Creating Value ...

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Built to Last? An Evaluation of Aging In-stream Structures.

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Presentation Objectives

- **Provide an evaluation of "aged" vane-type in-stream structures (single arm vanes, j-hook vanes, and cross vanes) to include:**
  - **Early design goal(s) and attributes for structures**
  - **Did the structures function as designed**
  - **How the structures evolved in both form and function since installed**
  - **Provide recommendations for future structure design based on evaluation results**

Evaluation Parameters & Assumptions

- **Only vane type in-stream structures were evaluated (predominantly boulder)**
- **Upper Piedmont NC stream projects**
- **Bi-modal stream systems (gravel bed/sand wash load)**
- **In-stream structures evaluated were 5 to 12 years old, with average age of 7 years old**
- **Each in-stream structure has been “tested” by numerous large storm events**

Early Design Goals & Structure Attributes

- **Design (conservative) for C stream type (W/D>12) to evolve to E stream type (W/D<12)**
- **Bank protection (single arm/J-hook vanes) and grade control (cross-vanes)**
- **Structure arm geometry:**
  - **Steeper arm slopes (≥10%) built to bankfull elevation**
  - **Larger arm angles (≥25 degrees)**
- **Boulders/rock as primary materials**

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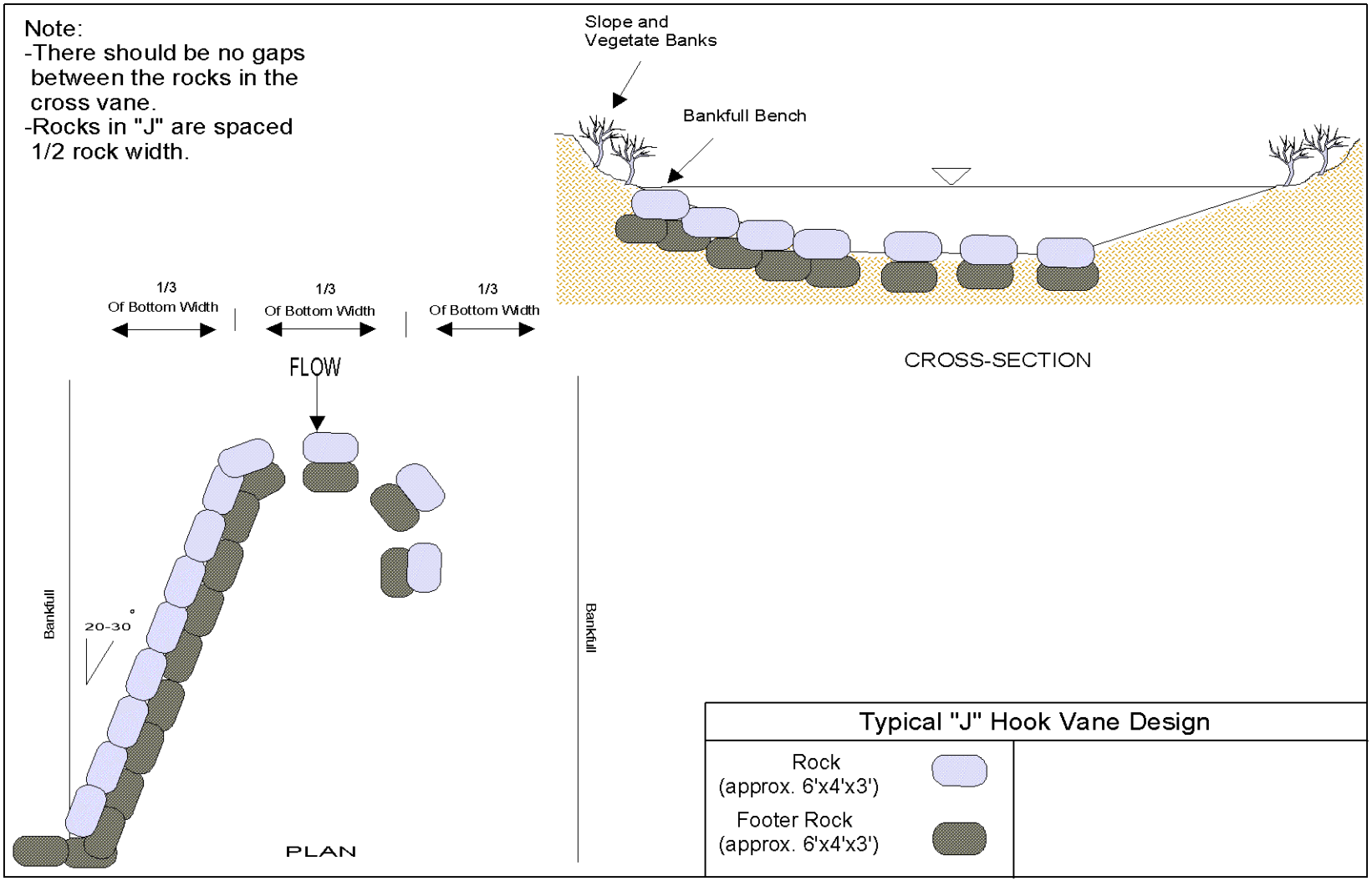
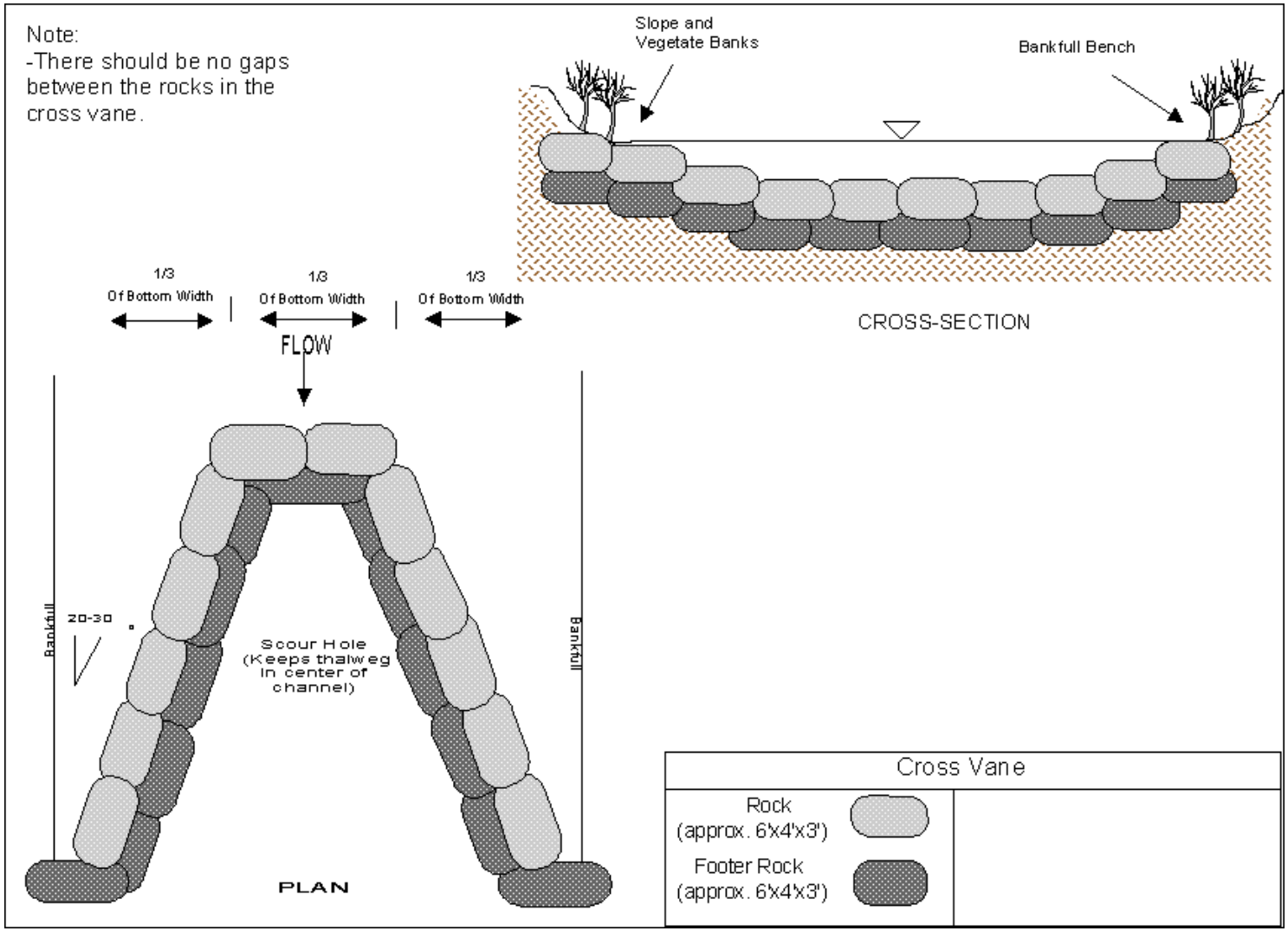
Early Design Goals & Structure Attributes (continued)

