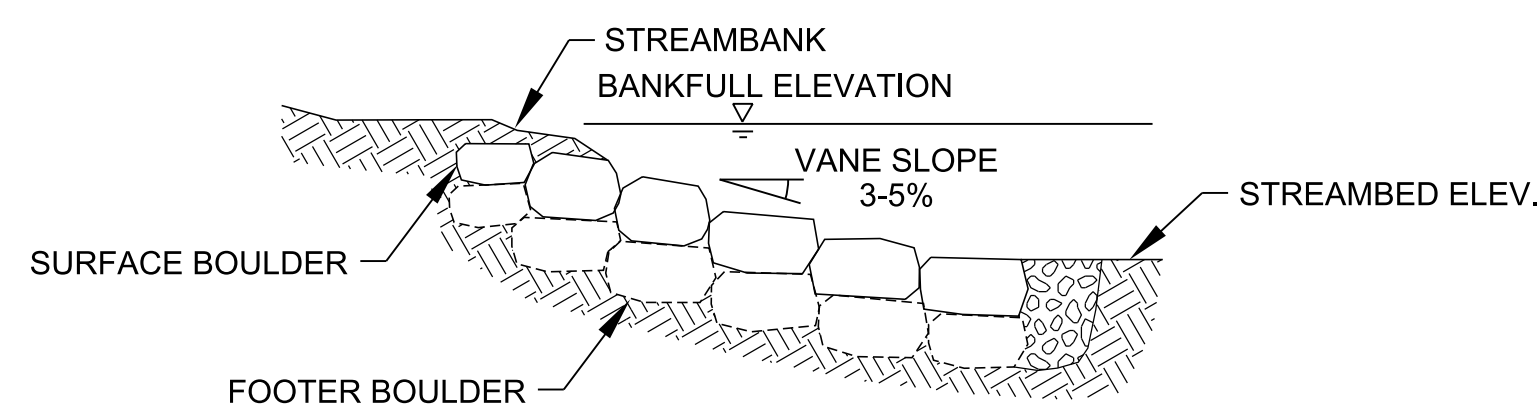
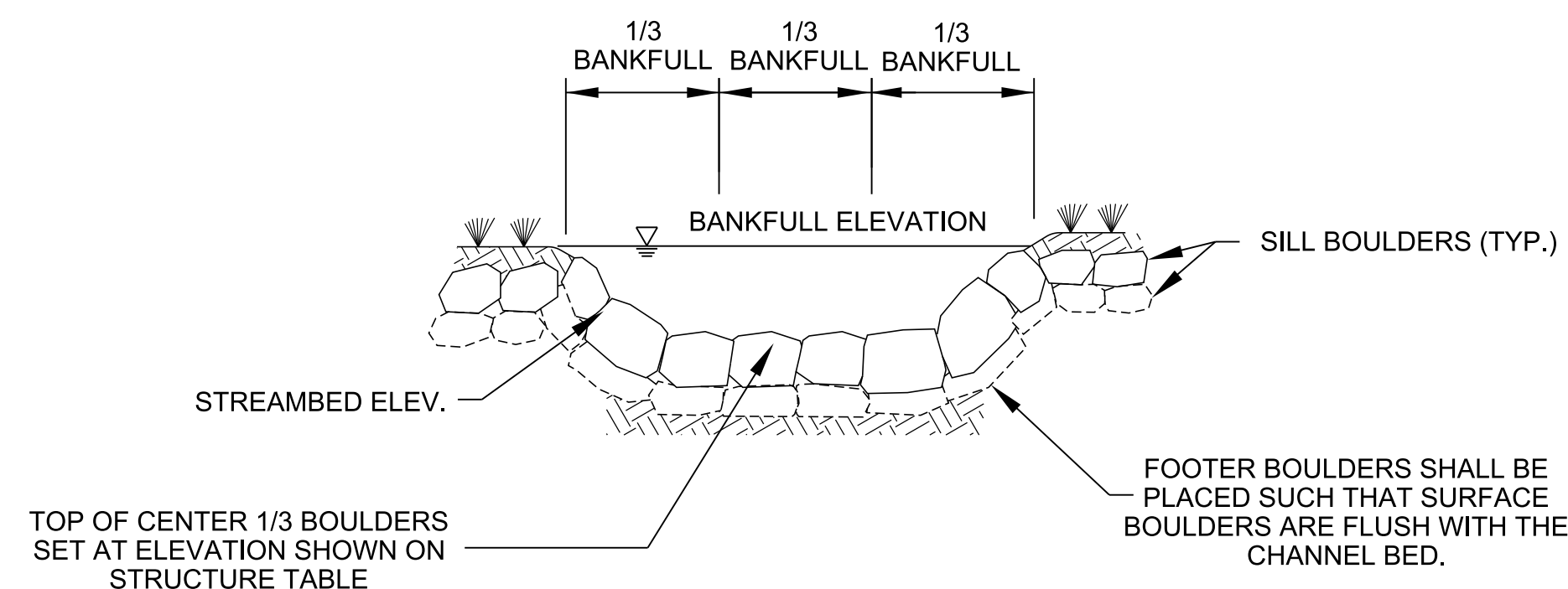


