E&SC on Stream Restoration Projects

Planning Considerations for Designers

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Goals of an E&SC Plan

- **Protection of Property & Water Quality**
  - **Prevent accelerated erosion onsite**
  - **Prevent off-site sedimentation**
- **Requires an integrated system of:**
  - **control practices *(Best Management Practices (BMPs))* &**
  - **management techniques *(construction sequencing)***
- **Stabilize site prior to completion of construction**

"Persons conducting land-disturbing activity shall take all reasonable measures to protect all public and private property from damage caused by such activities."

Source: NC DENR Erosion and Sediment Control Planning and Design Manual

E&SC Plan Concepts

- **Reduce the amount of off-site water from entering the site.**
- **All site water goes through a sediment control device.**
- **Runoff is pooled in order to settle sediment before discharging off site.**

Basic Objectives of an E&SC Plan

1) Identify Critical Areas

Identify site areas subject to severe erosion, and off-site areas especially vulnerable to damage from erosion and sedimentation.

1) Limit Exposed Areas

Limit the size of the area exposed at any one time.

2) Limit Time of Exposure

Limit exposure to the shortest feasible time.

Basic Objectives of an E&SC Plan (con't)

4) **Control Surface Water**

Control surface water run-off originating upgrade of exposed areas in order to reduce erosion and sediment loss during exposure.

5) **Control Sedimentation**

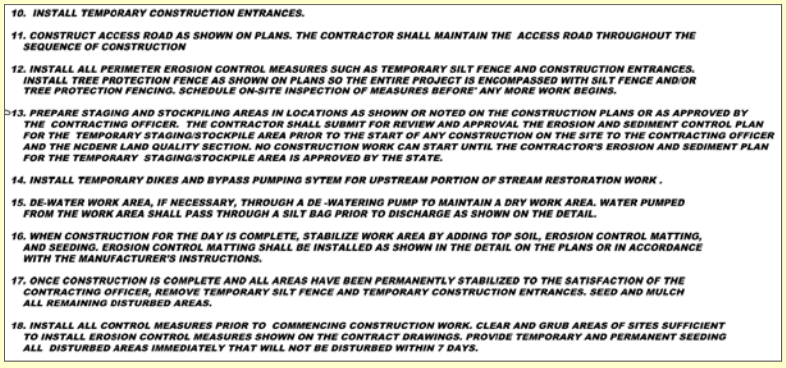
All land-disturbing activity is to be planned and conducted so as to prevent off-site sedimentation damage.

6) **Manage Storm Water Runoff**

When the increased velocity of storm water runoff resulting from a land-disturbing activity causes accelerated erosion of the receiving watercourse, plans shall include measures to control the velocity to the point of discharge.

Construction Sequence

- **One of most important components for successful project**
  - **Outlines steps of construction process**
  - **Details installation & removal of project components**
  - **Exceptions & modifications anticipated…designer & Land Quality inspector must approve first**



10. INSTALL TEMPORARY CONSTRUCTION ENTRANCES.

11. CONSTRUCT ACCESS ROAD AS SHOWN ON PLANS. THE CONTRACTOR SHALL MAINTAIN THE ACCESS ROAD THROUGHOUT THE SEQUENCE OF CONSTRUCTION

12. INSTALL ALL PERIMETER EROSION CONTROL MEASURES SUCH AS TEMPORARY SILT FENCE AND CONSTRUCTION ENTRANCES. INSTALL TREE PROTECTION FENCE AS SHOWN ON PLANS SO THE ENTIRE PROJECT IS ENCOMPASSED WITH SILT FENCE AND/OR TREE PROTECTION FENCING. SCHEDULE ON-SITE INSPECTION OF MEASURES BEFORE' ANY MORE WORK BEGINS.

13. PREPARE STAGING AND STOCKPILING AREAS IN LOCATIONS AS SHOWN OR NOTED ON THE CONSTRUCTION PLANS OR AS APPROVED BY THE CONTRACTING OFFICER. THE CONTRACTOR SHALL SUBMIT FOR REVIEW AND APPROVAL THE EROSION AND SEDIMENT CONTROL PLAN FOR THE TEMPORARY STAGING/STOCKPILE AREA PRIOR TO THE START OF ANY CONSTRUCTION ON THE SITE TO THE CONTRACTING OFFICER AND THE NCDENR LAND QUALITY SECTION. NO CONSTRUCTION WORK CAN START UNTIL THE CONTRACTOR'S EROSION AND SEDIMENT PLAN FOR THE TEMPORARY STAGING/STOCKPILE AREA IS APPROVED BY THE STATE.

