleum, Inc. site:

Common Name	Scientific Name	Quantity
Blackhaw	*Viburnum prunifolium*	18
Buttonbush	*Cephalantus occidentalis*	7
Tulip Poplar	*Liriodendron tulipifera*	8
	TOTAL	33

A total of 120 Native trees and shrubs, 892 square feet of jute matting, wetland meadow mix and perennial ryegrass was used to re-vegetate a second site, which had been disturbed during the construction of several in-stream habitat improvement devices. This site was located on Whitehall Township property, directly behind the upstream single log, multi-log deflector and the root wads that were placed along the right stream bank. This site also consisted of a clearing (Whitehall Township property) of approximately 11,370 square feet in area, which extended from Church Street to an outlet pipe, owned by LaFarge Corporation (Figure 7). This area serves as a right-of-way to provide a maintenance access to the outlet pipe. A large portion of this clearing was re-vegetated, while maintaining adequate access to the pipe (Figure 11). The following is a list of native trees and shrubs that were used to re-vegetate this site:

Common Name	Scientific Name	Quantity
Sassafras	Sassaras albidum	12
White Ash	Fraxinus americana	16
Red Oak	Quercus rubra	9
White Oak	Quercus alba	20
Black Cherry	Prunus serotina	8
Sweet Birch	Betula lenta	7
Tulip Poplar	Liriodendron tulipifera	4
Low Bush Blueberry	Vaccinium augustifolium	12
Witch Hazel	Hammamelis virginiana	6
Black Chokeberry	Aronia melanocarta	12
Sweet Pepperbush	Clethra alnifolia	14
	TOTAL	120

Figure 11 – Riparian buffer establishment on the Whitehall Township property.

The additions of jute matting, grass seed and native trees and shrubs within these areas should create a forested riparian buffer zone. This newly established zone will provide future bank stability, reduce stream temperatures and minimize non-point source pollution. The zone will also reduce soil evaporation, serve as a “sink” to store nutrients and provide a source of food and habitat for wildlife, fish and macro-invertebrates.

CONCLUSION

In January 1999, Wildlands Conservancy received a grant through the Pennsylvania Department of Environmental Protection’s Watershed Restoration and Assistance Program (WRAP) in the amount of $5,001.00 to implement a stream restoration project on Coplay Creek. The project site was located on the properties of Donald Boyko (Boyko Petroleum) and Whitehall Township, Lehigh County.

Wildlands Conservancy staff planned and implemented the Coplay Creek Stream Restoration Project with the assistance of Boyko Petroleum,Inc., Whitehall Township the Pennsylvania Fish and Boat Commission Habitat Management Section and Eagle Scout Tom Hays. Also assisting in the implementation of the stream restoration project were 38 volunteers from 7 local organizations and the general public. The objectives of the project were to minimize non-point source pollution, provide bank stabilization, improve overall water quality and restore degraded habitat for fish and aquatic macro-invertebrates. These objectives were achieved through the establishment of riparian buffers and through the construction of in-stream habitat improvement and bank stabilization devices.

During the in-stream habitat restoration phase of the project, a total of eight in-stream devices were constructed from stone, root wads, oak lumber and logs. These devices will reduce non-point source pollution by stabilizing 138 linear feet of stream bank and will improve habitat for fish and aquatic macro-invertebrates by narrowing the stream channel, creating pool variability and imitating undercut banks and natural woody cover.

During the riparian buffer establishment phase of the project, a total of 153 native trees and shrubs, wetland meadow mix, perennial ryegrass, turf grass seed, and 892 square feet of jute matting were installed on the properties of Boyko Petroleum, Inc. and Whitehall Township. These materials were used to stabilize and re-vegetate 365 linear feet of stream bank and a forest opening of approximately 11,370 square feet in area. These improvements will minimize non-point source pollution and provide immediate habitat benefits for wildlife.

The Coplay Creek Stream Restoration Project will serve as a demonstration site for future stream restoration projects, educating resource professionals, local and state government and the general public. It is anticipated that the results of the post-project habitat assessment and aquatic survey will show improvements in the quality and quantity of desirable fish and aquatic macro-invertebrate habitat, and an increase in species diversity and abundance. These improvements will have positive impacts not only on Coplay Creek, but on the Lehigh River as well.