- **Primary focus on stream stability, less focus on aesthetics and habitat**
  - **Scour pools**
  - **Some boulder clusters**
  - **Some rootwads**
- **Construction quality less advanced**

Early J-hook Vane Detail (circa 2000)

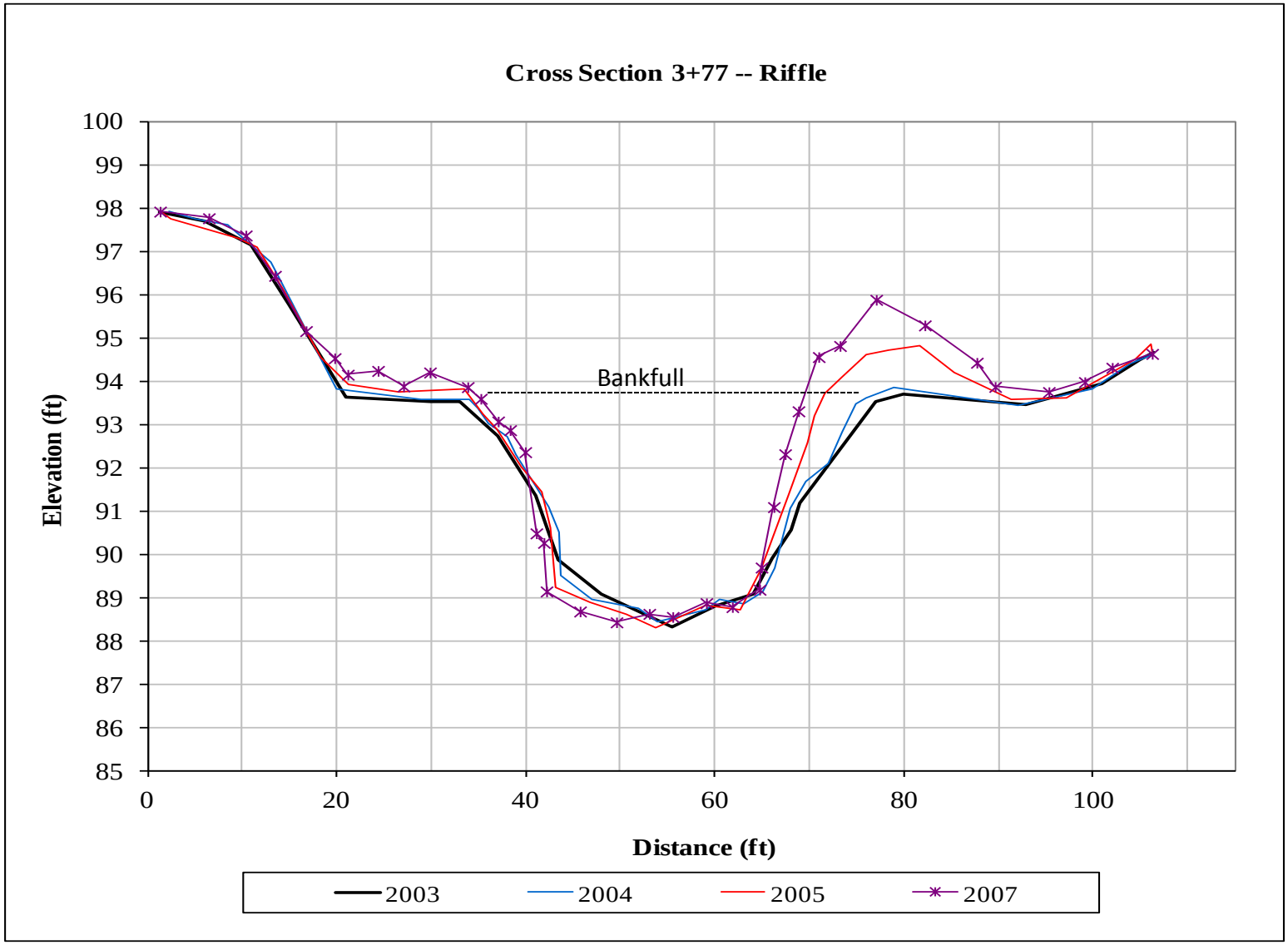


Early Cross-vane Detail (circa 2000)



- **Did the structures function as designed?**
- **How did the structures evolve in form and function?**
- **Before and after comparison photos**
  - **Bern Schumack Project**
  - **Joe Mickey Project**
  - **Dick Everhart Project**
  - **Benbow Park Project**
  - **Bailey Fork Project**

Mitchell River Riffle Cross Section



Bern Schumack Project

Bern Schumack Project

Bern Schumack Project

Construction - 2001

Oct 2011

Bern Schumack Project

Construction - 2001

Oct 2011

Bern Schumack Project

Construction - 2001

Oct 2011

Joe Mickey Project

Construction - 2002

Oct 2011

Joe Mickey Project

Construction - 2002

Oct 2011

Joe Mickey Project

Construction - 2002

Oct 2011

Dick Everhart Project

Construction - 1999
(photo taken in 2000)

Oct 2011

Dick Everhart Project

Construction - 1999
