Rewilding Streams and Floodplains to Enhance Ecosystem Services

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Greg Jennings, PhD, PE
Jennings Environmental PLLC
Professor Emeritus, NCSU
Asheville, NC, USA
greg@jenningsenv.com

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Learning Objectives:

- Understand components of rewilding projects for stream and floodplain ecosystems.
- Understand how to plan and implement successful rewilding projects.
- Communicate with stakeholders regarding ecological benefits of rewilding projects.

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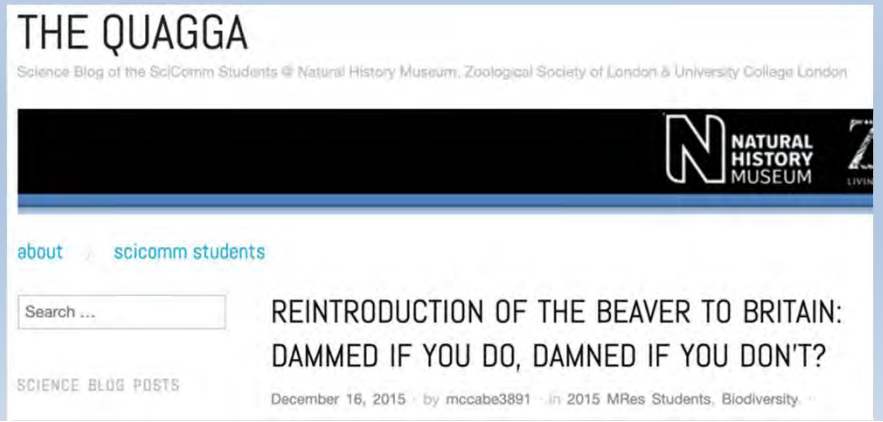
What is Rewilding?

- First defined in 1998 by American conservation biologists Michael Soulé and Reed Noss, as an approach focusing on “cores, corridors, and carnivores.”
- A form of environmental conservation and ecological restoration that increases biodiversity, creates self-sustainable environments, and mitigates climate change.
- Focused on restoring natural processes and wilderness areas, providing connectivity between such areas, and reintroducing keystone species.



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Translocation (Trophic) Rewilding:

- Enhances a species population in an ecosystem by either:
  1. Adding reinforcements to a current species to enhance viability and survival; or
  2. Reestablishing a species population in an area after local extinction.

Reintroduction of Wolves to Yellowstone NP in 1995

https://youtu.be/ysa5OBhXz-Q

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Passive Rewilding:

- Transforms a disturbed ecosystem back to nature with the goal of restoring natural ecosystem processes and reducing human influence on landscapes.

Floodplain Buyout Program in Flood Hazard Zones

https://charlottenc.gov/StormWater/Flooding

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Rewilding Streams and Floodplains:

- Systematic adjustment of physical, biological, and chemical conditions in the riparian corridor and watershed.
- Shifting the trajectory of a stream ecosystem toward improved ecological functions and services, with enhanced connectivity.

Beeson Creek, Kernersville, NC

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Connectivity:

- Longitudinal: upstream – downstream
- Floodplain: overbank flows and stormwater management
- Groundwater: hyporheic exchange
- Daylighting: returning a piped stream to nature

Dam!

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Longitudinal Connectivity: *Removal of Dams*

- Aquatic Organism Passage (AOP)
- Sediment Transport

Dam Removal with Boulder Cascade on Shuler Creek, Graham County, NC

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Longitudinal Connectivity: *Removal of Ponds*

- Fish Habitat and Water Quality
- Sediment Transport

Pond Removal on UT Sentell Creek, Henderson County, NC

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Longitudinal Connectivity: *Road Crossings*

- Open Upstream Habitat for Endangered Mussels
- Facilitate Vehicle Crossing on Wet Ford

Savannah Lilliput
Toxolasma pullus
Contributor: Jennifer Price

DESCRIPTION

Taxonomy and Basic Description

Vented Ford Crossing Removal with Boulder Cascade on Densons Creek, Troy, NC

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Floodplain Connectivity: *Reduction in Channel Incision*

- Hydraulic Energy Balance
- Sediment and Nutrient Retention and Processing
- Riparian Habitats