Appendix A

I. Site Location Map

II. Aquatic Survey

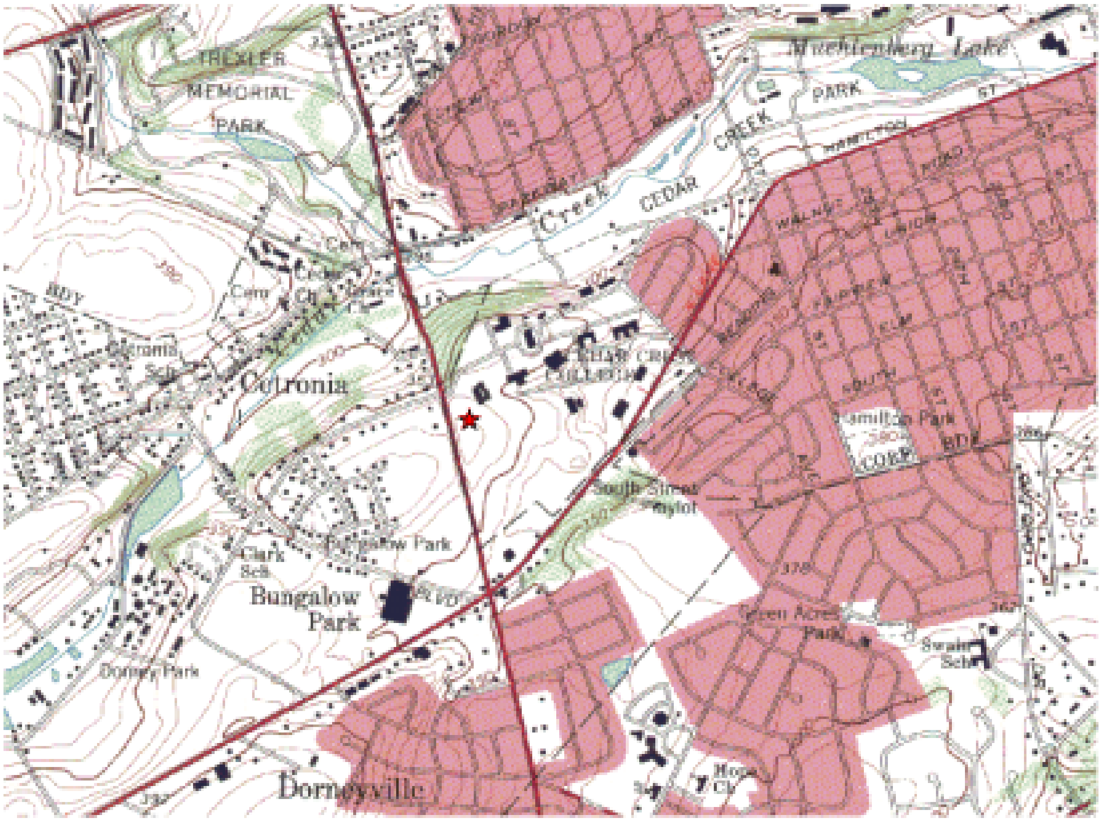
III. Habitat Assessment

IV. Standard Device Drawings

V. Habitat Improvement Plan

Coplay Creek Stream Restoration Project

CEMENTON QUANDRANGLE



Wildlands Conservancy

Site: Coplay Creek (Boyko Petroleum)
Date: June 15, 1999
Investigator: Lance Leonhardt
Sampling Gear:Electrofishing Backpack 100-1100 V DC/Blocknets/Dip Nets
Sampling Length and Width: 235 m (downstream from Chestnut Street Bridge to cement Blocks along stream) X 10m

