Ford Stream Crossings

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Ford Stream Crossings - Topics

- Ford vs. Culvert Crossings
  - Brief Culvert Introduction
- Site Selection
- Surveying and Field Data Collection
- Design
- Construction
- As-Built/Certification
- Case Studies/Examples

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DN-578

NATURAL RESOURCES CONSERVATION SERVICE
VIRGINIA ENGINEERING DESIGN NOTE 578 (DN-578)

Stream Crossing

May 2013

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Ford Stream Crossings

Culverts vs. Fords

- Fords should be the *default* for planning
  - "Least-cost technically feasible alternative" to address the resource concern
- Culverts: More expensive, more likely to fail
- Fords: Less expensive, less likely to fail
  - Also serve as a limited access watering point!
- Both require maintenance
  - Culverts: Removing debris from inlet, repairing damage from overtopping and possible scouring at inlet/outlet
    - Repairs may require heavy construction equipment
  - Fords: Periodic re-surfacing, removal of sediment deposits
    - Repairs typically accomplished with any farm tractor with loader

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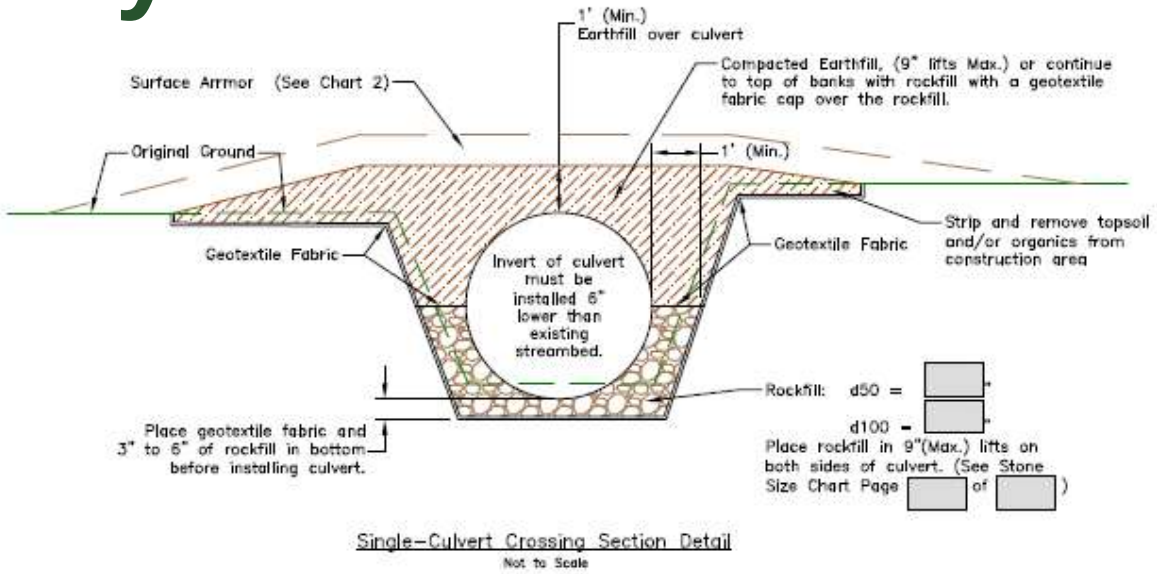
Why we avoid culverts

Key Features:



Single-Culvert Crossing Section Detail

Not to Scale

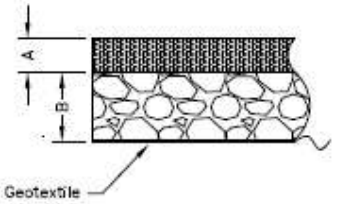
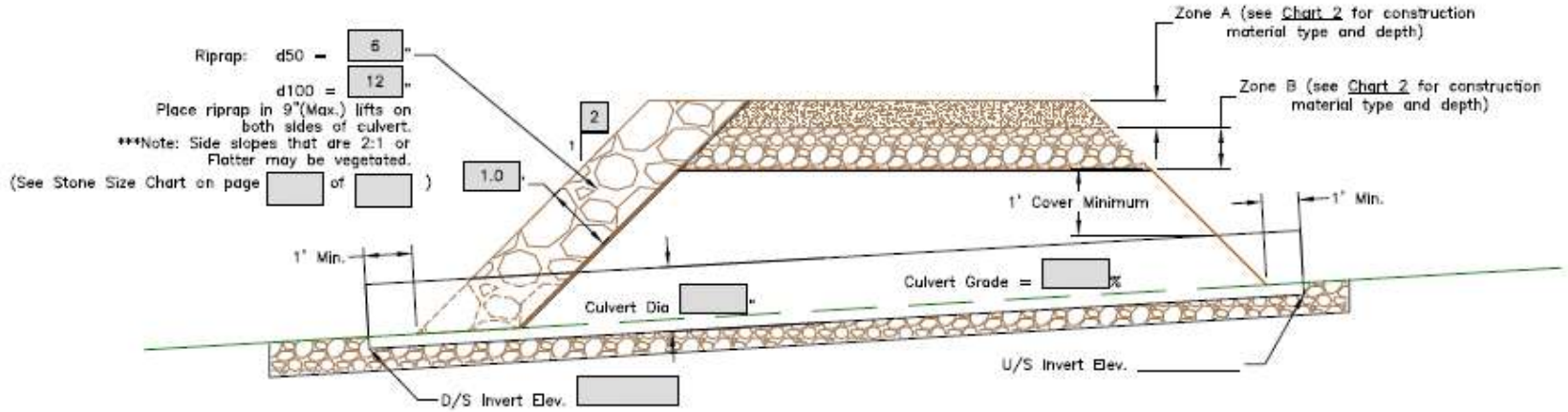
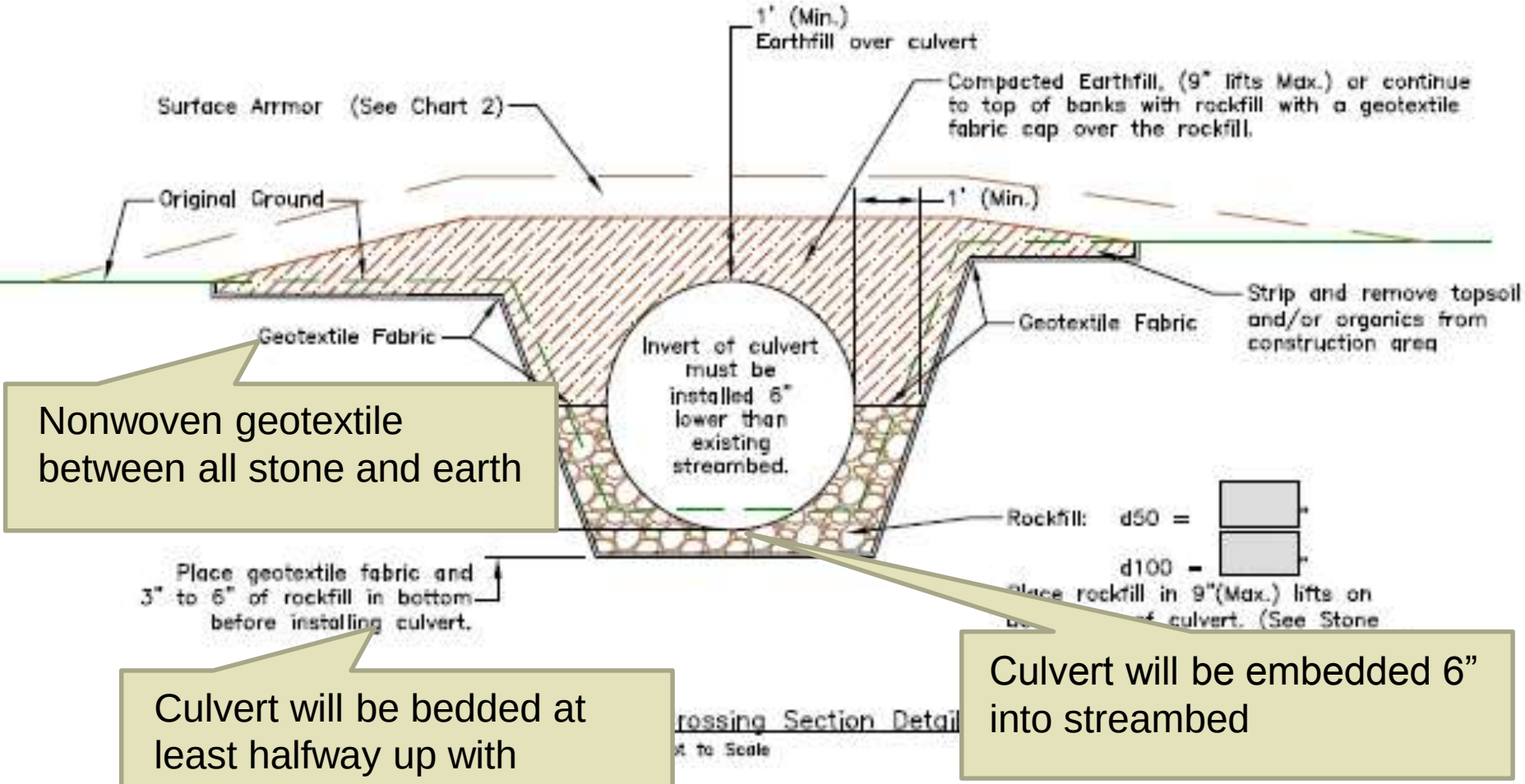


Chart 2 – Culvert Crossing Materials		
Zone	Construction Material	Depth of Material (inches)
A	VDOT # 57	3"
B	VDOT # 1	6"

(See Stone Size Chart on page of)

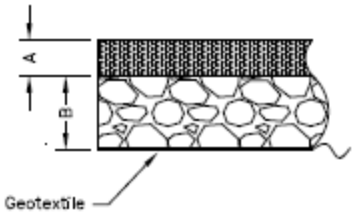




Nonwoven geotextile between all stone and earth

Culvert will be bedded at least halfway up with granular rockfill

Culvert will be embedded 6” into streambed

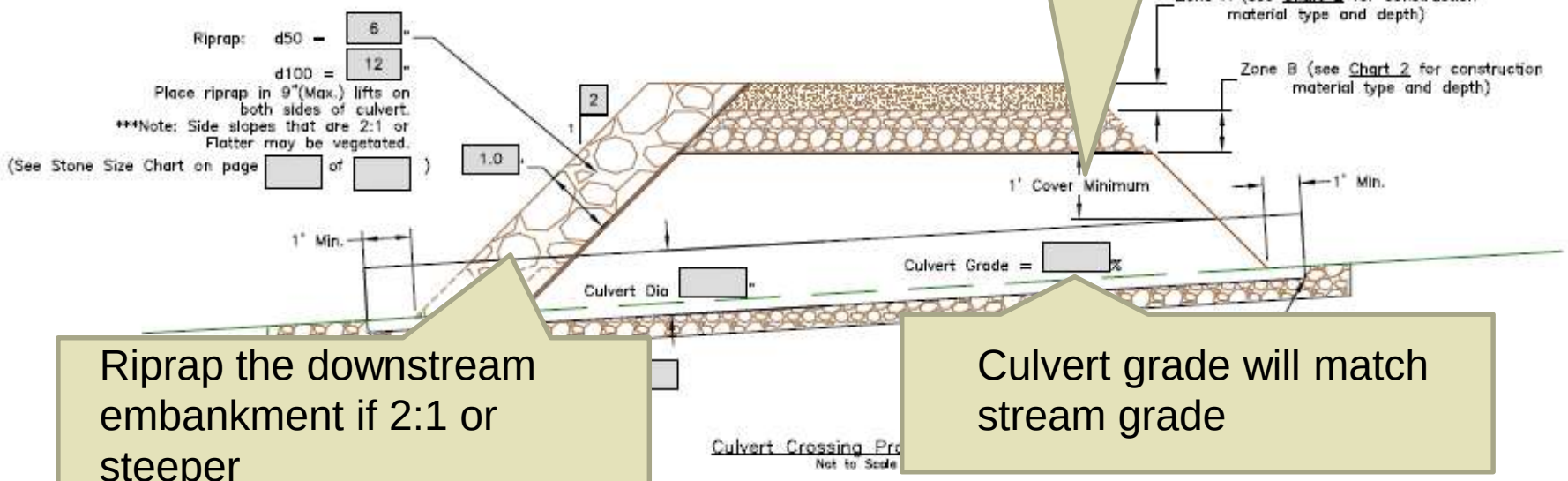


The stone layers are identical to those for ford crossings because the culvert is only sized for the 2-yr or bankfull flow and will likely be overtopped fairly frequently.

Chart 2 – Culvert Crossing Materials		
Zone	Construction Material	Depth of Material (inches)
A	VDOT # 57	3"
B	VDOT # 1	6"

(See Stone Size Chart on page ____ of ____)

Minimum of 1' of earthfill over culvert



Riprap the downstream embankment if 2:1 or steeper

Culvert grade will match stream grade

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When to use culverts:

- VA-578: “If the stream crossing is to be used frequently, or ***daily***, as in a dairy operation, a culvert crossing…should be used…”
- In a heavily incised channel
- In an area where a 6:1 ramp cannot be achieved for a ford and relocation to an area where it can be achieved is not possible
- When the resource concern requires it (e.g. small ruminants)
- NOT “because the farmer wants one”

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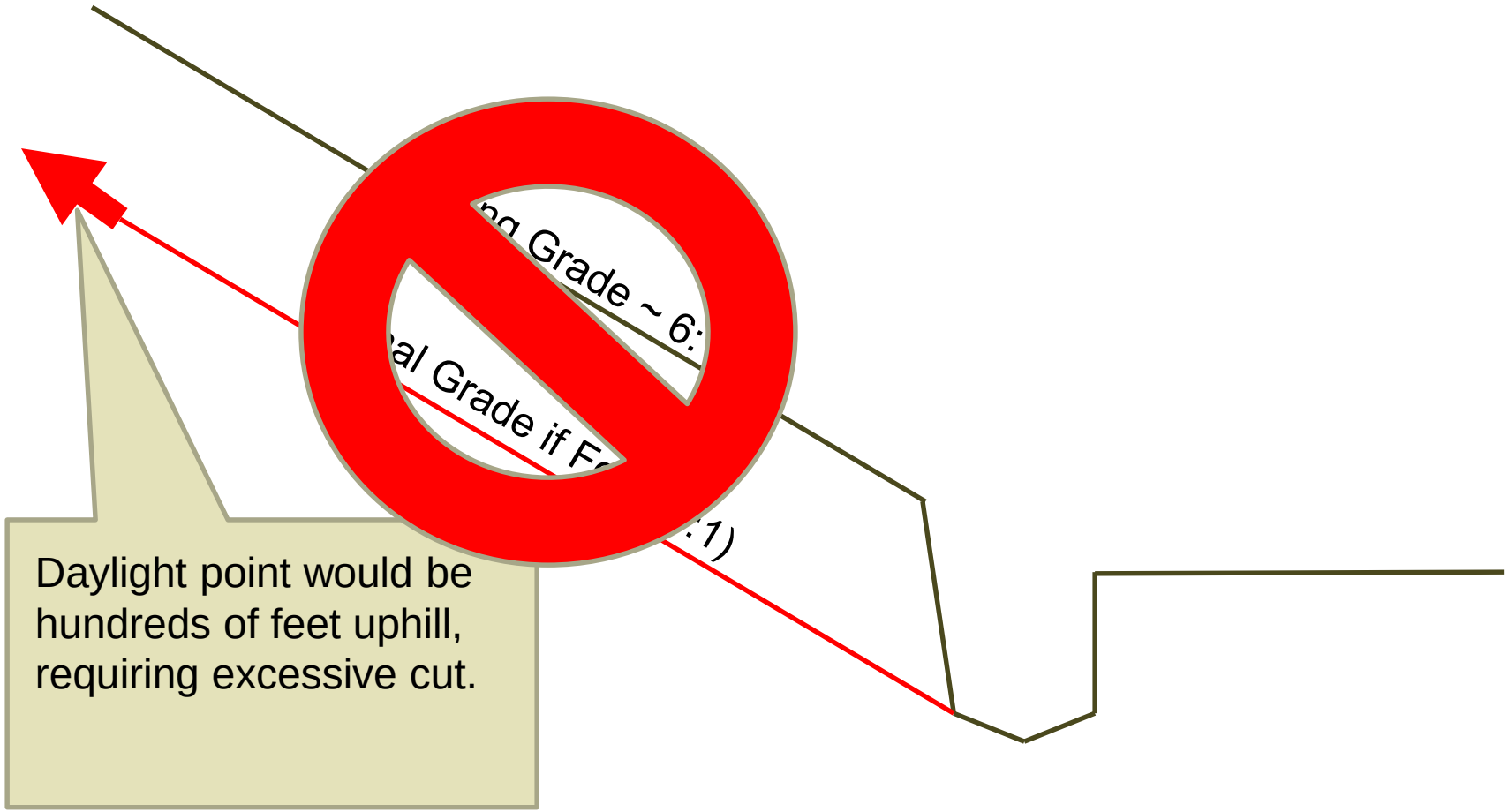
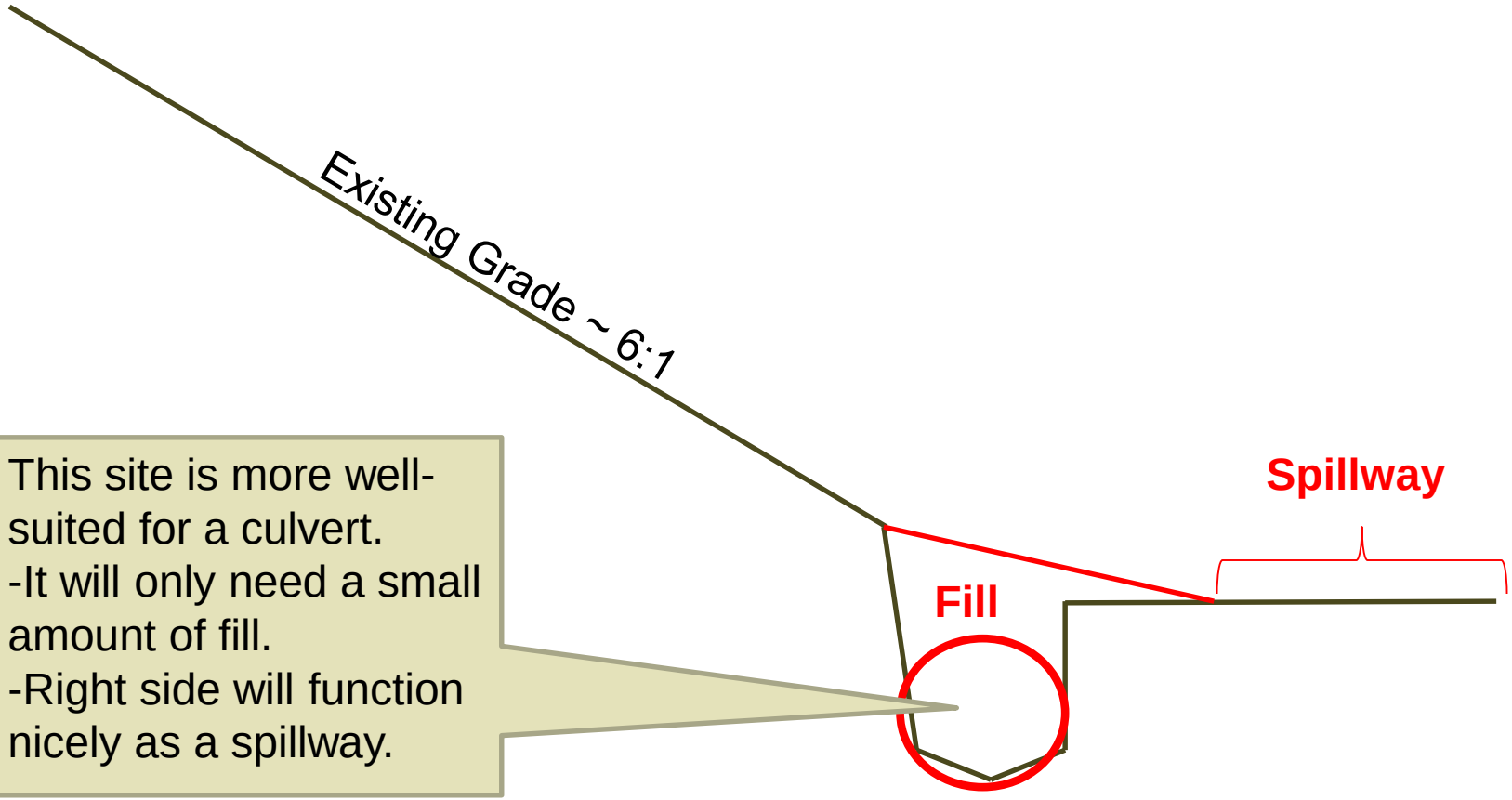
In an area where a 6:1 ramp cannot be achieved for a ford and relocation to a spot where a 6:1 can be achieved is not possible

Sketch of Previous Example:



Sketch of Previous Example:



This site is more well-suited for a culvert.
-It will only need a small amount of fill.
-Right side will function nicely as a spillway.

When NOT to use culverts

- When a ford is feasible
  - Least-cost technically feasible alternative
- When the ONLY reason to install it is because the landowner is pushing for it
- When the culvert size needed to carry the design flow cannot fit in the channel
- VA-578:
  - Where large flows of sediment or large woody material are expected
  - Where channel gradient exceeds 6%

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See DCR Website for more detailed presentation on design of culvert crossings:

- http://www.dcr.virginia.gov/soil-and-water/document/des-strm-xing-culverts.pdf

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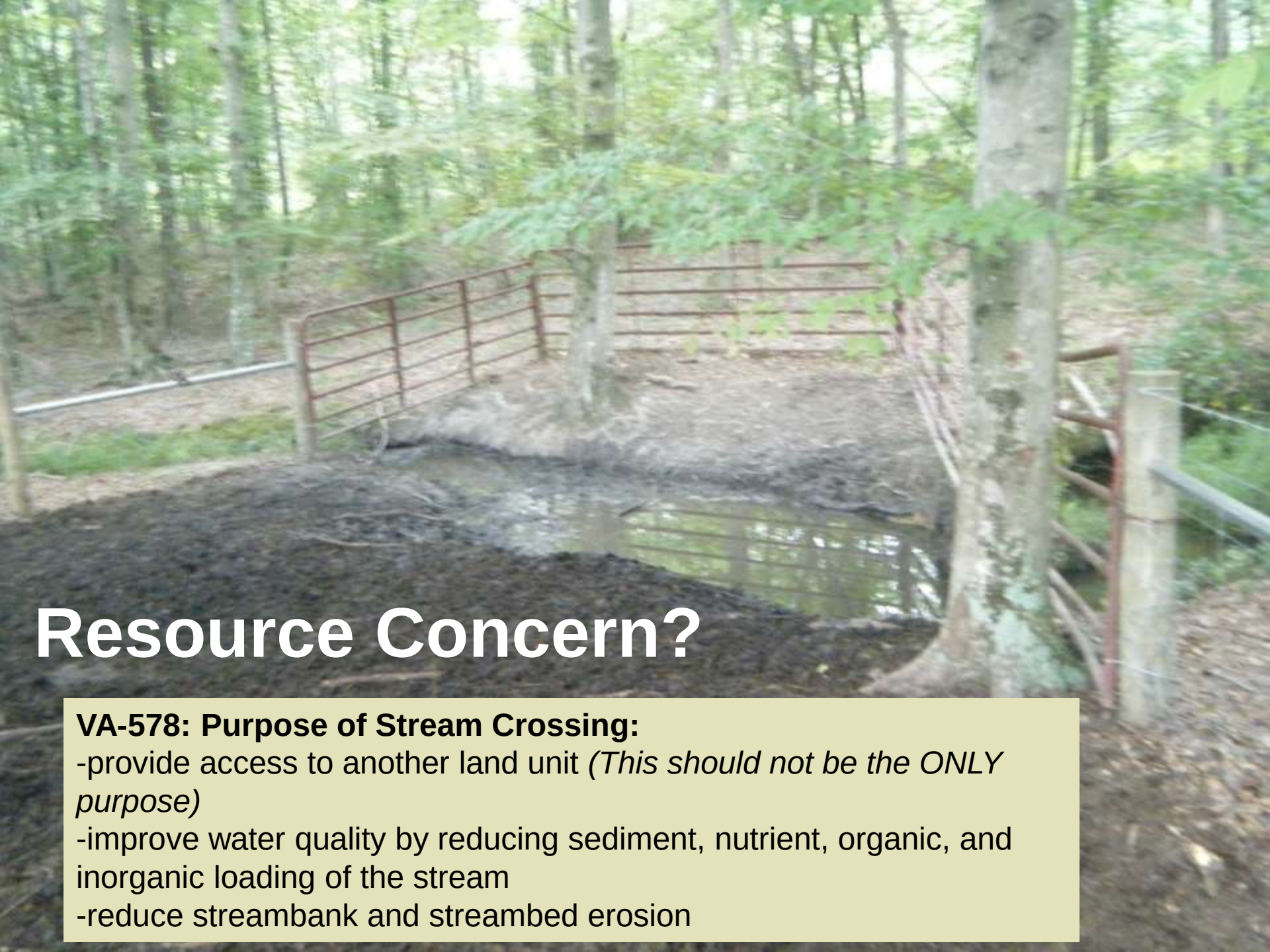
Site Selection

- Conservation Planning Considerations
- Existing vs. New
- Topography
- Wetlands/High Water Table
- Stream Stability
- Stream Bottom
- Watershed/Drainage Area

Conservation Planning Considerations

Before planning a crossing:

- Is there an existing resource concern?
- Will a resource concern be created by a fencing project?
- Are there any alternative solutions?
  - VA-578: “Avoid or minimize the use of or number of stream crossings, when possible, through evaluation of alternative trail or travel-way locations.”
- Is a crossing justifiable?
  - What’s on the other side of the stream? Must be Existing Pasture for SWCD projects



Resource Concern?

VA-578: Purpose of Stream Crossing:
-provide access to another land unit *(This should not be the ONLY purpose)*
-improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream
-reduce streambank and streambed erosion

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Conservation Planning Considerations

Will crossing also serve as a limited access?

- For water quality, typically prefer watering facility over limited access
- If not feasible to install trough (cost, practicality, etc), crossing can serve as limited access
- Fencing Challenges:
  - Must be good enough to contain livestock continuously
  - Especially problematic on large, flood-prone streams
- Ideally: locate limited accesses in stretches of stream with no trees
  - VA-578: “Keep vegetative disturbance in surface waters to a minimum.”

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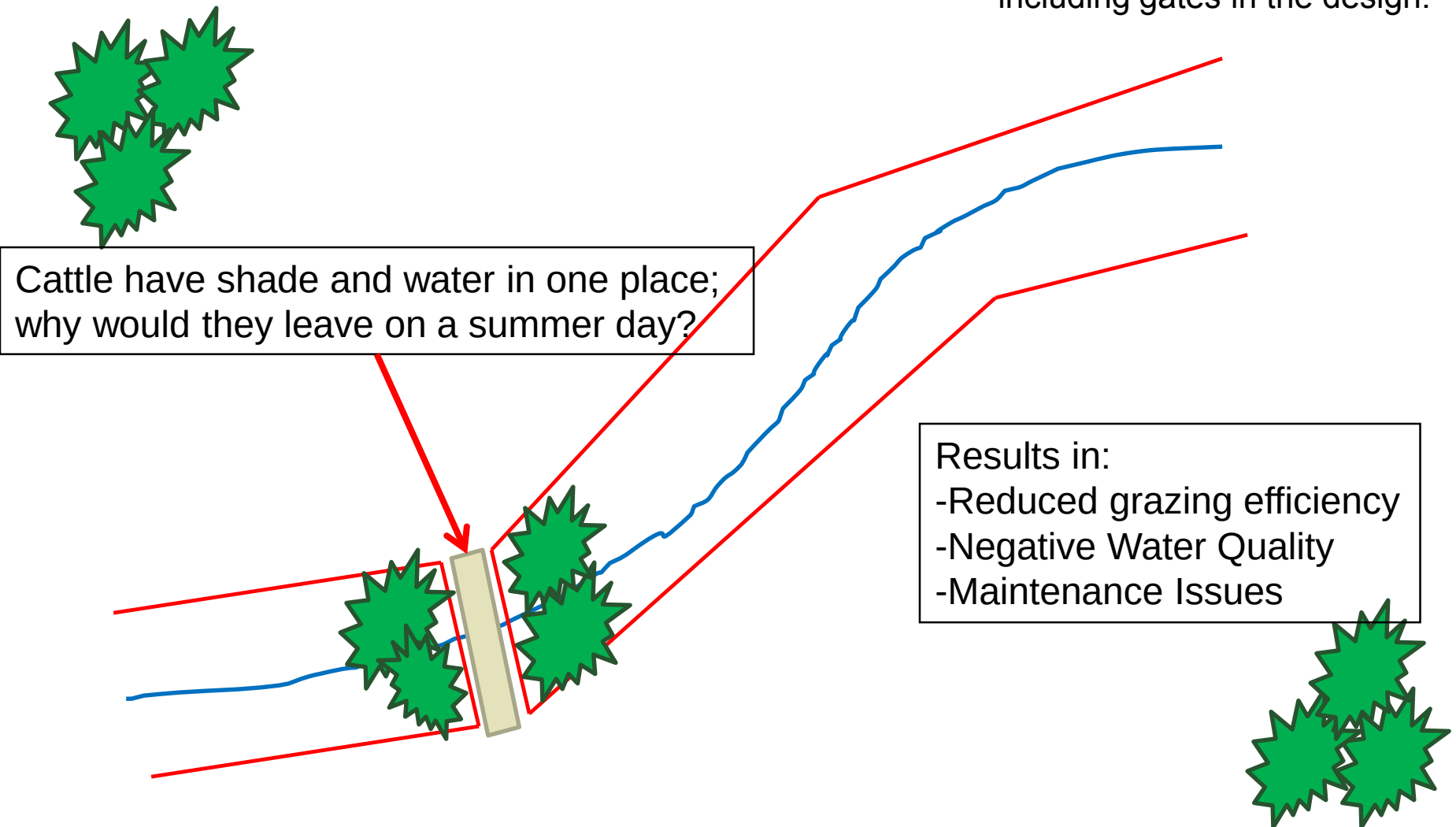
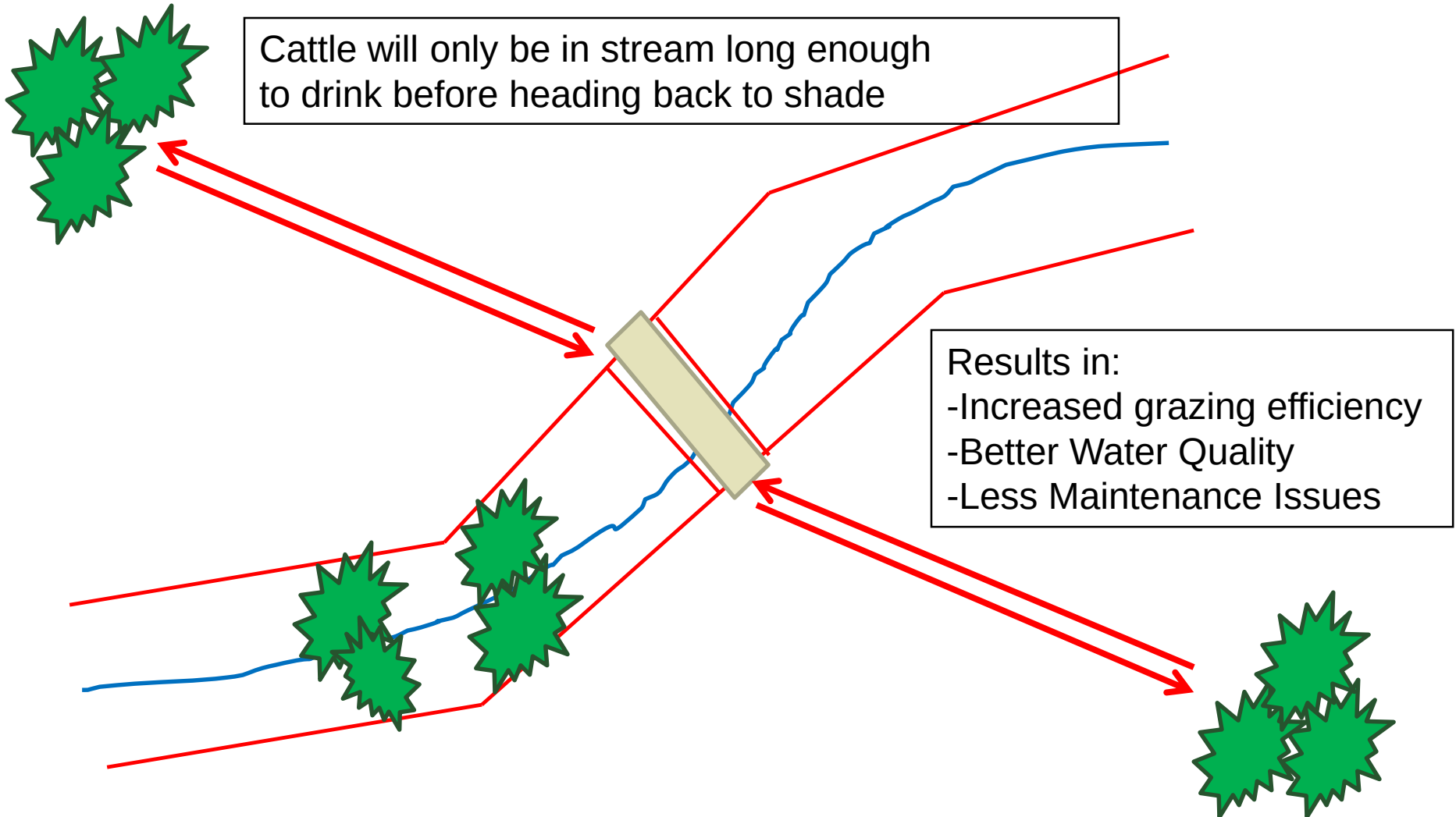
Limited Access in Shade:

VA-578: “Discourage livestock loafing in the stream by locating crossings, where possible, out of shady riparian areas or by including gates in the design.”



Limited Access Outside of Shade:



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Limited Access

- Reference CPS 614 “Watering Facility” if also serving as a limited access

NATURAL RESOURCES CONSERVATION SERVICE

VIRGINIA CONSERVATION PRACTICE STANDARD

WATERING FACILITY

(No.)

CODE 614

Watering Ramps

Where livestock or wildlife will drink directly from a pond or stream, use a watering ramp to provide a stabilized access to the water. Evaluate the existing and proposed fences, grazing patterns, shoreline slope, and water depth when choosing the optimum location for the ramp.

Width. Make the ramp wide enough to accommodate the expected usage but not less than 12 feet.

Length. Extend the ramp into the stream or pond far enough to achieve the desired depth during the driest times of the year.

Surface drainage. Divert surface runoff from the approach to the ramp.

Slope. Make the slope of the watering ramp consistent with planned animal usage but not steeper than 3:1.

Side slopes. Make all side slope cuts and fills stable for the soil materials on the site. Make the side slopes of cuts or fills in soil materials no steeper than 2 horizontal to 1 vertical (2:1). Make rock cuts or fills no steeper than 1.5 horizontal to 1 vertical (1.5:1).

Foundation. Where necessary, prepare the foundation by removal and disposal of material that are not adequate to support the design loads.

Surface material. Use the criteria in NRCS CPS *Heavy Use Area Protection (Code 561)* to design the ramp surface. The selected material must be of adequate quality to withstand underwater conditions.