Stream and Floodplain Restoration on Limekiln Creek, McDowell County, NC



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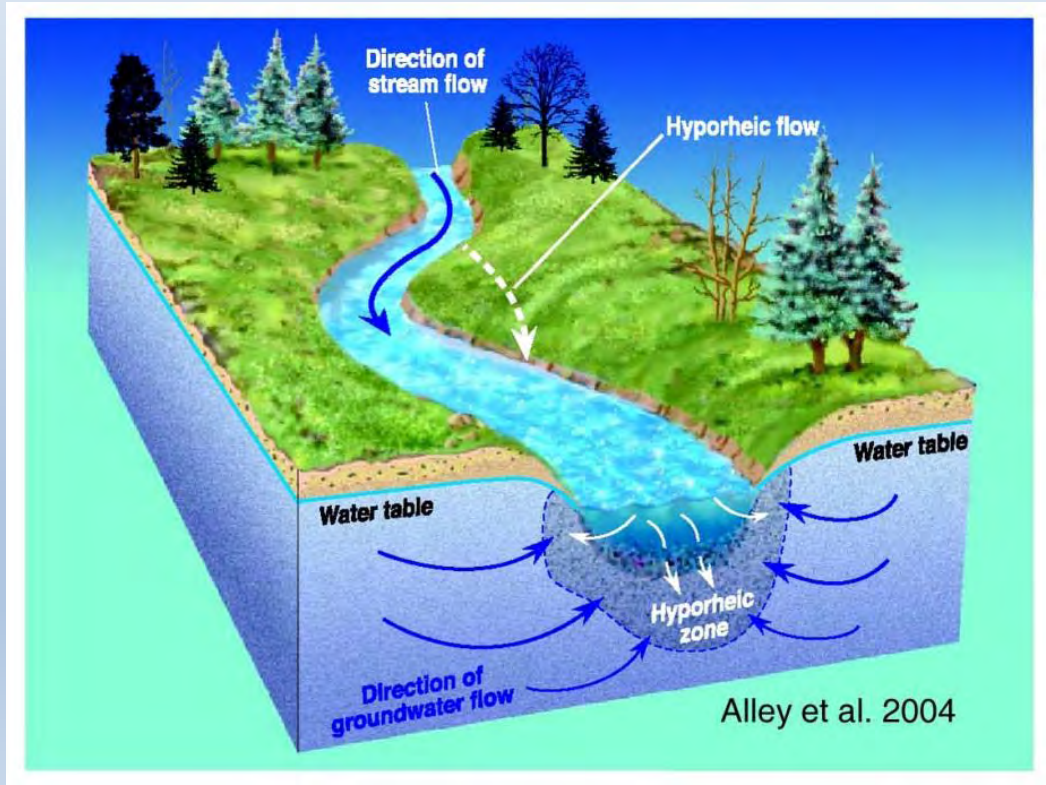
Groundwater Connectivity: *Hyporheic Exchange*

- Aquatic Habitat
- Water Quality



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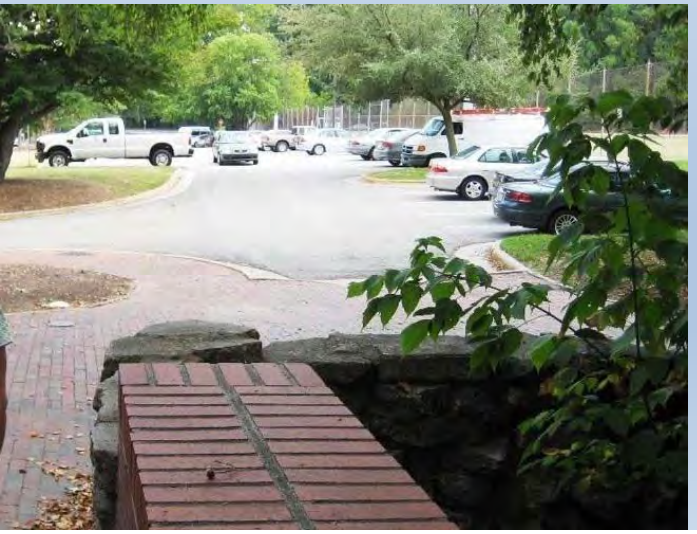
Daylighting a Piped Stream:

- Restored Ecosystem Functions and Services
- Social Values to the Community

Daylighting a Section of Rocky Branch, Raleigh, NC



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Components of Stream and Floodplain Restoration Projects:

- Fluvial Geomorphology: Channel & Floodplain Forms and Processes
- In-stream Structures (grade control, bank protection, bedform)
- Streambank Bioengineering and Riparian Buffers

Stream and Floodplain Restoration on Rocky Branch, Raleigh, NC



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Fluvial Geomorphology:

- Study of how stream systems are shaped by flowing water and sediment
- Equilibrium conditions determined by dimension, pattern, profile, substrate
- Departure from equilibrium results in erosion, deposition, migration, headcutting

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Reference Streams:

- Basis of Design for Restoring Equilibrium in Disturbed Stream System
- Template for Equilibrium Stream Morphology in Similar Watershed

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In-Stream Structures:

- Natural Materials (Logs and Rocks)
- Support Bedform Diversity, Sediment Transport, Energy Dissipation

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Streambank Bioengineering and Riparian Buffers:

- Native Plants
- Woody and Herbaceous Community for Erosion Control and Habitat Enhancement

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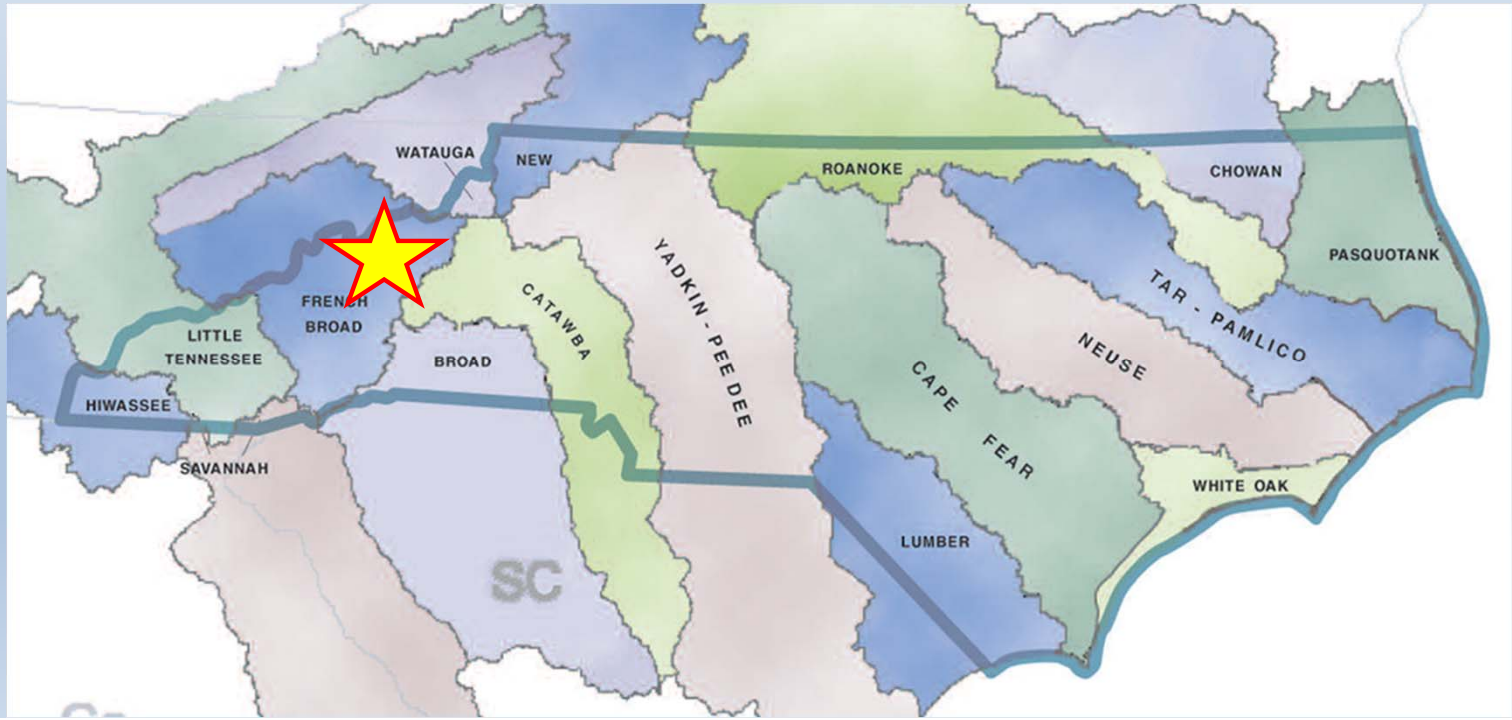
Case Study: Grassy Creek Restoration, Spruce Pine, NC

- French Broad River Basin, Blue Ridge Ecoregion 65
- 3,000 feet of Stream with Urban Constraints
- DA = 9.4 sq mi
- 2016 Implementation



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Grassy Creek Restoration

- Habitat Enhancement Opportunity for Fish and Salamanders
- Grant Funding from NCDEQ, NCCWMTF, USFWS, NCWRC

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Grassy Creek Problems

- Streambank Erosion
- Incised Channel with Plane Bed and Poor Habitats
- Poor Riparian Buffer with Utility Crossings
- Stormwater Runoff from Shopping Center

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Grassy Creek Constraints

- Surrounding Land Uses and Utilities
- Floodplain Permit Requiring “No-Rise/No-Impact” Design

As-built Aerial Photo 3 Years After Construction

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Grassy Creek Opportunities

- Trout Fishing
- Habitat for Eastern Hellbender Salamander (*Cryptobranchus a. alleganiensis*)
  - Need fast flow for DO absorption
  - Need shelter rocks, deep pools
  - Need food supply (crayfish)

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Grassy Creek Restoration Objectives