Common Name	SCIENTIFIC NAME	# OF INDIVIDUALS IN SAMPLE	RANGE IN TOTAL LENGTH (mm)	Tolerance Guild		Feeding Guild		TEMPERATURE GUI	
Brook Trout	***Salvelinus fontinalis***	**4**	**200-340**	**I**	**A.**	**P**	**TC**	**SC**	**C**
B. BROWN TROUT	***Salmo trutta***	**6**	**190-260**		**I**	**P**	**TC**	**SC**	**Ct**
White Sucker	***Catostomus commersoni***	**66**	**70-315**	**T**	**T**	**O**	**GF**	**E**	**E**
Blacknose Dace	***Rhinichthys attratulus***	**159**	**600**	**O**	**T**	**I**	**GF**	**E**	**E**
Longnose Dace	***Rhinichthys cataractae***	**11**	**55-75**	**I**	**M**	**I**	**BI**	**SC**	**Ct**
Creek Chub	***Semotilus atromaculatus***	**9**	**70-95**	**T**	**T**	**O**	**GF**	**E**	**E**
Tessellated Darter	***Etheostoma olmstedi***	**12**	**50-80**	**O**	**M**	**I**	**BI**	**SC**	**E**
American Eel	***Anguilla rostratus***	**1**	**80-120**	**T**	**T**	**I**	**TC**	**SC**	**E**
Total # Species in Sample = 8		**Total # Individuals in Sample = 268**							

- **adapted for Ross**

(Attributes used for F-IBI #1) Ross et. al. USGS Biological Resources Division, Research Cevelopment Laboratory, Wellsboro, PA

II. Tolerance Guild

T = tolerant (able to tolerate environmental degradation)
I = Intolerant (sensitive to a wide range of environmental stresses)
O = Other (either intermediate in tolerance or conflicting tolerance designations in the literature)

Temperature Guild

SC = stenothermal cool/coldwater
E = eurythermal

Feeding Guilds

I= Insectivore
O= Omnivore
P = Piscivore

(**Attributes used for F-IBI # 2**) Leonhardt (Adapted in-part from: Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities, ed Simon, Table12.)

Tolerance (to environmental perturbations)

T = Tolerant
M = Intermediate
I = Intolerant (sensitive to a wide range of environmental stresses)

Temperature Guild

C= Coldwater
Ct = Coldwater transitional
E = Eurythermal (inhabits C-W waters)
W = Warmwater

Feeding Guilds

GF = Generalist Feeder
BI = Benthic Insectivore
TC = Top Carnivore
WC = Water column insectivore

F-IBI # 1 (adapted from Ross, van Snik Gray, Bennett: A Coldwater Index of Biotic Integrity for Tributaries of the Middle and Upper Delaware River, USGS Biological Resources Division, Research Cevelopment Laboratory, Wellsboro, PA) (under revision)

Category	III. Metric	Stream Order	Scoring: 5 (best)	3	1 (worst)	Stream site/Date Coplay Boyko Site 6/15/99
Species richness and community composition	**1. Number of stenothermal cool/coldwater species**	**2 (3) 4**	**>4 >5 >7**	**4 5 5-7**	**<4 <5 <5**	**3 (5 species)**
	2. Number of eurythermal species	**2 (3) 4**	**<4 <4 <4**	**4 4-7 4-11**	**>4 >7 >11**	**5 (3 species)**
	3. Presence of brook trout[1]		**PRESENT**		**ABSENT**	**5**
	4. Percent of individuals as salmonids[2]		**>55%**	**20-55%**	**<20%**	**1 (3.7%)**
	5. Proportion of individuals as stenothermal cool/coldwater species[3]		**>80%**	**50-80%**	**<50%**	**1 (12.6%)**
	6.Number of intolerant species[4]	**2**	**>3**	**3**	**<3**	**1 (3 species)**