14. INSTALL TEMPORARY DIKES AND BYPASS PUMPING SYTEM FOR UPSTREAM PORTION OF STREAM RESTORATION WORK .

15. DE-WATER WORK AREA, IF NECESSARY, THROUGH A DE -WATERING PUMP TO MAINTAIN A DRY WORK AREA. WATER PUMPED FROM THE WORK AREA SHALL PASS THROUGH A SILT BAG PRIOR TO DISCHARGE AS SHOWN ON THE DETAIL.

16. WHEN CONSTRUCTION FOR THE DAY IS COMPLETE, STABILIZE WORK AREA BY ADDING TOP SOIL, EROSION CONTROL MATTING, AND SEEDING. EROSION CONTROL MATTING SHALL BE INSTALLED AS SHOWN IN THE DETAIL ON THE PLANS OR IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.

17. ONCE CONSTRUCTION IS COMPLETE AND ALL AREAS HAVE BEEN PERMANENTLY STABILIZED TO THE SATISFACTION OF THE CONTRACTING OFFICER, REMOVE TEMPORARY SILT FENCE AND TEMPORARY CONSTRUCTION ENTRANCES. SEED AND MULCH ALL REMAINING DISTURBED AREAS.

18. INSTALL ALL CONTROL MEASURES PRIOR TO COMMENCING CONSTRUCTION WORK. CLEAR AND GRUB AREAS OF SITES SUFFICIENT TO INSTALL EROSION CONTROL MEASURES SHOWN ON THE CONTRACT DRAWINGS. PROVIDE TEMPORARY AND PERMANENT SEEDING ALL DISTURBED AREAS IMMEDIATELY THAT WILL NOT BE DISTURBED WITHIN 7 DAYS.

Construction Entrance/Exit

- **Provides stabilized ingress/egress point**
- **Located adjacent to public road**
- **Rough surface to dislodge soil from tires to prevent tracking onto public/private roads**

Construction Entrance/Exit

- **Example of construction entrance located adjacent to home—narrow easement**

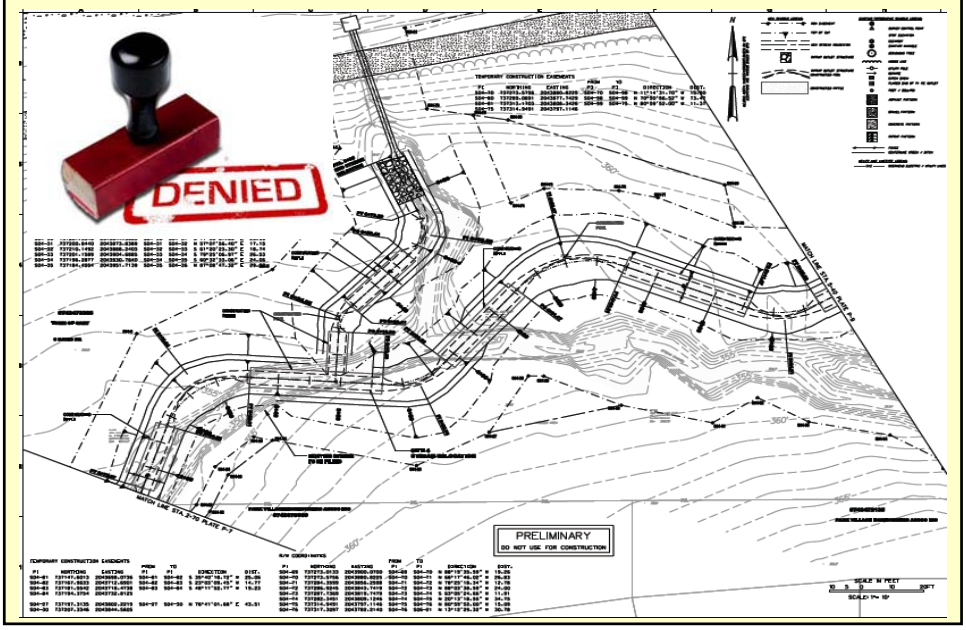
Construction Entrance/Exit

- **Consider moving back 10-20 ft from road if steep transition; requires additional ABC stone**