Access. Use fencing or other barriers to delineate the boundaries of the ramp. Use Virginia NRCS CPS *Fence (Code 382)* for the design and construction of a fence. Barriers must be of sufficient size, strength, and quality to meet the intended use of the facility. Do not use electric fencing in the area immediately adjacent to the water.

Ramps in Streams. Use the criteria in Virginia NRCS CPS *Stream Crossing (Code 578)* for the design and construction of a ford crossing except as noted above.

Locate the watering ramp so that it does not impede the movement of aquatic organisms in the stream.

Ramps in Ponds. A minimum water depth of 3 feet, measured from the designed permanent water level, is recommended. Where the pond depth is greater than 3 feet at the ramp location, it may be necessary to excavate the ramp into the pond bank to provide a stable base at the lower end. Extend the ramp a minimum of 0.5 feet above the designed permanent water level.

Watering ramps. Where livestock exclusion from a stream is part of the planned installation, consider installing a watering ramp that can be used if emergency access to water is needed. Use a gate to restrict access to the ramp.

The slope of the ramp can influence animal behavior. Steeper slopes tend to discourage loitering in the ramp area.

Select a surface material for the ramp that will discourage loitering but still provide a stable footing. The larger stone will make the hoof contact slightly uncomfortable.

Avoid locating watering ramps in shady places where possible.

It is difficult to put a fence in the middle of a stream. Where possible, extend the fence completely across the stream. Swinging gates can be used to restrict animal movement.

NATURAL RESOURCES CONSERVATION SERVICE
VIRGINIA CONSERVATION PRACTICE STANDARD

WATERING FACILITY

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It is difficult to put a fence in the middle of a stream. Where possible, extend the fence completely across the stream. Swinging gates can be used to restrict animal movement.

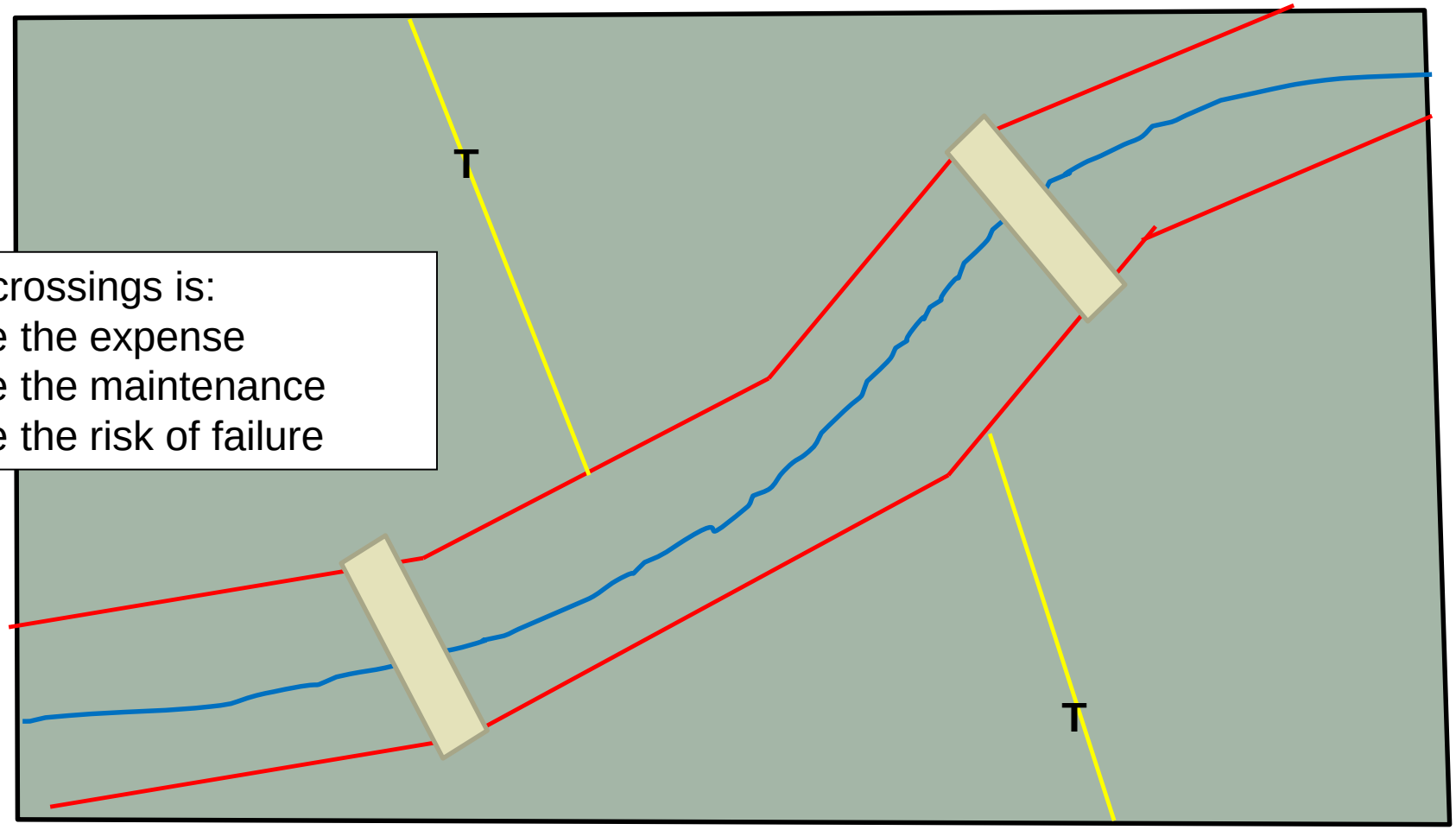
Conservation Planning Considerations

- Avoid areas that will require excessively long walkways (adds to initial cost and maintenance)

Sometimes, your best option may still be a long road…

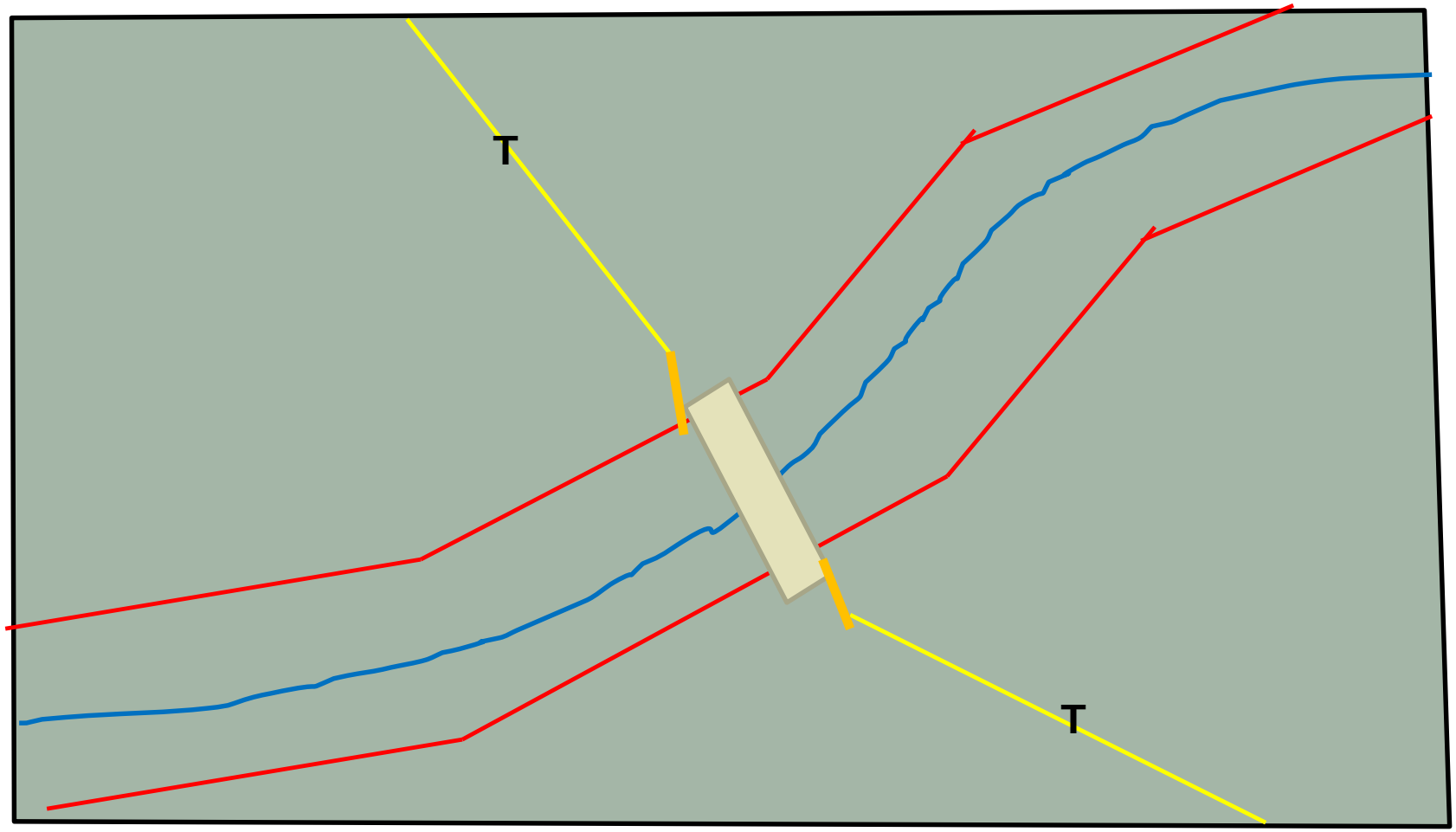
- Planning new infrastructure around crossing locations can maximize use while minimizing cost

Consider this farm:



Two crossings is:
-twice the expense
-twice the maintenance
-twice the risk of failure

Consider this farm:



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Beware of potential management issues…


This looks like a decent crossing location…

…but the landowner has historically fed adjacent to it, and on the far side of the stream from his hay storage. Old habits die hard. Landowner will likely continue to feed here, resulting in excessive livestock and tractor movement in the crossing. This will likely increase maintenance requirements.

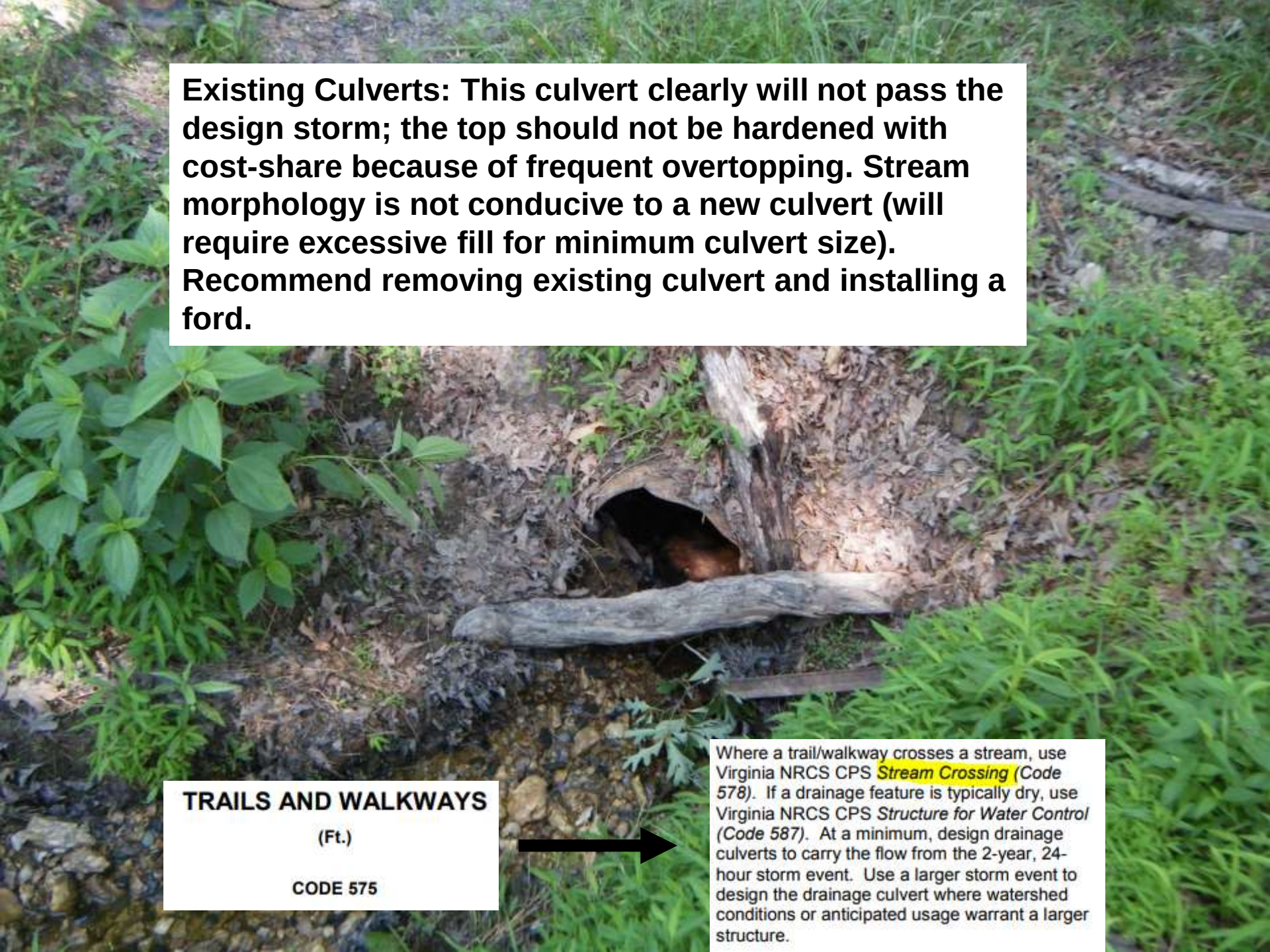
Existing vs. “New” Crossing Sites

- Typically, the livestock and/or landowner have already found the best available crossing location
  - Naturally solid bottom
  - Easy approaches
  - May be excavated already
- Infrastructure may already be set up for the existing location
- Existing sites are better regarding environmental compliance


LFSWCD

When NOT to use an Existing Crossing:

- Existing maintenance issues
  - Stream Instability
  - Banks eroded too far back
- Existing culverts that are too small or will not last
- When there is a clearly better location



Existing Culverts: This culvert clearly will not pass the design storm; the top should not be hardened with cost-share because of frequent overtopping. Stream morphology is not conducive to a new culvert (will require excessive fill for minimum culvert size). Recommend removing existing culvert and installing a ford.

TRAILS AND WALKWAYS

(Ft.)

CODE 575

Where a trail/walkway crosses a stream, use Virginia NRCS CPS *Stream Crossing (Code 578)*. If a drainage feature is typically dry, use Virginia NRCS CPS *Structure for Water Control (Code 587)*. At a minimum, design drainage culverts to carry the flow from the 2-year, 24-hour storm event. Use a larger storm event to design the drainage culvert where watershed conditions or anticipated usage warrant a larger structure.

Topography

- Avoid areas where the stream crossing will begin/end at base of a steep slope
- Exceptionally flat (floodplain) areas
  - will require excavated material to be moved long distances
  - May require armoring a longer distance if wet
- All else being equal, select a site where the stream grade is lower to reduce expected velocity


10/15/2015

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Beware of upland drainage. Here is an instance where a swale discharges across the armored portion of the crossing and it has started to wash away. Some of this can be corrected by ditches/diversions, but all else being equal, avoid areas such as this.

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Wetlands/High Water Tables

AVOID because of:

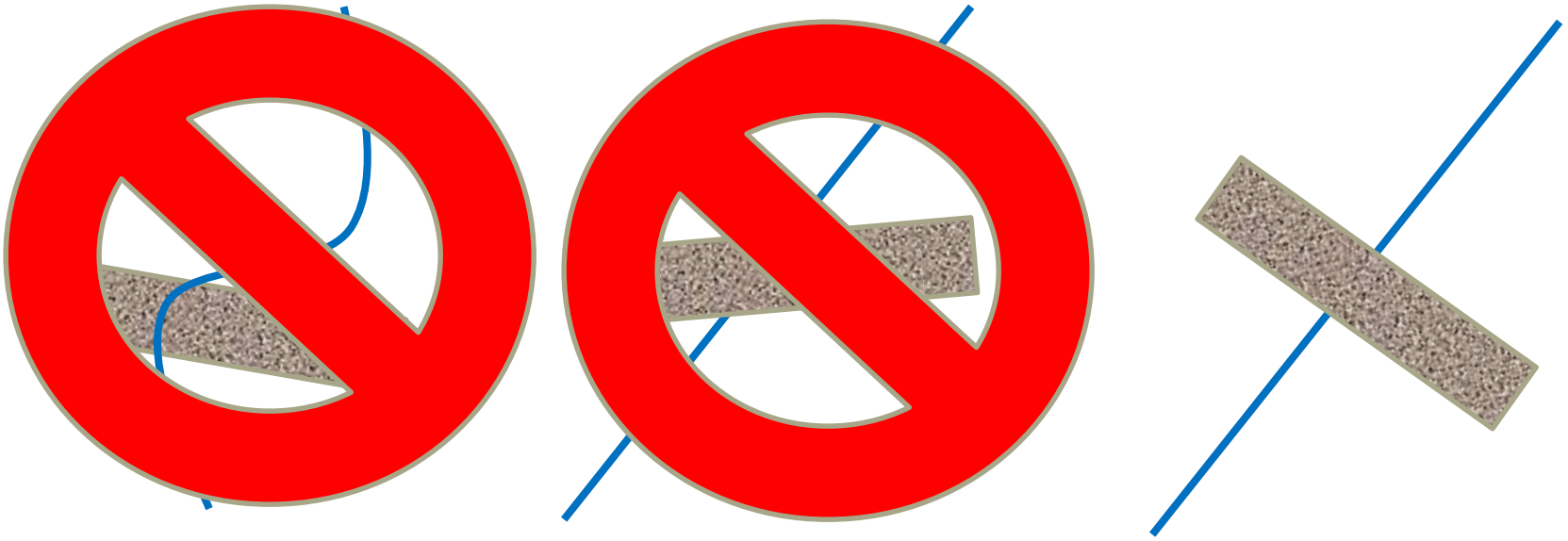
- Permitting/Environmental Compliance Issues
- Construction Issues
  - Equipment issues
  - Lack of suitable subgrade
  - Hydrostatic pressure under geotextile → "pumping"
- Check for high water table during soil investigation

VA-578: "Avoid wetland areas."

Equipment Issues

Stream Stability

- Select a spot where the crossing will be perpendicular to the stream in a relatively straight stretch of the stream



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Stream Stability

- Avoid turbulent areas
  - Immediately downstream of culverts (esp. roadway culverts)
    - VA-578: “Ford crossings should not be placed immediately downstream from a pipe or culvert because of potential damage from localized high velocity flows.”
  - Near large boulders
  - Rapid grade changes
- VA-578: “Do not place crossings where channel grade or alignment changes abruptly, excessive seepage or instability it evident, overfalls exist (evidence of incision and bed instability), where large tributaries enter the stream…”

Stream Bottom

- If the stream bottom is solid enough for vehicles/tractors to cross, then you may only need to harden the ramps and not mess with the streambed
  - Make sure grades can be achieved – check for bedrock in areas where ramps would be cut
- Areas immediately upstream of “riffle” sections *generally* make good crossing locations
  - Solid stream bottom
  - Low depth of water

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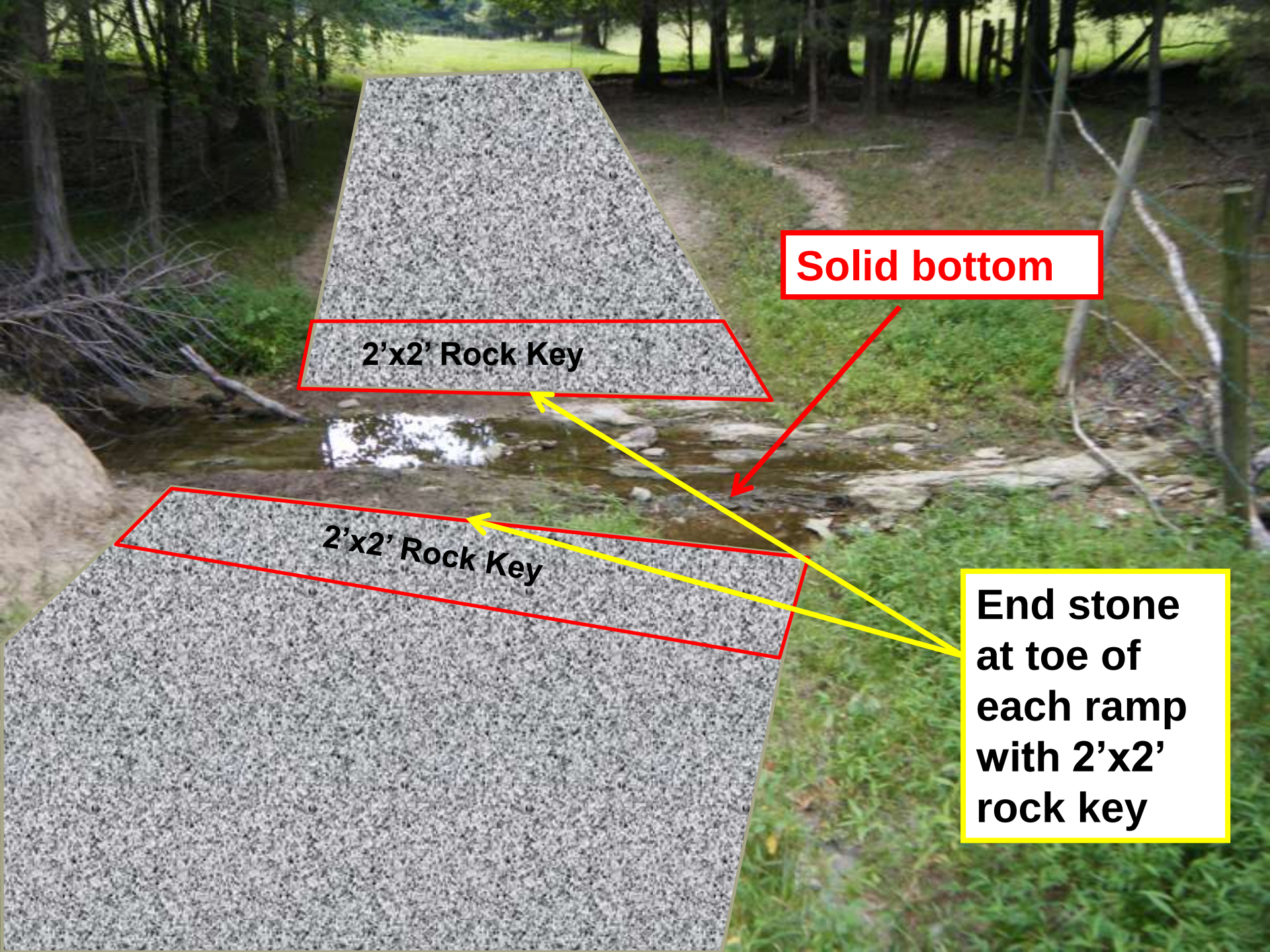
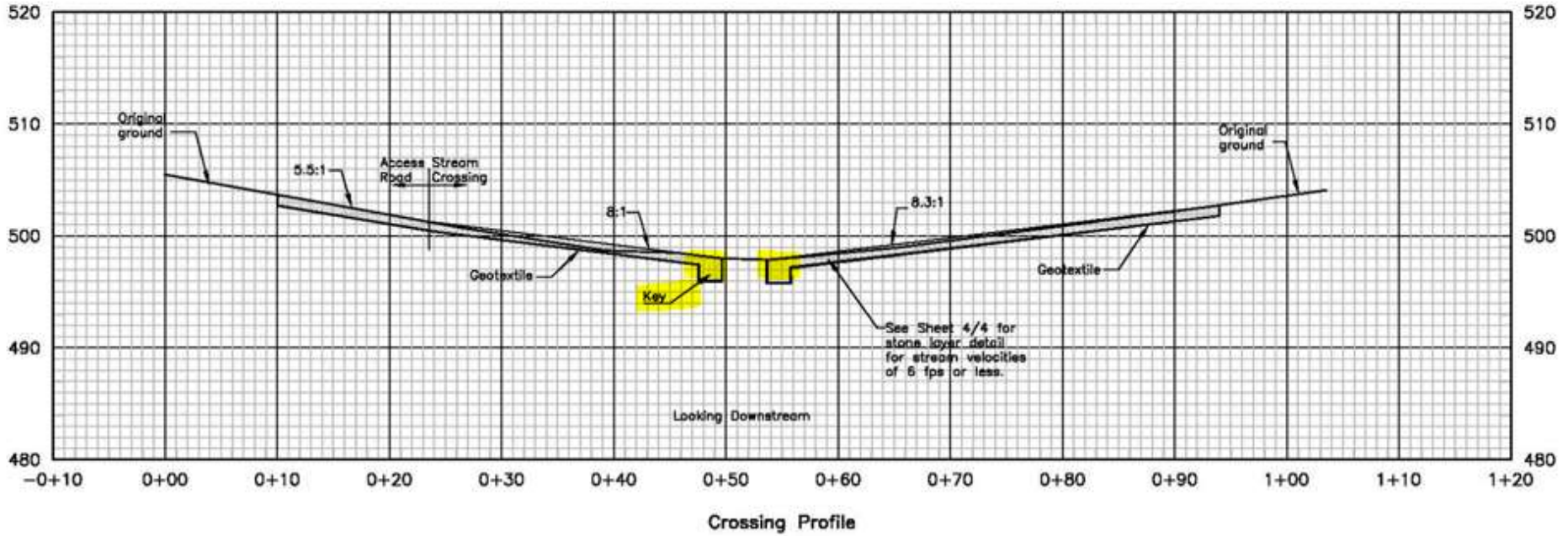

Solid bottom
2’x2’ Rock Key
2’x2’ Rock Key
End stone at toe of each ramp with 2’x2’ rock key



Crossing Profile

Stream Crossing Profile
(On centerline of crossing)

Scale:
Horizontal 1"= 10'-0" Vertical 1"= 10'-0"

Stream Crossing Design Notes

1. The slope of the approaches (ramps) shall be 6:1 or flatter. (8:1 is recommended)
2. If livestock will have access to the side slopes, then the side slopes shall be armored. If fencing will restrict livestock access, the side slopes may be seeded. Grade side slopes to 3:1 or flatter if they are to be seeded. Grade side slopes to 2:1 if they are to be armored. Armoring shall consist of 6 inches of VDOT #1 (2" to 4") stone over geotextile.
3. If necessary to provide a solid bottom at the crossing, the existing streambed shall be excavated to the depth of the selected Typical Stone Layer (on Sheet 2). Any stone placed to harden the channel bottom must be installed below the existing natural grade of the stream.
4. If no stone is needed to harden the stream bottom, then the stone on the ramps shall be placed so that the ramps blend naturally into the streambed. A 2'x2' rock key may be placed at the end of each ramp to provide toe protection. Do not place any stone that will obstruct the natural flow path of the stream.
5. Excavated material shall be spread outside of the floodplain.
6. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification VA-795 Geotextiles. Class II may be used with engineers approval.
7. Seed all disturbed areas according to the Attachment to Virginia Construction Specification VA-706. Seeding.

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Watershed/Drainage Area

- Less DA means (generally) lower peak flow, but not necessarily lower velocity
- Must be less than 5 square miles to fall under 578 blanket permit (USACE, VMRC, DEQ, etc.)
  - See the standard for the full list of conditions that must be met for the JPA exemption
- VA-578: “Do not place crossings…where large tributaries enter the stream…”

USGS StreamStats https://streamstats.usgs.gov/ss/

- A quick delineation tool to tell you if your watershed is above or below 5sq.mi. of drainage area!

Site Selection: Final Tip

- Walk as much of the stream as possible. You might find a decent site for a stream crossing, but there may be an even better site that you could miss if you don't inventory the whole stream.
- All else being equal, select a site that is close to the spoil site.

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Sometimes the best engineered solution is not an engineered one.

Not every site is suitable for a stream crossing. Look for management alternatives.

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Survey/Field Data Collection

Survey/Field Data Collection

- Soils Investigation
- Survey
- Manning's "n" Recon
- Photographs

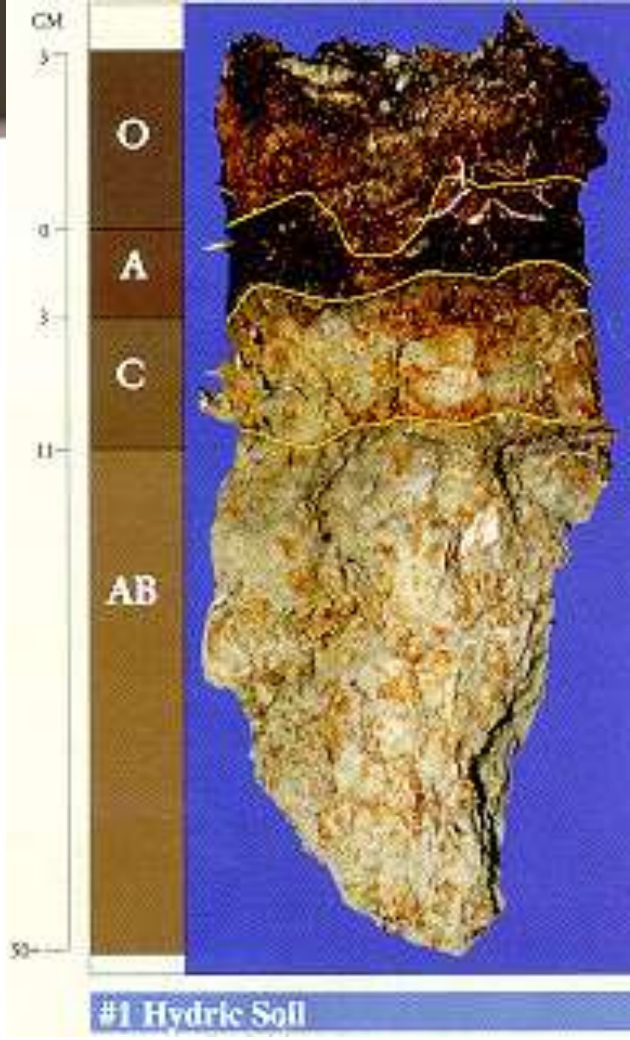
See the "Design Data" section of the 578 standard.

Soils Investigation

- Perform an on-site soils investigation at the crossing site
- Do borings prior to surveying to make sure site will work
- Do borings where cut will occur

Soils Investigation: What to Look For

- Layers that would affect construction:
  - Bedrock
  - Sand Lenses
  - Water Table
  - Mottling (evidence of hydric soils)
    - Typically orange/red/brown streaks/spots in gray soils



https://www.na.fs.fed.us/spfo/pubs/n_resource/wetlands/wetlands5_soils.htm

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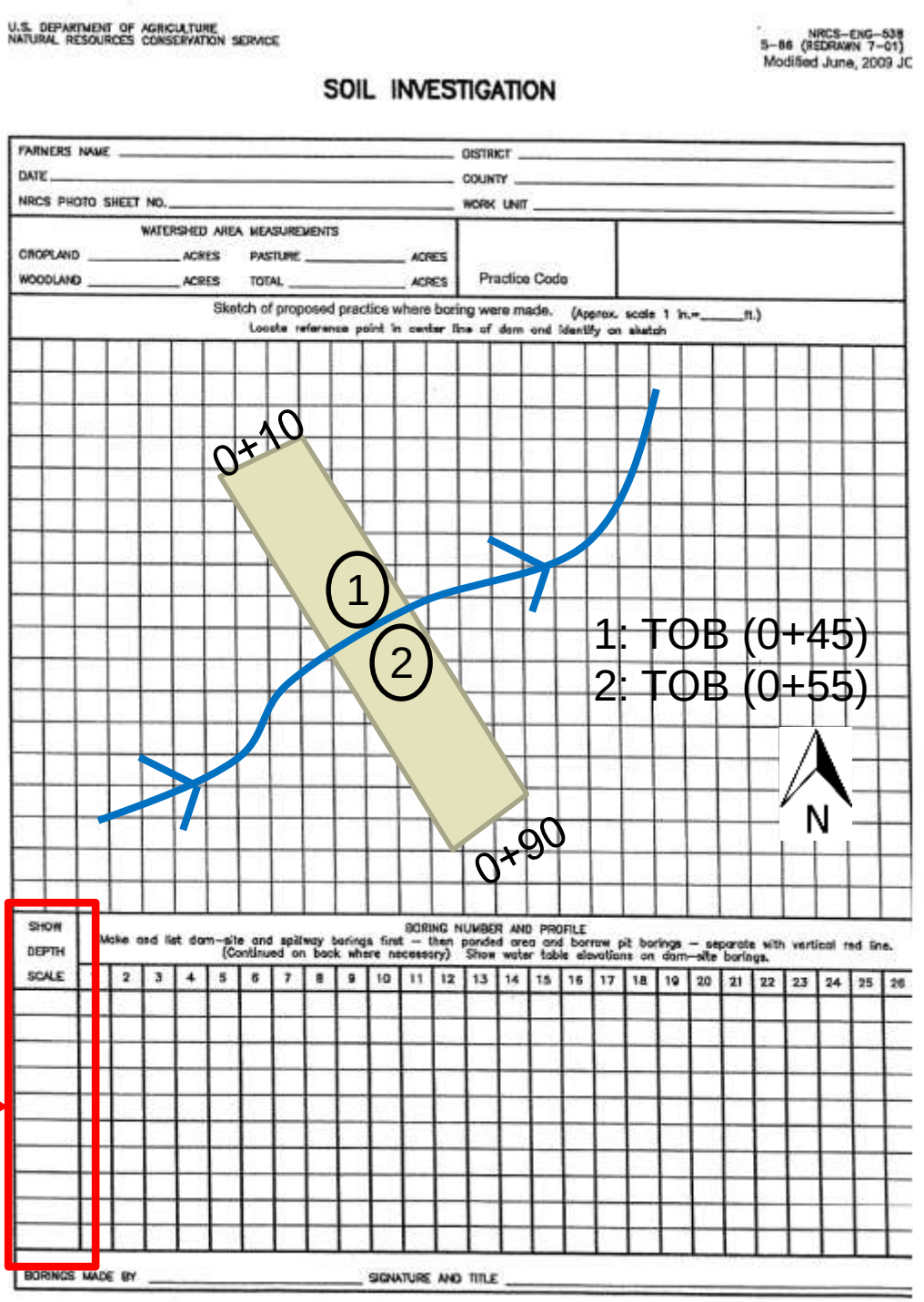
Pick locations where cut will occur (typically at least one boring on each top of bank; if significant cut will be needed, do more borings).

Typically use 0.5ft increments (depth of bucket of soil auger)



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Make notes about your findings on the back of the form.