(photo taken in 2001)

Oct 2011

Benbow Park Project

Construction - 2004

Sept 2010

Bailey Fork Project

Bailey Fork Project

Conclusions: Design Recommendations & Info

- **Structure Applications**
  - More emphasis on aesthetics and habitat improvement
  - More bioengineering (geolifts and brush mattresses) for bank protection
  - Constructed riffles & rollers for grade control
- **Structure Materials**
  - Less rock and more wood…keep wood wet
  - Better backfill gradation
  - Geotextile and “chinking” for all structures

Conclusions: Design Recommendations & Info (continued)

- **Structure Geometry**
  - Arms slopes built to 1/2 to 2/3 bankfull elev. vs. bankfull elev. (+/-5% arm slope)
  - Arm angles built 20 deg. vs. 30 deg.
- **Aesthetics normally improve over time**
  - Boulders stain naturally over time
  - Bed material fills in
  - Stream banks "grow" in to cover structure arms
- **Shifted boulders may not be a failure**

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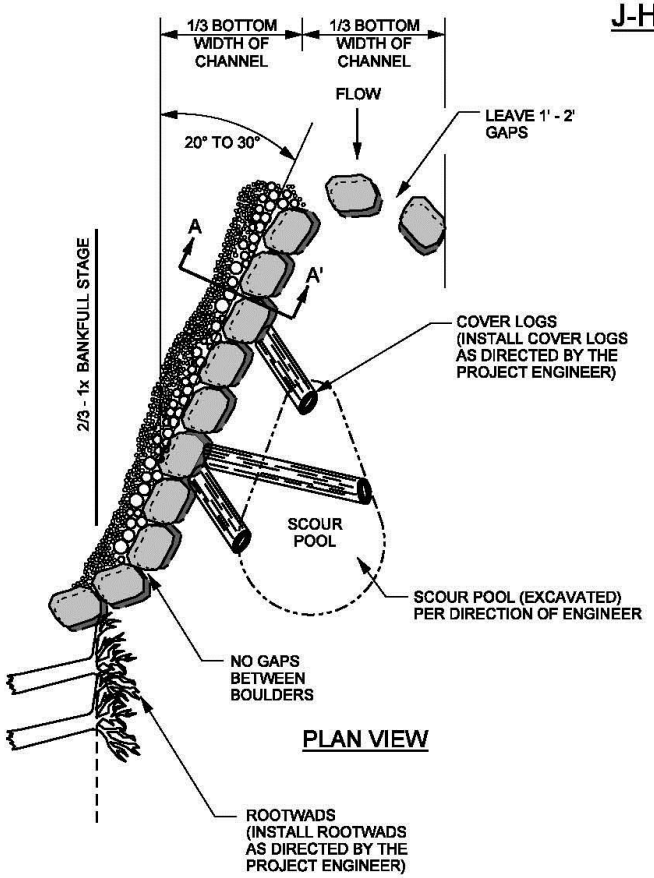
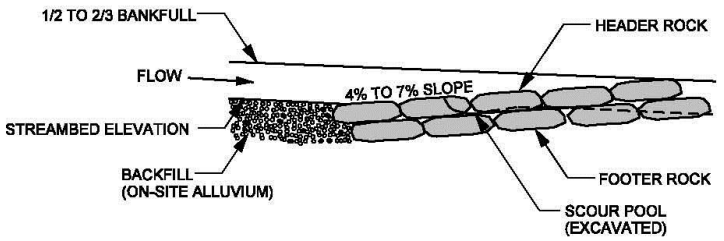
Conclusions: Design Recommendations & Info (continued)