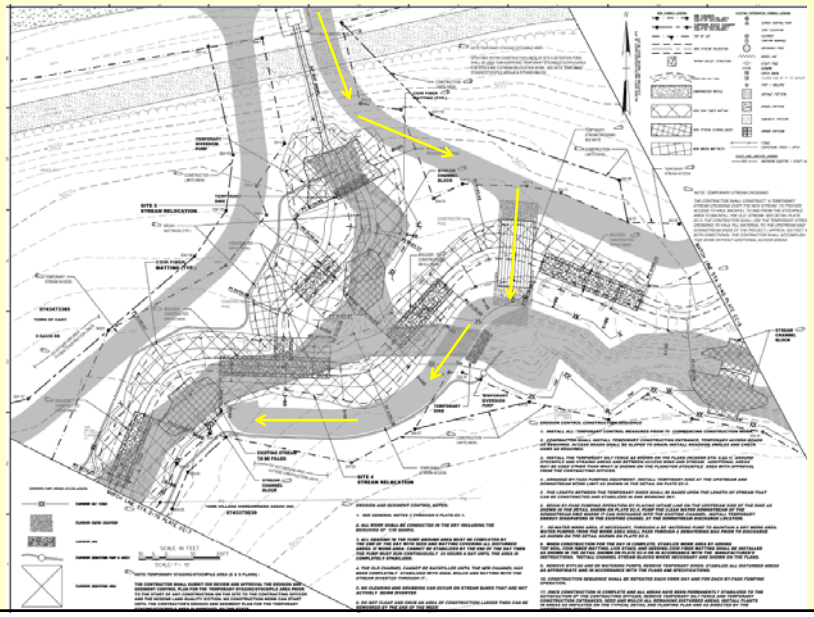
Travel Corridors

- **Depict equipment haul roads on plans…never leave to discretion of contractor**
- **Helps identify appropriate E&SC measures & limits of disturbance**

No Travel Corridors Depicted



Revised w/ Travel Corridors



Special Sediment Control Fence

- Reduces water flow and retains sediment on-site
- Placed anywhere sediment may flow off site
- Typically used where standard sediment fence would fail

Sediment (Silt) Fence

- Reduces water flow and retains sediment on-site
- Placement
  - anywhere sediment may flow off site
  - low sides of stockpile & staging areas
  - low side of unarmored equipment corridors
  - Not to be placed in concentrated flow area

Sediment (Silt) Fence

Should silt fence be placed along top of bank?

Not practical unless along completed, functioning section of stream

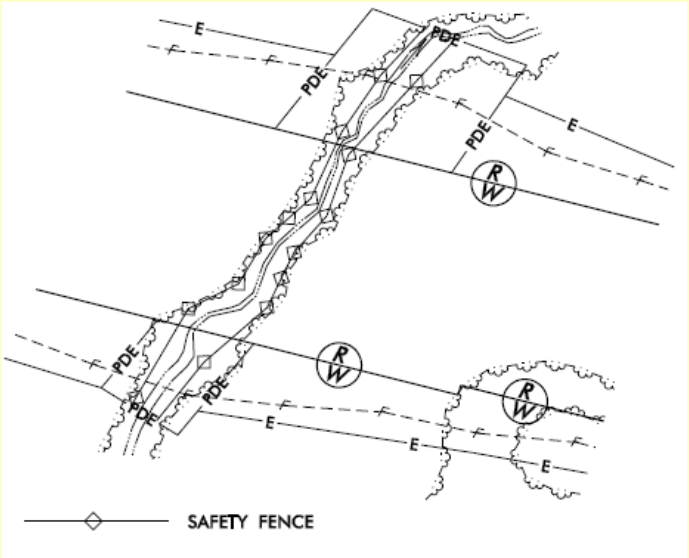
Turnout for Sediment Fence

- **Opening to allow water to flow through without undermining sediment fence**
- **Placed in low point of sediment fence**
- **Reinforced with a 3-6 ft wide section of Special Sediment Control Fence**

Tree Protection (Safety) Fence

- **Polyethylene or polypropylene <u>orange</u> fencing**
- **Installed along the outside *riparian buffer, wetland*, or *water boundary* located within the construction corridor**
- **Can be used to protect existing trees by placing around tree's drip line**
- **Installed prior to ANY land disturbance**
- **Conform to the ground contours**

Tree Protection (Safety) Fence



Clearing & Grubbing

What's the difference?

- **Clearing is removing tops of trees, leaving roots**
  - **Minimal soil disturbance**
- **Grubbing is removing stumps/roots**
  - **Major soil disturbance**
  - **Greatest soil loss potential**

Clearing & Grubbing

Minimize Disturbed Footprint

- **The limits of C&G on project is big issue on all but very smallest restorations**
- **NCDENR may request note stating C&G in channel not to exceed distance that can be stabilized w/in one (1) workday**
- **May also set requirement for maximum distance C&G can occur above bank**
- **Project specific requirements to achieve:**
  - **Limiting disturbed area**
  - **Limiting time area is disturbed**

Clearing & Grubbing

What <u>NOT</u> To Do

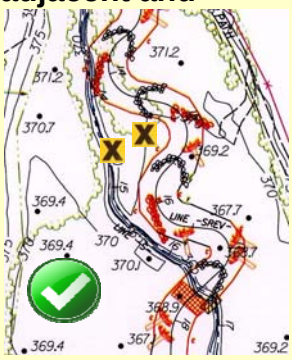
- **This far exceeded maximum limit**

Stockpile Management

- **Stockpile soil materials away from active stream**
- **Protect with silt fence & turnouts (as needed)**
- **Cover with tarp if necessary**

Stockpile Management

- NCDENR requires note restricting temp. stockpile of soil in a stream that is open to stream flow
- Can you use old channel to stockpile excavated material when new offline channel is adjacent and pump around is operational?
- NO! Think about…
  - Pump failure
  - Storm bursts
  - Lack of supplies
  - Loss of manpower
    - Introducing flows into incomplete, unstabilized channel can lead to unacceptable soil loss!