NRCS–ENG–538
(CONTINUATION)

TYPES OF MATERIAL ENCOUNTERED IN BORINGS
(Use one of systems below)

UNIFIED CLASSIFICATION

GW – Well graded gravel; gravel, sand mix
GP – Poorly graded gravels
GM – Silty gravels; gravel–sand–silt mix
GC – Clayey gravels; gravel–sand–clay mix
SW – Well graded sands; sand–gravel mix
SP – Poorly graded sands
SM – Silty sand
SC – Clayey sands; sand–clay mixtures
ML – Silts; silty, v. fine sands; sandy or clayey silt
CL – Clays of low to medium plasticity
CH – Inorganic clays of high plasticity
MH – Elastic silts
OL – Organic silts and silty clays, low plasticity
OH – Organic clays, medium to high plasticity

USDA CLASSIFICATION

g – gravel
s – sand
vfs – very fine sand
sl – sandy loam
fsl – fine sandy loam
l – loam
gl – gravelly loam
si – silt
sil – silt loam
cl – clay loam
sicl – silty clay loam
scl – sandy clay loam
sic – silty clay
c – clay

1. Suitable material is available for practice. ☐ YES ☐ NO (Indicate where located on the sketch on reverse side)

REMARKS:

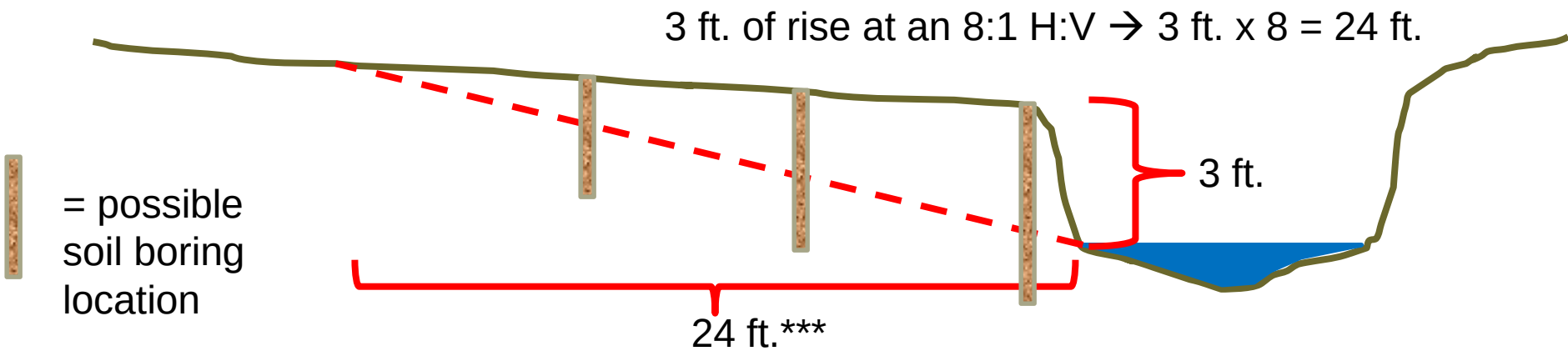
2. Explain hazards requiring special attention in design (Seepage, spring, rock, etc.)

GENERAL REMARKS:

27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54

Tips for Soils Investigations

- Do a quick calculation to determine where the final grade will daylight
  - Lets you make sure the crossing will be reasonable and that you've collected enough survey and soil boring data



***This distance will actually be longer if the "top of bank" elevation is lower than the estimated daylight point; this will just get you "in the ballpark"

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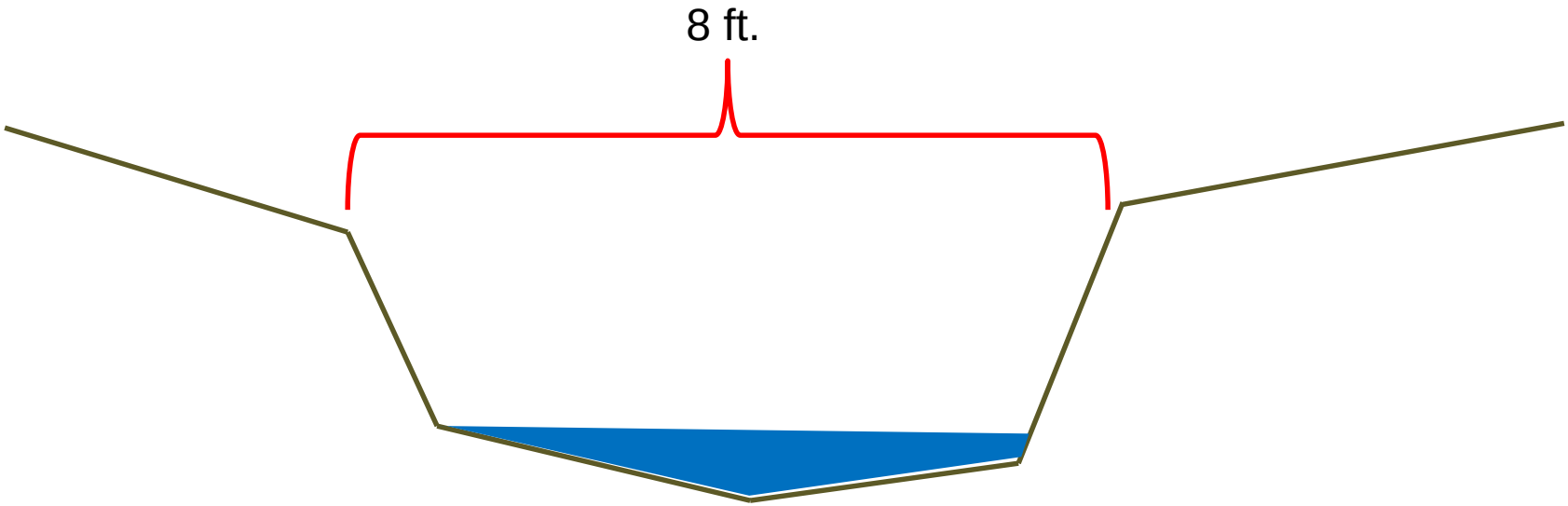
3. Survey and plot data: profile, cross-sections, topography, as needed.
   a. Survey and plot profile along centerline of stream (distance should be sufficient to determine channel slope).
   b. Survey and plot the existing cross-section perpendicular to the flow, extending beyond the ends of the planned ramps to ensure adequate representation of the designed cross section. Include typical cross sections as needed.

Survey Data

- Cross-section of stream along centerline of proposed crossing
- "Natural" or "typical" cross-section of stream if crossing site has been altered
  - "Natural" cross-section will be used for velocity calculations
- Upstream and downstream stream centerline points to calculate stream slope
  - Take shots in riffles, not in pools
  - DN-578: "collect points along a reach that extends at least 10 bankfull widths upstream and downstream of the crossing site"

“Bankfull Widths” Example

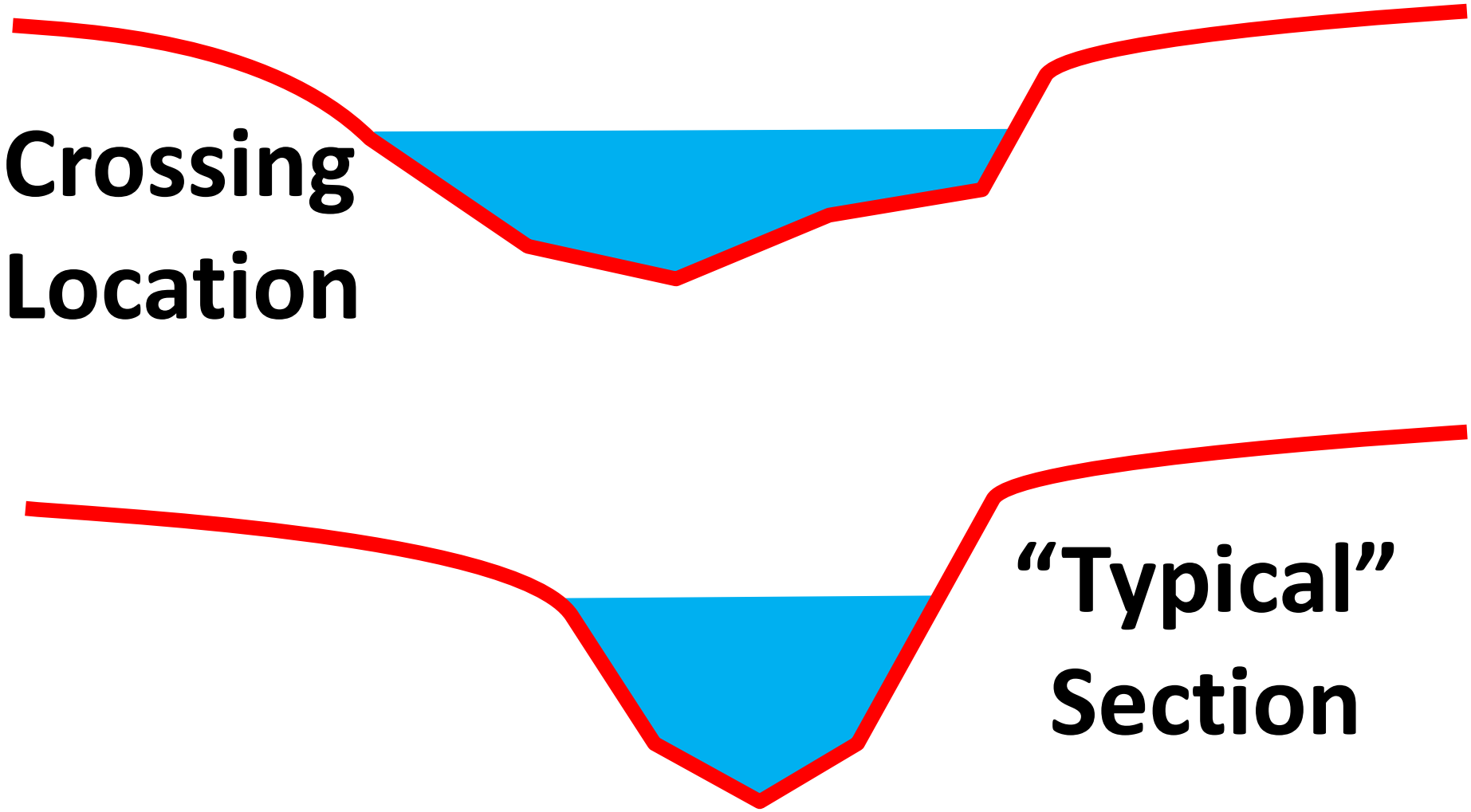


Bankfull Width: 8 ft.
10 Bankfull Widths: 8 ft. x 10 = 80 ft.
Find riffles for stream slope shots at least 80 ft. upstream and 80 ft. downstream

Channel Slope, S:

Survey “riffle to riffle.”

Survey 2 Cross-Sections:



Survey Cross-Sections

- Capture enough elevation data to make an accurate representation on paper
- Take at least 7-points:

1. Enter Survey Data (ft):		
	Distance (ft)	Elevation (ft)
Cross Section:		
Left Floodplain		
Top Left Bank		
Toe Left Bank		
Center		
Toe Right Bank		
Top Right Bank		
Right Floodplain		

- Survey to the fence setbacks; recommend going farther to make sure you capture enough data

Surveying Suggestion

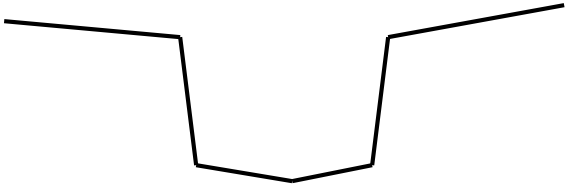
It is better to take too many survey shots in the field and not need a few than to get back to the office and realize that you should've taken a few more than you did!

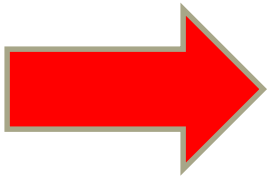
Measuring the Survey Stations

- The survey stations for the cross-sections need to be measured in such a way that they reflect *only* the horizontal distance.
- A measuring wheel is fine for relatively flat areas, but at the channel, use a measuring tape or lay the survey rod horizontally to measure the horizontal distance.

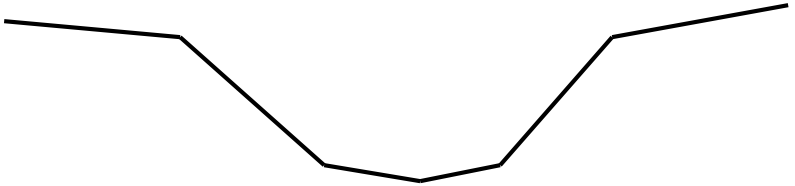
Using the measuring wheel to measure stations across the channel will result in a distorted representation on paper and will affect the velocity calculations.

A channel that actually looks like this…





…will look more like this on paper if survey stations are measured with the wheel.



A tape (pulled taut) or rod across the channel will accurately measure horizontal distance.

Recommended Approach:

- Use pin flags to temporarily mark survey point locations
- Measure horizontal distance between pin flags & write on station number on flag
- Use wood stakes (with lumber crayons) to mark permanent locations
  - E.g., planned start of stream crossing

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“Bankfull”

- VA-578 requires rock ford crossings to “remain stable for the bankfull flow”
  - Lower top of bank elevation
  - “Bankfull flow is the discharge that fills a stream channel up to the elevation at which flow begins to spill onto the floodplain”
- Bankfull elevations are not always easy to determine
- When in doubt, take plenty of survey shots and take good notes

Bankfull Indicators

- Elev. of active floodplain
- Change in vegetation
- Tops of depositional bars
- Break in bank slope
- Change in bank material (from coarser to finer)
- Small inundation benches
- Staining on rocks
- Exposed root hairs

Survey Notes Sketch

- North
- TBM Location and Description
- Stream Flow Direction
- Centerline of Crossing with Direction of Stations
  - Typically survey from left to right looking downstream
- Location of “natural” cross-section (if needed)
- Existing fences and structures
- Note planned crossing width (discuss with landowner)

Deciding on Crossing Width

- VA-578:
  - Multi-Use (Equipment+): No less than 12ft.
  - Livestock-Only: 8ft. to 30ft. wide
  - 16ft. wide will suffice for most equipment, but be sure to ask the producer
- VA-614: “not less than 12 feet”

Design the “least-cost technically feasible” alternative.

Manning's "n" Recon

- Gather information about the channel to determine the Manning's "n" value when you get back to the office
- This value will be used to help determine the bankfull velocity
- Print the following worksheet to take with you and circle values while you're in the field

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- Page 40 of DN-578

- Keep in mind: total values for most Virginia streams will be between 0.035 and 0.075

Table 2. Factors Affecting Manning's *n* (based on the *Virginia Erosion and Sediment Control Handbook* and USGS WSP 2339).

n factor	Condition of Channel or Floodplain	n Value or Adjustment Factor	Description for Channels	Description for Floodplains
n_1 (Base Value: Material)	Earth	0.02		
	Rock	0.025		
	Fine gravel	0.024		
	Coarse gravel	0.028		
n_2 (Adjustment for Irregularity)	Smooth	0	Smoothest attainable for materials	Smoothest and flattest attainable for materials
	Minor	0.005	Good dredged channels; slightly eroded side slopes	Slightly irregular in shape with a few dips, rises, or sloughs.
	Moderate	0.010	Fair to poor dredged channels; moderately eroded side slopes	More rises, dips, sloughs, hummocks
	Severe	0.020	Badly sloughed banks of natural streams	Very irregular with many rises, dips, or sloughs. May have furrows perpendicular to flow.
n_3 (Adjustment for variation in cross section size and shape for channels)	Gradual	0	Gradual change	Not applicable to floodplains.
	Occasional	0.005	Large and small sections alternating occasionally	
	Frequent	0.010-0.015	Large and small sections alternating frequently	
n_4 (Adjustment for obstructions)	Negligible	0	Obstructions (debris, stumps, roots, boulders) occupy less than 5% of the cross-sectional area	Obstructions (debris, stumps, roots, boulders) occupy less than 5% of the cross-sectional area
	Minor	0.010-0.015	Obstructions occupy less than 15% of the cross-sectional area	Obstructions occupy less than 15% of the cross-sectional area
	Appreciable	0.020-0.030	Obstructions occupy 15%-50% of the cross-sectional area	Obstructions occupy 15%-50% of the cross-sectional area
	Severe	0.040-0.060	Obstructions occupy more than 50 % of the cross-sectional area	Obstructions occupy more than 50 % of the cross-sectional area
n_5 (Adjustment for vegetation)	Low	0.005-0.010	Dense turf grass or weeds with avg. depth of flow = 2 or more times the vegetation height. Tree switches with avg. depth of flow = 3 or more times the vegetation height.	Dense turf grass or weeds with avg. depth of flow = 2 or more times the vegetation height. Tree switches with avg. depth of flow = 3 or more times the vegetation height.
	Medium	0.010-0.020	Turf grasses with flow 1-2 times height of grass; stemmy grasses, tree seedlings with flow 2 to 3 times height of veg.; bushy growth, dormant season, no veg. along bottom, with R>2 ft.	Turf grasses with flow 1-2 times height of grass; stemmy grasses, tree seedlings with flow 2 to 3 times height of veg.; bushy growth, dormant season, no veg. along bottom.
	High	0.025-0.050	Turf grass with flow = height of grass; willows, cottonwoods in the dormant season with R = 2 to 4 ft.	Turf grass with flow = height of grass; willows, cottonwoods in the dormant season.
	Very High	0.050-0.100	Turf grass with very shallow flow; bushy willows; trees with full foliage and weeds with R = 10 to 12 ft.	Turf grass with very shallow flow; bushy willows; trees with full foliage and weeds.
n_6 (Adjustment for sinuosity)	Minor	0	Meander length/straight length = 1.0 to 1.2	Not applicable to floodplains.
	Appreciable	$0.15n_6$	Meander length/straight length = 1.2 to 1.5	
	Severe	$0.30n_6$	Meander length/straight length = 1.5 and greater	
			Where $n_6 = n_1 + n_2 + n_3 + n_4 + n_5$	

Photographs

- Take pictures while you're surveying for the following uses:
  - If needed for T&E Review
    - Stream Crossing Location
    - Facing Upstream of Crossing
    - Facing Downstream of Crossing
    - Banks
    - Streambed
  - To help with Manning's "n" determinations
  - For "Before & After" purposes
  - To send to DCR or NRCS engineering staff if you have questions while designing


Before


After

Design

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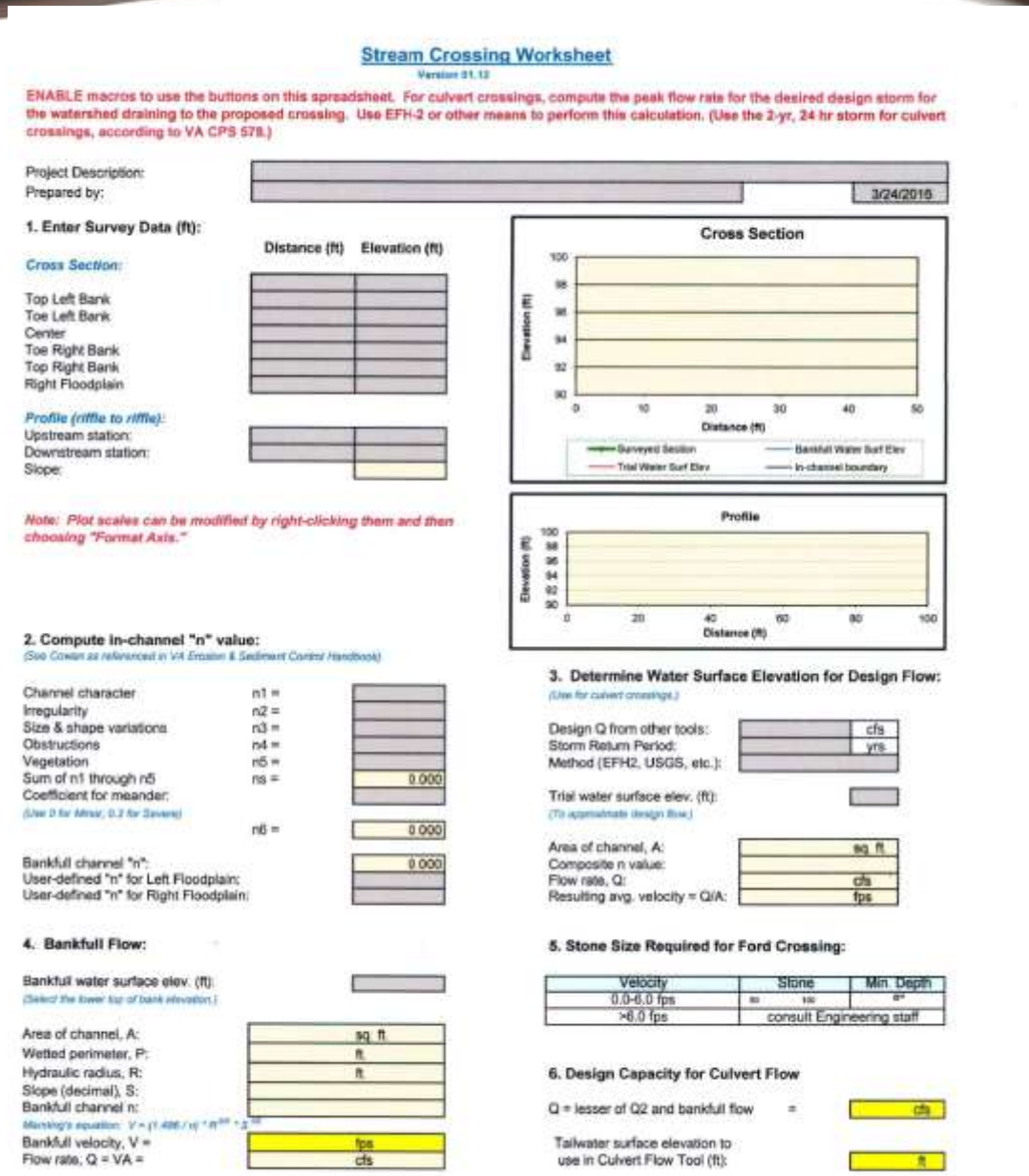
Design

1) Velocity Calculations
2) Determine Stone Layers
3) Plot on Stream Crossing Design Sheets
4) Determine Ramp Slope
5) Complete Design Packet

1) Velocity Calculations

- NRCS "Stream Crossing worksheet" makes velocity calculations easy
- If your cross section does not follow the normal 7-point profile:
  - Calculate manually (see DN-578, pg.10 & 41-42)
  - Use another cross-section analyzer worksheet



Stream Crossing Worksheet

Version 01.12

ENABLE macros to use the buttons on this spreadsheet. For culvert crossings, compute the peak flow rate for the desired design storm for the watershed draining to the proposed crossing. Use EFH-2 or other means to perform this calculation. (Use the 2-yr, 24 hr storm for culvert crossings, according to VA CPS 578.)

Project Description:
Prepared by: 3/24/2016

1. Enter Survey Data (ft):

Cross Section:

	Distance (ft)	Elevation (ft)
Top Left Bank		
Toe Left Bank		
Center		
Toe Right Bank		
Top Right Bank		
Right Floodplain		

Profile (riffle to riffle):

Upstream station:		
Downstream station:		
Slope:		

Note: Plot scales can be modified by right-clicking them and then choosing "Format Axis."

Cross Section

Profile

2. Compute in-channel "n" value:

(See Cowan as referenced in VA Erosion & Sediment Control Handbook)

Channel character	n1 =	
Irregularity	n2 =	
Size & shape variations	n3 =	
Obstructions	n4 =	
Vegetation	n5 =	
Sum of n1 through n5	ns =	0.000
Coefficient for meander: (Use 0 for Minor, 0.3 for Severe)		
	m5 =	0.000
Bankfull channel "n":		0.000
User-defined "n" for Left Floodplain:		
User-defined "n" for Right Floodplain:		

3. Determine Water Surface Elevation for Design Flow:

(Use for culvert crossings.)

Design Q from other tools:		cfs
Storm Return Period:		yrs
Method (EFH2, USGS, etc.):		
Trial water surface elev. (ft): (To approximate design flow.)		
Area of channel, A:		sq. ft
Composite n value:		
Flow rate, Q:		cfs
Resulting avg. velocity = Q/A:		fps

4. Bankfull Flow:

Bankfull water surface elev. (ft): (Select the lower top of bank elevation.)

Area of channel, A:		sq. ft
Wetted perimeter, P:		ft
Hydraulic radius, R:		ft
Slope (decimal), S:		
Bankfull channel n:		
Manning's equation: V = (1.486 / n) * R^2/3 * S^1/2		
Bankfull velocity, V =		fps
Flow rate, Q = VA =		cfs

5. Stone Size Required for Ford Crossing:

Velocity	Stone	Min. Depth
0.0-6.0 fps	to	d=
>6.0 fps	consult Engineering staff	

6. Design Capacity for Culvert Flow

Q = lesser of Q2 and bankfull flow = cfs

Tailwater surface elevation to use in Culvert Flow Tool (ft): ft

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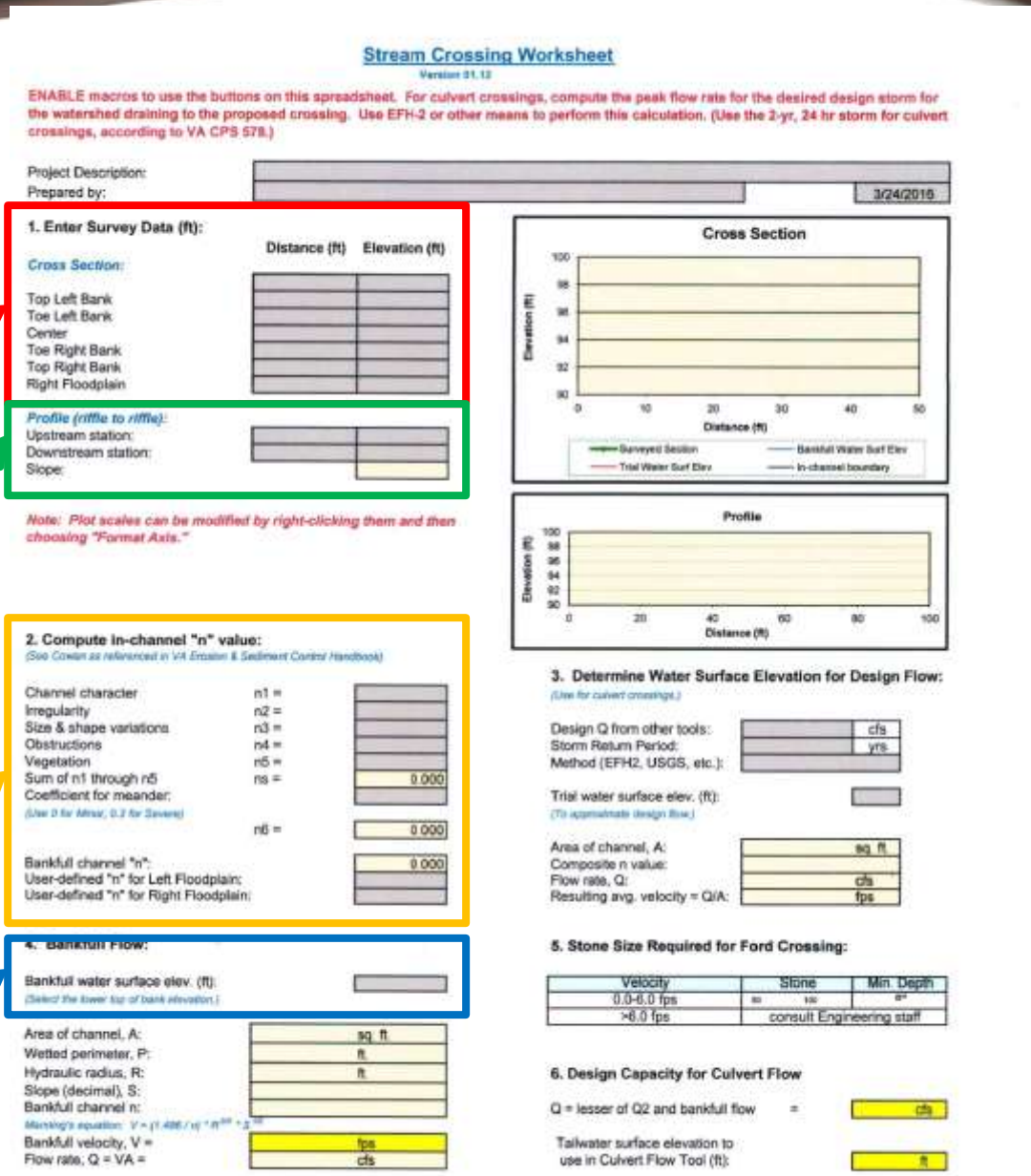
1) Velocity Calculations

Use the "natural"/ "typical" cross-section survey data

If upstream slope is significantly higher than the average slope, consider using the upstream slope for the calculation

(See following slide for Manning's "n" suggestions)

"Select the lower top of bank elevation"



Stream Crossing Worksheet

Version 01.12

ENABLE macros to use the buttons on this spreadsheet. For culvert crossings, compute the peak flow rate for the desired design storm for the watershed draining to the proposed crossing. Use EFH-2 or other means to perform this calculation. (Use the 2-yr, 24 hr storm for culvert crossings, according to VA CPS 578.)

Project Description:
Prepared by: 3/24/2016

1. Enter Survey Data (ft):

Cross Section:

	Distance (ft)	Elevation (ft)
Top Left Bank		
Toe Left Bank		
Center		
Toe Right Bank		
Top Right Bank		
Right Floodplain		

Profile (riffle to riffle):

Upstream station:		
Downstream station:		
Slope:		

Note: Plot scales can be modified by right-clicking them and then choosing "Format Axis."

Cross Section

Profile

2. Compute In-channel "n" value:

(See Cowan as referenced in VA Erosion & Sediment Control Handbook)

Channel character	n1 =	
Irregularity	n2 =	
Size & shape variations	n3 =	
Obstructions	n4 =	
Vegetation	n5 =	
Sum of n1 through n5	ns =	0.000
Coefficient for meander:		
(Use 0 for Minor, 0.2 for Severe)	n6 =	0.000
Bankfull channel "n":		0.000
User-defined "n" for Left Floodplain:		
User-defined "n" for Right Floodplain:		

4. Bankfull Flow:

Bankfull water surface elev. (ft):

(Select the lower top of bank elevation.)

Area of channel, A:	sq. ft.
Wetted perimeter, P:	ft.
Hydraulic radius, R:	ft.
Slope (decimal), S:	
Bankfull channel n:	
Manning's equation: V = (1.486 / n) * R^2/3 * S^1/2	
Bankfull velocity, V =	fps
Flow rate, Q = VA =	cfs

3. Determine Water Surface Elevation for Design Flow:

(Use for culvert crossings.)

Design Q from other tools:		cfs
Storm Return Period:		yrs
Method (EFH2, USGS, etc.):		
Trial water surface elev. (ft):		
(To approximate design flow.)		
Area of channel, A:		sq. ft.
Composite n value:		
Flow rate, Q:		cfs
Resulting avg. velocity = Q/A:		fps

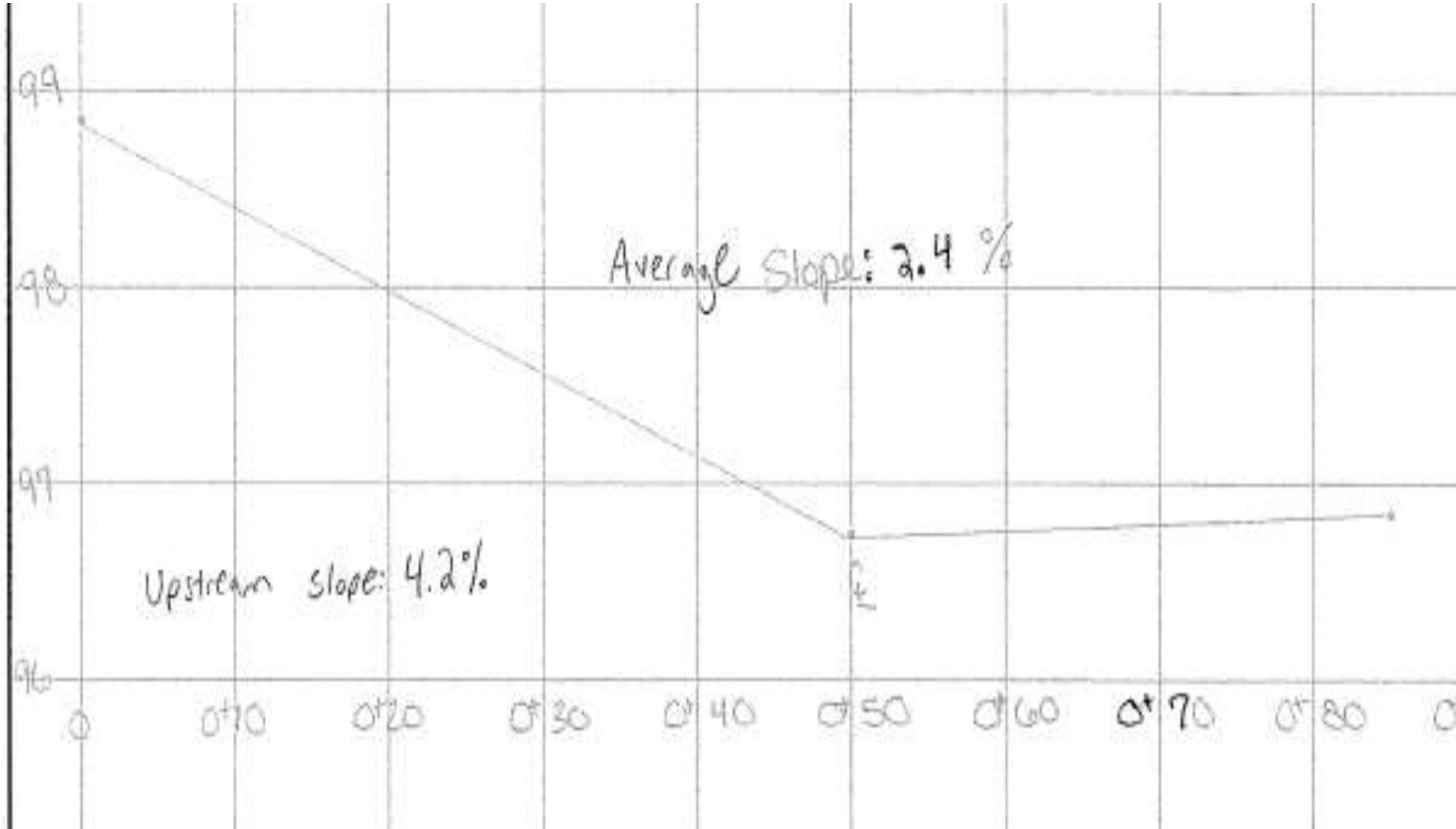
5. Stone Size Required for Ford Crossing:

Velocity	Stone	Min. Depth
0.0-6.0 fps		
>6.0 fps	consult Engineering staff	

6. Design Capacity for Culvert Flow

Q = lesser of Q2 and bankfull flow = cfs

Tailwater surface elevation to use in Culvert Flow Tool (ft): ft


99
98
97
96
Average Slope: 2.4 %
Upstream Slope: 4.2%
0
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80

1) Velocity Calculations: Manning's "n" determination

2. Compute in-channel "n" value:

(See Cowan as referenced in VA Erosion & Sediment Control Handbook)

Channel character	n1 =	
Irregularity	n2 =	
Size & shape variations	n3 =	
Obstructions	n4 =	
Vegetation	n5 =	
Sum of n1 through n5	ns =	0.000
Coefficient for meander:		
(Use 0 for Minor, 0.3 for Severe)		
	n6 =	0.000
Bankfull channel "n":		0.000
User-defined "n" for Left Floodplain:		
User-defined "n" for Right Floodplain:		

- See DN-578, Pg. 40 for criteria for selecting these values
- Come up with one *representative value for entire bankfull height*
- Better to underestimate

<u>Higher "n"</u> → <u>More resistance in channel</u> → <u>Lower Velocity</u>

Overestimating "n" means the velocity will be underestimated and the stone will be prone to washing away. THIS IS A DISSERVICE TO THE LANDOWNER who has to maintain the crossing.

PREFACE

SUPPLEMENT B

HYDRAULICS

This supplement expands and augments subsection 4.4 of the Hydraulics Section of the Engineering Handbook.

The objective of Supplement B is to present a systematic procedure for the estimation of n values for use in hydraulic computations associated with natural streams, floodways and drainage channels.