		(3) 4	>4 >5	4 4-5	<4 <4	
	7. Percent individuals as white sucker[5]		**<10%**	**10-30%**	**>30%**	**3 (24.6%)**
Trophic composition	**8. Percent individuals as omnivores**		**<20%**	**20-45%**	**>45%**	**3 (27.9%)**
	9.Percent of individuals as insectivorous cyprinids[4]		**>45%**	**45-20%**	**<20%**	**5 (63.4%)**
Fish abundance and condition	**10. Individuals per square meter**	**2 (3) 4**	**>0.08 >0.15 >0.28**	**0.05-0.08 0.10-0.15 0.17-0.28**	**<0.06 <0.10 <0.17**	**3 (.11)**
	11. Percent of individuals with disease, tumors, fin damage, and skeletal anomalies[4]		**<2%**	**2-5%**	**>5%**	**5**
[1] Metric from Steedman (1988) [2] Metric from Maret et al. (1997) [3] Metric adapted from Lyons et al. (1996) [4] Metric from Karr et al. (1986) [5] Metric from New Jersey (Northern) IBI **Scoring: Excellent = 60-57 Good = 52-48 Fair = 44-39 Poor = 35-28 Very Poor = 23-12**						**Total score: 38.2 FAIR/POOR (multiply initial total x 1.091 adjustment factor to get final total)**

F-IBI # 2 (Leonhardt: A F-IBI for 1-4 Order Coldwater Streams in southeastern, PA.)

Category	IV. Metric	Stream Order	Scoring: 5 (best)	3	1 (worst)	Stream site/Date: Coplay Boyko Site 6/15/99
Species richness and community composition	**1 .Number of coldwater/coldwater transition species [1]**		**>3**	**2-3**	**0-1**	**3 (3 species)**
	2. Number of eurythermal/warmwater species[2]	**2 (3) 4**	**<4 <4 <4**	**4 4-7 4-11**	**>4 >7 >11**	**3 (5 species)**
	3. Presence of brook trout[3]		**PRESENT**		**ABSENT**	**5**
	4. Percent of individuals as salmonids[4]		**>55%**	**20-55%**	**<20%**	**1 (3.7%)**
	5. Proportion of individuals as coldwater/coldwater transition		**>88%**	**42-88%**	**<42%**	**1 (7.8%)**

	species[5]					
	6. % Intolerant individuals[1]		>43%	10-43%	<10%	1 (3.7%)
	7. Percent individuals as white sucker[6]		<10	10-30	>30	3 (24.6%)
Trophic composition	8. Percent individuals as generalist feeders[6]		<20%	20-45%	>45%	1 (87.3%)
	9.Percent of individuals as benthic insectivores[7]		> 45%	20-45%	<20%	1 (8.5%)
Fish abundance and condition	10. Individuals per square meter[2]	2 (3) 4	>0.08 >0.15 >0.28	0.05-0.08 0.10-0.15 0.17-0.28	<0.06 <0.10 <0.17	3 (.11)
	11. Percent of individuals with disease, tumors, fin damage, and skeletal anomalies[8]		<2%	2-5%	>5%	5
	12. Number of warmwater individuals per sample [1] (adjust proportionally for lesser/greater sampling lengths)[1]		<6 (50m) <12 (100m) <16 (150m)	6-20 (50m) <12-40 (100m) 16-60 (150m)	>20 (50m) >40 (100m) >60 (150m)	5 (0)

[1] Metric adapted from Mundahl and Simon (1999) [4] Metric from Maret et al. (1997) [7] Metric adapted from Leonard and Orth (1986)
[2] Metric adapted from Ross et al. (2000) [5] Metric adapted from Lyons et al. (1996) [8] Metric from Karr et al. (1986)
[3] Metric from Steedman (1988) [6] Metric from New Jersey (Northern) IBI

Scoring: Excellent = 60-57 Good = 52-48 Fair = 44-39 Poor = 35-28 Very Poor = 23-12

A. TOTAL SCORE = 32 POOR

Excellent: Comparable to best situations with the least human disturbance: intolerant native coldwater species common; brook trout are the primary top carnivores and are present in good numbers; exotic salmonids are absent or uncommon; tolerant species may be present in low to moderate numbers.
Good: Evidence for some environmental degradation and reduction in biotic integrity; brook trout uncommon or absent; exotic salmonids often dominate, keeping the abundance of top carnivores high; tolerant species may be common but do not dominate.
Fair: The stream reach has experienced moderate environmental degradation, and biotic integrity has been significantly reduced; total species richness is often relatively high , but intolerant and native stenothermal coldwater species are usually uncommon; exotic salmonids may be common to abundant, but tolerant eurythermal species or warmwater species or both are usually more abundant.
Poor and Very Poor : Major environmental degradation has occurred, and biotic integrity has been severely reduced: total species richness may be relatively high, but intolerant native species are usually absent, tolerant eurythermal species or warmwater species or both dominate. (Adapted in part from Lyons and Wang 1996)