- **Encourage creativity and "complexity" in both design and construction**
  - "Speed up" aesthetics and habitat benefits
  - Better recycling of on-site wood materials
  - Similar/off-set construction costs and effort
  - Workmanship is key
- **Use various structures in close combination with each other for increased habitat benefits**
- **Improved construction experience and quality**

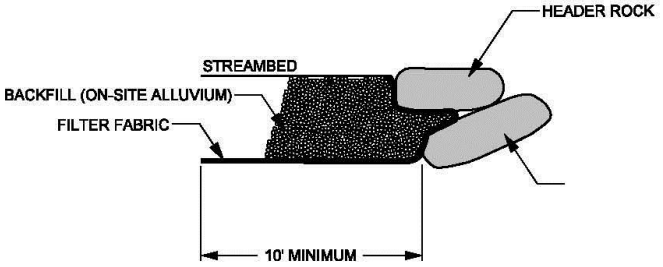
J-HOOK VANE



PLAN VIEW



PROFILE VIEW

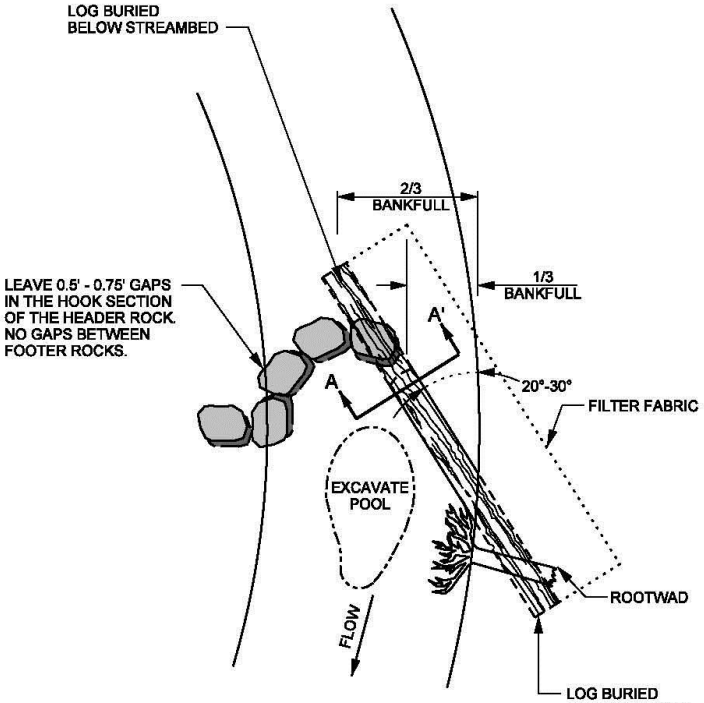


SECTION A - A'

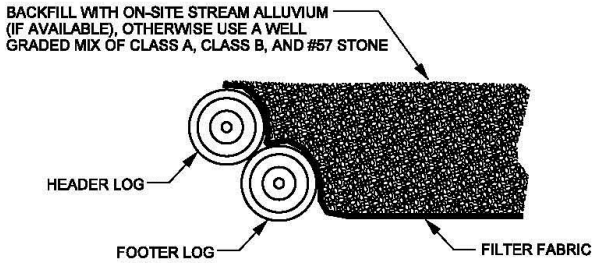
NOTES FOR ALL VANE STRUCTURES:

1. BOULDERS MUST BE AT LEAST 5' X 4' X 3'. 6' X 5' X 4' BOULDERS ARE PREFERRED.
2. INSTALL FILTER FABRIC FOR DRAINAGE BEGINNING AT THE MIDDLE OF THE HEADER ROCKS AND EXTEND DOWNWARD TO THE DEPTH OF THE BOTTOM FOOTER ROCK, AND THEN UPSTREAM TO A MINIMUM OF TEN FEET.
3. DIG A TRENCH BELOW THE BED FOR FOOTER ROCKS AND PLACE FILL ON UPSTREAM SIDE OF VANE ARM, BETWEEN THE ARM AND STREAMBANK.
4. START AT BANK AND PLACE FOOTER ROCKS FIRST AND THEN HEADER (TOP) ROCK.
5. CONTINUE WITH STRUCTURE, FOLLOWING ANGLE AND SLOPE SPECIFICATIONS.
6. AN EXTRA BOULDER CAN BE PLACED IN SCOUR POOL FOR HABITAT IMPROVEMENT.
7. USE ON-SITE ALLUVIUM TO FILL GAPS ON UPSTREAM SIDE OF BOULDERS TO THE ELEVATION OF THE TOP OF THE HEADER ROCK.
8. START SLOPE AT 1/2 TO 2/3 TIMES THE BANKFULL STAGE.

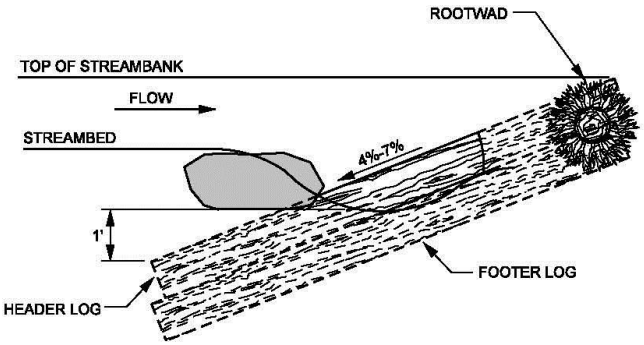
GRADE CONTROL LOG J-HOOK VANE



PLAN VIEW



SECTION A - A'