This method of estimating roughness coefficients was developed by Woody L. Cowan. Mrs. Vivian Edwards typed the manuscript.

For n5, Vegetation:

n5 (Adjustment for vegetation)	Low	0.005-0.010	Dense turf grass or weeds with avg. depth of flow = 2 or more times the vegetation height. Tree switches with avg. depth of flow = 3 or more times the vegetation height.
	Medium	0.010-0.020	Turf grasses with flow 1-2 times height of grass; stemmy grasses, tree seedlings with flow 2 to 3 times height of veg.; bushy growth, dormant season, no veg. along bottom, with R>2 ft.
	High	0.025-0.050	Turf grass with flow = height of grass; willows, cottonwoods in the dormant season with R = 2 to 4 ft.
	Very High	0.050-0.100	Turf grass with very shallow flow; bushy willows; trees with full foliage and weeds with R = 10 to 12 ft.

- Many of the descriptions depend on the depth of flow.
  - E.g:
    - bankfull depth = 2ft.
    - Fescue-lined channel (H=8in.)
    - n5 = 0.005 – 0.010

Keep in mind that you are coming up with a composite for the **whole channel** at the bankfull elevation. If you have a wide channel with trees on the banks, do NOT use “Very High” for n5, because the bulk of the flowing water will not actually be impacted by the trees.

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- Veg. Height: 9”
  Bankfull Height: 9”
  n_5 = 0.025

- Veg. Height: 2’
  Bankfull Height: 4’
  n_5 = 0.015

High	0.025-0.050	Turf grass with flow = height of grass; willows, cottonwoods in the dormant season with R = 2 to 4 ft.

Medium	0.010-0.020	Turf grasses with flow 1-2 times height of grass; stemmy grasses, tree seedlings with flow 2 to 3 times height of veg.; bushy growth, dormant season, no veg. along bottom, with R>2 ft.

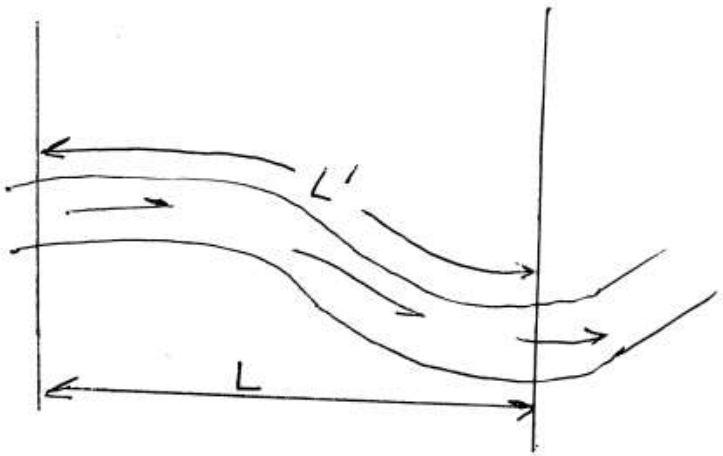
For n6, Coefficient of Meander:

TABLE 5-23

REDUCTION IN PERMISSIBLE VELOCITY BASED ON SINUOSITY

Sinuosity*	Percent Reduction in Permissible Velocity
Slight (1.0 to 1.2)	5%
Moderate (1.2 to 1.5)	13%
Very Sinuous (1.5 and greater)	22%

* Sinuosity - degree of curvature of channel.



Sinuosity = L'/L

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After calculating the “n” value using the “Stream Crossing Worksheet”, come back to this chart to see if your value falls within the general range for the stream type. If not, consider adjusting your values.

Manning's n for Channels (Chow, 1959).

Type of Channel and Description	Minimum	Normal	Maximum
Natural streams - minor streams (top width at floodstage < 100 ft)			
1. Main Channels			
a. clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. same as above, but more stones and weeds	0.030	0.035	0.040
c. clean, winding, some pools and shoals	0.033	0.040	0.045
d. same as above, but some weeds and stones	0.035	0.045	0.050
e. same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. same as "d" with more stones	0.045	0.050	0.060
g. sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
a. bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. bottom: cobbles with large boulders	0.040	0.050	0.070
3. Floodplains			
a. Pasture, no brush			
1.short grass	0.025	0.030	0.035
2. high grass	0.030	0.035	0.050
b. Cultivated areas			
1. no crop	0.020	0.030	0.040
2. mature row crops	0.025	0.035	0.045
3. mature field crops	0.030	0.040	0.050
c. Brush			
1. scattered brush, heavy weeds	0.035	0.050	0.070
2. light brush and trees, in winter	0.035	0.050	0.060
3. light brush and trees, in summer	0.040	0.060	0.080
4. medium to dense brush, in winter	0.045	0.070	0.110
5. medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. dense willows, summer, straight	0.110	0.150	0.200
2. cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. same as 4. with flood stage reaching branches	0.100	0.120	0.160

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xsecAnalyzerVer16.xlsm

Mannings Equation Analysis

version 16, Jan 2016

Murky Creek station 27+00

cross-section data: preview

station	elevation	n-value
0	100	0.05
10	98	
100	97.6	0.04
105	95.2	0.03
110	95	
120	95.1	0.04
130	97	0.05
150	97.5	
190	98	
196	99.1	

analyze single water surface elevation

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

unit system: eng

auto scale: yes

hydraulic properties for given water surface elevation:

w.s. elev	flow area	wetted P	hydr. radius	top width	hydr. depth	n value	darcy-weis. f	conveyance	discharge	velocity	shear
97.75	79.0	104.5	0.76	104	0.76	0.046	0.0586	4557	170.5	2.16	0.066

calculate rating table

profile slope= 0.00140

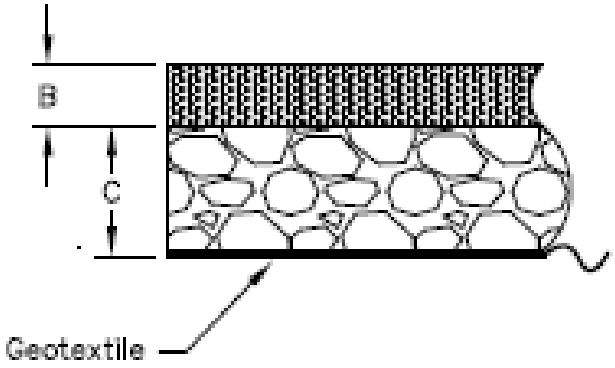
bank stations: left 100.0 right 130.0

hydraulic properties rating table:

w.s. elev	flow area	wetted P	hydr. radius	top width	hydr. depth	n value	darcy-weis. f	conveyance	discharge	velocity	shear
100.00	493.2	197.9	2.49	196	2.52	0.048	0.1476	32525	1217	2.47	0.218
99.50	395.8	194.9	2.03	194	2.05	0.048	0.1457	23718	887.4	2.24	0.177
99.00	299.7	191.4	1.57	190	1.57	0.048	0.1376	16227	607.1	2.03	0.137
98.50	205.8	186.1	1.11	185	1.11	0.048	0.1154	10225	382.6	1.86	0.097
98.00	114.5	180.7	0.63	180	0.64	0.048	0.0624	5857	219.1	1.91	0.055
97.50	61.5	50.5	1.22	49.8	1.24	0.042	0.0899	3634	136.0	2.21	0.106

2) Determine Stone Layers

For All Streams Flowing 6fps or Less



For All Streams Flowing Greater Than 6fps

Consult your Area Engineer or DCR Engineering Staff

For Streams Flowing 6fps or Less		
Layer	Material Type	Layer Depth
B	VDOT #57 or #357 (D50 = 0.75", D100 = 1.5")	3"
C	VDOT #1 (D50 = 2", D100 = 4")	6" Minimum (8" ~~Recommended~~)

Recommend avoiding "clean" or "washed" stone; specifying a "well-graded" stone will aid in packing/ aggregation and result in a better crossing.

*May be capped with optional 2" of Crusher Run (#25) or VDOT #21A

Sizes of Open–Graded Coarse Aggregates

% Passing Sieve Openings

Vg. Size No.	4 in.	3 1/2 in.	3 in.	2 1/2 in.	2 in.	1 1/2 in.	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8	No. 16	No. 50	No. 100
1	Min 100	90–100		25–60		Max. 15		Max. 5							
2			Min. 100	95–100	35–70	Max. 15		Max. 5							
3				Min. 100	90–100	35–70	0–15		Max. 5						
357				Min. 100	90–100		35–70		10–30		Max. 5				
57						Min. 100	95–100		25–60		Max. 10	Max. 8			
78								Min. 100	90–100	40–75	5–25	Max. 10	Max. 5		

* From VDOT Road and Bridge Specifications, 2007

Due to variations in sizing from one quarry to another, refer to chart above for proper stone sizing when ordering stone.

The VDOT classifications may vary slightly from quarry to quarry across the state. To make sure that the contractor acquires the right size stone, you can specify the gradation more specifically using the chart above from the VDOT Road and Bridge Specifications.

Stone Sizing Schedule

NRCS

File Name
Aggregate Sizes

Drawing Name
Engineering Plan View Sheet, Virginia NRCS

Sheet of

VDOT #1

Clean Stone (#57)

- Avoid clean stone on ramps. It does not aggregate well.
- Add a note to the design to use a “well-graded” stone, NOT a “clean” or “washed” stone

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Clean Stone

(AVOID on Ramps)

DCR
Virginia Department of Conservation & Recreation

VDOT #21A

Keep in mind that velocity calculations are for the *base* stone. The top layers are for hoof contact and will be washed away in large storm events. Maintenance will be required.

DCR
Virginia Department of Conservation & Recreation

- If your bankfull elevation seems excessively high and the resulting velocity is unrealistically high, check with your NRCS Area Engineer or DCR Engineering Staff for possible alternatives

Will this stream ever actually flow at bankfull? Or were the banks eroded historically by cattle?

3) Plot on SC Design Sheets

Plot the proposed crossing centerline profile here. (There is no need to plot the "natural" cross-section in the design.)

Connect survey points with a dashed line for the existing grade.

1" = 10' (horizontal) and 1" = 2' (vertical) typically works well for stream crossings.

Start the vertical elevation low enough that you can show the full depth of the stone layer.

Stream Crossing Profile
(On centerline of crossing)

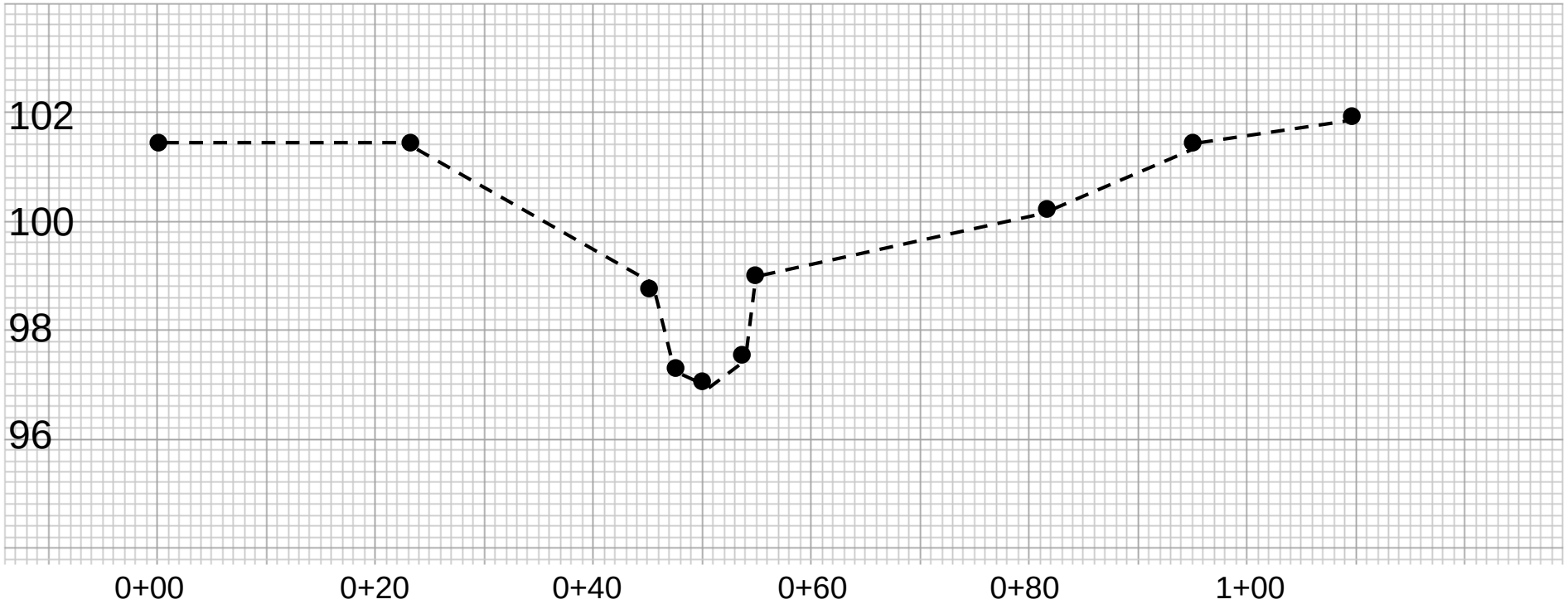
Scale:
Horizontal 1"= Vertical 1"=

Stream Crossing Design Notes

1. The slope of the approaches (ramps) shall be 6:1 or flatter. (8:1 is recommended)
2. If livestock will have access to the side slopes, then the side slopes shall be armored. If fencing will restrict livestock access, the side slopes may be seeded. Grade side slopes to 3:1 or flatter if they are to be seeded. Grade side slopes to 2:1 if they are to be armored. Armoring shall consist of 6 inches of VDOT #1 (2" to 4") stone over geotextile.
3. If necessary to provide a solid bottom at the crossing, the existing streambed shall be excavated to the depth of the selected Typical Stone Layer (on Sheet 2). Any stone placed to harden the channel bottom must be installed below the existing natural grade of the stream.
4. If no stone is needed to harden the stream bottom, then the stone on the ramps shall be placed so that the ramps blend naturally into the streambed. A 2'x2' rock key may be placed at the end of each ramp to provide toe protection. Do not place any stone that will obstruct the natural flow path of the stream.
5. Excavated material shall be spread outside of the floodplain.
6. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification VA-795 Geotextiles. Class II may be used with engineers approval.
7. Seed all disturbed areas according to the Attachment to Virginia Construction Specification VA-706. Seeding.

Stream Crossing Detail

This drawing adapted from NRCS Standard Drawing VA-SO-801 v2.1.1



1. Plot the points from the survey.

2. Connect the points with a dashed line. Dashed lines represent existing grades. Final grades (if different than existing grades) will be shown with solid lines.

3) Plot on SC Design Sheets

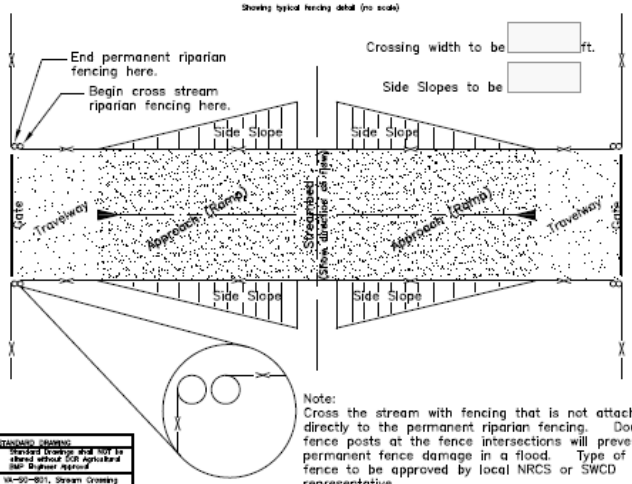
Plot the stream profile (from your upstream and downstream survey shots) on this sheet.

Scale:

Horizontal 1"= Vertical 1"=

Stream Profile
(On centerline of stream)

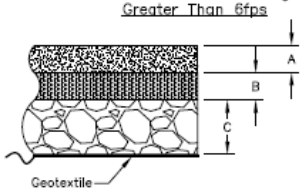
Typical Plan View
Showing typical fencing detail (no scale)



Note:
Cross the stream with fencing that is not attached directly to the permanent riparian fencing. Double fence posts at the fence intersections will prevent permanent fence damage in a flood. Type of fence to be approved by local NRCS or SWCD representative.

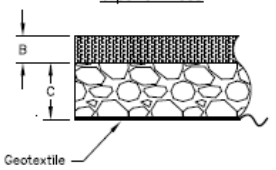
Typical Stone Layer

For All Streams Flowing Greater Than 6fps



For Streams Flowing Greater than 6fps		
Layer	Material Type	Layer Depth
A		
B		
C		

For All Streams Flowing 6fps or Less



For Streams Flowing 6fps or Less		
Layer	Material Type	Layer Depth
B		
C		

Stream Crossing Detail

This drawing adapted from NRCS Standard Drawing VA-SO-801 v2.1.1

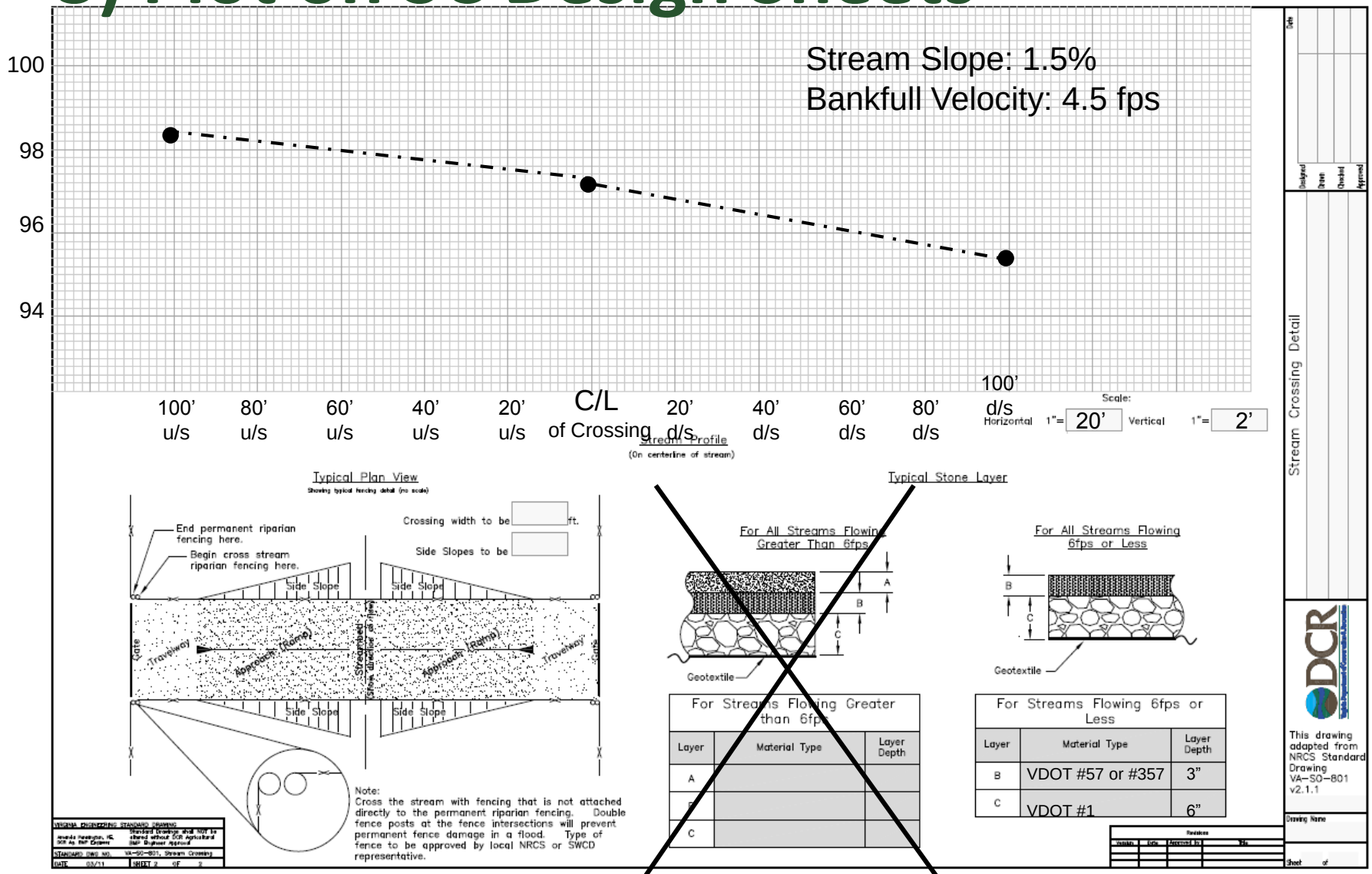
VIRGINIA ENGINEERING STANDARD DRAWING
Standard Drawings shall NOT be altered without SCR Agricultural Staff Engineer Approval
STANDARD DWG NO. VA-SO-801, Stream Crossing
DATE 03/11 SHEET 2 OF 2

Revisions
Number | Date | Approved by | Title

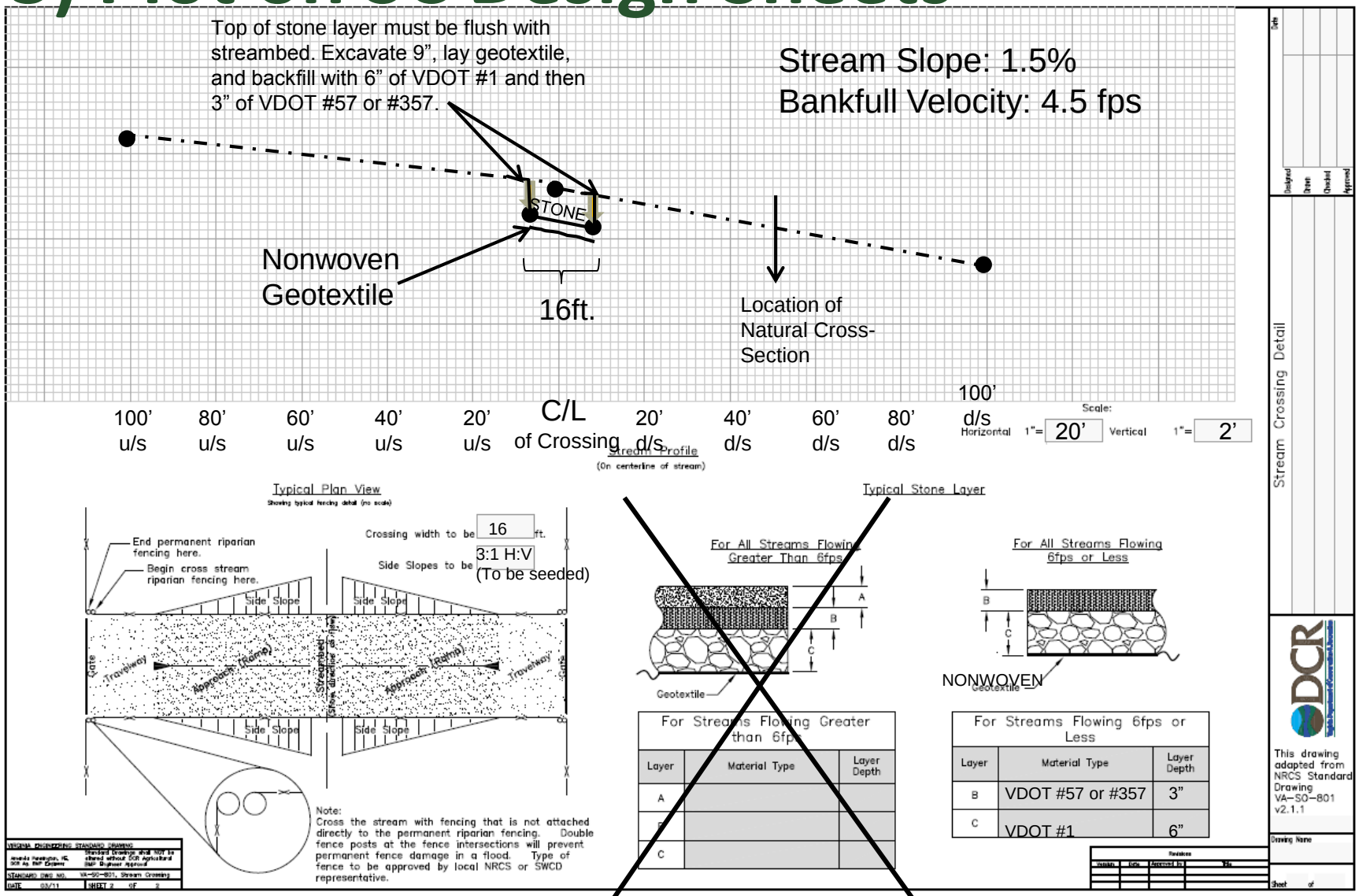
Drawing Name

Sheet of

3) Plot on SC Design Sheets



3) Plot on SC Design Sheets

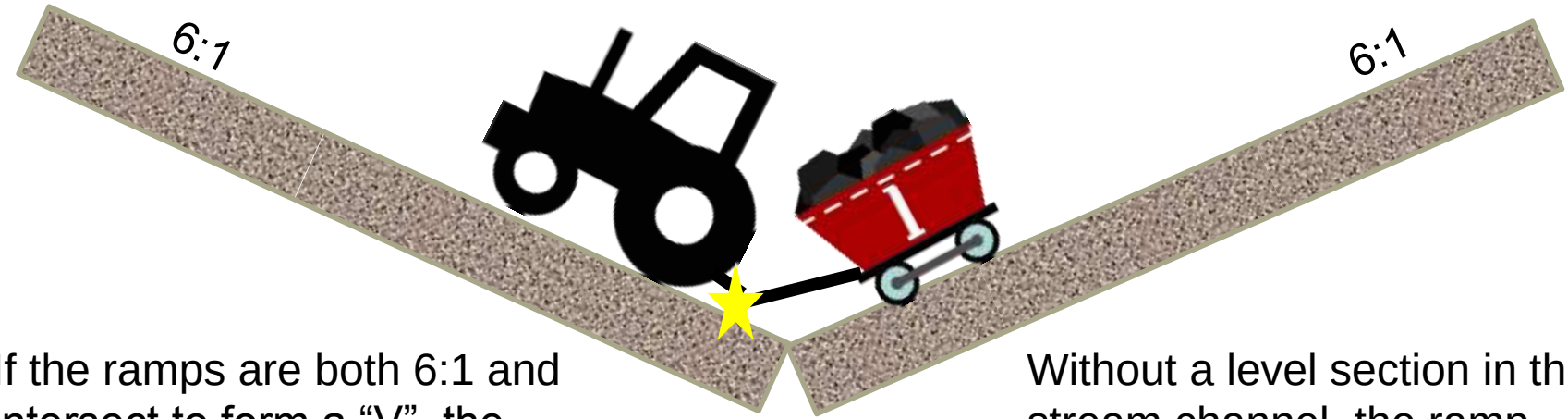


4) Determine Ramp Slope/Final Grades

- The final grade you choose will depend on the planned use and existing site conditions (slopes and soil investigation)
- VA-578: “Make the approaches stable, with gradual ascent and descent grades which are not steeper than 6 horizontal to 1 vertical (6:1).”
- 8:1 is recommended for crossings that will also serve vehicles and tractors

4) Determine Ramp Slope/Final Grades

- Especially for narrow stream channels, 6:1 approaches will likely cause trailer tongues/hitches or tractor implements to drag.



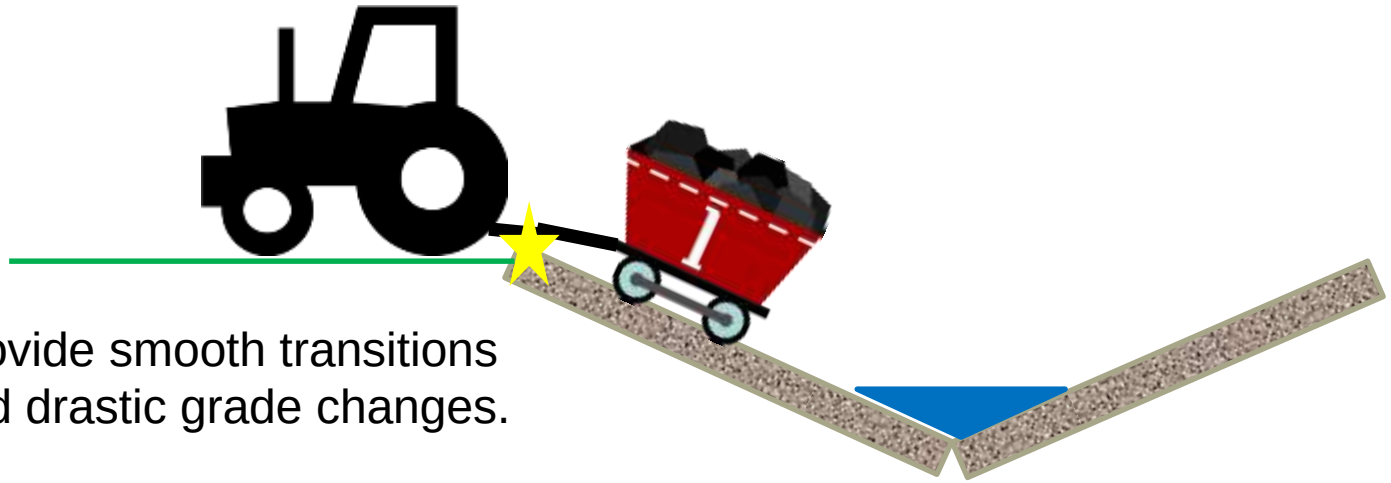
If the ramps are both 6:1 and intersect to form a "V", the tractor is really facing a **3:1** grade change.

Without a level section in the stream channel, the ramp slopes would need to be decreased.

- VA-578: "Configure the crossing approaches (gradient and curves) to properly accommodate the length and turning radii of vehicles using the crossing."

4) Determine Ramp Slope/Final Grades

- Beware that a similar problem can occur if there is a drastic grade change at the point of daylight.

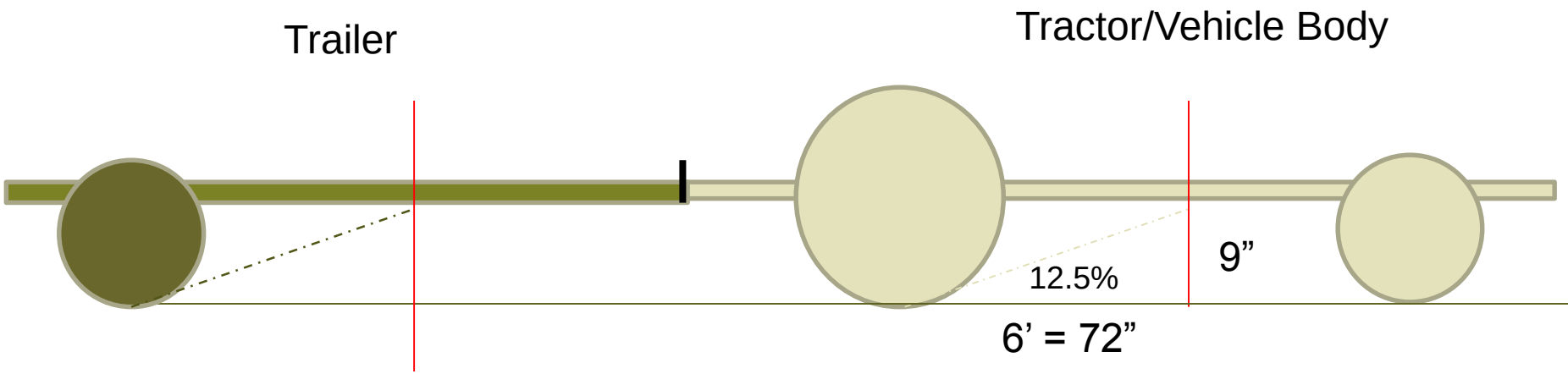


Try to provide smooth transitions and avoid drastic grade changes.

- VA-578: “Configure the crossing approaches (gradient and curves) to properly accommodate the lengnth and turning radii of vehicles using the crossing.”

Determining Max. Gradient Change without Bottoming Out

(at top of ramps)



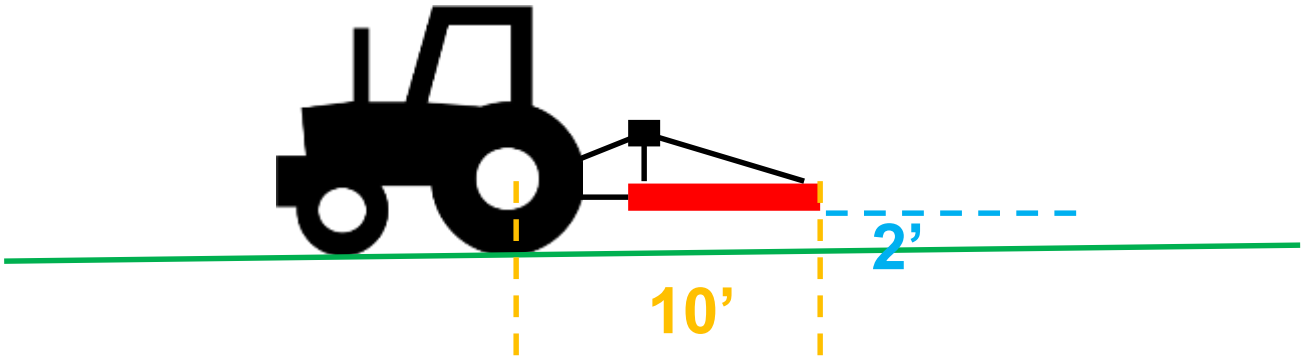
1. Find mid-point of vehicle or mid-point of trailer (i.e. halfway between axles for tractor or axle & hitch for trailer)
2. Measure height of lowest point at midpoint
3. Calculate slope by comparing the halfway length to the chassis height. This is the maximum grade change that could occur without bottoming out when going over break point at top of ramp.

Ex: 9”/72” = 0.125 = 12.5% = 8:1 → Max. Grade Change at top of ramp can be 8:1 or 12.5%

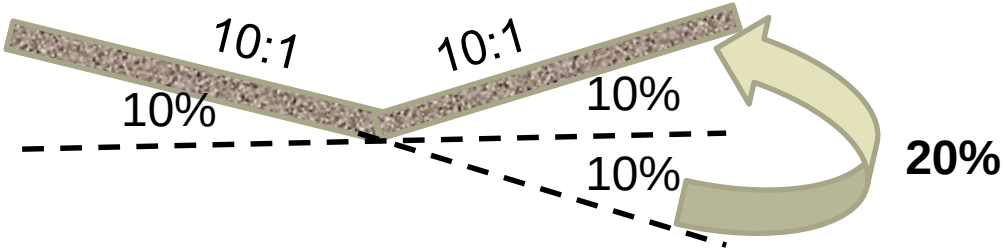
*NOTE: This is generally a *conservative* approach for trailers because of extra clearance provided by the tongue.

Slide adapted from one provided by Keith Burgess, Monacan SWCD

Example: A producer has a rotary cutter that extends 10’ from the center of the rear tire and, when fully raised, is 2’ off of the ground.