- Improve water quality by reducing sediment & nutrients
- Improve aquatic and terrestrial habitats
- Provide educational opportunities for community
- Connect Overmountain Victory Trail

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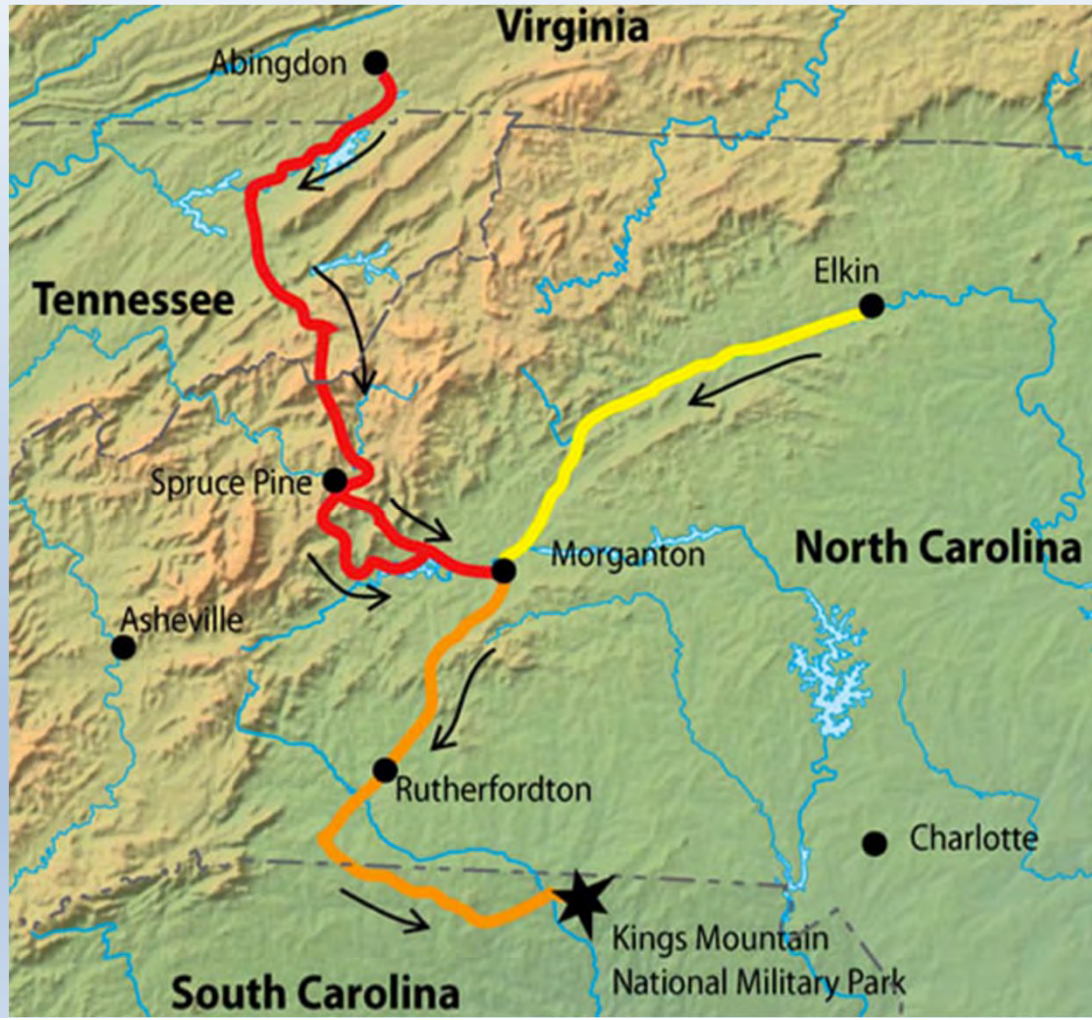
Overmountain Victory Trail

- Route of the Overmountain Men march to the Battle of Kings Mountain, October 7, 1780
- Community Walking and Fishing Trail



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Grassy Creek Restoration: *Upstream Reach*

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- Bank stabilization
- In-stream habitat structures
- Grade control at utility crossing
- Native riparian vegetation