Stockpile Management

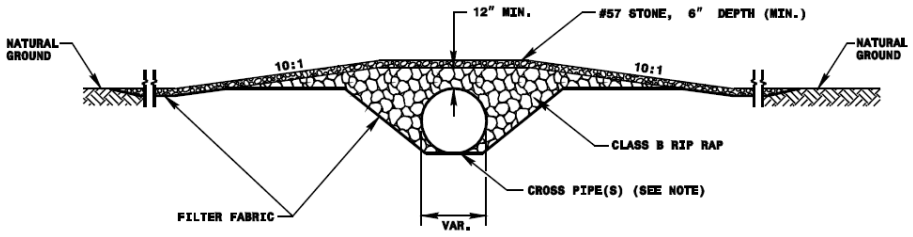
Be Prepared!

Need Stockpile Protection During Construction

Temporary Stream Crossing: Piped Crossing

- Aerial equipment crossing(s)
- Minimizes sediment impacts to stream
- Must pass normal daily flow ++
- Nearly flat approach for stable travel surface

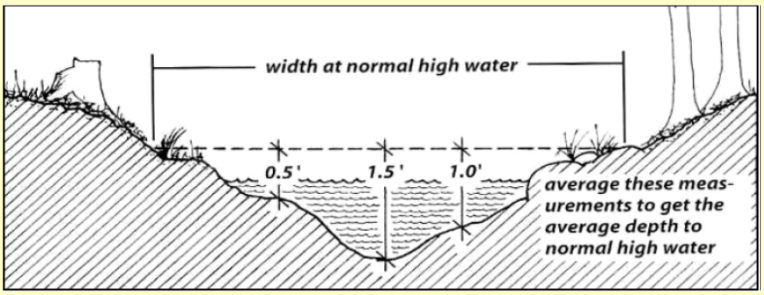
Temporary Stream Crossing: Piped Crossing



SECTION A-A
NOT TO SCALE

Temporary Stream Crossing: Temporary Pipe Sizing

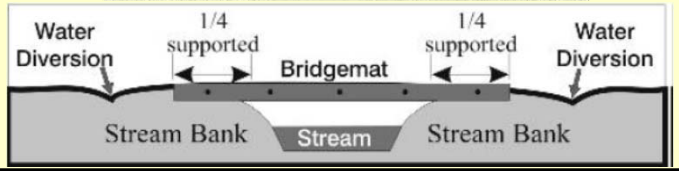
Average Channel Width (inches)	Average Channel Depth (inches) 6	12	18	24	30	36	42
12	15	18	18	24	24	30	36
18	15	18	24	24	30	30	36
24	15	24	30	30	36	36	48
30	18	24	30	30	36	48	48
36	18	24	30	36	48	48	48
48	24	30	36	48	48	48	60



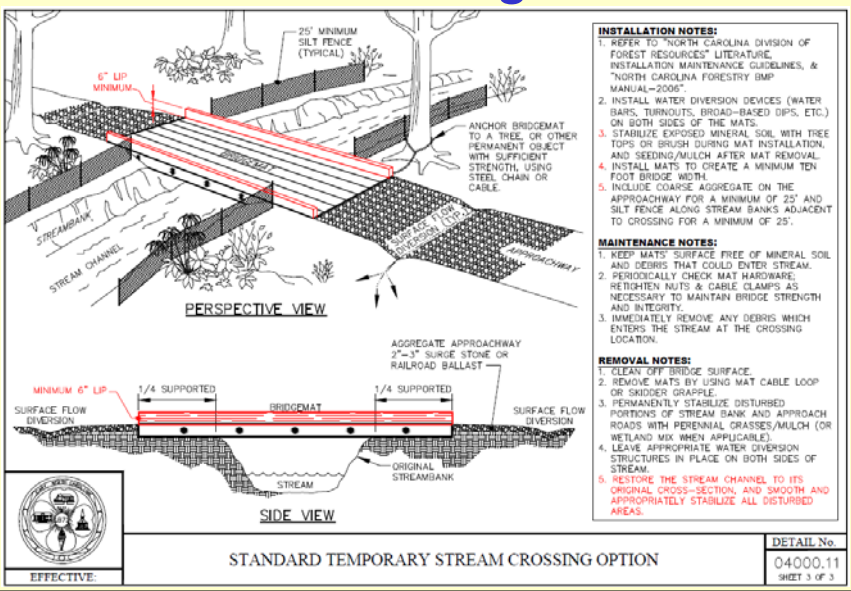
Reference: NC Division of Forest Resources "Forestry Best Management Practices Manual" http://www.dfr.state.nc.us/water_quality/bmp_manual.htm