Max. Grade Change at Centerline of Stream = 2’/10’ = **20%**

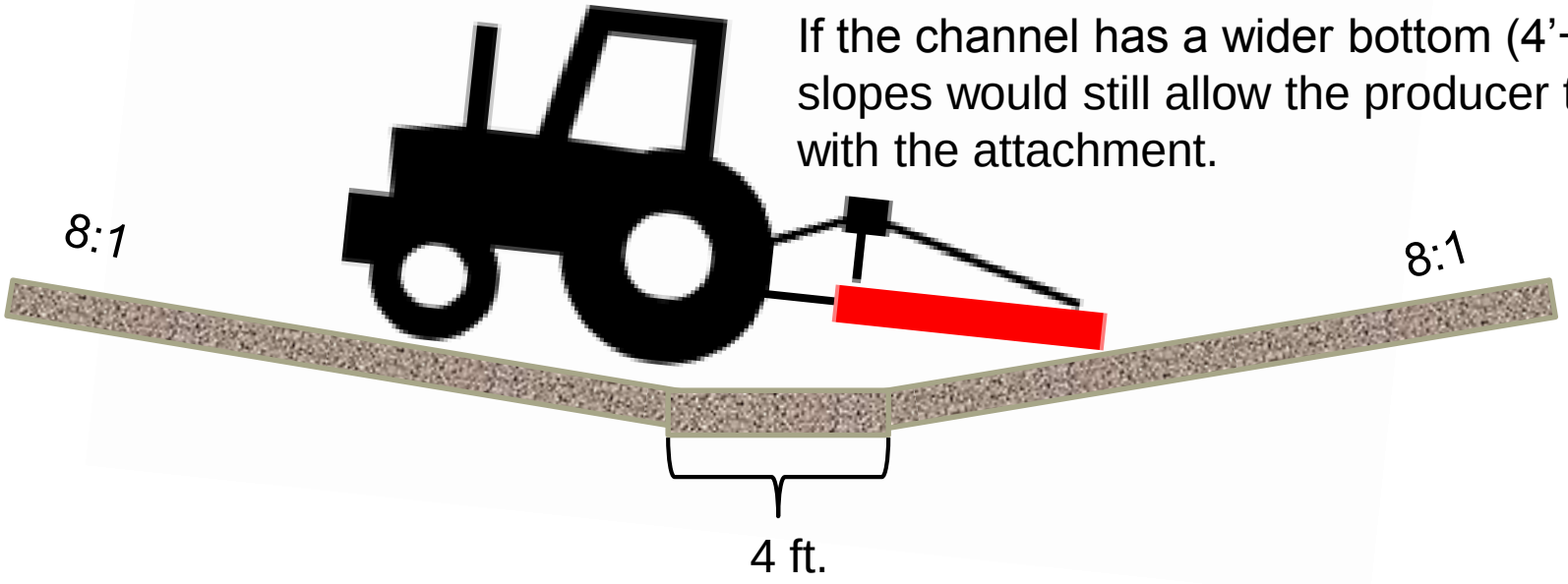


20%

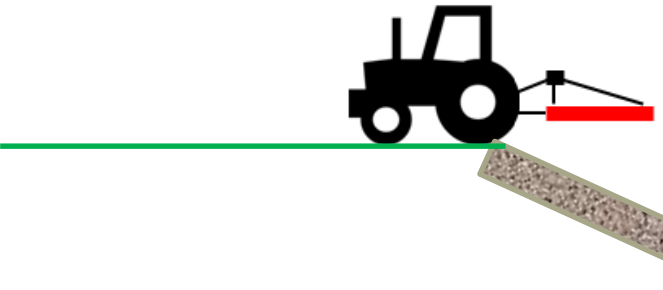
If ramps will form a V (in a narrow channel), then ramps would have to combine to be less than a 20% grade change. Two 10:1 ramps would work (barely).

Example Continued

Max. Grade Change at Centerline of Stream = 2'/10' = 20%



If the channel has a wider bottom (4'+), then 8:1 slopes would still allow the producer to cross with the attachment.

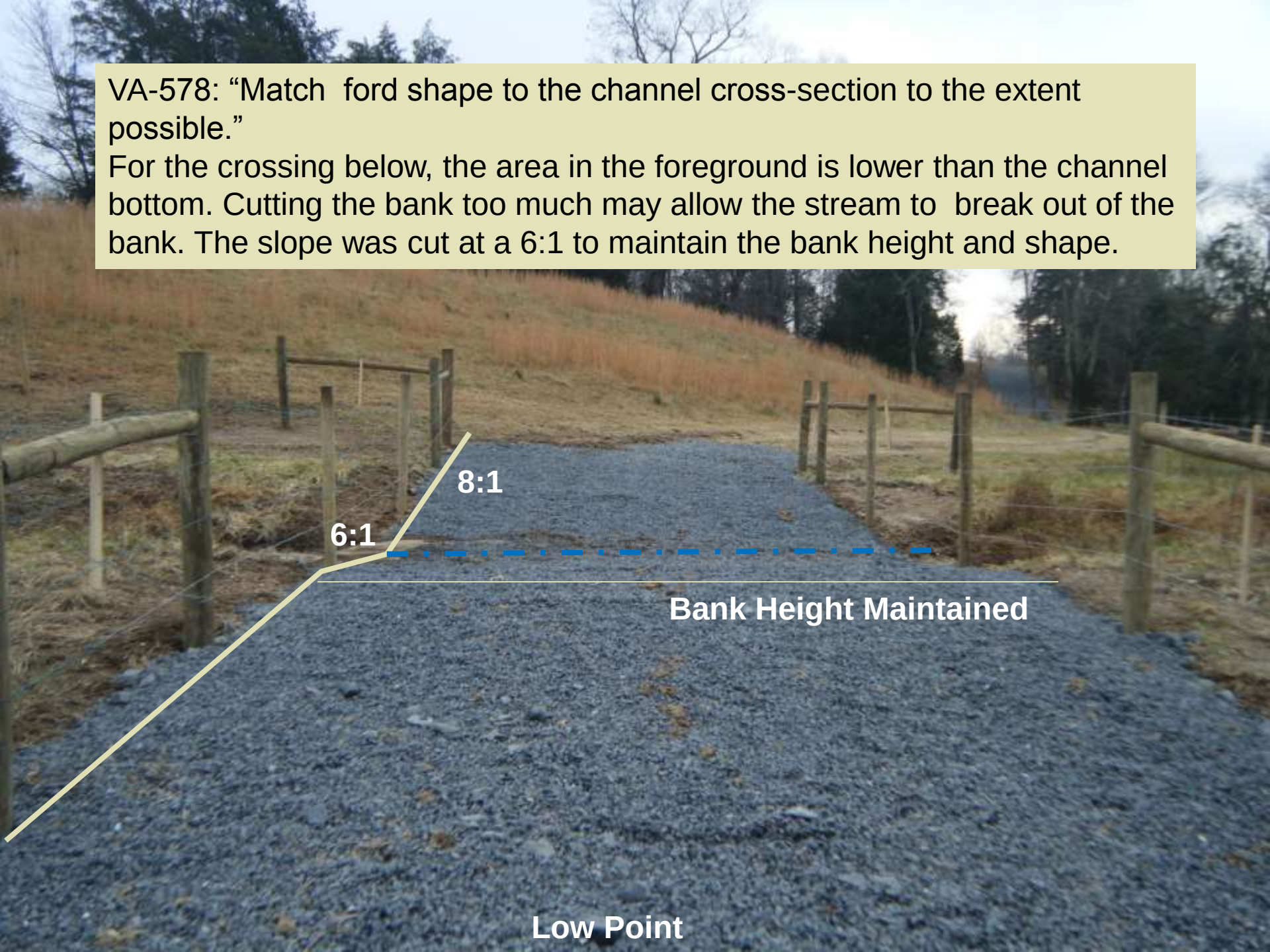


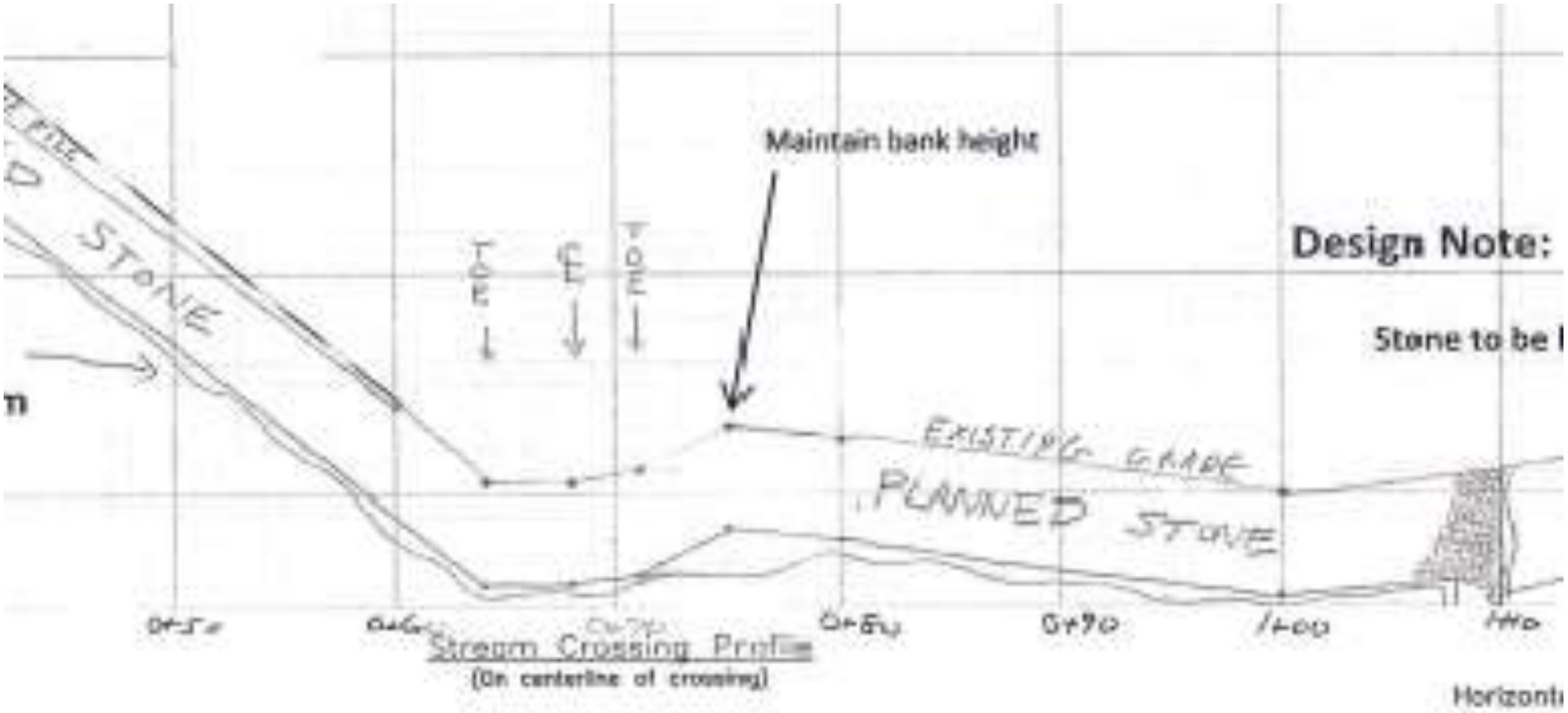
Note: This type of attachment is not a concern at the top of the ramp (unlike a trailer). Just check to make sure that the tractor itself will not bottom out.

4) Determine Ramp Slope/Final Grades

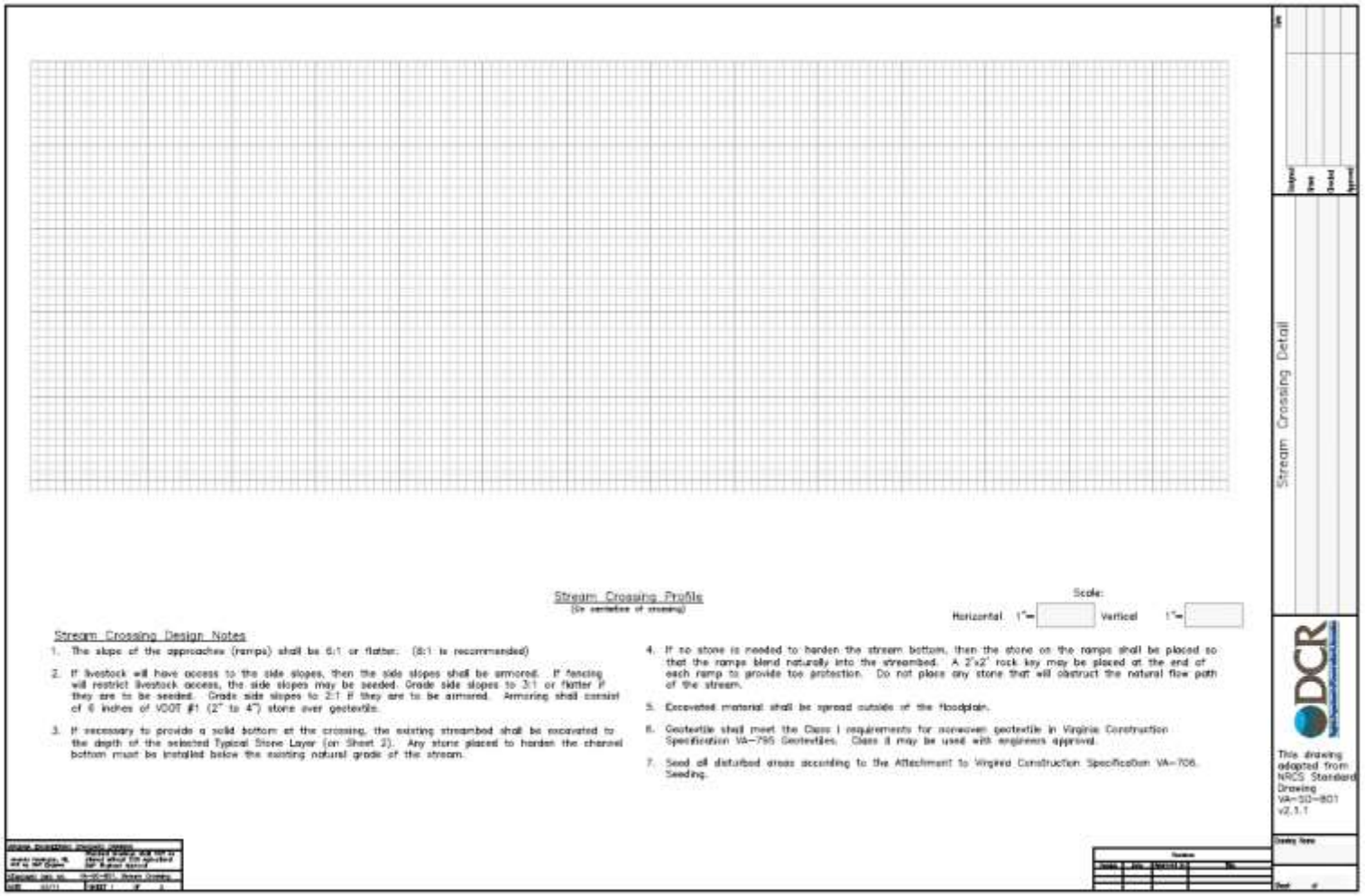
- VA-578: “Make the cross-sectional area of the crossing equal to or greater than the natural channel cross-sectional area.”
  - Also avoid excessive cutting and/or widening of the channel at the crossing; will create depositional areas
- Avoid any fill material for a ford crossing
  - Fill material means that the stone layers would be above the natural grade and be more prone to washing away
  - Fill may cause permitting issues (USACE, FEMA, etc.)

VA-578: “Match ford shape to the channel cross-section to the extent possible.”
For the crossing below, the area in the foreground is lower than the channel bottom. Cutting the bank too much may allow the stream to break out of the bank. The slope was cut at a 6:1 to maintain the bank height and shape.




Maintain bank height
Design Note:
Stone to be
TOE
TOE
TOE
EXISTING GRADE
PLANNED STONE
Stream Crossing Profile
(On centerline of crossing)

Example Stream Crossing Profile



Stream Crossing Profile
(Or variation of crossing)

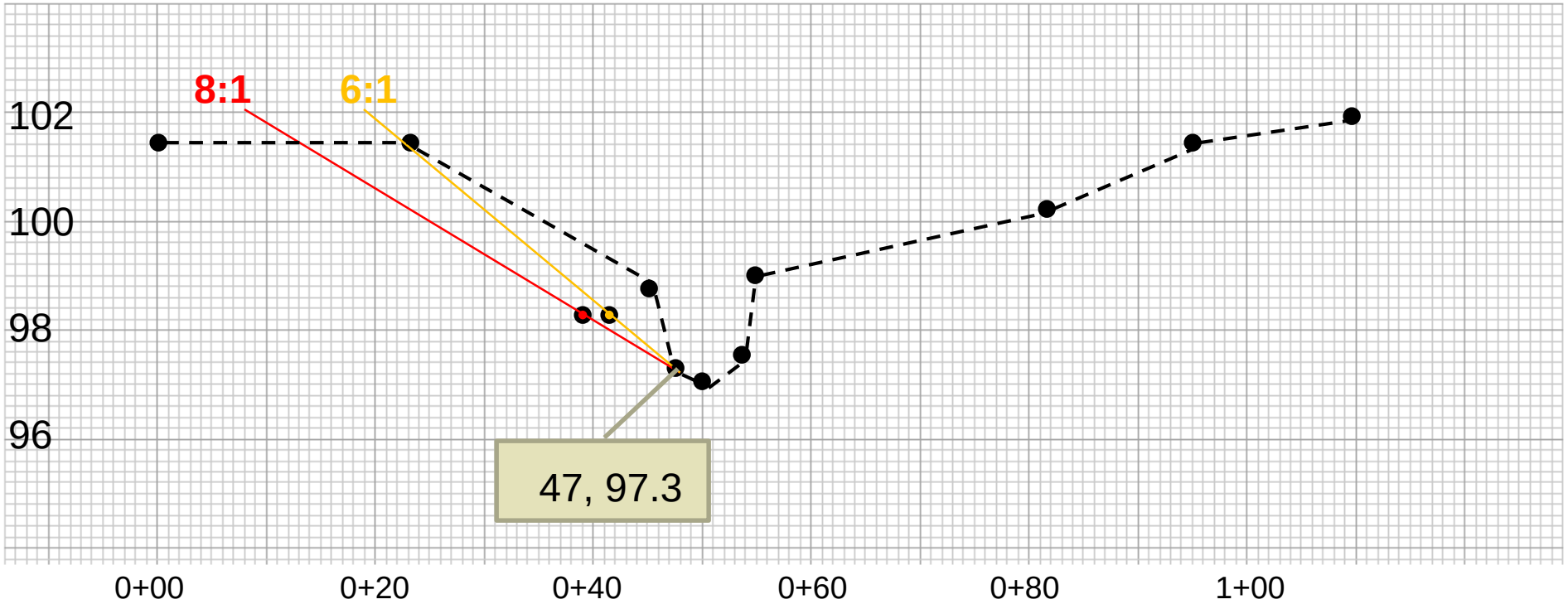
Scale:
Horizontal 1"= Vertical 1"=

Stream Crossing Design Notes

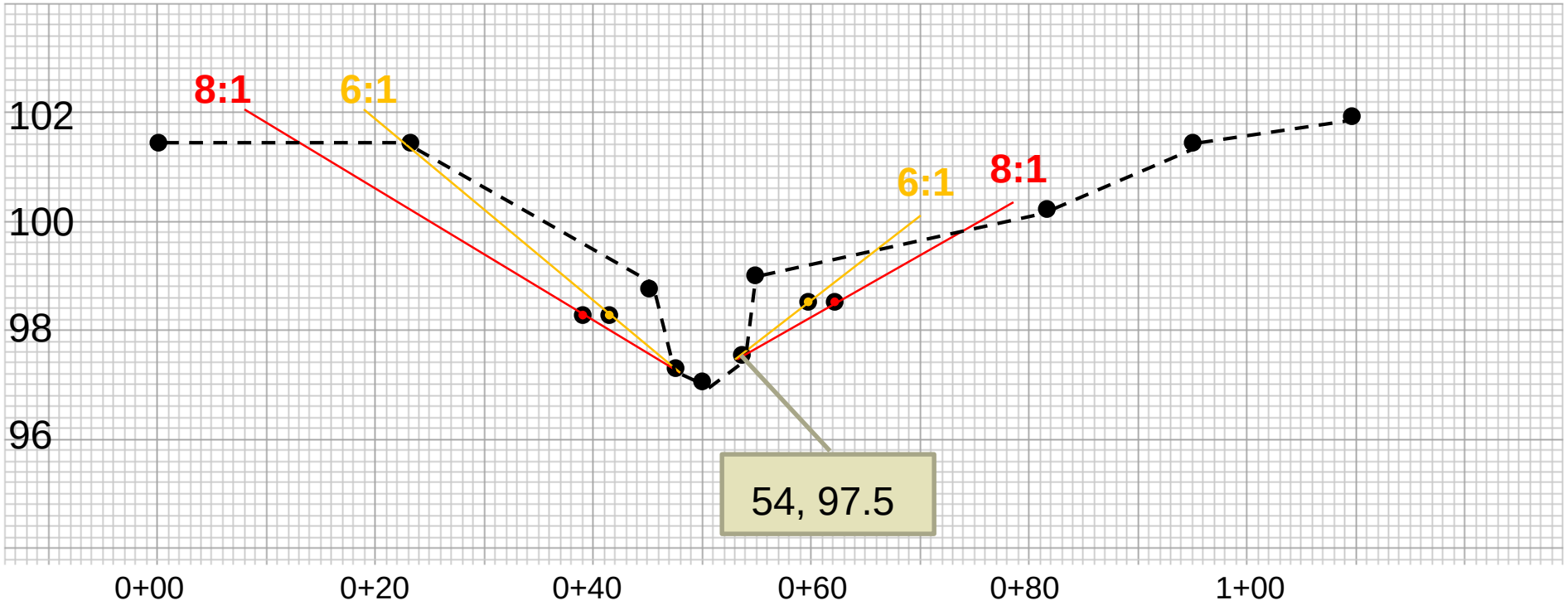
1. The slope of the approaches (ramps) shall be 6:1 or flatter. (8:1 is recommended)
2. If livestock will have access to the side slopes, then the side slopes shall be armored. If fencing will restrict livestock access, the side slopes may be seeded. Grade side slopes to 3:1 or flatter if they are to be seeded. Grade side slopes to 2:1 if they are to be armored. Armoring shall consist of 6 inches of VDOT #1 (2" to 4") stone over geotextile.
3. If necessary to provide a solid bottom at the crossing, the existing streambed shall be excavated to the depth of the selected Typical Stone Layer (on Sheet 2). Any stone placed to harden the channel bottom must be installed below the existing natural grade of the stream.
4. If no stone is needed to harden the stream bottom, then the stone on the ramps shall be placed so that the ramps blend naturally into the streambed. A 2'x2' rock key may be placed at the end of each ramp to provide toe protection. Do not place any stone that will obstruct the natural flow path of the stream.
5. Excavated material shall be spread outside of the floodplain.
6. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification VA-795 Geotextiles. Class II may be used with engineers approval.
7. Seed all disturbed areas according to the Attachment to Virginia Construction Specification VA-706. Seeding.

Stream Crossing Detail

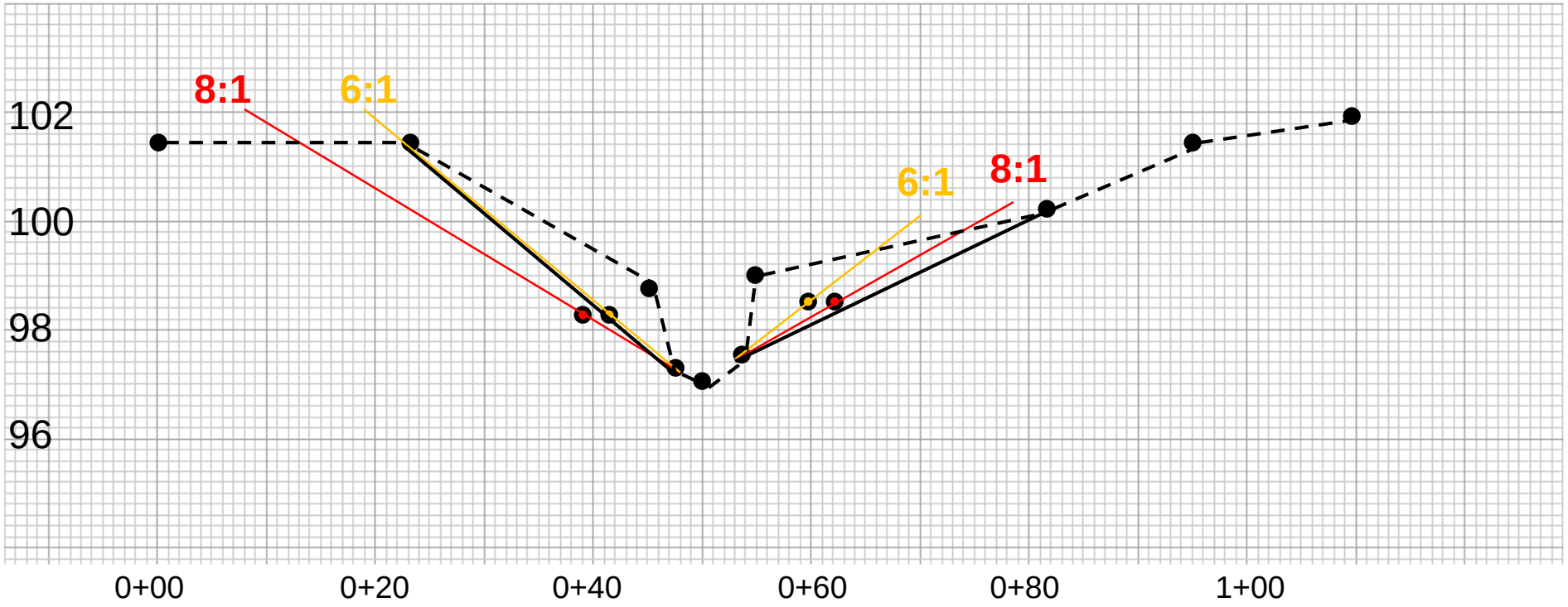
This drawing adapted from NRCS Standard Drawing VA-SD-801 v2.1.1



1. Plot the point that corresponds to the **8:1** slope from the Left Toe of Bank.
   Station: 0+47 – 8 = 0+39
   Elevation: 97.3 + 1 = 98.3
2. Plot the point that corresponds to the **6:1** slope from the Left Toe of Bank.
   Station: 0+47 – 6 = 0+41
   Elevation: 97.3 + 1 = 98.3
3. Draw the lines to “connect the dots” to determine which line fits best.



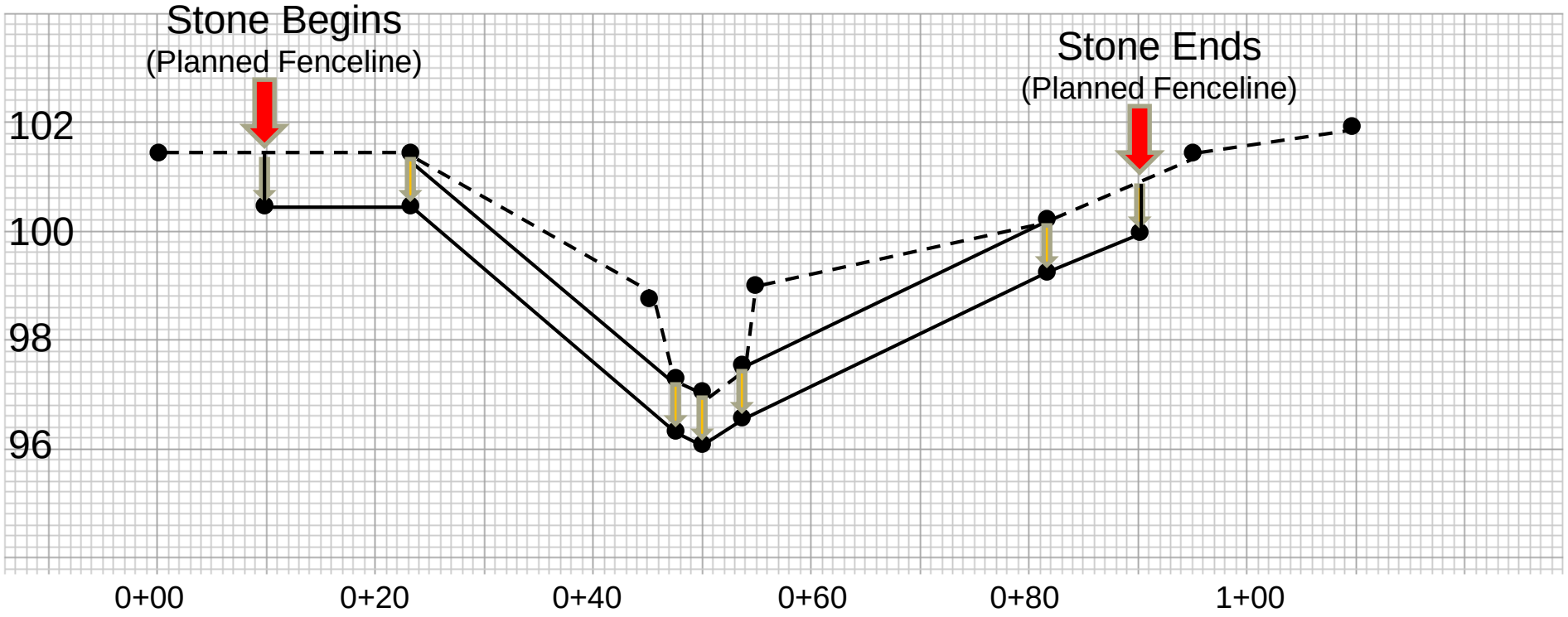
4. Plot the point that corresponds to the **8:1** slope from the Right Toe of Bank.
   Station: 0+54 + 8 = 0+62
   Elevation: 97.5 + 1 = 98.5
5. Plot the point that corresponds to the **6:1** slope from the Tight Toe of Bank.
   Station: 0+54 + 6 = 0+60
   Elevation: 97.5 + 1 = 98.5
6. Draw the lines to “connect the dots” to determine which line fits best.



7. Use your judgment to determine the final grades that will best suit the site.

   Left Side: 8:1 would result in excessive cut; 6:1 ties in nicely to an existing grade change and will more closely maintain channel shape. Pick 6:1.

   Right Side: 8:1 does not require much more cut than 6:1, and it may be best to avoid having 6:1 slopes on both sides (for trailer access). Use 8:1. For the final grade line, tying into the existing point will give a nice uniform slope.

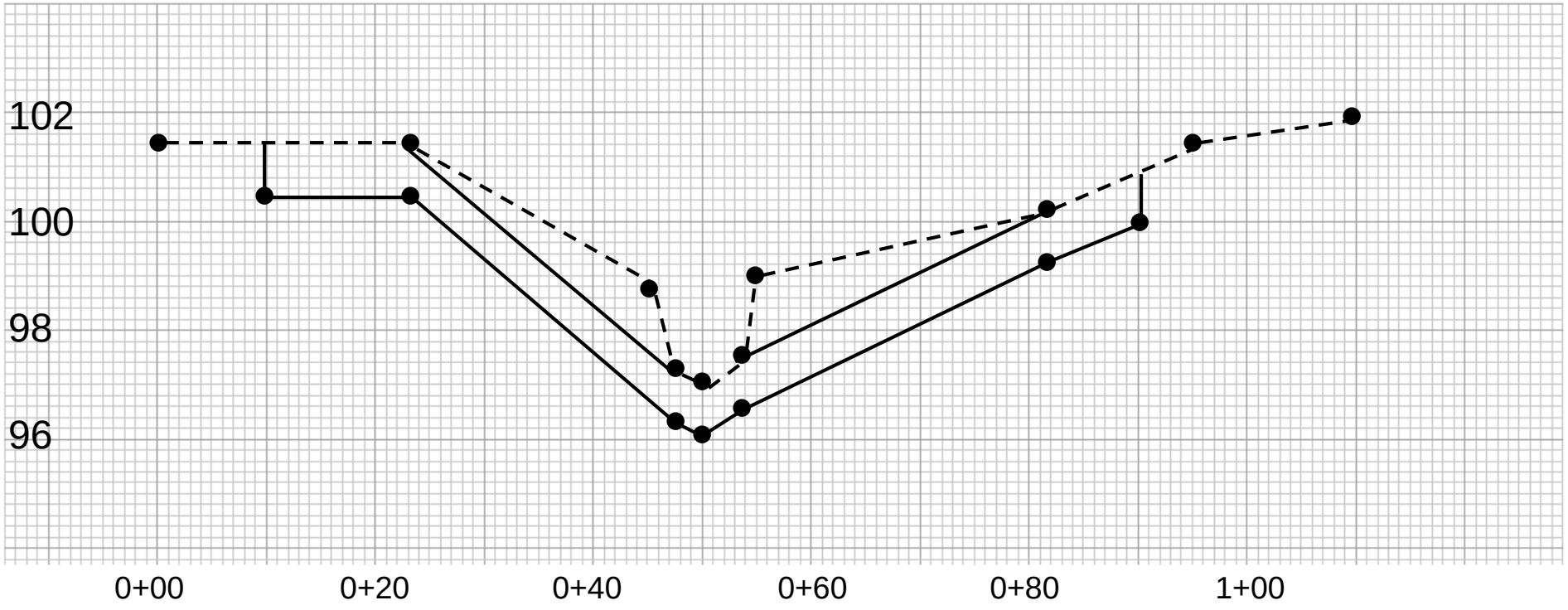


8. Draw in the stone layers.

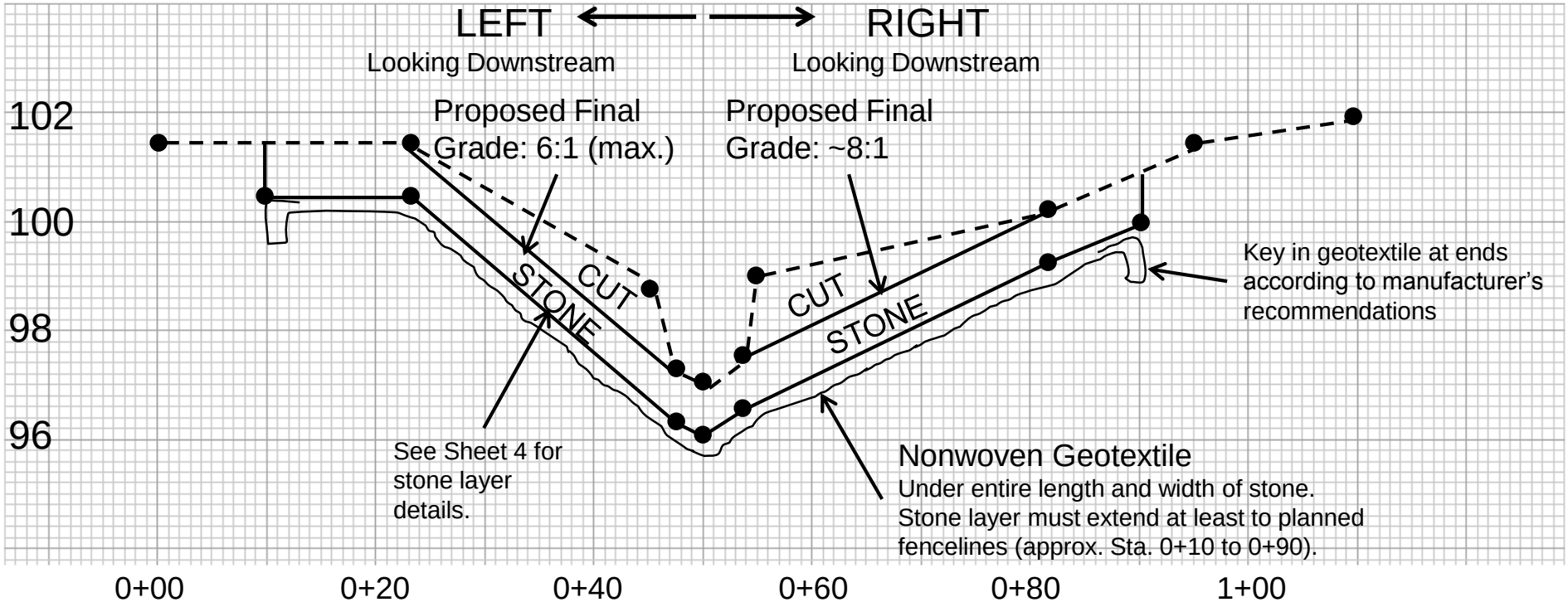
   a. Determine where the stone will start and stop. (In this case, fences will be 35 ft. from the top of bank.)

   b. Draw points for the depth of stone. If using the standard 9” of stone, draw points 9” = 0.75’ below each vertex of the final grade line.

   b. Connect the dots to show the final boundaries of the stone layer.