B. STREAM HABITAT ASSESSMENT DATA SHEET TOTAL SCORE: 89

Coplay Creek / Boyko Site 8/2/99
Stream/Site **Date**

1 EPIFAUNAL SUBSTRATE/AVAILABLE COVER

Habitat Parameter	V. Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/Available Cover (high and low gradient)	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potent potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for lo for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
VI. SCORE _2__	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

1.

2. 2 EMBEDDEDNESS

Habitat Parameter	VII. Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
2.a Embeddedness (high gradient)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-70% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
VIII. SCORE _10__	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

3a VELOCITY/DEPTH COMBINATIONS

Habitat Parameter	IX. Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
3a. Velocity/Depth Regimes (high gradient)	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <0.3 m/s, deep is > 0.5m)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
X. SCORE _11__	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

XI. 4 SEDIMENT DEPOSITION

Habitat Parameter	XII. Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
4. Sediment Deposition **(high and low gradient)**	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constructions and bends; moderate depositions of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
XIII. SCORE _2__	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

5 CHANNEL FLOW STATUS

Habitat Parameter	**XIV. Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
5. Channel Flow Status (high and low gradient)	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
XV. SCORE _9__	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

XVI. 6 CHANNEL ALTERATION

Habitat Parameter	**XVII. Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration **(high and low gradient)**	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
XVIII. SCORE _18__	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

7a FREQUENCY OF RIFFLES (OR BENDS)

Habitat Parameter	**XIX. Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7a.Frequency of Riffles (or bends) (high gradient)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is	Occurrence of riffle infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.

	important.			
XX. SCORE _8__	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

8 BANK STABILITY (condition of banks)

Habitat Parameter	**XXI. Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable, infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
XXII. SCORE _3__ (LB)	**Left Bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
XXIII. SCORE _7__ (RB)	**XXIV. Right Bank 10 9**	**XXV. 8 7 6**	**XXVI. 5 4 3**	**XXVII. 2 1 0**

XXVIII. 9 BANK VEGETATIVE PROTECTION

Habitat Parameter	**XXIX. Condition Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
9. Vegetative Protection (score each bank) **Note: Determine left** or right side by facing downstream (high and lowgradient)	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegeation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 cm. or less in average stubble height.