Temporary Stream Crossing: Timber Bridgemat

- **Aerial equipment crossing**
- **Minimizes sediment impacts to stream**
- **Placed across top of bank on narrow channels**
- **Flat approach for stable travel surface**



Temporary Stream Crossing: Timber Bridgemat



Temporary Stream Crossing: Timber Bridgemat

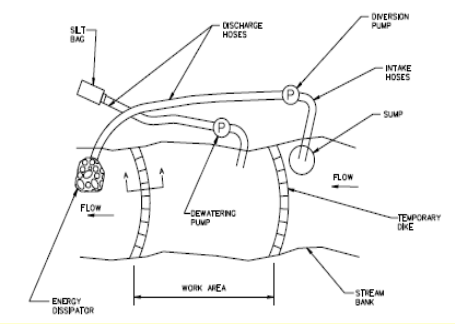
Sediment Control When Working In-stream

"Working in the Wet"

- **In stream work is performed only when alternatives are impractical due to:**
  - **Stream size or volume**
  - **Lack of bank side work space for diversion**
  - **Noise from pump around prohibited**
  - **Impractical or prohibited bank access**
  - **Requires NCDENR approval**

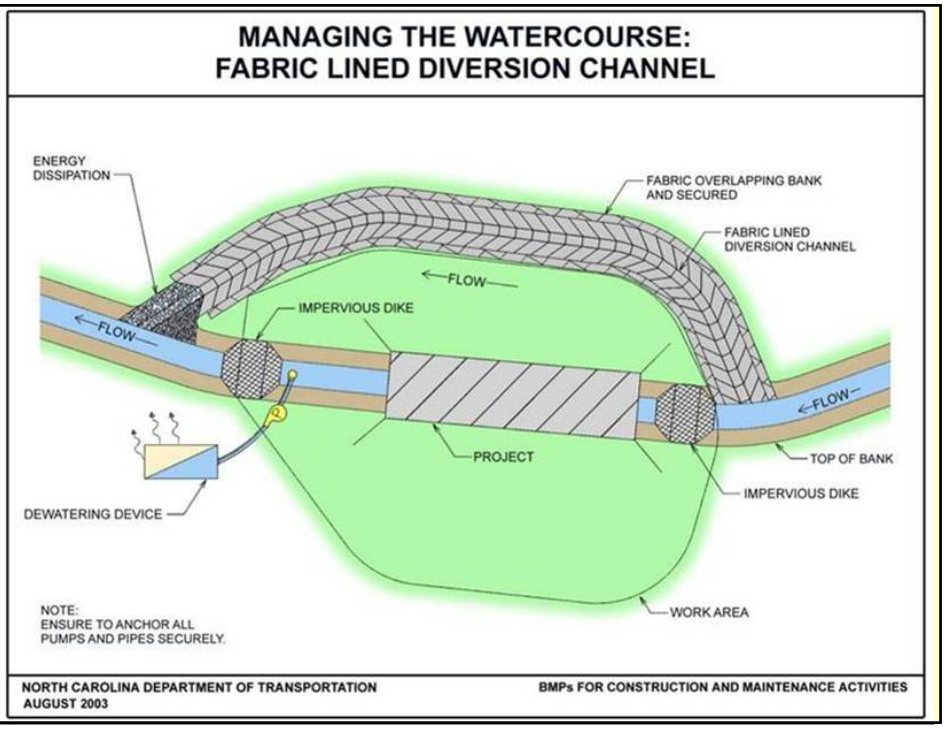
Construction in the Dry

- **Several Methods Include:**
  - **Diversion Channel**
  - **Piped Diversion**
  - **Pump Around**
    - **Main pump**
    - **Impervious dike**
    - **Trash pump**
    - **Dewatering device**