***Double-check your soils investigation to make sure that no construction hazards (bedrock, water table, sand lenses, etc) will be encountered at the excavation depth.



9. Draw geotextile fabric.

10. Add labels.

5. Complete the Design Packet

DCR
Virginia Department of Conservation & Recreation

Design Data

See complete list of "Design Data" in the VA-578 CPS.

DESIGN DATA

1. Completed Environmental Evaluation and subsequent requirements.
2. Soils investigation.
3. Survey and plot data: profile, cross-sections, topography, as needed.
   a. Survey and plot profile along centerline of stream (distance should be sufficient to determine channel slope).
   b. Survey and plot the existing cross-section perpendicular to the flow, extending beyond the ends of the planned ramps to ensure adequate representation of the designed cross section. Include typical cross sections as needed.
4. Design computations, including purpose of practice and references used.
   a. Sketch of area to indicate stream meandering and limits of stream protection, if needed.
   b. Determine drainage area, land use, and, if applicable, design flows and design velocities.
   c. For ramp crossings, design ramp to best fit the section and meet the design criteria. For culvert crossings, show culvert design calculations.
   d. Add construction sequence to include stream channel diversion, dewatering, and sediment control measures, as needed.
   e. Document landowner/VDGIF contact concerning the proposed stream crossing. Record date, contact person, and outcome of site visit, if one occurred.
5. Plan view of site with existing and planned features, showing dimensions, distances, etc. Include such items as: utilities; fencing; crossing width and length; ramp slopes and side slopes; culvert material, diameter, and length.
6. Standard Cover Sheet (VA-SO-100) including crossing location map.
7. Materials and quantities needed. Identify borrow material and/or spoil area, as needed. Specify thickness, gradation, quantities and type of rock or stone. Specify type, dimensions, and anchoring requirements of geotextile. Specify thickness, compressive strength, reinforcement, and other special requirements for concrete, if used.
8. Vegetation and/or ground cover requirements.
9. Identification of needed Erosion & Sediment Control measures.
10. Supplemental practices required.
11. Virginia Conservation Practice Specifications (700 Series).
12. Operation and Maintenance Plan

Note: Regulatory agencies may request spot checks of stream crossings to ensure permit conditions are being followed.

CHECK DATA

1. As-built surveys.
   a. Cross-section of completed crossing.
   b. Profile of stream channel to show crossing and stream are on a uniform grade.
2. As-built plans including dimensions, types and quantities of materials installed, and variations from design. Include justification for variations.
3. Locations of appurtenant practices.
4. Adequacy of vegetation and/or ground cover.
5. Complete as-built section of Cover Sheet.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan and implement it for the life of the practice.

Include the following items in the operation and maintenance plan, as a minimum:

Inspect the stream crossing, appurtenances, and associated fence after each major storm event and make repairs if needed.

- Remove any accumulation of organic material, woody material, or excess sediment.
- Replace surfacing stone used for livestock crossing as needed.

Stream Crossing Design Components:

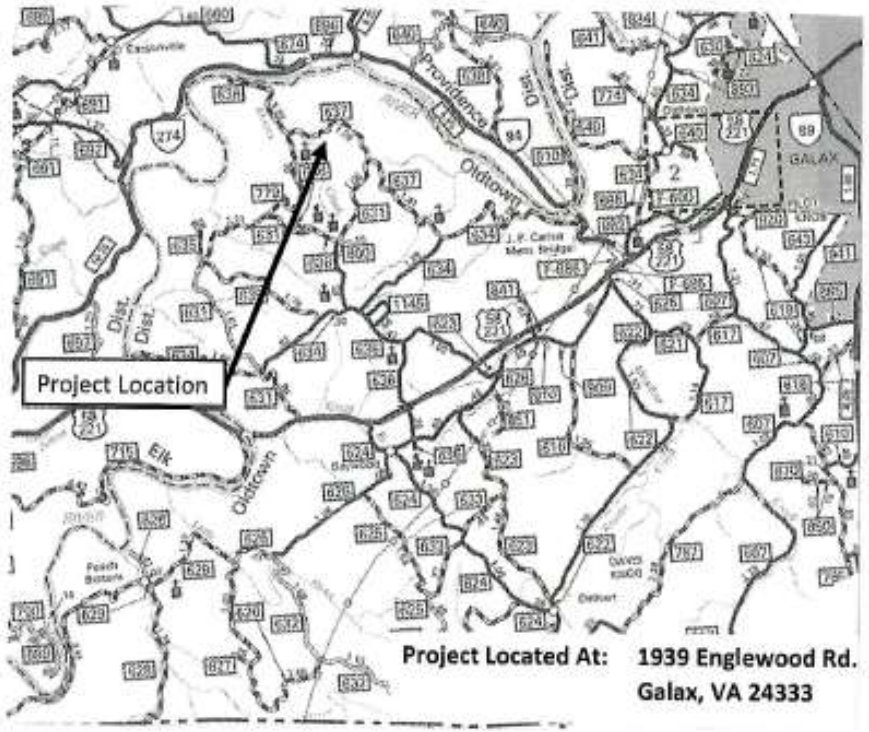
- Sheet 1: Cover Sheet
- Sheet 2: Plan View
- Sheet 3: Stream Crossing Detail Pt. 1: Stream Crossing Profile
- Sheet 4: Stream Crossing Detail Pt. 2: Stream Profile
- Attachments:
  - NRCS Construction Specifications
  - NRCS Practice Operation & Maintenance Agreement (VA-578 Stream Crossing)
  - Survey Notes

- In Project File: Calculations (e.g. material quantity calculations, stream crossing worksheet)

An Example Design

DCR Cover Sheet

Virginia Department of Conservation & Recreation



Site Location Map

Scale 1 Inch = N/A feet

Notes

1. The landowner/operator is responsible for obtaining and complying with all permits and easements. This includes all federal, state and local permits.
2. The landowner/operator is responsible for checking and complying with all local ordinances that may affect the project.
3. MISS UTILITY (Virginia telephone number 811) must be contacted at least 3 working days before construction begins. The landowner/operator is responsible for ensuring that the contractor contacts MISS UTILITY. The contractor must be able to provide the MISS UTILITY ticket number within 24 hours upon request by the DCR/SWCD representative. The landowner/operator is responsible for locating any buried utilities (water lines, electric lines, telephone lines, gas lines, sewer lines, etc.) in the work area that are not covered by the MISS UTILITY program.
4. DCR/SWCD makes no representation of the existence or nonexistence of utilities. The presence or absence of utilities on the construction drawings does not assure that there are or are not utilities in the work area.
5. The contractor is responsible for knowing and following the appropriate safety standards required by the Virginia Safety and Health Codes Board.
6. The landowner/operator shall notify the DCR/SWCD representative at least one week prior to beginning construction, and at all other times specified in this construction plan and attached specifications.
7. Any deviation from these construction drawings and specifications without written approval from DCR/SWCD representative may result in in failure of this practice to meet NRCS Standards and the withdrawal of technical assistance for this project.
8. Prior to beginning construction, the cover sheet must be signed by the landowner/operator, the contractor, and the DCR/SWCD representative. The landowner/operator is responsible for informing the contractor of these responsibilities by providing the contractor a copy of this cover sheet. The contractor must sign the cover sheet acknowledging that these responsibilities are understood and the landowner/operator must return the signed cover sheet to the DCR/SWCD Representative. If requested by DCR/SWCD, the landowner/operator shall arrange for a meeting between the contractor and DCR/SWCD to review the construction drawings and specifications prior to construction.

The SWCD Representative (include title) for this project is: Name, Title
The SWCD office telephone number is: (XXX) XXX-XXXX
The SWCD office address is: Address, City, State ZIP

Benchmark Descriptions

TBM # 1 Assumed Elev. 100.00
Description:
Top of nail in nob on south side of maple tree located upstream of crossing on west side of stream (painted orange).

TBM # N/A Assumed Elev. N/A
Description:
N/A

Acknowledgment Signatures

These construction drawings and attached specifications have been reviewed I understand what is required. (Sign and date below)

Landowner/Operator

Contractor

SWCD Representative

Engineering Job Class: I

"As Built" Documentation

Certified By and Date

Practice Completion Date

811 Know what's below. Call before you dig.

Index of Sheets

Sheet No.	Title
1	Cover Sheet
2	Plan View
3	Stream Crossing Profile
4	Stream Crossing Detail
Attachments	NRCS Construction Specifications
	NRCS O&M Agreement

Specification Table

No.	Title
VA-705	Pollution Control
VA-706	Seeding
VA-707	Site Preparation
VA-708	Salvaging & Spreading Topsoil
VA-721	Excavation
VA-796	Geotextile

Table of Estimated Quantities

Item	Unit	Quantity
VDOT#1 Stone (D50 = 2", D100 = 4")	TONS	47
VDOT #57, #357, or #21A (D50 = 0.75", D100 = 1.5")	TONS	24
Class I Nonwoven Geotextile	SQ.FT.*	1264
*Estimate is for sq.ft. of coverage; extra needed for keys & overlap		
Seed, straw, soil amendments to meet VA-706	JOB	1

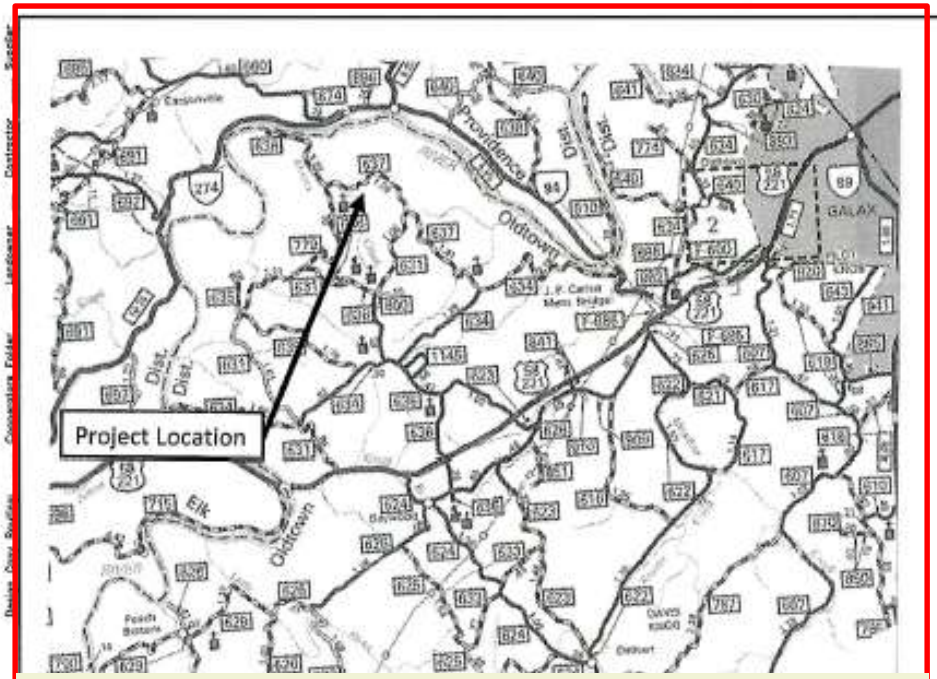
Engineering Design Cover Sheet
SL-6 Ford Stream Crossing
Participant Name Tract 1234
XXXX County, Virginia

Designed MDY
Drawn MDY
Checked MDY
Approved MDY

This drawing adapted from NRCS Standard Drawing VA-SO-100 v2.4.0

Sheet 1 of 4

Cover Sheet



LOCATION Map: Ideally a VDOT map or similar. Purpose is to guide contractors and agency staff to the site.

Notes

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The SWCD office telephone number is: (XXX) XXX-XXXX
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Benchmark Descriptions

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Description:
Top of nail in nob on south side of maple tree located upstream of crossing on west side of stream (painted orange).

TBM # N/A Assumed Elev. N/A
Description:
N/A

Acknowledgment Signatures

These construction drawings and attached specifications have been reviewed I understand what is required. (Sign and date below)

Landowner/Operator

Contractor

SWCD Representative

Engineering Job Class: I

"As Built" Documentation

Certified By and Date

Practice Completion Date

811 Know what's below. Call before you dig.

Engineering Design Cover Sheet
SL-6 Ford Stream Crossing
Participant Name Tract 1234
XXXX County, Virginia

Designed MDY
Drawn MDY
Checked MDY
Approved MDY

This drawing adapted from NRCS Standard Drawing VA-SO-100 v2.4.0

Site Location Map
Scale 1 Inch = N/A feet

Index of Sheets

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Specification Table

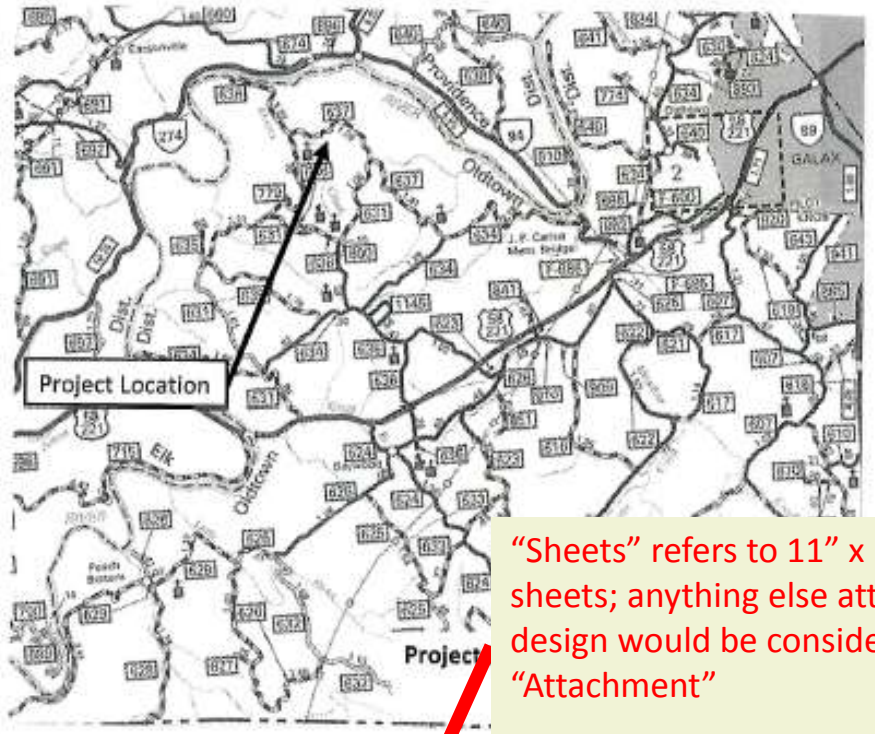
No.	Title
VA-705	Pollution Control
VA-706	Seeding
VA-707	Site Preparation
VA-708	Salvaging & Spreading Topsoil
VA-721	Excavation
VA-796	Geotextile

Table of Estimated Quantities

Item	Unit	Quantity
VDOT#1 Stone (D50 = 2", D100 = 4")	TONS	47
VDOT #57, #357, or #21A (D50 = 0.75", D100 = 1.5")	TONS	24
Class I Nonwoven Geotextile	SQ.FT.*	1264
*Estimate is for sq.ft. of coverage; extra needed for keys & overlap		
Seed, straw, soil amendments to meet VA-706	JOB	1

Sheet 1 of 4

Cover Sheet



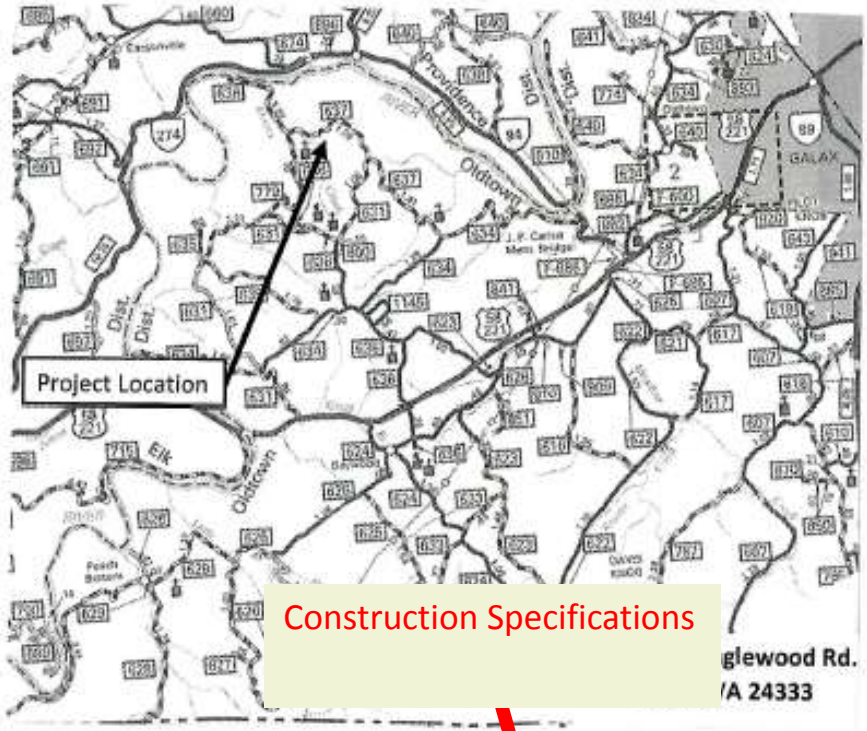
"Sheets" refers to 11" x 17" design sheets; anything else attached to the design would be considered an "Attachment"

Common Attachments for Stream Crossings:

- NRCS Construction Specifications
- NRCS O&M Agreements
- Conservation Plan Map
- Survey Notes

Cover Sheet

Virginia Department of Conservation & Recreation



Construction Specifications

Site Location Map

Scale: 1 Inch = N/A

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Engineering Job Class: I

"As Built" Documentation

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Seed, straw, soil amendments to meet VA-706	JOB	1

Engineering Design Cover Sheet
SL-6 Ford Stream Crossing
Participant Name Tract 1234
XXXX County, Virginia

Designed MDY
Drawn MDY
Checked MDY
Approved MDY

This drawing adapted from NRCS Standard Drawing VA-SO-100 v2.4.0

Sheet 1 of 4

Note: For culvert crossings, may need to include VA-745, VA-751, or VA-757.

Design Attachments: Construction Specifications

Spec. #	Title	When to Include?
VA-703	Structure Removal	E.g., if a culvert or fence needs to be removed to install the crossing
VA-705	Pollution Control	Anytime ground disturbance involved
VA-706	Seeding	Anytime ground disturbance involved
VA-707	Site Preparation	Typically include for stream crossings
VA-708	Salvaging & Spreading Topsoil	Include if topsoil will need to be stripped. May not be necessary for ex. crossing sites
VA-711	Removal of Water	If working in live surface water
VA-721	Excavation	Always include for stream crossing
VA-727	Diversions	Include if diversions are planned to divert upland surface runoff away from crossing
VA-731	Concrete Construction	Only if crossing will be made of concrete
VA-761	Loose Rock Riprap	If riprap will be used to stabilize cut slopes
VA-795	Geotextile	Covers geotextile under stone

DCR
Virginia Department of Conservation & Recreation

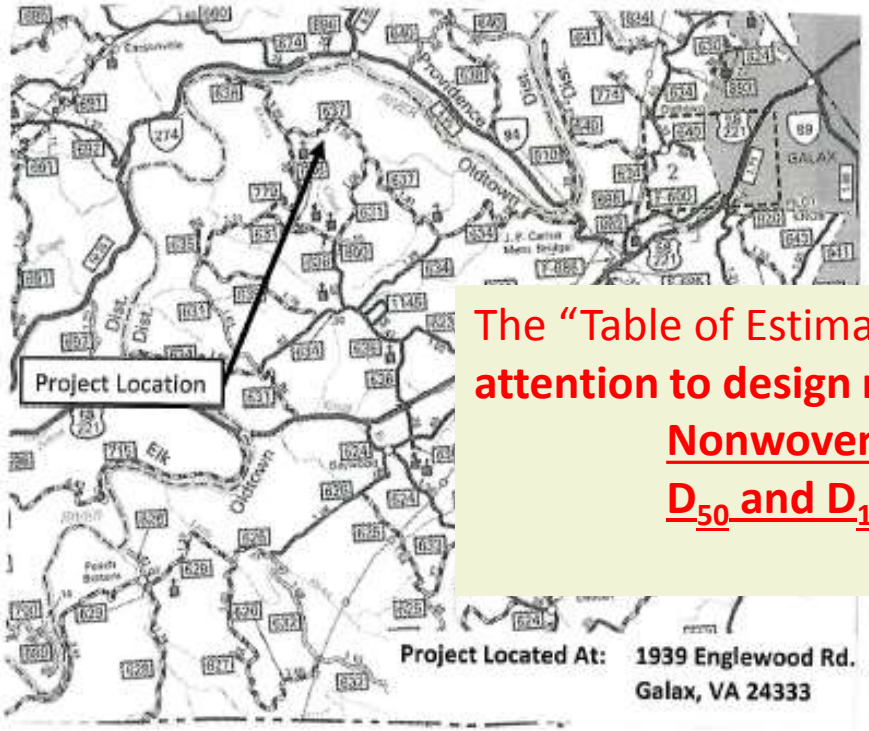
VA-703 “Structure Removal”

DCR
Virginia Department of Conservation & Recreation

DCR
Virginia Department of Conservation & Recreation

Cover Sheet

DCR Virginia Department of Conservation & Recreation



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The "Table of Estimated Quantities" is **an opportunity to call attention to design requirements for each component**, e.g.:

Nonwoven Class I Geotextile

D_{50} and D_{100} of Stone Gradations

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Contractor

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Engineering Design Cover Sheet
SL-6 Ford Stream Crossing
Participant Name Tract 1234
XXXX County, Virginia

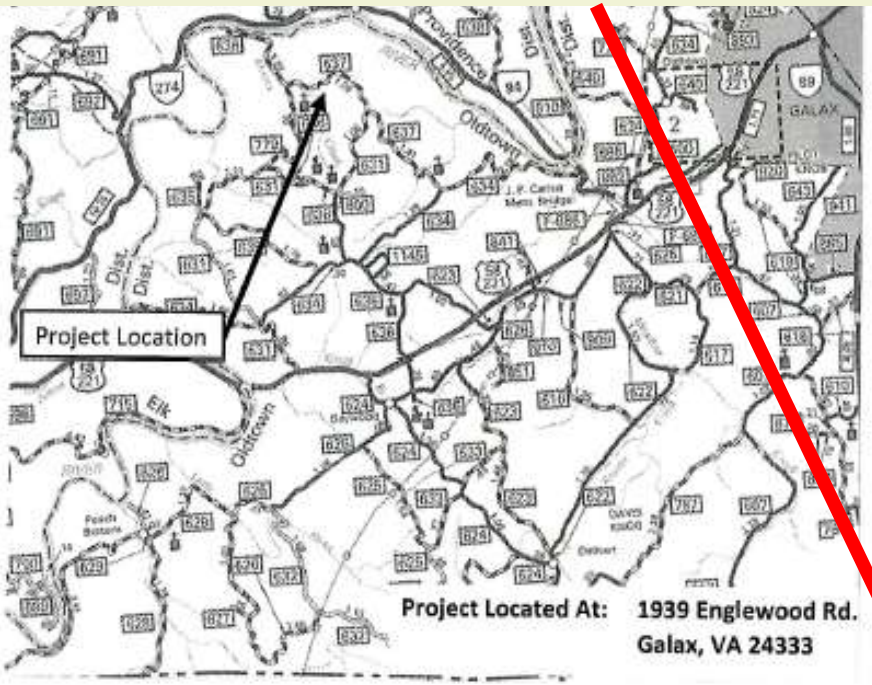
Designed MDY
Drawn MDY
Checked MDY
Approved MDY

This drawing adapted from NRCS Standard Drawing VA-SD-100 v2.4.0

Sheet 1 of 4

Cover Sheet

Benchmark Descriptions: Provide the TBM # and elevation, as well as a detailed description of its location.



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Seed, straw, soil amendments to meet VA-706	JOB	1

Engineering Design Cover Sheet
SL-6 Ford Stream Crossing
Participant Name Tract 1234
XXXX County, Virginia

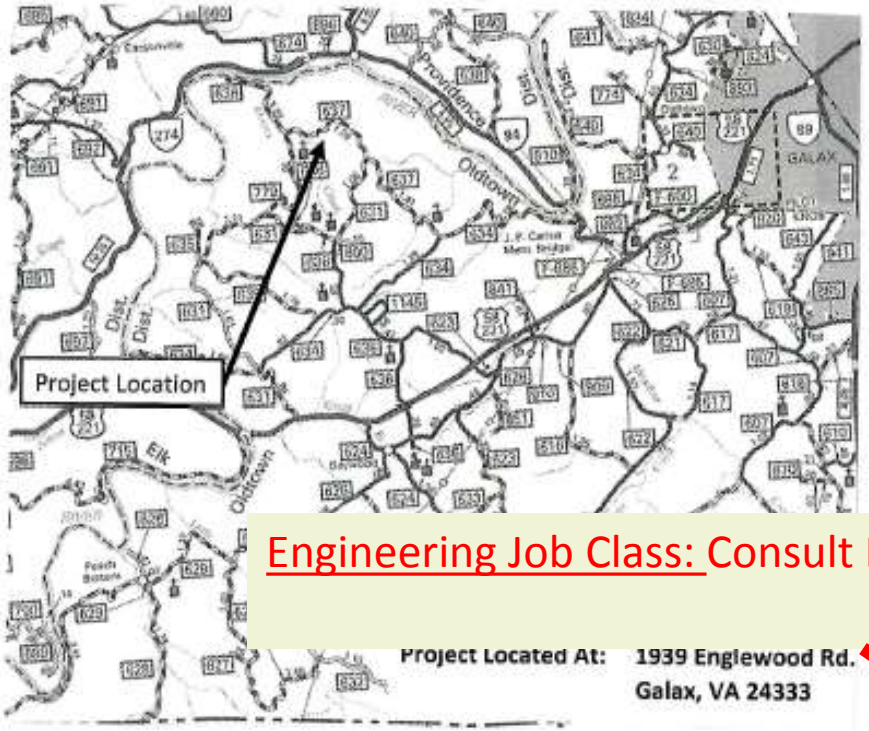
Designer MDY
Drawer MDY
Checker MDY
Approver MDY

This drawing adapted from NRCS Standard Drawing VA-SO-100 v2.4.0

Sheet 1 of 4

Cover Sheet

DCR Virginia Department of Conservation & Recreation



Engineering Job Class: Consult NRCS/DCR EJAA Spreadsheets

Project Located At: 1939 Englewood Rd.
Galax, VA 24333

Notes

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Address
City, State ZIP

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Engineering Design Cover Sheet
SL-6 Ford Stream Crossing
Participant Name Tract 1234
XXXX County, Virginia

Designer MDY
Drawer MDY
Checker MDY
Approver MDY

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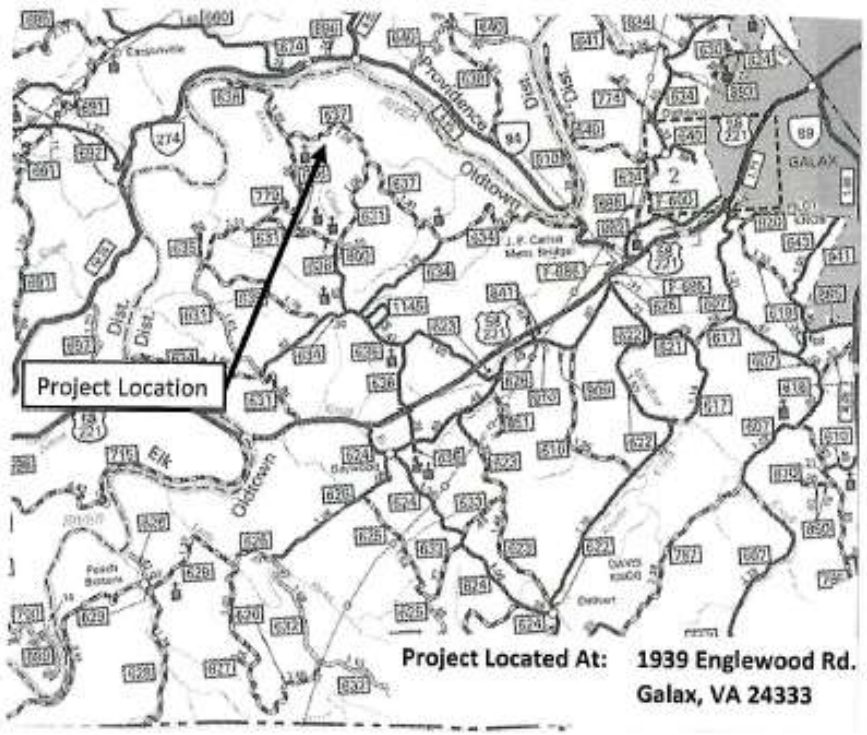
Cover Sheet

Someone with appropriate level of Design EJAA needs to review the design and sign “Approved” before the design goes to construction.

All parties sign the Acknowledgment signatures at the Pre-Con conference after reviewing the design.



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VA-756	Geotextile

Notes

1.
2.
3.
4.
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Participant Name Tract 1234
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Designed MDY
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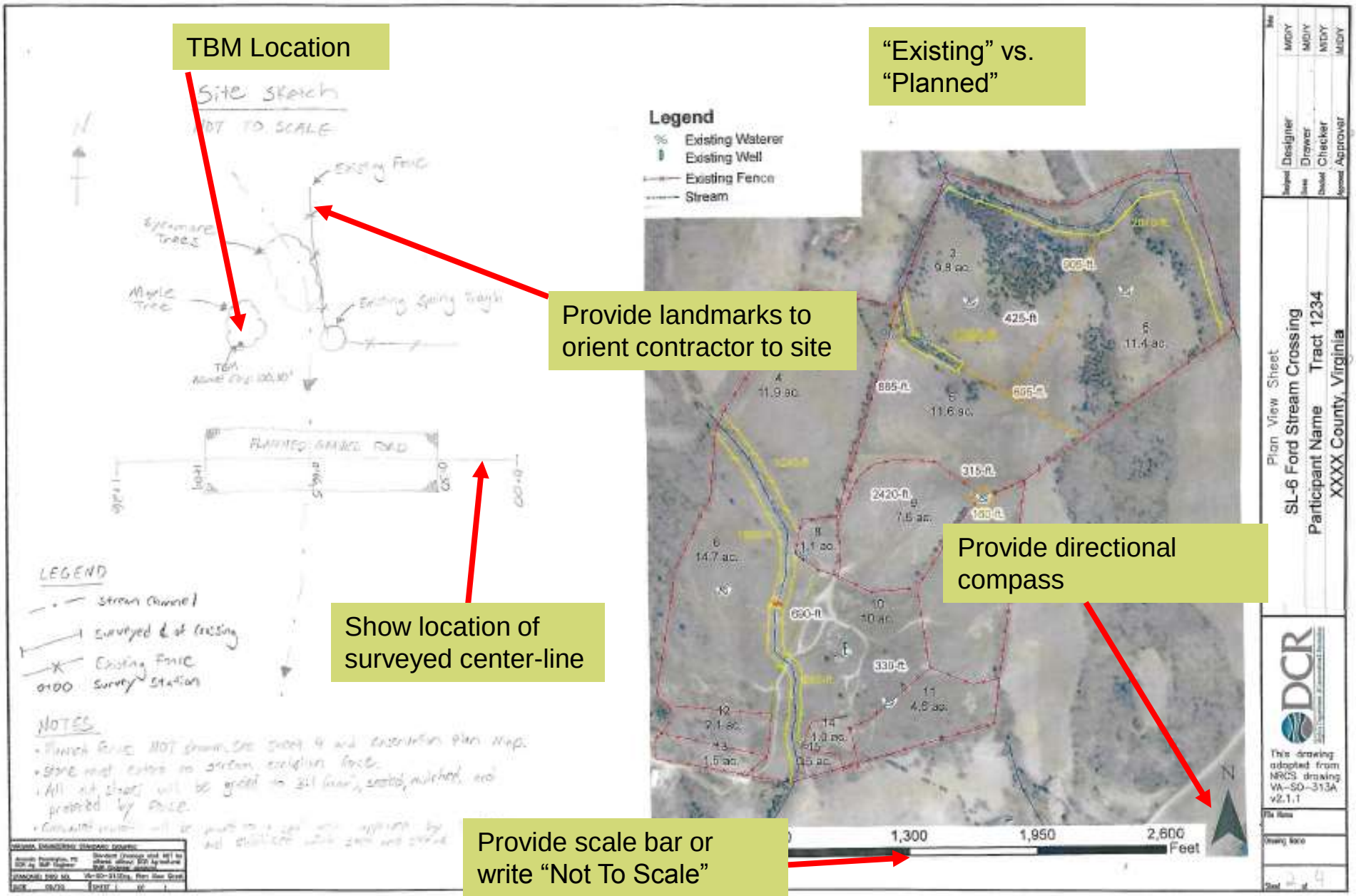
DCR