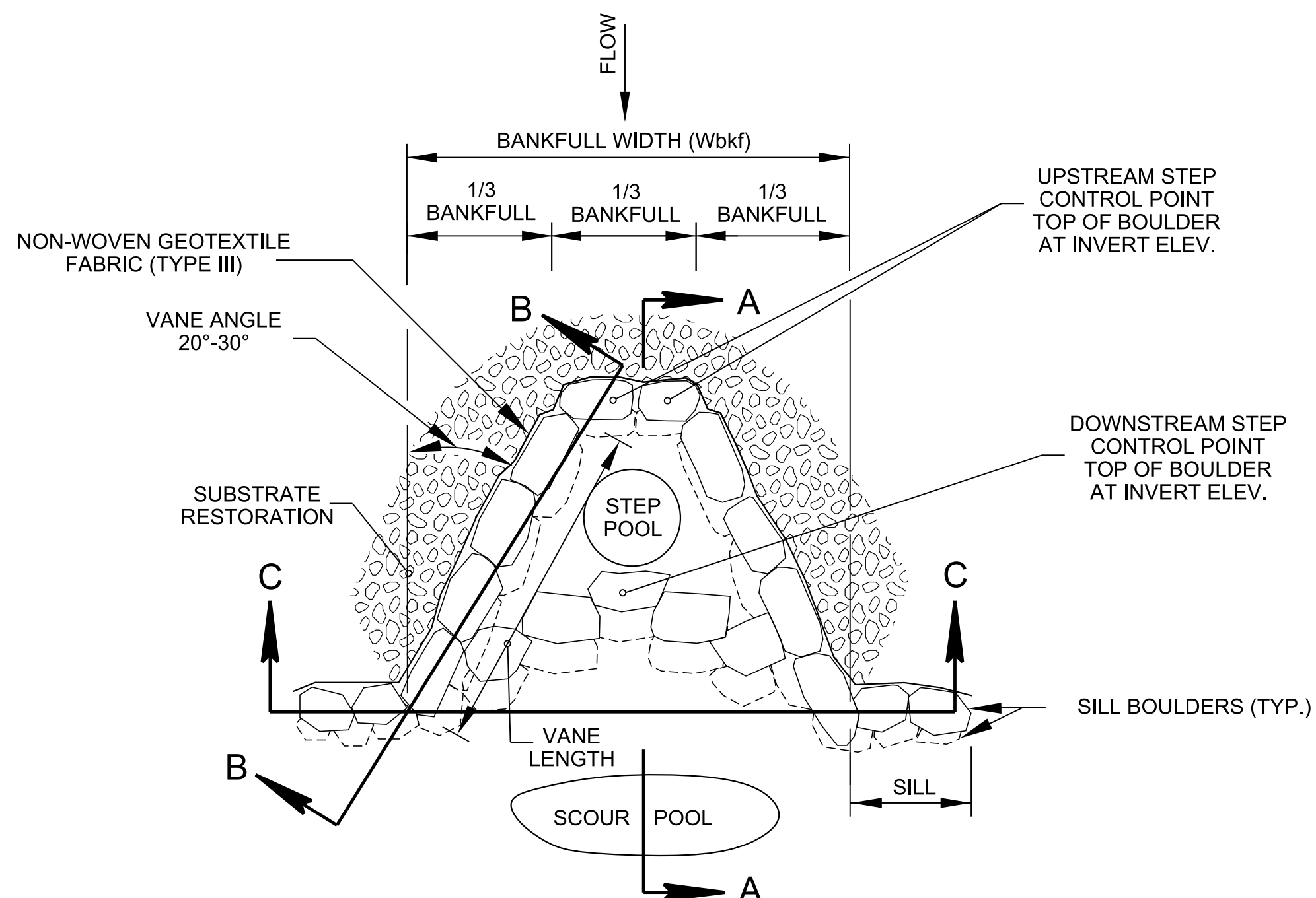
SECTION A-A



SECTION B-B



SECTION C-C



PLAN VIEW

**BOULDER CROSS VANE WITH STEP**

**BOULDER CROSS VANE WITH STEP NOTES**

- (A) BOULDER CROSS VANES WITH STEPS ARE HYDRAULIC AND GRADE CONTROL MEASURES THAT ARE USED TO DIRECT FLOW AWAY FROM THE CHANNEL BANK, CONCENTRATE FLOWS INTO THE CENTER OF THE CHANNEL, AND ENHANCE HABITAT. THE ADDITION OF A STEP HELPS REDUCE THE ELEVATION DROP ACROSS THE STRUCTURE, THEREBY DISSIPATING ENERGY AND PROMOTING PASSAGE BY AQUATIC ORGANISMS.
- (B) BOULDER CROSS VANES WITH STEPS SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND CONFIGURATION INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH, MEDIAN BOULDER SIZE, VANE AND SILL LENGTHS, AND INVERT ELEVATIONS OF THE WEIR AND STEP, SHOULD BE SPECIFIED IN THE STREAM MITIGATION DATA TABLE.
- (C) REFER TO D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".
- (D) BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.
- (E) THE WEIR AND THE STEP OF THE BOULDER CROSS VANE WITH STEP ARE TYPICALLY LOCATED IN THE CENTER THIRD OF THE STREAM CHANNEL, UNLESS THE STRUCTURE IS DESIGNED WITH OFF-SET VANES TO CONFORM TO BENDS IN THE CHANNEL. THE SURFACE BOULDERS COMPRISING THE WEIR AND STEP ARE SET AT THE INVERT ELEVATIONS OF THE STRUCTURE. THE STEP INVERT SHOULD BE AT OR ABOVE THE TOP OF THE UPSTREAM FOOTER BOULDER.
- (F) A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFLE AND RUN HABITATS AND TO FILL GAPS IN THE VANE BOULDERS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO STANDARD DRAWINGS D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.
- (G) CONSTRUCT BOULDER CROSS VANE WITH STEP STRUCTURES BY
  - (1) FIRST SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.