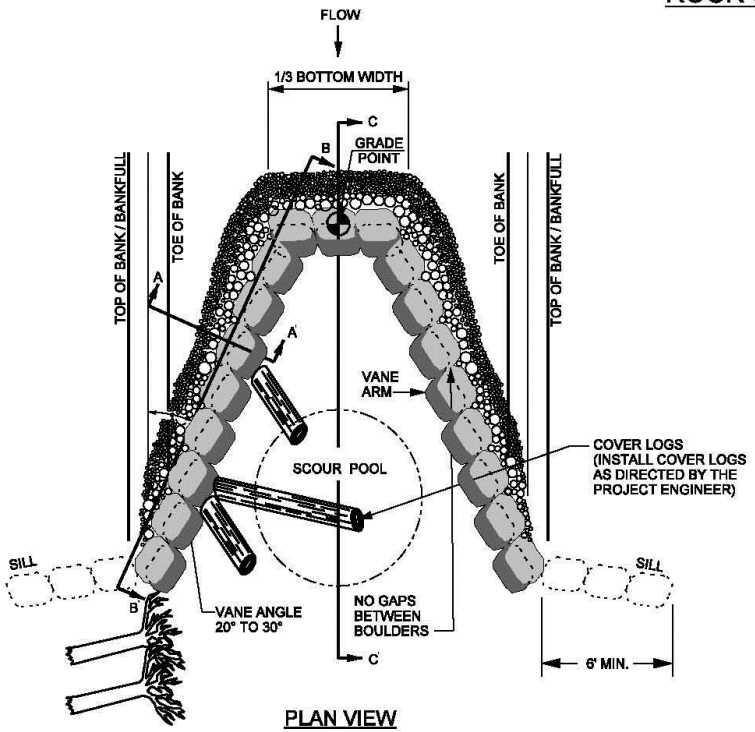


PROFILE VIEW

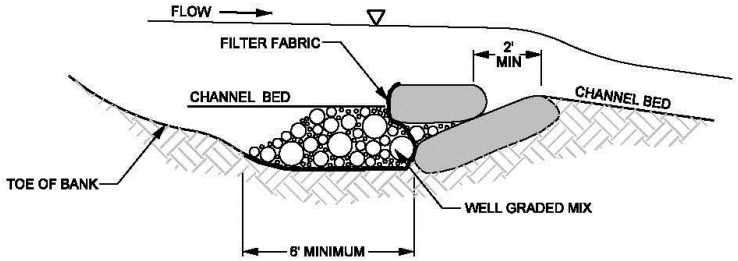
NOTES:

1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. BOULDERS MUST BE AT LEAST 3' x 2' x 2'.
3. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOG.
4. ROOTWADS SHOULD BE PLACED BENEATH THE HEADER LOG AND PLACED SO THAT IT LOCKS THE HEADER LOG INTO THE BANK. SEE ROOTWAD DETAIL.
5. BOULDERS SHOULD BE PLACED ON TOP OF HEADER LOG FOR ACHORING.
6. HEADER BOULDERS TO BE PLACED 0.5 TO 0.75 FEET APART.
7. FILTER FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
8. TRANSPLANTS CAN BE USED INSTEAD OF ROOWADS, PER DIRECTION OF ENGINEER.

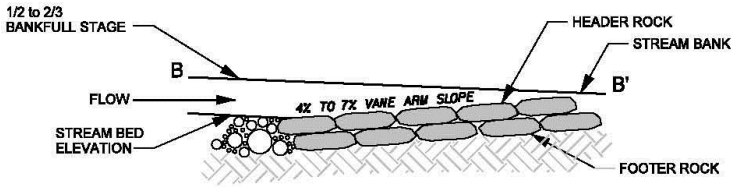
ROCK CROSS VANE



PLAN VIEW



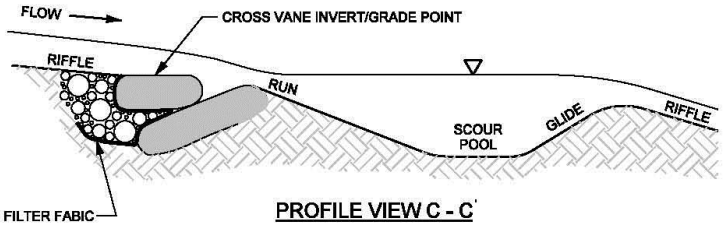
SECTION A - A'



PROFILE VIEW B - B'
VANE ARM

NOTES FOR ALL VANE STRUCTURES:

1. BOULDERS MUST BE AT LEAST 3' x 2' x 1'.
2. INSTALL FILTER FABRIC FOR DRAINAGE BEGINNING AT THE MIDDLE OF THE HEADER ROCKS AND EXTEND DOWNWARD TO THE DEPTH OF THE BOTTOM FOOTER ROCK, AND THEN UPSTREAM TO A MINIMUM OF SIX FEET.
3. DIG A TRENCH BELOW THE BED FOR FOOTER ROCKS AND PLACE FILL ON UPSTREAM SIDE OF VANE ARM, BETWEEN THE ARM AND STREAMBANK.
4. CONSTRUCT FOLLOWING ANGLE AND SLOPE SPECIFICATIONS.
5. USE CLASS 1 STONE TO FILL GAPS ON UPSTREAM SIDE OF BOULDERS, AND CLASS A STONE TO FILL GAPS ON UPSTREAM SIDE OF CLASS 1 STONE.
6. AFTER ALL STONE HAS BEEN PLACED, FILL IN THE UPSTREAM SIDE OF THE STRUCTURE WITH ON-SITE ALLUVIUM TO THE ELEVATION OF ONE HALF THE HEADER ROCK.
7. BOULDER SILL MUST BE A MINIMUM OF 6'.



PROFILE VIEW C - C'

Linville Project

Linville Project

Joe Mickey Project

Stone Mountain Project

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