This drawing adapted from NRCS Standard Drawing VA-SO-100 v2.4.0

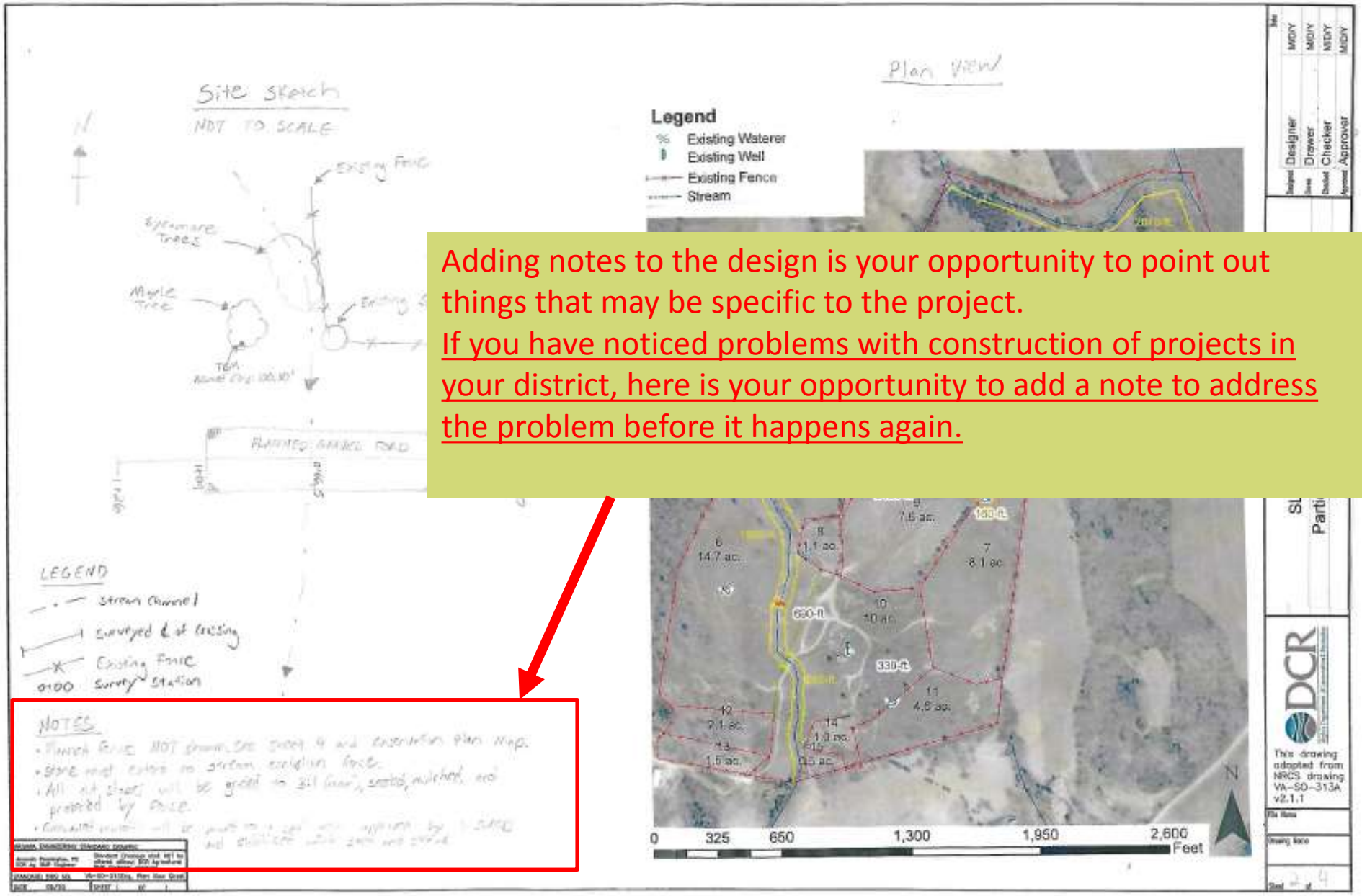
Plan View


TBM Location
Site Sketch
NOT TO SCALE
Existing Fence
Sycamore Trees
Maple Tree
Existing Spring Head
TBM
PLANNED GRAVEL ROAD
LEGEND
Stream Channel
Surveyed ℄ of Crossing
Existing Fence
Survey Station
NOTES
Provide landmarks to orient contractor to site
Show location of surveyed center-line
"Existing" vs. "Planned"
Legend
Existing Waterer
Existing Well
Existing Fence
Stream
Provide directional compass
Provide scale bar or write "Not To Scale"
1,300
1,950
2,600
Feet
N
Plan View Sheet
SL-6 Ford Stream Crossing
Participant Name Tract 1234
XXXX County, Virginia
Designer
Drawer
Checker
Approver
This drawing adapted from NRCS drawing VA-SO-313A v2.1.1

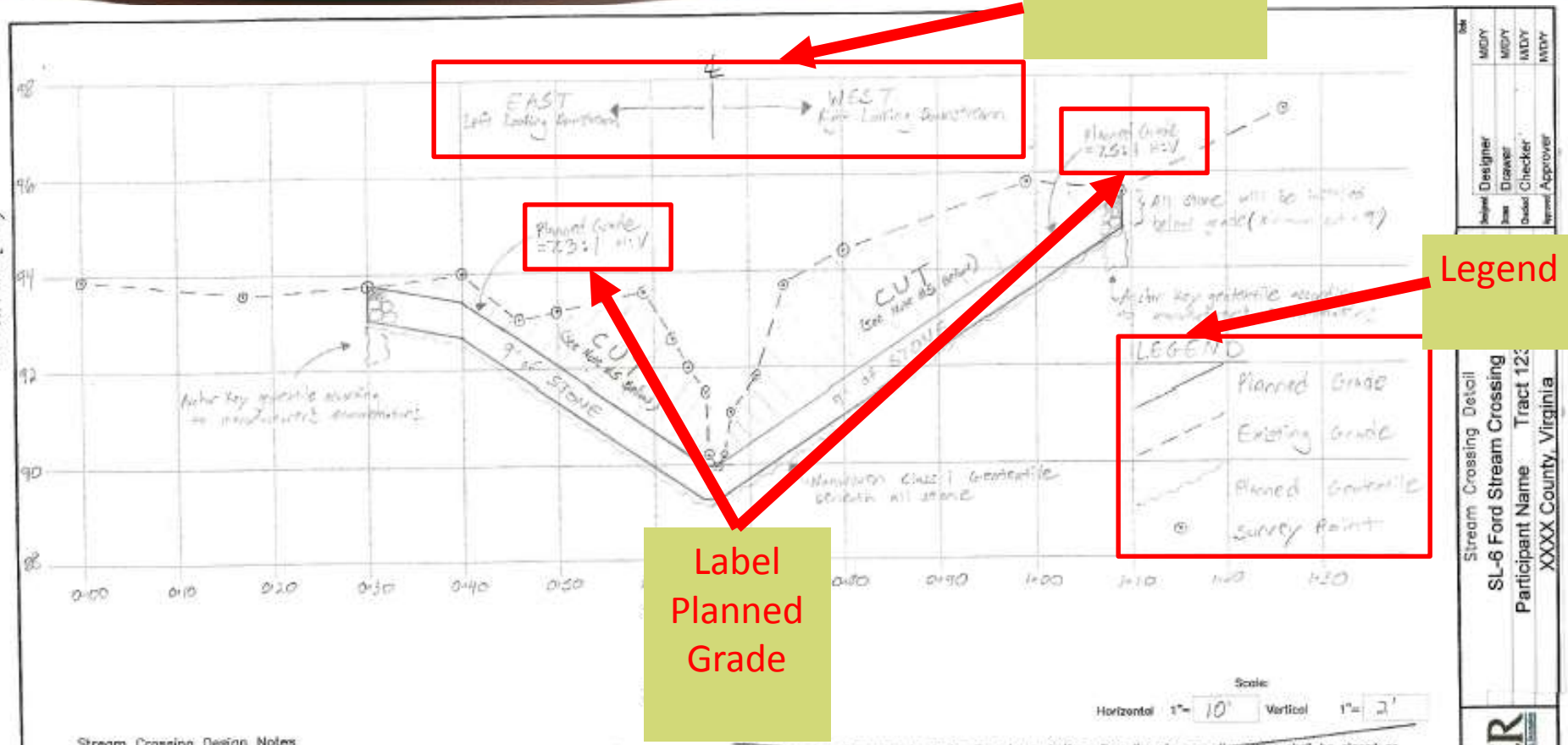
Plan View

Adding notes to the design is your opportunity to point out things that may be specific to the project.

<u>If you have noticed problems with construction of projects in your district, here is your opportunity to add a note to address the problem before it happens again.</u>



Stream Crossing Profile



Stream Crossing Detail
SL-6 Ford Stream Crossing
Participant Name Tract 123
XXXX County, Virginia

Scale:
Horizontal 1"= 10' Vertical 1"= 2'

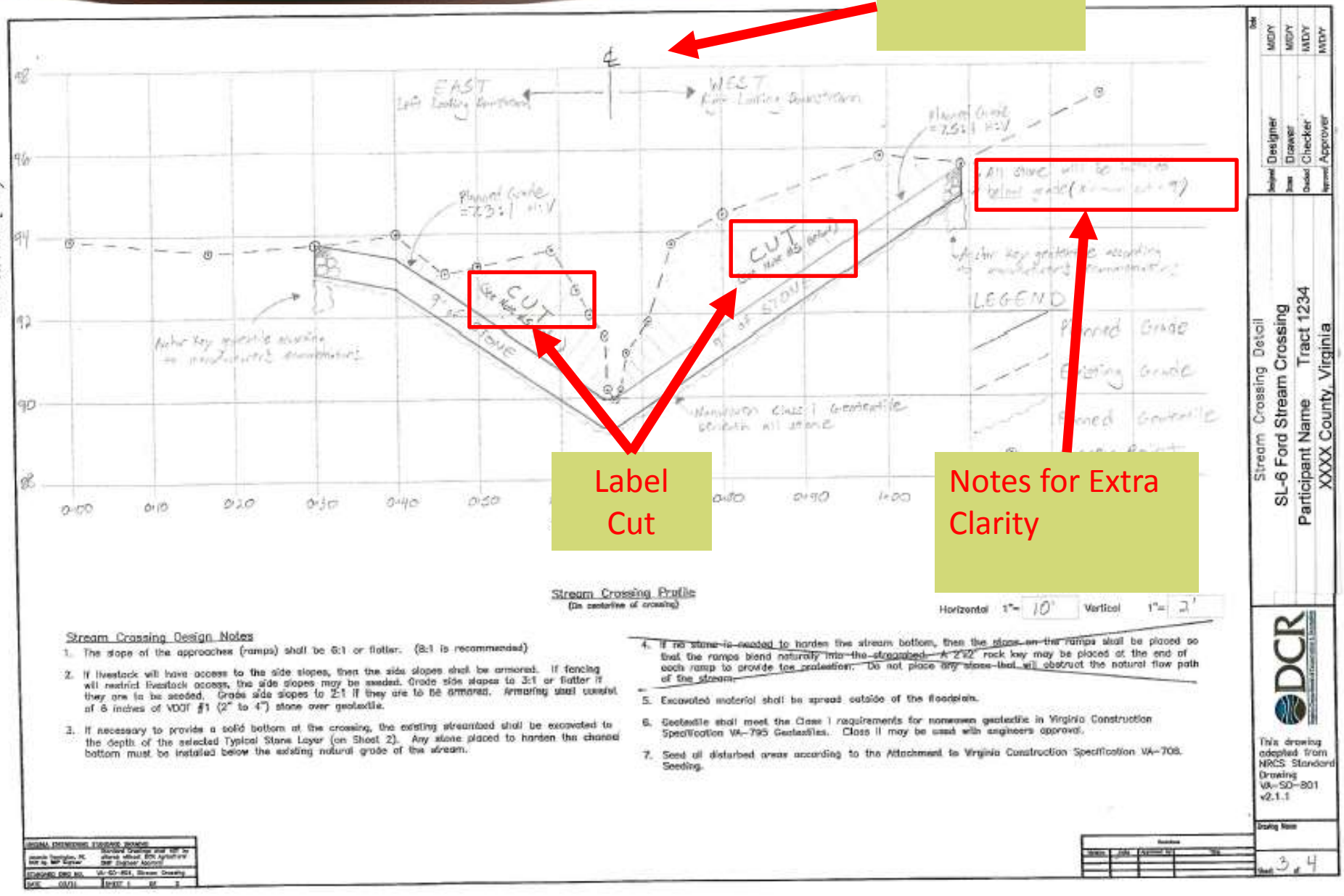
Stream Crossing Design Notes

1. The slope of the approaches (ramps) shall be 6:1 or flatter. (8:1 is recommended)
2. If livestock will have access to the side slopes, then the side slopes shall be armored. If fencing will restrict livestock access, the side slopes may be seeded. Grade side slopes to 3:1 or flatter if they are to be seeded. Grade side slopes to 2:1 if they are to be armored. Armoring shall consist of 6 inches of VDOT #1 (2" to 4") stone over geotextile.
3. If necessary to provide a solid bottom at the crossing, the existing streambed shall be excavated to the depth of the selected Typical Stone Layer (on Sheet 2). Any stone placed to harden the channel bottom must be installed below the existing natural grade of the stream.
4. If no stone is needed to harden the stream bottom, then the stone on the ramps shall be placed so that the ramps blend naturally into the streambed. A 2'x2' rock key may be placed at the end of each ramp to provide toe protection. Do not place any stone that will obstruct the natural flow path of the stream.
5. Excavated material shall be spread outside of the floodplain.
6. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification VA-795 Geotextiles. Class II may be used with engineers approval.
7. Seed all disturbed areas according to the Attachment to Virginia Construction Specification VA-708 Seeding.

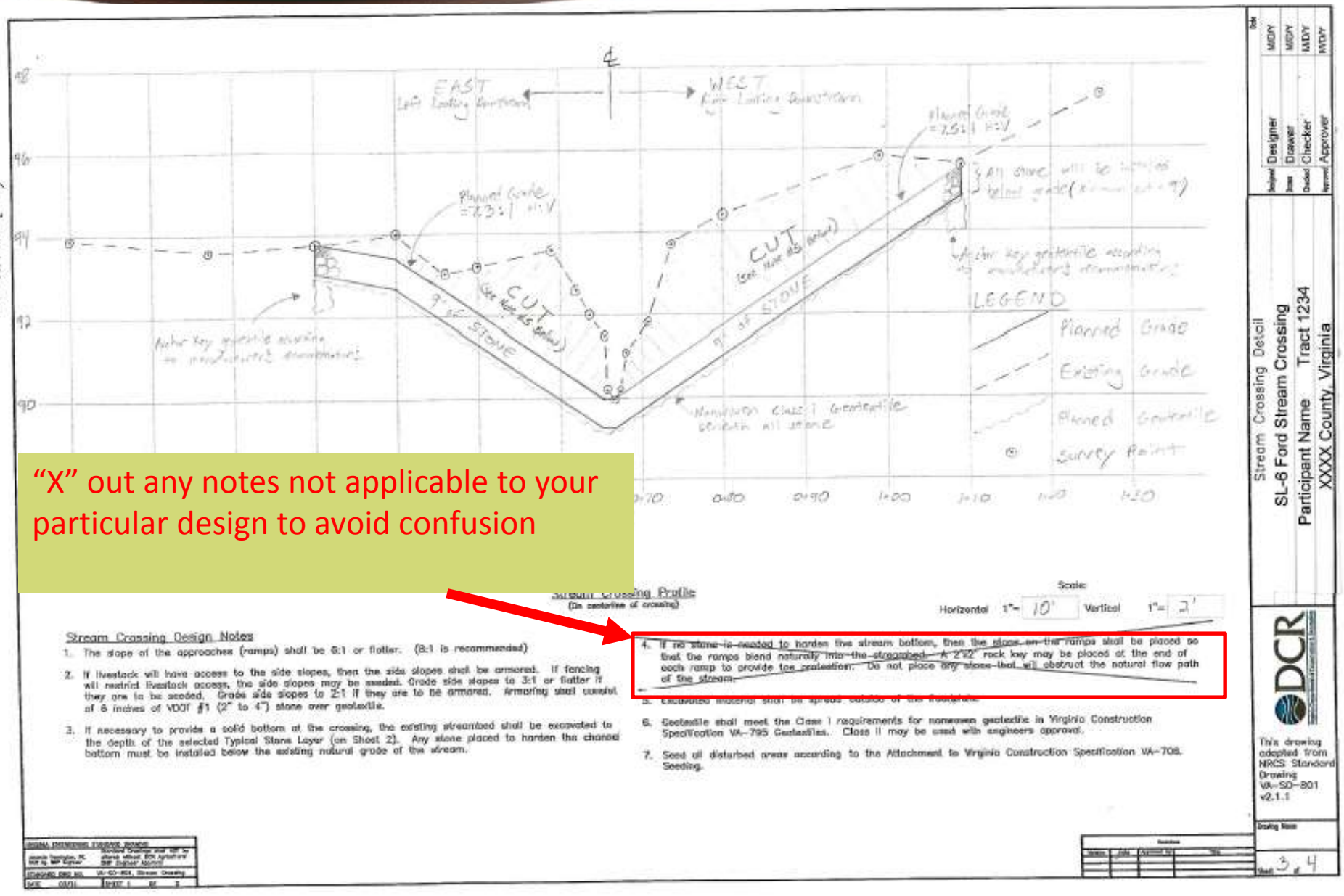
This drawing adapted from NRCS Standard Drawing VA-SD-801 v2.1.1

Sheet 3 of 4

Stream Crossing Profile

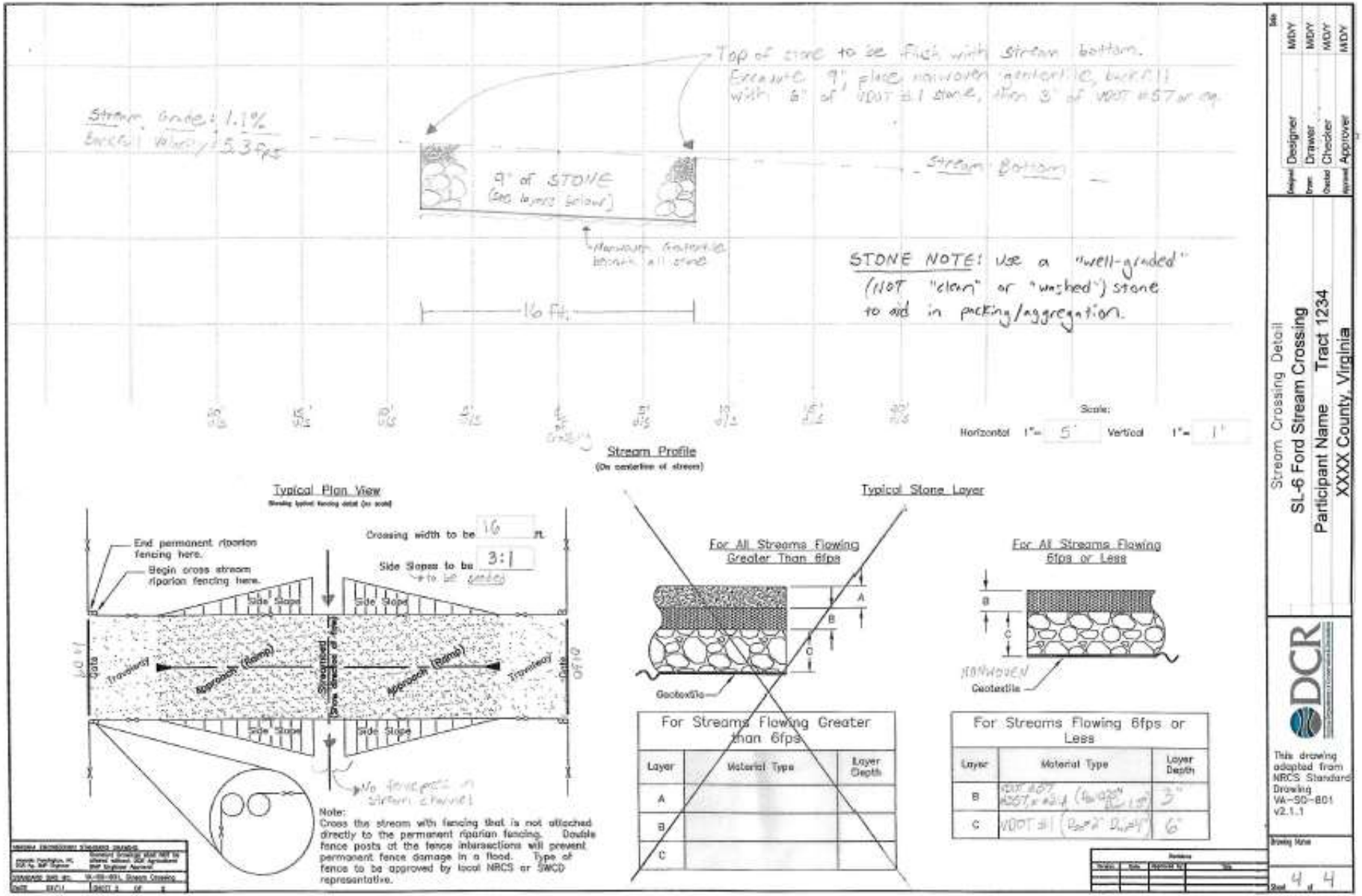


Stream Crossing Profile



"X" out any notes not applicable to your particular design to avoid confusion

Stream Profile



Stream Profile

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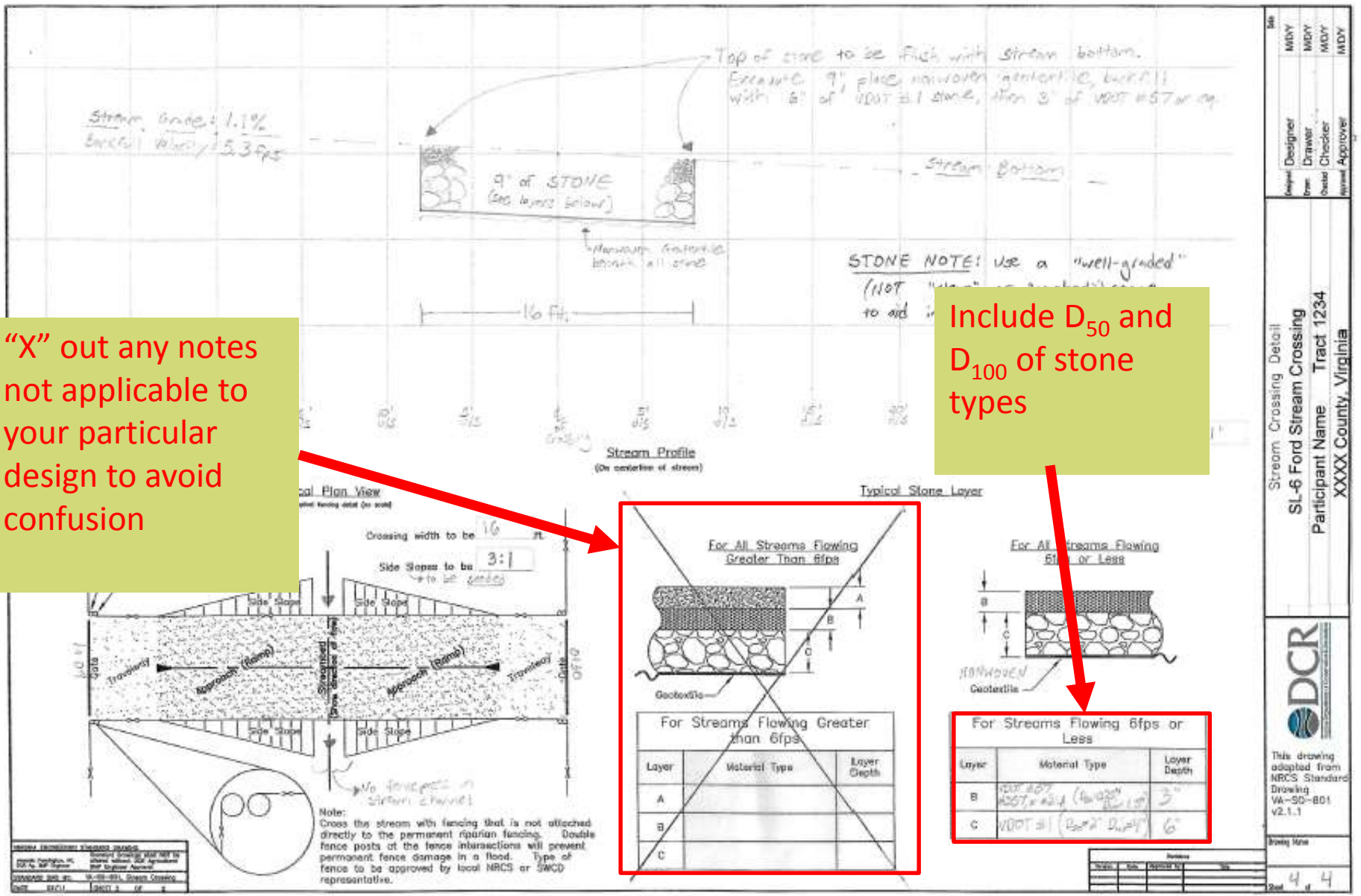
"X" out any notes not applicable to your particular design to avoid confusion

Include D_{50} and D_{100} of stone types



Availability

- DCR Design Sheets must be used for projects designed by SWCD staff.
- Sheets are available online in .pdf and .dwg (for AutoCAD) formats at:

  http://www.dcr.virginia.gov/soil-and-water/district-engineering-services

- NRCS Stds. and Specs. are available on the eFOTG, section IV

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Construction

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General Steps in Construction

1) Pre-Construction Conference
2) Excavation
3) Armoring (Geotextile + Stone)
4) Fencing
5) Seeding

1. Pre-Construction Meeting

- A pre-construction meeting and good oversight will prevent many construction issues from happening.

Must be “Approved” by someone with appropriate EJAA before issued for construction

Make sure to get “Acknowledgement Signatures” from all parties at pre-con meeting

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Things to stress at Pre-Con Meeting/ Things that contractors tend to "forget":

- Deliverables/Inspections
  - Construction Specifications
- NON-woven geotextile
- KEY ends of geotextile
- MAX slopes
- Stone gradations
- Final stone layers must be FLUSH with streambed
- Removal of cut material outside of floodplain
- Seed all disturbed areas

Pre-Construction Meeting

Ideally: Meet on-site, stake the corners of the proposed crossing and go over the cut depths at different points along the profile

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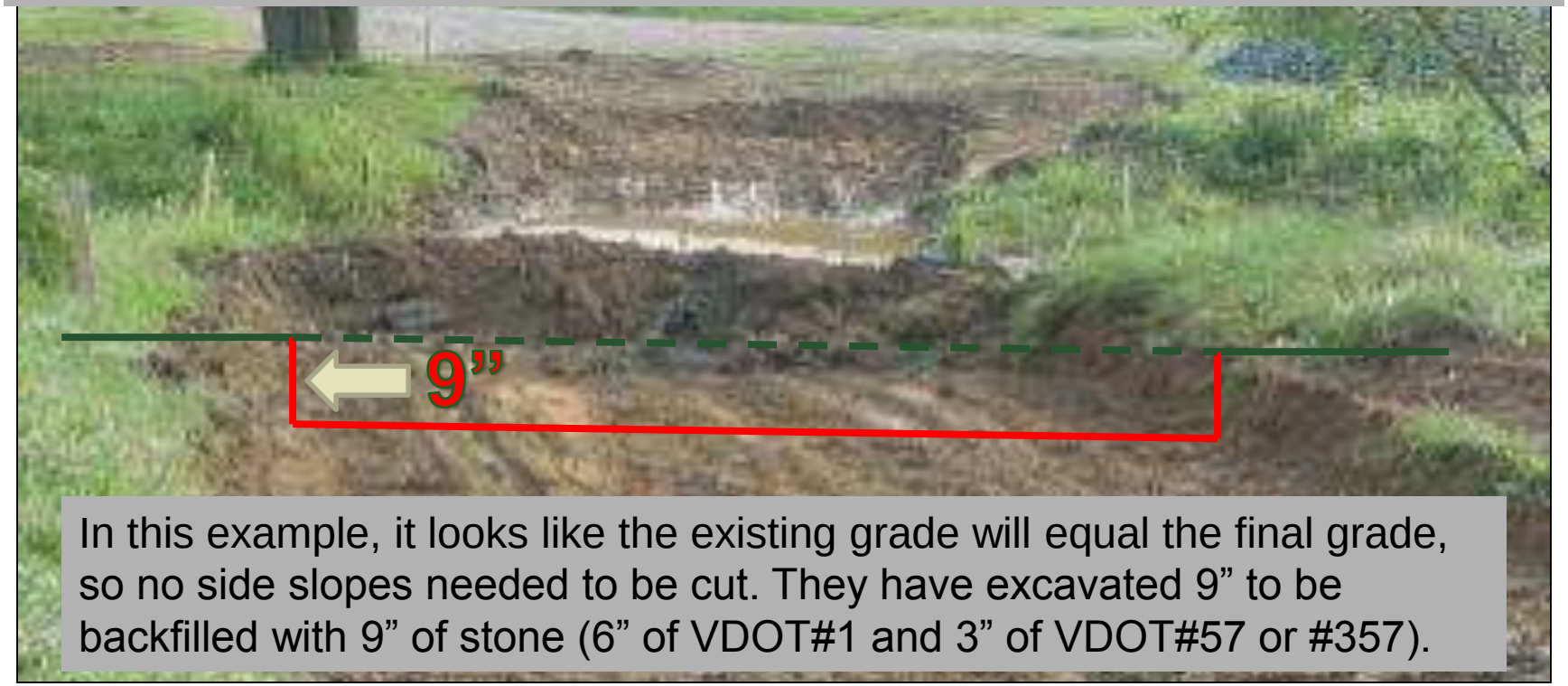
2. Excavation

Cut to the depth at which the proposed stone layer thickness will bring the crossing to the proposed final grade. Cut side slopes back to the desired slope (3:1 (seeded), 2:1 (armored), or 1.5:1 in rock cuts)



In this example, it looks like the existing grade will equal the final grade, so no side slopes needed to be cut. They have excavated 9” to be backfilled with 9” of stone (6” of VDOT#1 and 3” of VDOT#57 or #357).

Photograph courtesy of John Cooke, VA NRCS State Office. From DN-578

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Anything wrong with this picture?

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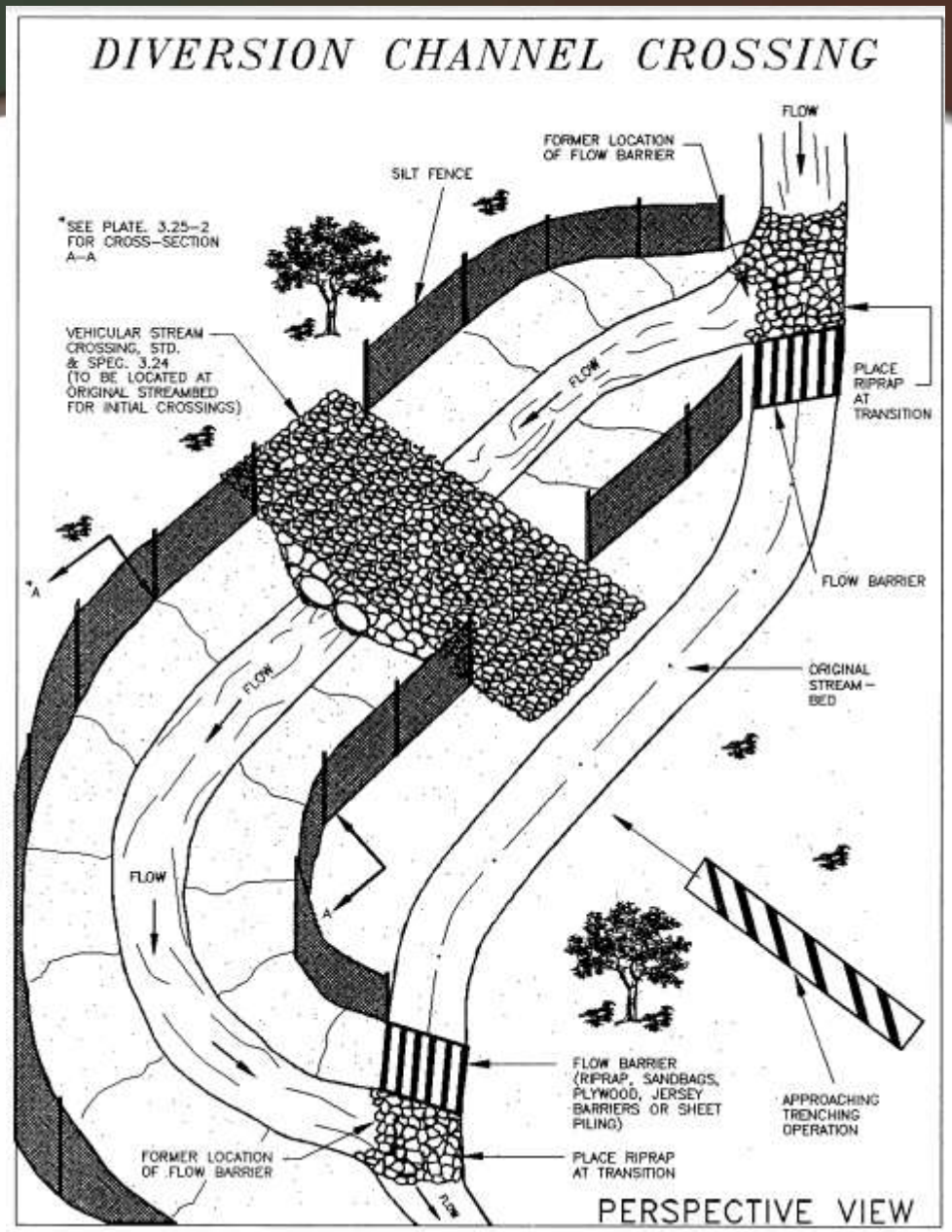
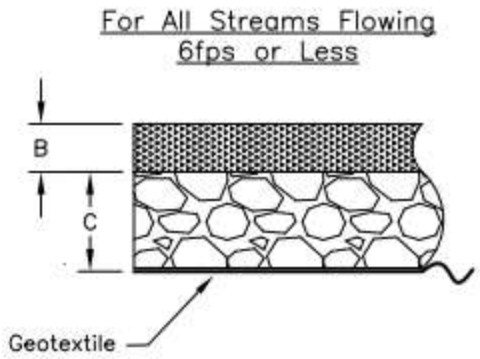
A *Diversion Channel* may be utilized to allow "work in the dry".

Virginia Erosion and Sediment Control Handbook

STD & SPEC 3.25

UTILITY STREAM CROSSING

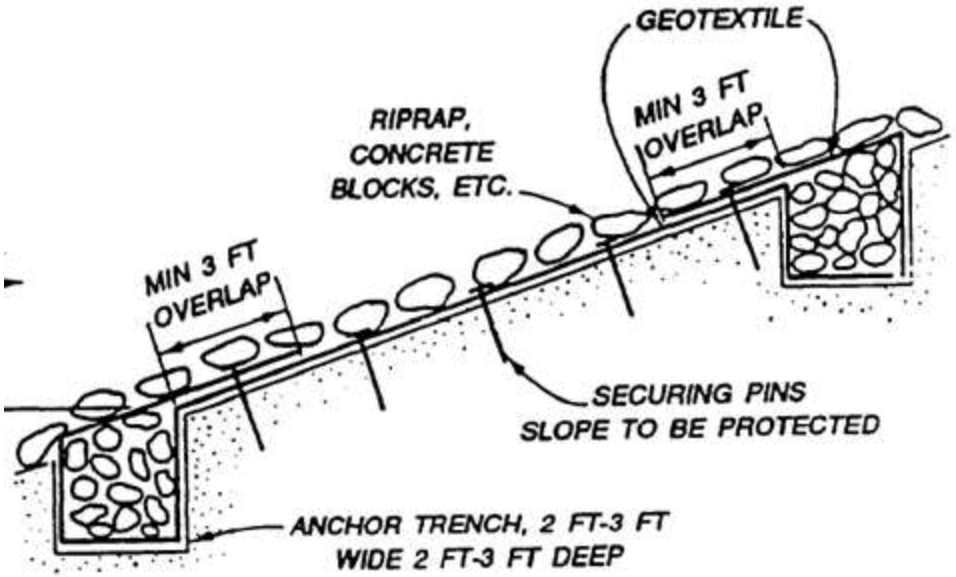




3. Armoring

- Lay Nonwoven Geotextile
  - Under entire length and width of stone layer
  - Key in at all ends
- Base Stone
- Surface Stone

Army TM 5-818-8 Key Detail:



Geotextile: VA-795

- VA-795: “Each roll of geotextile will be clearly marked to identify the brand, type and production run.”
- VA-795: “The surface on which the geotextile is to be placed will be graded to the neat lines and grades as shown on the construction drawings…The surface preparation will be inspected and approved by the NRCS or SWCD representative prior to placing the geotextile.”
- “The geotextile will be unrolled along the placement area and loosely laid (not stretched)”
- “In no case will the cover material be dropped on uncovered geotextile from a height greater than 3 feet.”
- “The minimum overlap of adjacent geotextile panels will be 24 inches for unsewn fabric.”

6. Geotextile shall meet the Class I requirements for nonwoven geotextile in Virginia Construction Specification VA–795 Geotextiles. Class II may be used with engineers approval.