  - (2) NEXT, EXCAVATE ENOUGH BED MATERIAL TO PLACE THE BOULDERS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III) AND SELECT MATERIAL FOR BACKFILL AND SUBSTRATE REPLACEMENT.
  - (3) PLACE FOOTER BOULDERS AND SURFACE BOULDERS AT THE CHANNEL INVERTS OF THE WEIR AND STEP, AND THEN USE SURVEY EQUIPMENT TO CHECK THE ELEVATIONS OF THE INVERTS IN ACCORDANCE WITH THE STREAM MITIGATION PLANS.
  - (4) ONCE THE INVERTS HAVE BEEN ESTABLISHED, THE REMAINDER OF THE FOOTER AND SURFACE BOULDERS SHALL BE PLACED, MINIMIZING VOIDS.
  - (5) FILL THE VOIDS BETWEEN BOULDERS ON THE UPSTREAM SIDE OF THE STRUCTURE.
  - (6) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF THE STRUCTURE, EXTENDING FROM THE BOTTOM OF THE FOOTER TO THE FINISHED GRADE ELEVATION. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED.
  - (7) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE), OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).
  - (8) ONCE THE STRUCTURE IS INSTALLED, EXCAVATE SCOUR POOL AND PLACE SELECT MATERIAL AS REQUIRED.
  - (9) 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.
- (H) THE SURFACE OF CROSS VANE WITH STEP STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE PLANS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.10 FOOT OF THE GRADES AND ELEVATIONS INDICATED, OR AS DIRECTED BY THE ENGINEER. ALL GAPS OR VOIDS SHALL BE PLUGGED WITH SELECT MATERIAL TO FORM A TIGHT-FITTING SEAL.
- (I) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.
- (J) PAYMENT FOR THE BOULDER CROSS VANES WITH STEPS SYSTEM SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY FOR CONSTRUCTION, AND SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

209-03.54, STREAM MITIGATION - CROSS VANE STRUCTURE W/STEP, EACH.

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

STATE OF TENNESSEE  
STANDARD DRAWING  
DEPARTMENT OF TRANSPORTATION

BOULDER CROSS  
VANE WITH STEP