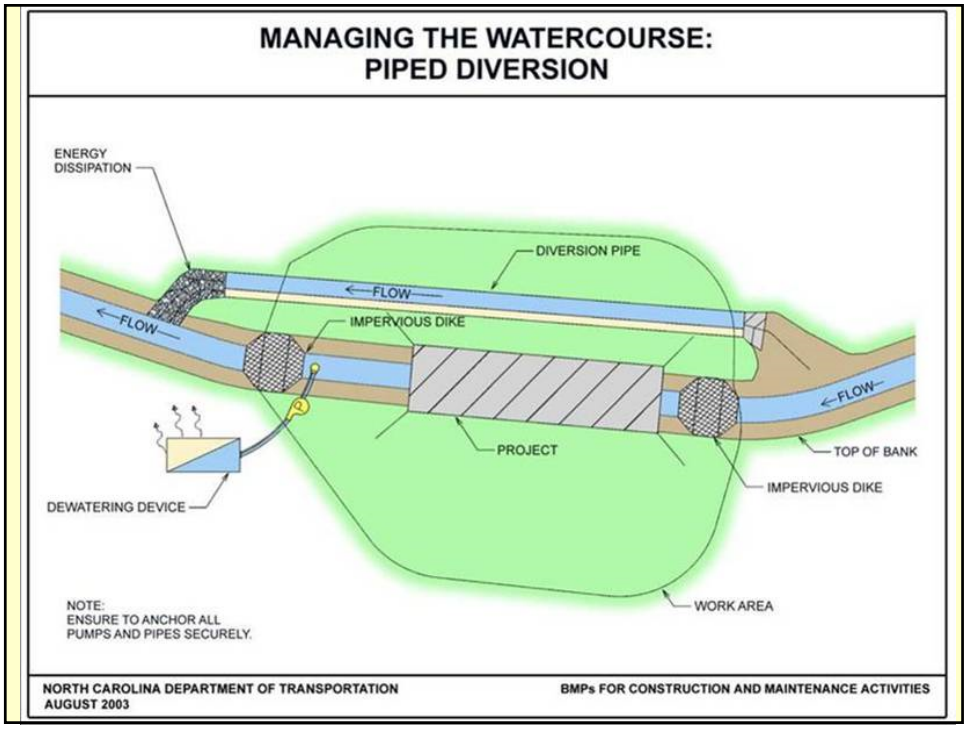
Diversion Channel

- **Bypass channel used to carry normal daily flow and stormflow—say 10-year storm**
- **Gravity flow**
- **Protect with sediment fence**
- **Line with woven geotextile**
- **Can add in rock check dams to slow velocity**



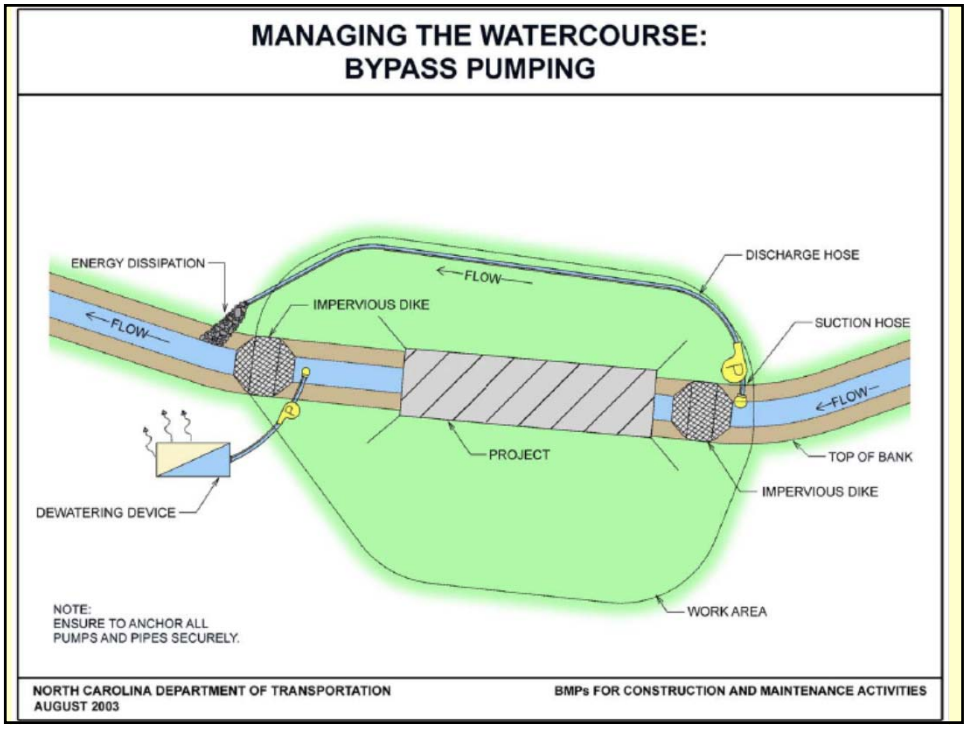
Piped Diversion

- **Temporary pipe used to bypass streamflow and stormflow around site**
- **Gravity flow**
- **Do not use when pipe would adversely impact the aquatic habitat**



Pump Around

- Mechanical method of streamflow diversion
- Pump sized to handle normal daily flow ++
- Usually pump small sections of channel to reduce cost
- NCDENR may require 24-hr pump around!!
- Consider “quiet” pumps if located near residential areas
- Work with pump contractor to appropriately size pump