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Log J-Hook Vane

Meander bend streambank protection and scour pool maintenance

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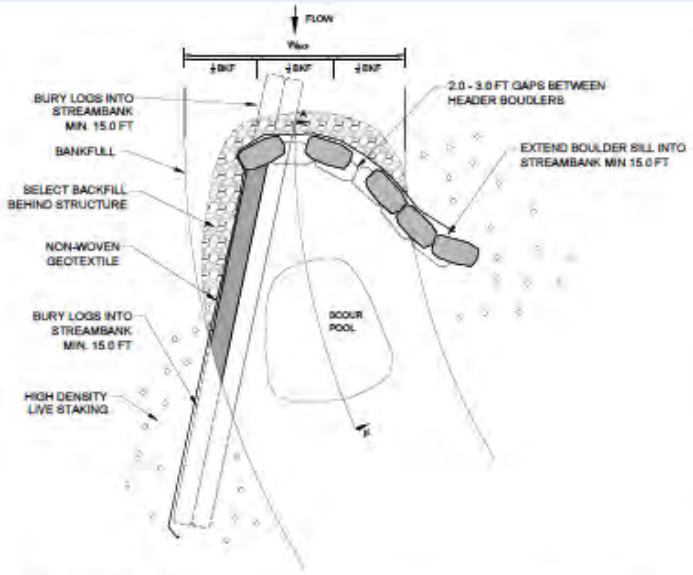
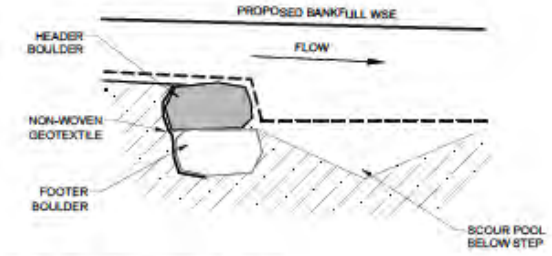
Log J-hook Vane for flow direction & habitat



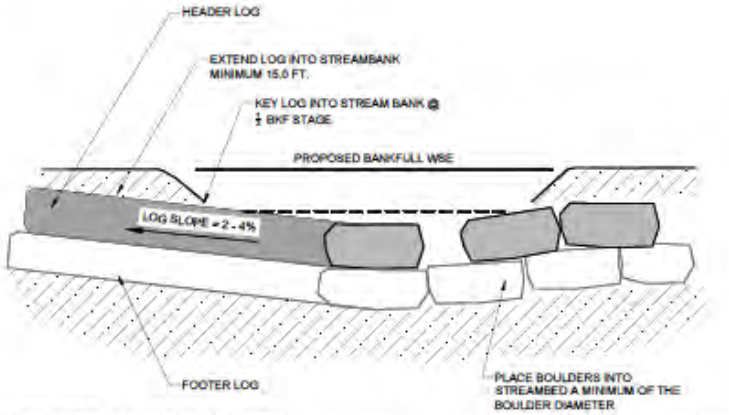
LOG J-HOOK WITH BOULDERS
DETAILED PLAN
NOT TO SCALE



LOG J-HOOK WITH BOULDERS
SECTION A - A'
NOT TO SCALE

LOG J-HOOK WITH BOULDERS
NOTES

1. THE LOG J-HOOK WITH BOULDERS IS A DESIGN FEATURE USED TO PROVIDE ENERGY DISSIPATION, FLOW DIRECTION CONTROL AND TO REDUCE NEAR BANK STRESS. THIS STRUCTURE WILL ALSO ENCOURAGE POOL MAINTENANCE AND CREATE A DIVERSITY OF AQUATIC HABITAT THROUGH SCOUR OF THE RIVER BED. THE LOG J-HOOK WITH BOULDERS IS COMPOSED OF A BOULDER SILL, WHICH IS A ROW OF BOULDERS SET AT AN ELEVATION PROVIDED IN THE PROPOSED PROFILE THAT SPANS PERPENDICULAR TO AND SLIGHTLY ARCED ACROSS THE CHANNEL. THE BOULDER SILL EXTENDS EXTENDS FROM A LOG VANE ARM INTO THE OPPOSITE STREAMBANK. THE LOG VANE ARM EXTENDS UP AND TOWARDS THE OUTSIDE STREAM BANK, EVENTUALLY KEYING INTO THE BANK AT AN ELEVATION HIGHER THAN THE SILL BOULDERS.
2. ALL BOULDERS USED FOR THE BOULDER SILL SHALL BE STRUCTURAL STONE, CUBICAL OR RECTANGULAR IN SHAPE. BOULDERS AVAILABLE ONSITE MAY BE USED IF APPROVED BY THE ENGINEER.
3. DIMENSIONS AND SLOPES OF STRUCTURES DESCRIBED IN THE DETAIL MAY BE ADJUSTED BY DESIGN ENGINEER TO FIT CONDITIONS ONSITE.
4. CONTRACTOR WILL BE REQUIRED TO FIT LOGS AND BOULDERS TOGETHER TIGHTLY. ALL LOGS AND BOULDERS SHALL BE INSTALLED WITH FOOTERS.
5. HEADER BOULDERS SHALL HAVE 2.0 FT - 3.0 FT GAPS BETWEEN EACH BOULDER TO MAINTAIN SEDIMENT TRANSPORT FUNCTIONS AND FISH PASSAGE.
6. GAPS BETWEEN LOGS AND FOOTER BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER AND PLUGGING WITH NC DOT CLASS A, WOODY DEBRIS AND SELECT MATERIAL OR CHINKING STONE APPROVED BY DESIGN ENGINEER, AND LINING WITH FILTER FABRIC.
7. THE LOG VANE SHALL EXTEND INTO THE OUTSIDE STREAMBANK AND STREAMBED A MINIMUM OF 15.0 FT ON EACH END.
8. THE BOULDER SILL SHALL EXTEND A MINIMUM OF 15.0 FT INTO THE INSIDE STREAM BANK.
9. BOULDERS SHALL BE 3.0 FT X 4.0 FT X 2.0 FT +/- 0.5 FT. MINIMUM LOG DIAMETER IS 2.0 FT.
10. NON-WOVEN GEOTEXTILE SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH FOOTER BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF THE STRUCTURE.