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Nonwoven Geotextiles

TABLE 2 - REQUIREMENTS FOR NONWOVEN GEOTEXTILES

Property	Test Method	Units	Class I 2/	Class II 2/
Grab Tensile Strength	ASTM D4632	pounds	202 (min.)	157 (min.)
Elongation at Failure	ASTM D4632	percent	50 (min.)	50 (min.)
Trapezoidal Tear Strength	ASTM D4533	pounds	79 (min.)	56 (min.)
Puncture Strength	ASTM D6241	pounds	433 (min.)	309 (min.)
Ultraviolet Stability (Retained Strength)	ASTM D4355	percent	50 (min.)	50 (min.)
Permittivity	ASTM D4491	sec^{-1}	0.7 (min.), or as specified	
Apparent Opening Size (AOS) 3/	ASTM D4751	mm	0.22 (max.), or as specified	

1/ *All values are minimum average roll values (MARV) in the weakest principal direction, unless otherwise noted.*
2/ *Needle punched geotextiles are required for both class I and class II.*
3/ *Maximum average roll value.*

Mirafi® 180N

Drainage Separation

Mirafi® 180N is a needlepunched nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Mirafi® 180N is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids. Mirafi® 180N meets AASHTO M288-06 Class 1 for Elongation > 50%.

TenCate Geosynthetics Americas Laboratories are accredited by a2La (The American Association for Laboratory Accreditation) and Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP). NTPEP Listed

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D4632	lbs (N)	205 (912)	205 (912)
Grab Tensile Elongation	ASTM D4632	%	50	50
Trapezoid Tear Strength	ASTM D4533	lbs (N)	80 (356)	80 (356)
CBR Puncture Strength	ASTM D6241	lbs (N)	500 (2224)	
			Maximum Opening Size	
Apparent Opening Size (AOS)	ASTM D4751	U.S. Sieve (mm)	80 (0.18)	
			Minimum Roll Value	
Permittivity	ASTM D4491	sec^{-1}	1.4	
Flow Rate	ASTM D4491	$gal/min/ft^2$ ($l/min/m^2$)	95 (3870)	
			Minimum Test Value	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	70	

Physical Properties	Unit	Roll Sizes	
Roll Dimensions (width x length)	ft (m)	12.5 x 360 (3.8 x 110)	15 x 300 (4.57 x 91.4)
Roll Area	yd^2 (m^2)	500 (418)	

This particular geotextile meets both Class I and II requirements.

Mirafi® 140N

Mirafi® 140N is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Mirafi® 140N is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids. Mirafi® 140N meets AASHTO M288-06 Class 3 for Elongation > 50%.

TenCate Geosynthetics Americas Laboratories are accredited by a2La (The American Association for Laboratory Accreditation) and Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP). NTPEP Listed

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D4632	lbs (N)	120 (534)	120 (534)
Grab Tensile Elongation	ASTM D4632	%	50	50
Trapezoid Tear Strength	ASTM D4533	lbs (N)	50 (223)	50 (223)
CBR Puncture Strength	ASTM D6241	lbs (N)	310 (1380)	
			Maximum Opening Size	
Apparent Opening Size (AOS)	ASTM D4751	U.S. Sieve (mm)	70 (0.212)	
			Minimum Roll Value	
Permittivity	ASTM D4491	sec^{-1}	1.7	
Flow Rate	ASTM D4491	$gal/min/ft^2$ ($l/min/m^2$)	135 (5500)	
			Minimum Test Value	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	70	

Physical Properties	Unit	Roll Sizes	
Roll Dimensions (width x length)	ft (m)	12.5 x 360 (3.8 x 110)	15 x 360 (4.5 x 110)
Roll Area	yd^2 (m^2)	500 (418)	600 (502)

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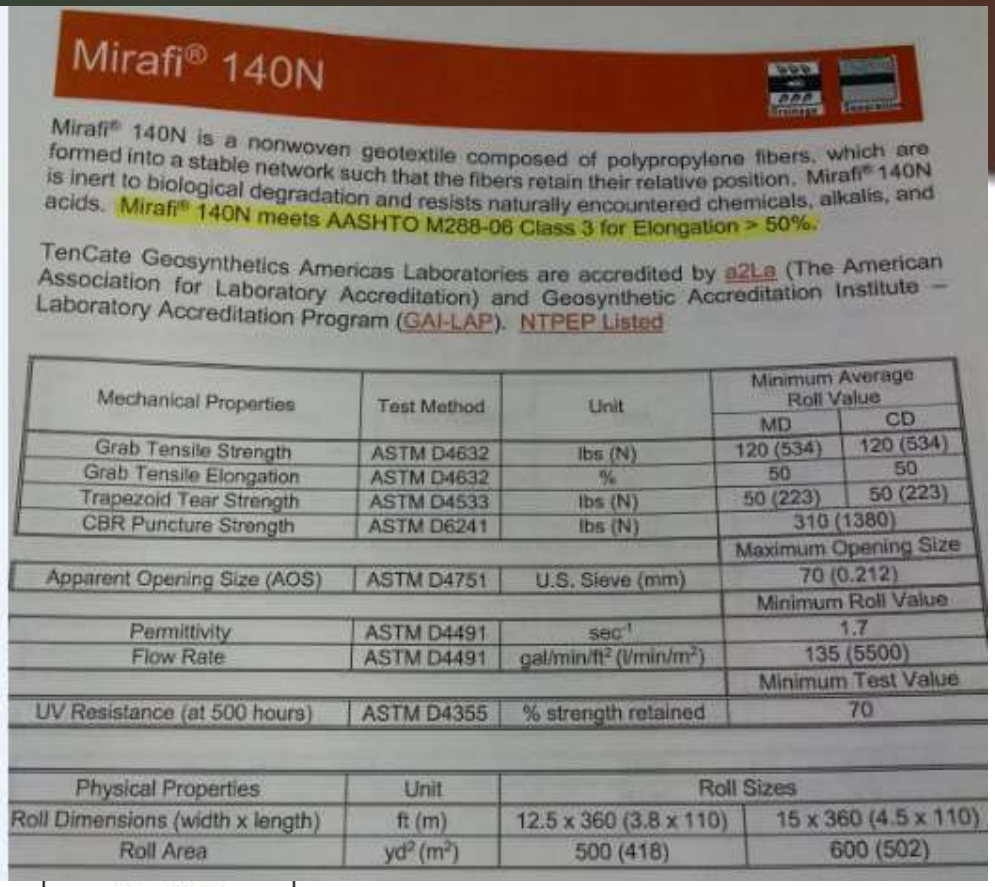
Nonwoven Geotextiles



Mirafi® 140N

Mirafi® 140N is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Mirafi® 140N is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids. Mirafi® 140N meets AASHTO M288-06 Class 3 for Elongation > 50%.

TenCate Geosynthetics Americas Laboratories are accredited by a2La (The American Association for Laboratory Accreditation) and Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP). NTPEP Listed

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D4632	lbs (N)	120 (534)	120 (534)
Grab Tensile Elongation	ASTM D4632	%	50	50
Trapezoid Tear Strength	ASTM D4533	lbs (N)	50 (223)	50 (223)
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Flow Rate	ASTM D4491	$gal/min/ft^2$ ($l/min/m^2$)	135 (5500)	
			Minimum Test Value	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	70	

Physical Properties	Unit	Roll Sizes	
Roll Dimensions (width x length)	ft (m)	12.5 x 360 (3.8 x 110)	15 x 360 (4.5 x 110)
Roll Area	yd^2 (m^2)	500 (418)	600 (502)

TABLE 2 - REQUIREMENTS FOR NONWOVEN GEOTEXTILES

Property	Test Method	Units	Class I 2/	Class II 2/
Grab Tensile Strength	ASTM D4632	pounds	202 (min.)	157 (min.)
Elongation at Failure	ASTM D4632	percent	50 (min.)	50 (min.)
Trapezoidal Tear Strength	ASTM D4533	pounds	79 (min.)	56 (min.)
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Ultraviolet Stability (Retained Strength)	ASTM D4355	percent	50 (min.)	50 (min.)
Permittivity	ASTM D4491	sec^{-1}	0.7 (min.), or as specified	
Apparent Opening Size (AOS) 3/	ASTM D4751	mm	0.22 (max.), or as specified	

1/ *All values are minimum average roll values (MARV) in the weakest principal direction, unless otherwise noted.*
2/ *Needle punched geotextiles are required for both class I and class II.*
3/ *Maximum average roll value.*

This particular geotextile does not meet Class I or II requirements.

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3. If necessary to provide a solid bottom at the crossing, the existing streambed shall be excavated to the depth of the selected Typical Stone Layer (on Sheet 2). Any stone placed to harden the channel bottom must be installed below the existing natural grade of the stream.

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Will this be able to serve as a limited access?

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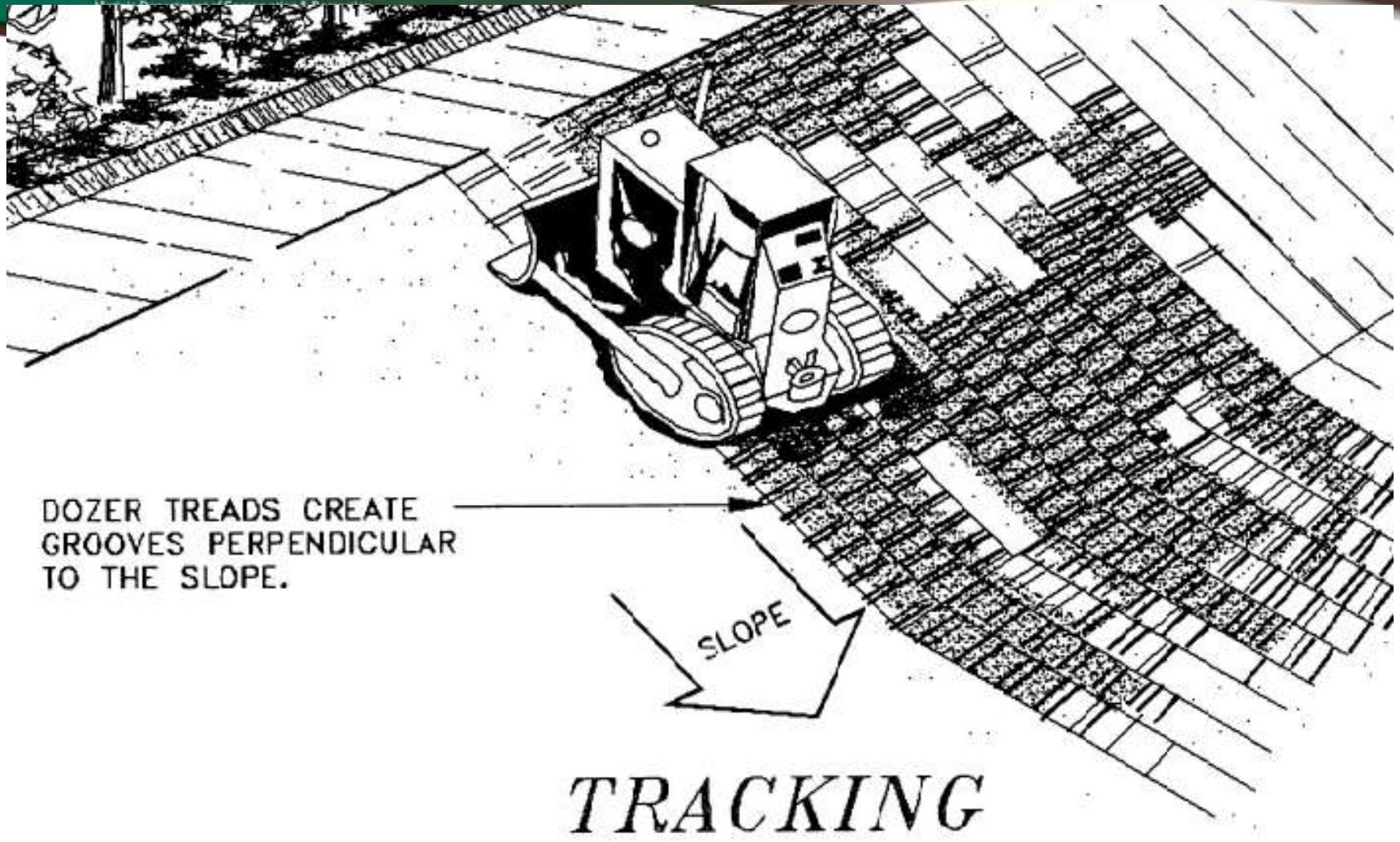
Compacting Surface Stone Layer:

- VA-795: “Gravel…will be compacted with vibratory rollers **EXCEPT** on animal trails or stream crossings.”
- VA-795: “…moderate to heavy static rollers (steel drum or rubber tired) will be used. Fine-grained backfill will be compacted with sheepsfoot or rubber tired rollers.”



No matter what method of compaction is used, a well graded stone will pack better than a “clean” stone.

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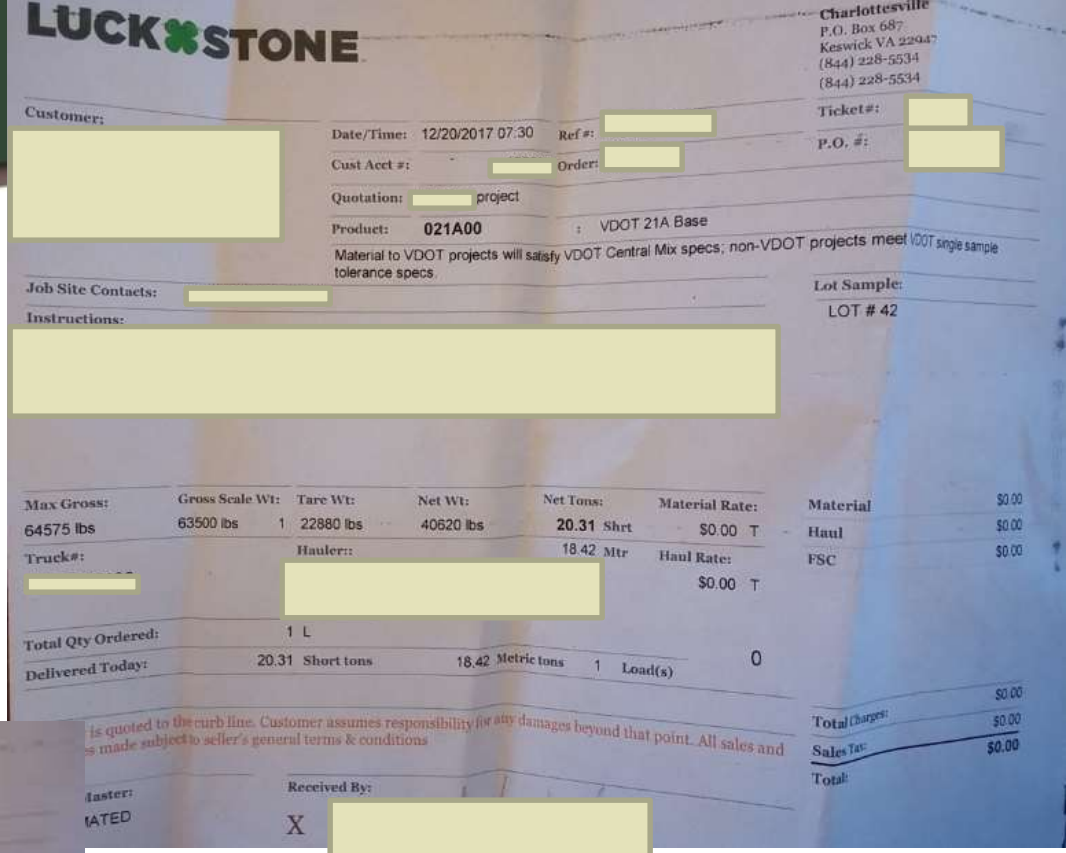

LUCK STONE

Charlottesville
P.O. Box 687
Keswick VA 22947
(844) 228-5534
(844) 228-5534

Customer:

Date/Time: 12/20/2017 07:30 Ref #:
Cust Acct #: Order:
Quotation: project
Product: 021A00 : VDOT 21A Base
Material to VDOT projects will satisfy VDOT Central Mix specs; non-VDOT projects meet VDOT single sample tolerance specs.

Ticket#:
P.O. #:

Job Site Contacts:
Instructions:

Lot Sample:
LOT # 42

Max Gross:	Gross Scale Wt:	Tare Wt:	Net Wt:	Net Tons:	Material Rate:
64575 lbs	63500 lbs 1	22880 lbs	40620 lbs	20.31 Shrt	$0.00 T
Truck#:		Hauler::		18.42 Mtr	Haul Rate: $0.00 T

Material	$0.00
Haul	$0.00
FSC	$0.00

Total Qty Ordered: 1 L
Delivered Today: 20.31 Short tons 18.42 Metric tons 1 Load(s) 0

is quoted to the curb line. Customer assumes responsibility for any damages beyond that point. All sales and
s made subject to seller's general terms & conditions

Total Charges:	$0.00
Sales Tax:	$0.00
Total:	$0.00

Master:
IATED

Received By:
X

LUCK STONE

Product: 001500 VDOT #1
Aggregate grading shipped under this certification is subject to visual inspection and approval by Project Engineer/Inspector

Material $0.00
Haul $0.00
FSC $0.00

Total Charges: $0.00
Sales Tax: $0.00
Total: $0.00

Weigh Master:
AUTOMATED

Received By:
X

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4. Fencing

Fencing. Restrict livestock access to the crossing through the use of fence and gates, as needed.

Install cross-stream fencing at fords, with breakaway wire, swinging floodgates, hanging electrified chain, or other devices to allow the passage of floodwater and large woody material during high flows.

Design and construct all fencing in accordance with Virginia NRCS Conservation Practice Standard *Fence (Code 382)*.

- Proper fence selection and installation is an important part of crossing success
- Improper fencing can cause the crossing to fail
- If separate contractors will be hired for fencing and stream crossings, provide stream crossing design to fencer
- There should be no space between the stone and the fence.
  - If there is space, that is where cattle will walk, which defeats the purpose of the crossing!

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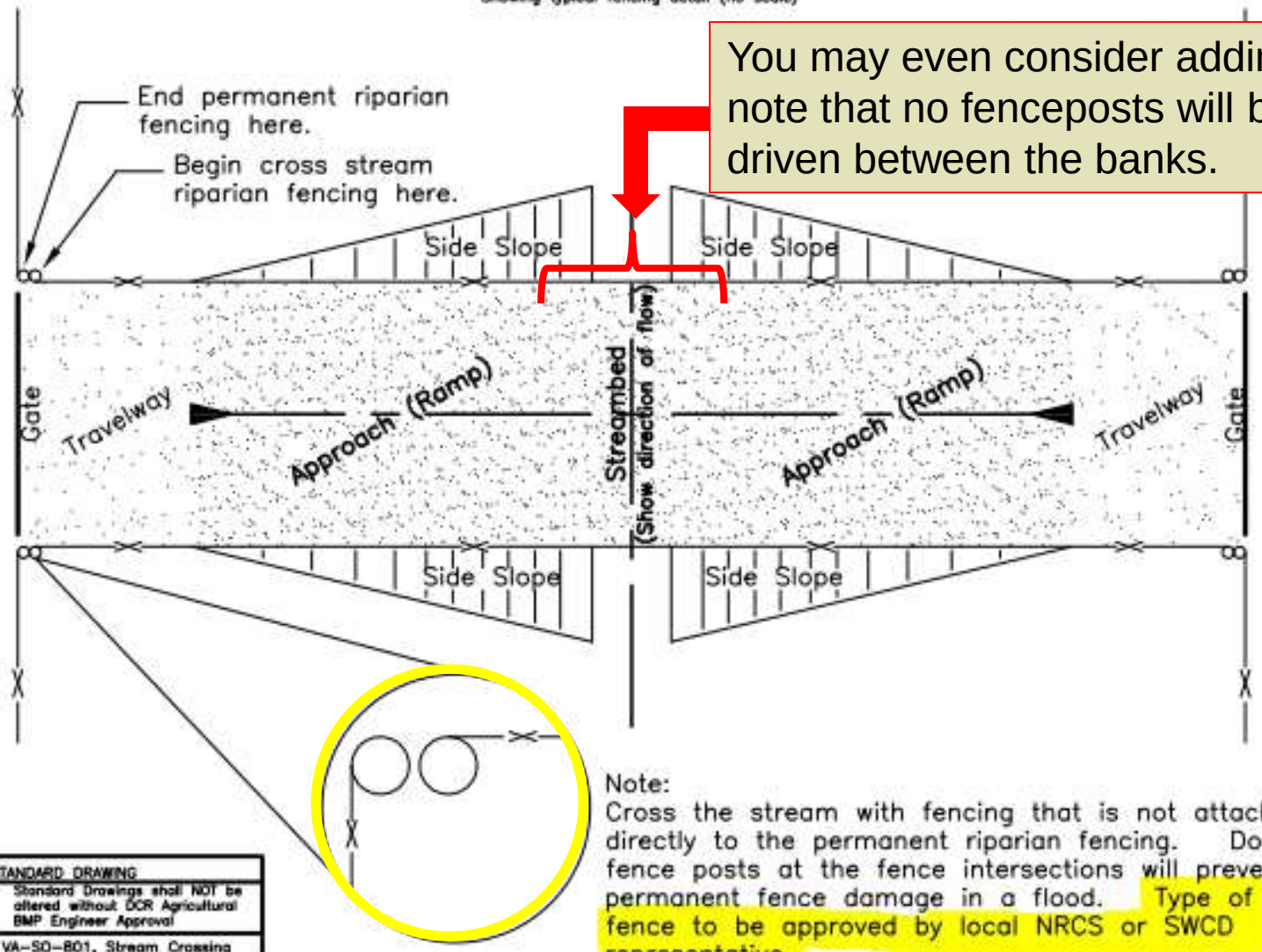
Typical Plan View

Showing typical fencing detail (no scale)



You may even consider adding a note that no fenceposts will be driven between the banks.

Note:
Cross the stream with fencing that is not attached directly to the permanent riparian fencing. Double fence posts at the fence intersections will prevent permanent fence damage in a flood. Type of fence to be approved by local NRCS or SWCD representative.

VIRGINIA ENGINEERING STANDARD DRAWING	
Amanda Pennington, PE, DCR Ag. BMP Engineer	Standard Drawings shall NOT be altered without DCR Agricultural BMP Engineer Approval
STANDARD DWG NO.	VA-SO-801, Stream Crossing
DATE 03/11	SHEET 2 OF 2


05/12/2014

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Installing fencing *after* the stone is placed:

- Keeps the fence out of the way during grading
- Allows fenceposts to be installed immediately adjacent to gravel (so there is no gap between the fenceposts and the stone)
  - If given the choice, cattle will choose to walk on soft ground next to the stone instead of the stone.

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2. If livestock will have access to the side slopes, then the side slopes shall be armored. If fencing will restrict livestock access, the side slopes may be seeded. Grade side slopes to 3:1 or flatter if they are to be seeded. Grade side slopes to 2:1 if they are to be armored. Armoring shall consist of 6 inches of VDOT #1 (2" to 4") stone over geotextile.

For Crossing Fencing:

(especially in flood-prone areas)

HT Smooth > Barbed > Woven

High-tensile smooth wire is the easiest to repair and is less likely to catch debris.

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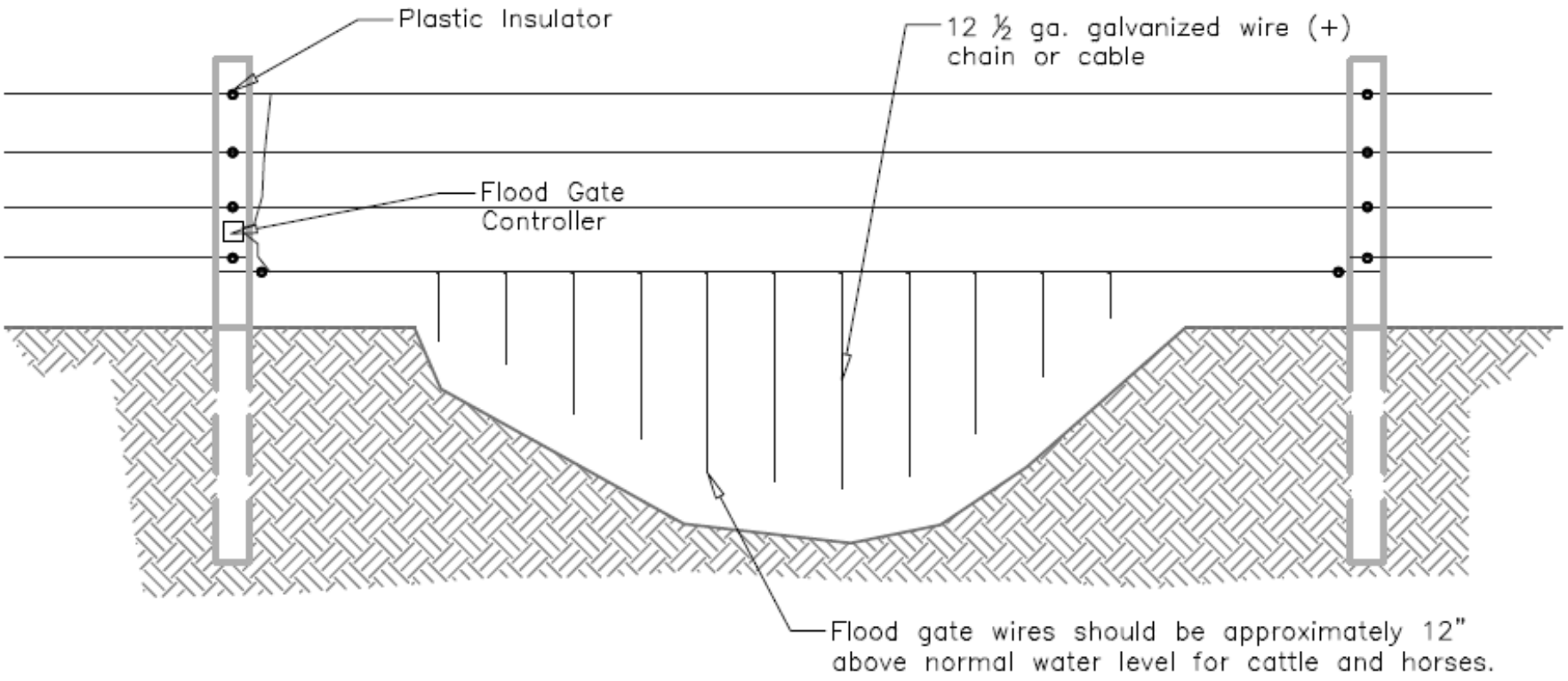

Electric Flood Gate

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http://www.lancasterwatersheds.org/Why%20Keep%20the%20Cows%20Out%20of%20the%20Streams.pdf

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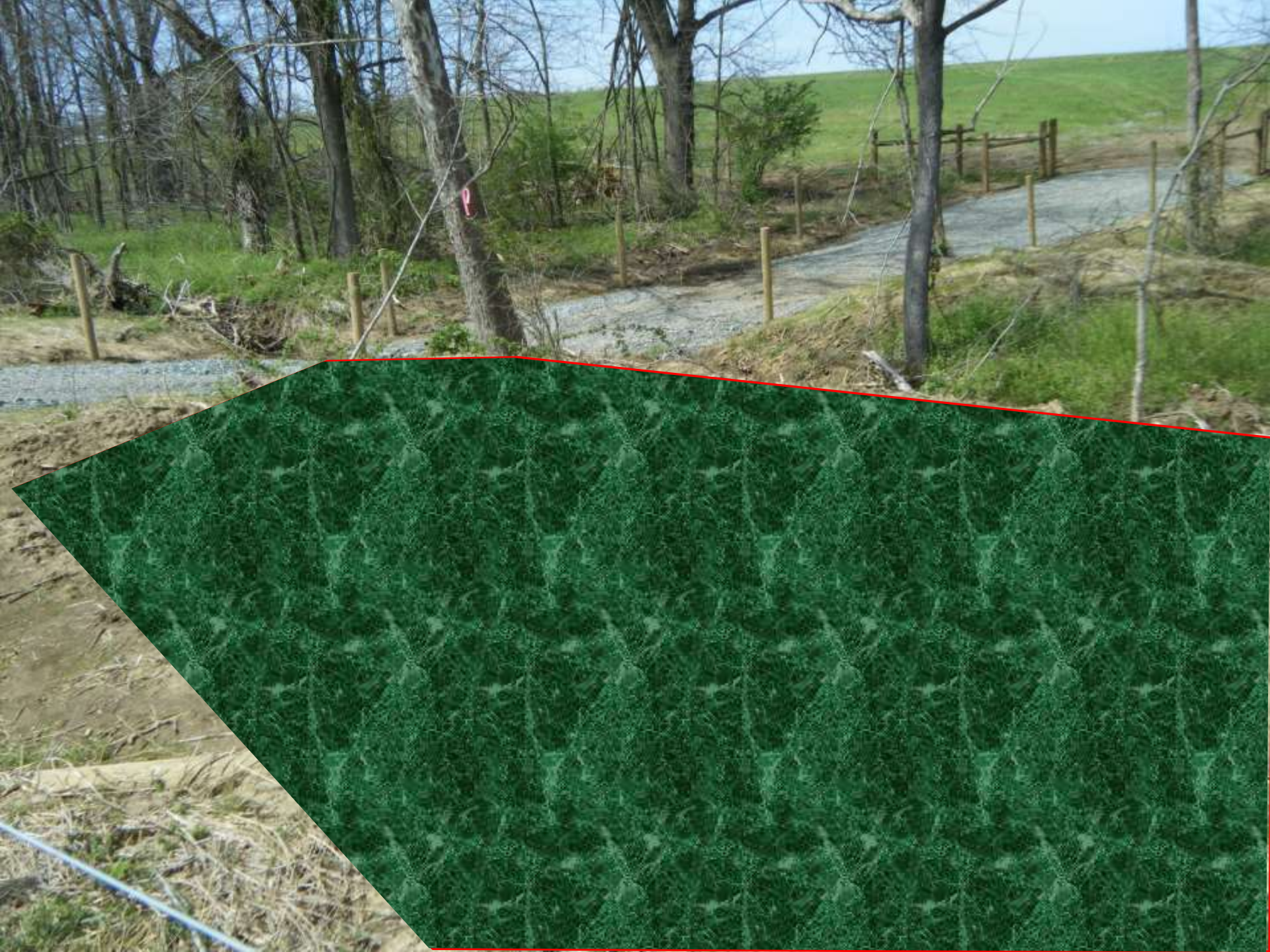
How many things are wrong here?
-Woven wire
-Fenceposts in stream
-(Geotextile through stream (solid bottom))

5. Seeding

- Seed all disturbed area according to NRCS Construction Spec. VA-706
- “Plant all areas to be vegetated as soon as practical after construction.” (VA-578)
- “All excavated material must be placed in upland sites and not in any streams/floodplains or wetlands.” (VA-578)



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As-Built/Certification

CHECK DATA

1. As-built surveys.
   a. Cross-section of completed crossing.
   b. Profile of stream channel to show crossing and stream are on a uniform grade.
2. As-built plans including dimensions, types and quantities of materials installed, and variations from design. Include justification for variations.
3. Locations of appurtenant practices.
4. Adequacy of vegetation and/or ground cover.
5. Complete as-built section of Cover Sheet.

As-Built/Certification

- Complete the checkout:
  - As-Built Survey: Survey the profile of the crossing
    - (If initial survey stakes have been removed, run the survey and use stream center-line as reference)
    - Also survey a few cross-sections to show that the side slopes were graded back properly
    - If you armored all the way through the stream, survey the centerline of the stream in proximity to the crossing to show that the stone was installed flush with the streambed
  - Measurements: Length, Width, Depth of Stone Layers
  - Document Gradation of Stone and Presence of Nonwoven Geotextile (and its class)
  - Make sure crossing as installed meets stds., specs., and design requirements
  - Take photographs for case file

As-Built/Certification Continued

- Complete the “As-Built” Drawings:
  - Plot the As-Built Survey in red on the original design sheets
    - The stream centerline can often be used to standardize the stations with the original survey
  - Verify that the final grades are satisfactory: Did they achieve the grades that were specified?
  - Document Measurements of Stone Layers
  - Document Gradation of Stone and Presence of Nonwoven Geotextile

If the crossing as installed meets NRCS Standards and Specifications, sign the "As-Built" Documentation block on the design cover sheet.

If you do NOT have EJAA to sign off on the design, send the red-lined As-Built design and supporting documentation to someone who does for their signature.

Design Copy Routing: ___ Cooperators Folder ___ Landowner ___ Contractor ___ Supplier

Notes

1. The landowner/operator is responsible for obtaining and complying with all permits and easements. This includes all federal, state and local permits.
2. The landowner/operator is responsible for checking and complying with all local ordinances that may affect the project.
3. MISS UTILITY (Virginia telephone number 811) must be contacted at least 3 working days before construction begins. The landowner/operator is responsible for ensuring that the contractor contacts MISS UTILITY. The contractor must be able to provide the MISS UTILITY ticket number within 24 hours upon request by the NRCS/SWCD representative. The landowner/operator is responsible for locating any buried utilities (water lines, electric lines, telephone lines, gas lines, sewer lines, etc.) in the work area that are not covered by the MISS UTILITY program.
4. NRCS/SWCD makes no representation of the existence or nonexistence of utilities. The presence or absence of utilities on the construction drawings does not assure that there are or are not utilities in the work area.
5. The contractor is responsible for knowing and following the appropriate safety standards required by the Virginia Safety and Health Codes Board.
6. The landowner/operator shall notify the local NRCS/SWCD representative at least one week prior to beginning construction, and at all other times specified in this construction plan and attached specifications.
7. Any deviation from these construction drawings and specifications without written approval from NRCS/SWCD representative may result in in failure of this practice to meet NRCS Standards and the withdrawal of technical assistance for this project.
8. Prior to beginning construction, the cover sheet must be signed by the landowner/operator, the contractor, and the NRCS/SWCD representative. The landowner/operator is responsible for informing the contractor of these responsibilities by providing the contractor a copy of this cover sheet. The contractor must sign the cover sheet acknowledging that these responsibilities are understood and the landowner/operator must return the signed cover sheet to the NRCS/SWCD Representative. If requested by NRCS/SWCD, the landowner/operator shall arrange for a meeting between the contractor and NRCS/SWCD to review the construction drawings and specifications prior to construction.

The SWCD Representative for this project is:

The SWCD office telephone number is:

Engineering Design Cover Sheet

Designed | Drawn | Checked | Approved

Benchmark Descriptions

TBM # | Assumed Elev.
Description:

TBM # | Assumed Elev.
Description:

Acknowledgment Signatures

These construction drawings and attached specifications have been reviewed I understand what is required. (Sign and date below)

Landowner/Operator

Contractor

SWCD Representative

Engineering Job Class:

811 Know what's below. Call before you dig.

"As Built" Documentation

Certified By and Date

Practice Completion Date

Site Location Map

Scale 1 inch = feet

Index of Sheets

Sheet No.	Title

Specification Table

No.	Title

Table of Estimated Quantities

Item	Unit	Quantity

DCR

This drawing adapted from NRCS Standard Drawing A-SD-100 2.4.0

File Name

Drawing Name

Revisions

Sheet of

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Alternative Materials

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Geocells

Use minimum 6-inch deep geocells, if geocells are used. Use durable geosynthetic materials and install them according to the manufacturer's recommendations, including the use of staples, clips, and anchor pins.

Geoweb®, Presto Products Co

A Geoweb® is a plastic web that can be filled with gravel. A Geoweb® filled with gravel, and laid over filter fabric makes a very good stream crossing.

Pre-cast Hog Slats

Hog panel stream crossing

Pre-cast Cattle-Guards

Consider adding a well-graded rock riprap apron on the downstream edge of concrete crossings to dissipate flow energy.

Recycled Concrete

DCR
Virginia Department of Conservation & Recreation

Questions?

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