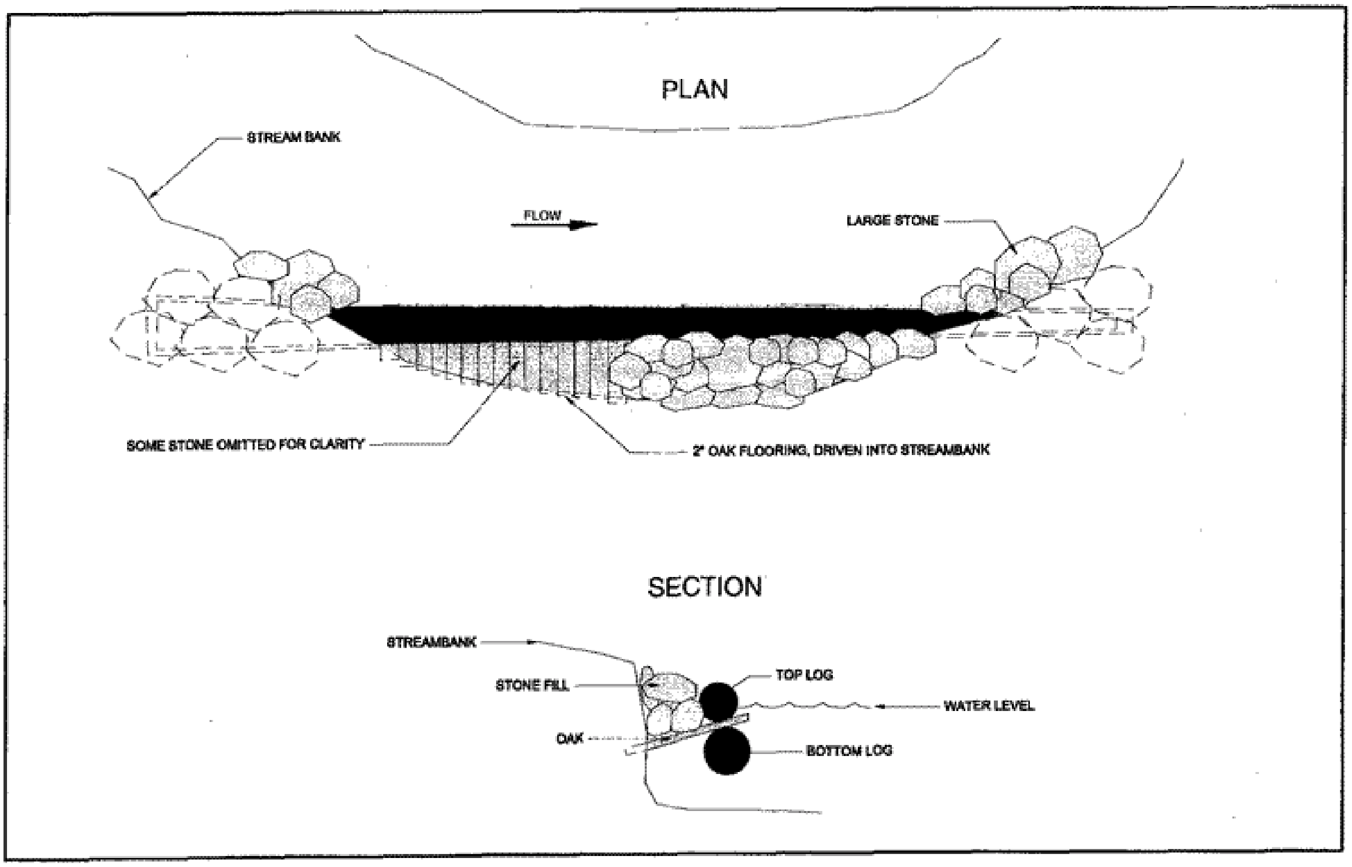
XXX. SCORE _3__ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
XXXI. SCORE _7__ (RB)	XXXII. Right Bank 10 9	XXXIII. 8 7 6	XXXIV. 5 4 3	XXXV.2 1 0

XXXVI.