LOG J-HOOK WITH BOULDERS
CROSS-SECTION
NOT TO SCALE

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Bank Grading and Planting

Sloping streambanks to 2:1 or flatter slopes and planting native vegetation

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Grassy Creek Restoration: *Downstream Reach*

- Realign channel away from parking lot
- Excavate floodplain down to bankfull stage
- In-stream habitat structures
- Native riparian vegetation

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Channel Relocation (900 feet)

- Realign channel away from parking lot
- Transplant bed substrate and fauna from old channel to new channel

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Toe Wood Revetment

Buried green wood to protect streambank and support meander pool habitat

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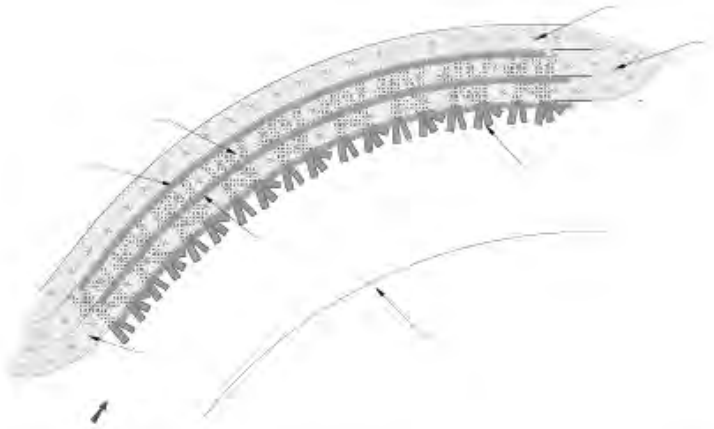
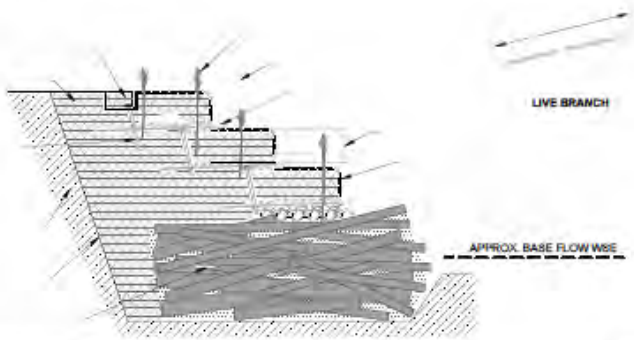
Toe Wood Revetment for bank protection, roughness, habitat