Impervious Dike

- Temporary impervious barrier placed in stream
  - Install upstream of work area for flow diversion
  - Install downstream to impound dirty water
- Must pump all (dirty) water between dikes through dewatering device
- Options include:
  - Stone with Impervious Fabric
  - Sand Bags
  - Prefabricated Dams
  - Sheet Piles

Impervious Dike: Stone with Impervious Fabric

- Impervious fabric wrapped around stone
  - Class A/B (4-8 inch) stone typical
  - Can use sediment control stone if small drainage area
- Conforms to existing channel shape
- Remove all trees and sharp rocks prior to installation

Impervious Dike: Sand Bags

- Filter bags filled with sand
- Manually stacked in channel (<15 ft tall)
- Wrapped with impervious liner
- Conforms to existing channel shape
- Remove all trees and sharp rocks prior to installation

Impervious Dike: Prefabricated Dams

- Impervious prefabricated dam
- Typically made of poly-fabric
- Weight of water holds in place
- Remove all trees and sharp rocks prior to installation

Impervious Dike: Sheet Piles

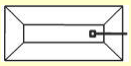
- Interlocking sheet piles
- Driven vertically into streambed
- Keeps work area “moderately” dry
- Cannot be placed where bedrock is near surface

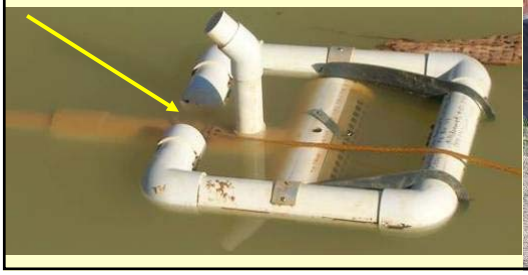
Dewatering the Work Area

- Water between impervious dikes is considered “dirty” effluent water
- Must be pumped out using submersible pump
- Water is discharged into a dewatering device
  - Skimmer basin with baffles
  - Stilling basin with baffles
  - Geotextile bag

Dewatering:
Skimmer Basin w/ Baffles

- Basin receives pumped water from active work area
- Water passes through 1-3 coir fiber baffles
- Water exits basin through surface skimmer—cleanest water
- Weir in dam for excess flow



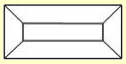


Dewatering:
Stilling Basin w/ Baffles

- Method of pumping the "dirty" water from between impervious dikes into a basin
- Basin "quiets" the water to settle sediment
- Addition of coir fiber baffles to increase sediment trapping efficiency

Dewatering: Geotextile Bag

- Geotextile bag that settles sediment from pumped water
- Used in areas of limited space
- Must be placed on LEVEL stone pad made of sediment control stone



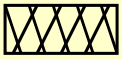
Temporary Ditch

- Small ditch or channel that directs runoff into a basin, sediment dam or rock silt check
- Placed adjacent to haul road to capture sediment
- Can be used along outside perimeter of project to direct water away from project limits
- Consider lining base of ditch with excelsior or straw matting

TSD

Temporary Rock Silt Check-Type A

- Small dam with weir outlet
- Placed in ditch adjacent to haul road to settle sediment
- Constructed of Class B rip-rap and sediment control stone
- Naturally formed storage area traps sediment



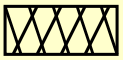
Polyacrylamide (PAM)

- Water soluble synthetic polymer
- Used for turbidity control after sediment settles
- Forms: dry powder, logs, solution, emulsion

Temporary Rock Silt Check-Type A w/ Excelsior/Coir Matting and PAM

- Modified Type A Silt Check with addition of excelsior (or coir) matting on top of Sediment Control Stone
- Typically placed in ditch adjacent to haul road to settle sediment and turbidity

- Sprinkle lower, center portion of fabric lined weir with 3.5 oz of PAM 705
- Reapply PAM after 0.5 inch rainfall or greater

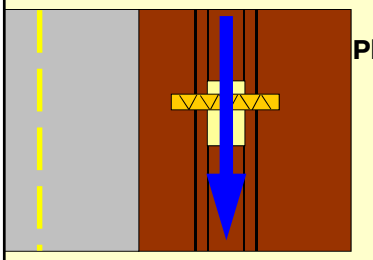


w/ PAM

Wattle

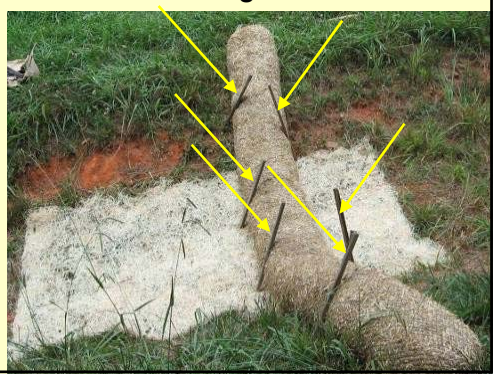
- Placed in ditch adjacent to haul road to settle sediment
- Constructed with fiber wattle, wooden stakes, u-shaped staples, erosion control matting (PAM optional)
- Naturally formed storage area traps sediment