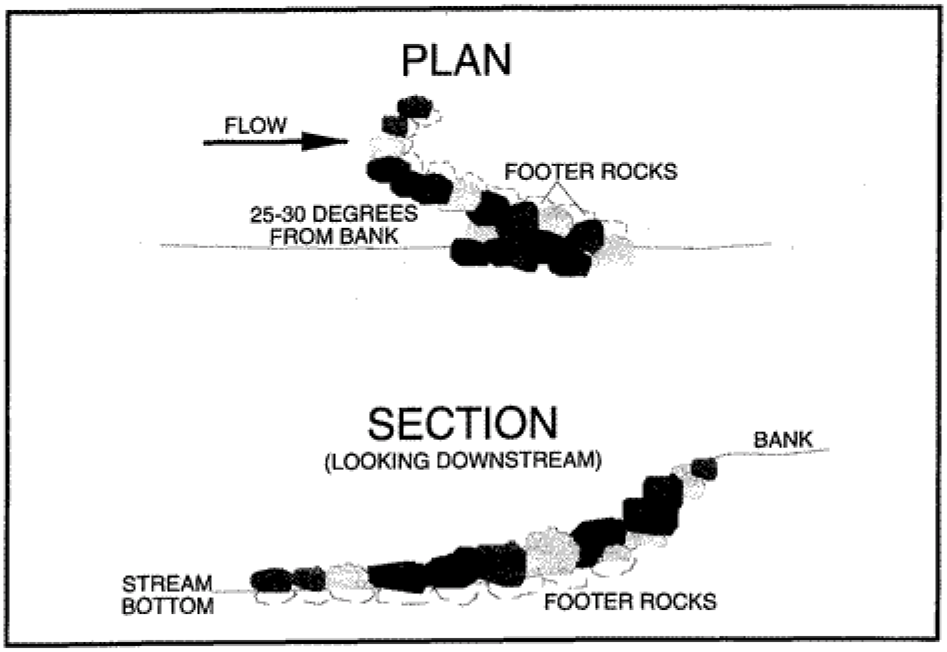
XXXVII. 10 RIPARIAN VEGETATIVE ZONE WIDTH

Habitat Parameter	XXXVIII. Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
10. Riparian Vegetative Zone Width (score each bank riparian zone) (high and low gradient)	**Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.**	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
XXXIX. SCORE _7__ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
XL. SCORE _2__ (RB)	XLI. Right Bank 10 9	XLII. 8 7 6	XLIII. 5 4 3	XLIV. 2 1 0