TOE WOOD REVETMENT WITH SOIL GEOLIFT
DETAILED PLAN
NOT TO SCALE



TOE WOOD REVETMENT WITH SOIL GEOLIFT
DETAILED PROFILE - SECTION A - A'
NOT TO SCALE

TOE WOOD REVETMENT WITH SOIL GEOLIFT

NOTES

1. COARSE WOODY DEBRIS SHALL CONSIST OF LOGS, ROOTWADS, AND LARGE BRANCHES NOT SUITABLE FOR CONSTRUCTION OF LOG STRUCTURES. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER.
2. COARSE WOODY DEBRIS SHALL BE CONSTRUCTED WITH THE LARGEST MATERIAL PLACED FIRST. NO LOGS SHALL BE PLACED PARALLEL TO THE FLOW OF WATER, UNLESS DIRECTED BY THE ENGINEER. LOGS SHALL BE PLACED IN A CROSSING PATTERN OR WEAVE SUCH THAT EACH LOG IS ANCHORED BY ANOTHER LOG.
3. SMALL/FINE WOODY DEBRIS SHALL CONSIST OF MEDIUM TO SMALL LIMBS, BRANCHES, BUSHES, AND/OR LOGS. INVASIVE SPECIES SHALL NOT BE USED.
4. SMALL/FINE WOODY DEBRIS SHALL BE PLACED ABOVE THE COARSE WOODY DEBRIS WITH THE LARGEST MATERIAL BEING PLACED FIRST AND THE SMALLEST MATERIAL PLACED LAST.
5. ALL WOODY DEBRIS SHALL BE COMPACTED WITH THE EXCAVATOR BUCKET IN ORDER TO REDUCE THE PRESENCE OF VOIDS IN THE SMALL/FINE WOODY DEBRIS LAYER.
6. THE HORIZONTAL LOCATIONS OF ALL WOODY DEBRIS ARE LOCATED ON THE PLAN AND PROFILE SHEETS AND WILL BE PROVIDED TO THE CONTRACTOR AS A 2004 FORMAT DWG FILE AND LAG FILE. NO LOCATIONS OF WOODY DEBRIS SHALL VARY FROM THE PLAN LOCATIONS WITHOUT DIRECTION FROM THE ENGINEER.
7. GRAVEL LEVELING BASE SHALL BE INSTALLED ABOVE THE HIGHEST ELEVATION OF THE WOODY DEBRIS BEFORE THE SOIL LIFTS ARE INSTALLED.
8. THE SOIL BACKFILL USED FOR LIFTS AND TOPSOIL USED FOR LAYERING WITH THE LIVE BRANCHES SHALL BE FREE OF ANY LARGE ROOTS OR WOODY DEBRIS AND SHALL GENERALLY BE FREE FROM ANY GRAVEL OR COBBLE MATERIAL.
9. SOIL BACKFILL SHALL BE COMPACTED SUCH THAT FUTURE SETTLING WILL BE KEPT TO A MINIMUM; YET, NOT SUCH THAT THE UNDERLYING BRUSH IS DISPLACED OR DAMAGED.
10. THE TOP OF THE BACKFILL FOR THE FIRST LIFT SHALL BE SLOPED AT APPROXIMATELY 5% AWAY FROM THE STREAM.
11. PLACE A LAYER OF TOPSOIL AND LIVE BRANCHES ON TOP OF EACH SOIL LIFT SUCH THAT APPROXIMATELY 6 INCHES TO 1 FOOT OF EACH LIVE BRANCH WILL BE EXPOSED AND THE REMAINDER (2' TO 4') OF EACH LIVE BRANCH WILL BE COVERED BY THE NEXT SOIL LIFT.
12. LIVE BRANCHES SHALL BE OF THE SPECIES SPECIFIED FOR LIVE STAKES OR APPROVED BY THE ENGINEER.
13. PLACE A LAYER OF 8.5 FEET WIDE GEOCOIR DEKOWE 700 EROSION CONTROL BLANKET, OR EQUIVALENT, ON TOP OF THE TOPSOIL AND LIVE BRANCHES SUCH THAT 2.5 FEET OF THE BLANKET WILL BE BURIED BELOW THE NEXT SOIL LIFT. ALLOW THE REMAINING 4.5 FEET OF BLANKET TO HANG OVER THE PRECEDING SOIL LIFT OR COIR FIBER LOGS.
14. PLACE A LAYER OF 8.5 FEET WIDE NON-WOVEN COIR MATTING OVER THE EROSION CONTROL BLANKET TO THE SAME LIMITS.
15. SOIL CAN BE COMPACTED BY STACKING A PIECE OF 2 X 6 SAWN LUMBER EDGEWAYS UP TO THE LIFT HEIGHT SPECIFIED IN THE STRUCTURE TABLE AND SECURING WITH WOODEN STAKES TO PROVIDE A RIGID BACKSTOP FOR COMPACTING SOIL LIFT.
16. PLACE SOIL BACKFILL UP TO THE LIFT HEIGHT SPECIFIED OF NO GREATER THAN 1.0 FT BEING CAREFUL NOT TO PUSH/PULL OR TEAR THE FABRIC PREVIOUSLY PLACED.
17. THE TOP OF THE SOIL BACKFILL SHALL BE FLAT WITHIN THE LIFT SETBACK DISTANCE SPECIFIED IN THE STRUCTURE TABLE. BEYOND THE LIFT SETBACK DISTANCE, THE SOIL BACKFILL SHALL BE SLOPED AT AN APPROXIMATE 5% SLOPE AWAY FROM THE STREAM.
18. TOP DRESS THE SOIL LIFT WITH TOPSOIL FROM THE FACE OF THE SOIL LIFT BACK INTO THE FLOODPLAIN AT LEAST 4FT.
19. REMOVE THE SAWN LUMBER AND WOODEN STAKES FROM THE FACE OF THE SOIL LIFT AND WRAP THE FACE AND TOP OF THE SOIL LIFT USING THE WOVEN AND NON-WOVEN COIR MATTING HANGING OVER THE PREVIOUS LIFT/COIR FIBER LOGS.
20. THE EROSION CONTROL FABRIC SHALL BE PULLED AS TIGHT AS POSSIBLE WITHOUT TEARING OR EXCESSIVELY DISTORTING THE FABRIC.
21. SECURE THE EROSION CONTROL AND NON-WOVEN MATTING IN PLACE BY STAKING THE END OF THE EROSION CONTROL FABRIC WITH WOODEN STAKES ON 1.5-FOOT CENTERS.
22. BEGIN CONSTRUCTION OF THE NEXT SOIL LIFT BY REPEATING THE PREVIOUS NOTES STARTING WITH NOTE 11.
23. THE OVERALL SLOPE CREATED BY THE LIVE BRUSH LAYERING SHALL MATCH THE PROPOSED CROSS SECTION SHAPE FOR THE OUTER BANK OF THE THE TYPICAL POOL CROSS-SECTION FOR EACH REACH.
24. THE COIR BLANKETS AND GEOTEXTILE FABRIC USED FOR THE UPPER MOST SOIL LIFT WILL BE SECURED WITHIN A 6 INCH DEEP TRENCH AS SHOWN IN DETAIL. TRENCH AS SHOWN IN THE DETAIL.
25. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED OR APPROVED BY THE ENGINEER.
26. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