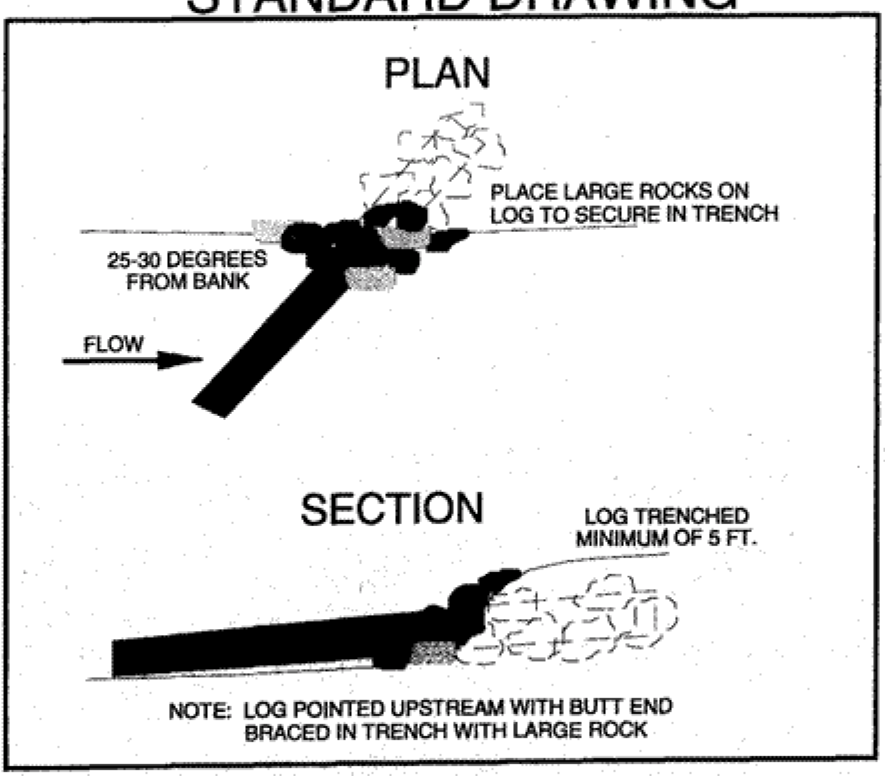
BANK CRIB STANDARD DRAWING



J-HOOK ROCK VANE STANDARD DRAWING

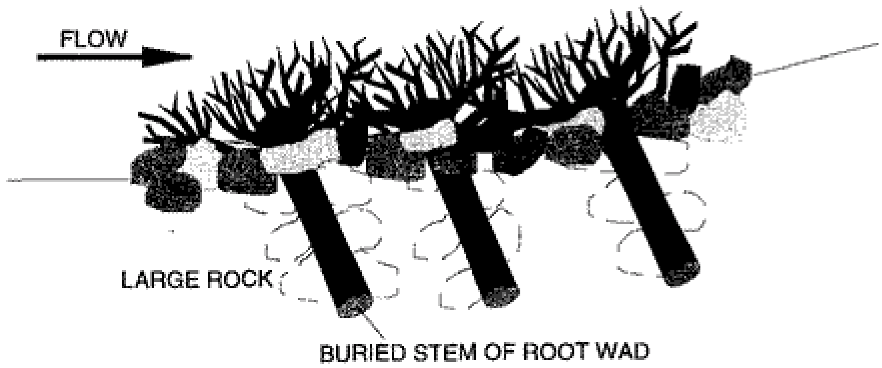


SINGLE LOG DEFLECTOR STANDARD DRAWING

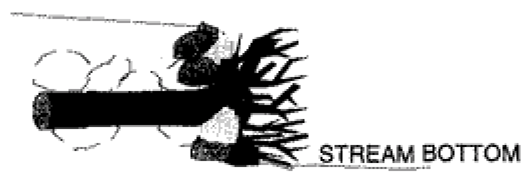


ROOT WAD DEFLECTOR
STANDARD DRAWING

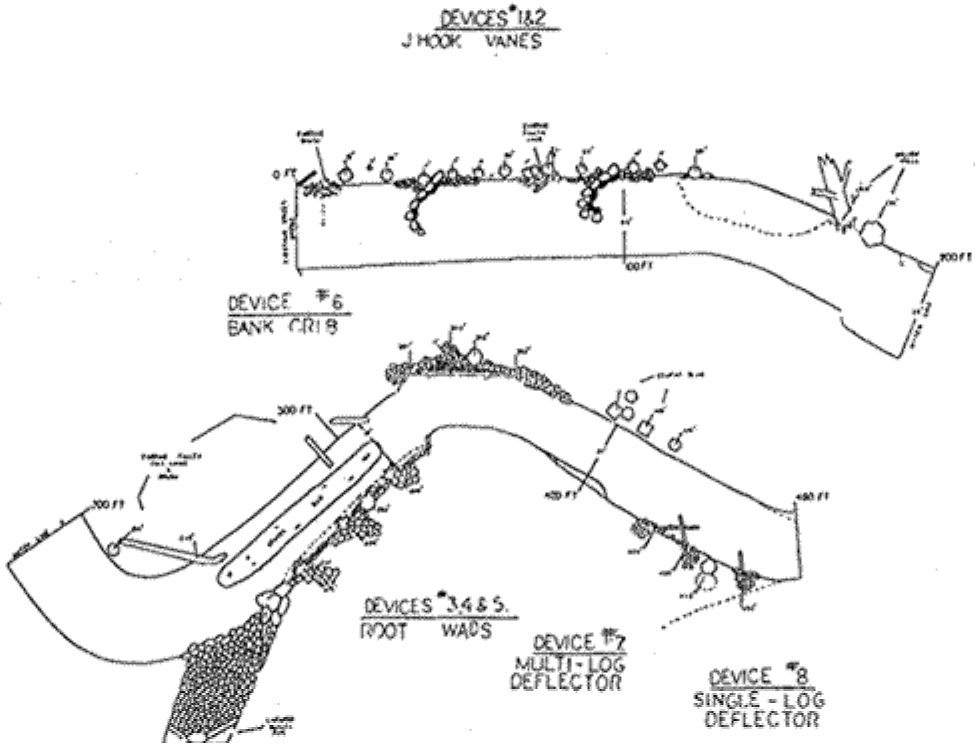
PLAN



SECTION



NOTE: BEGIN ROOT WAD PLACEMENT DOWNSTREAM AND WORK UPSTREAM (SHINGLING).
USE LARGE STONE TO SECURE STEM OF ROOT WAD INTO TRENCH.
USE LARGE STONE TO STABILIZE BANK BEHIND ROOT WAD AS NEEDED.


DEVICES #1&2
J HOOK VANES
0 FT
100 FT
200 FT
DEVICE #6
BANK CRIB
300 FT
400 FT
450 FT
DEVICES #3,4&5.
ROOT WADS
DEVICE #7
MULTI-LOG
DEFLECTOR
DEVICE #8
SINGLE - LOG
DEFLECTOR