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Sewer Line Crossing

Stream realignment for perpendicular crossing with bank protection

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Habitat Structures

Flat boulders in glides tilted up on downstream end

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Habitat Structures

Log vanes for scour pools

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Constructed Stormwater Wetlands

Collecting and treating parking lot runoff

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Riparian Vegetation

- Native grasses, shrub, trees
- Invasive exotic plant control

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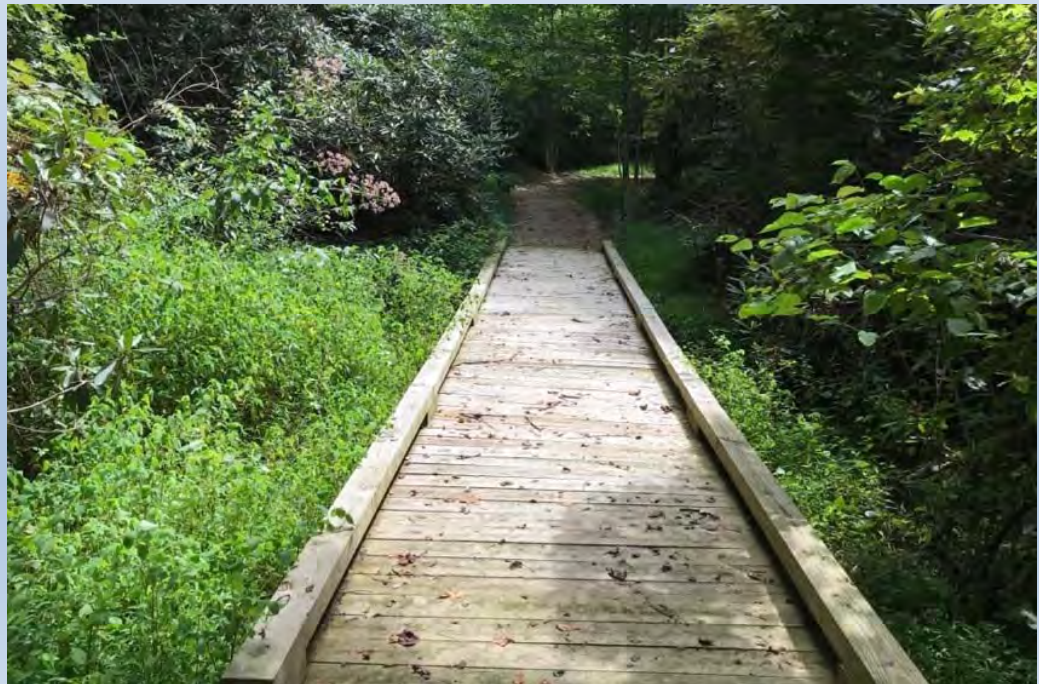
Education and Recreation

- Workshops and Tours
- Overmountain Victory Trail



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Monitoring for Hellbender Salamanders

- eDNA and photographic evidence of Hellbender in Spring, 2017
- Live specimens found since 2018

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Lessons Learned

- Habitat Focus:
  - Natural Materials: Rocks & Wood
  - Diversity: Riffles, Pools, Glides, Steps
  - Plants: Roots, Detritus, Shade
- Connectivity:
  - Floodplain: Overbank Flows
  - Ground Water: Hyporheic Connection
- Urban Environment:
  - Constraints limit design & construction
  - Flashy flow conditions

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Rewilding Stream and Floodplains:

- Enhanced Riparian Ecosystem Functions and Services.
- Expanded Education and Recreation Opportunities.
- Better Preparedness for Future Floods.