Wattle Installation Guide



Place erosion control matting as splash pad

- ~ 1/3 upslope and under wattle with remaining 2/3 down slope
- Staple edges and interior at 1 ft spacing; staple interior of matting in offset rows



- Place wooden stakes to secure wattle to ground contour and to prevent from dislodging in large/intense rain events
  - 4 wooden stakes on down slope side; angle upslope
  - 2 wooden stakes on upslope side; angle down slope

Temporary Rock Silt Check – Type B

- Small dam with center weir
- Constructed with Class B rip-rap
- Reduces runoff velocity
- Minimizes erosion of ditch
- Typically placed in ditch adjacent to haul road

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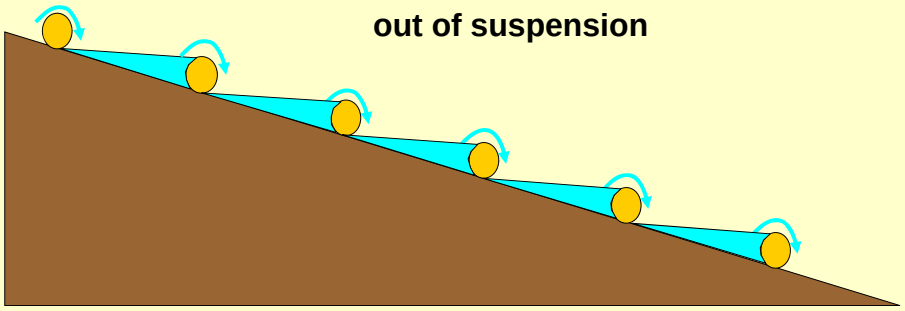
Ideal Spacing for Silt Checks and Wattles

- Spaced such that flow cascades over check dam or wattle into a pool of water

•This gives more time for sediment and flocs to fall out of suspension



Temporary Rock Sediment Dam – Type B

- Small dam with weir outlet and built-in sediment basin
- Receives water from temporary ditch
- Traps sediment (and flocs if PAM is used on BMPs in ditch)
- Contributing drainage area of 5 acres or less

Slope Drains

- **When used with berms can provide temporary protection of slopes that do not have sufficient vegetation established**

Streambank & Floodplain Stabilization

Why is it important?

- **If you build it, IT WILL COME!!!**

Streambank & Floodplain Stabilization

- **All disturbed areas required to be stabilized within 14 days**
- **Slopes steeper than 3:1 should be stabilized in 7 days**
- **The Best Sediment Control is Good Erosion Control**
- **Establish vegetation ASAP!**

GROUND STABILIZATION TIMEFRAMES		
Site Area Description	Stabilization	Timeframe Exceptions
Perimeter dikes, swales and slopes	7 Days	None
High Quality Water (HQW) Zones	7 Days	None
Slopes Steeper than 3:1	7 Days	If slopes are 10' or less in length and are not steeper than 2:1, 14 days are allowed
Slopes 3:1 or flatter	14 Days	7 days for slopes greater than 50' in length
All other areas with slopes flatter than 4:1	14 Days	None, except for perimeters and HQW Zones

Streambank Stabilization

- **Rolled Erosion Control Matting and Vegetation**
  - **Soil amendments (fertilizer, lime, topsoil/compost)**
  - **Seed (temporary & permanent)**
  - **Grain straw mulch (25% coverage)**
  - **700 g/m^2 coir (50% coverage)**
  - **Wooden stakes (2" x 24")**

Streambank Stabilization

Streambank Stabilization

Streambank & Floodplain Stabilization

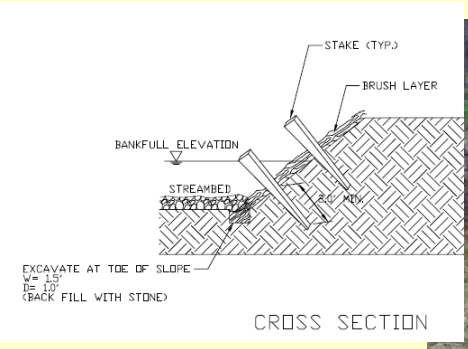
- **Hydromulch**
  - **Includes all amendments in one tank**
    - **Seed**
    - **Fertilizer**
    - **Lime**
    - **Water**
    - **Mulch**
    - **Tackifier**

Streambank Stabilization

- **Live Stakes**
  - **Live cuttings off dormant species**
  - **Installed through matting in winter**
  - **Native, water loving**
    - **Black Willow**
    - **Ninebark**
    - **Elderberry**
    - **Silky Dogwood**
    - **Silky Willow**
    - **Etc…**

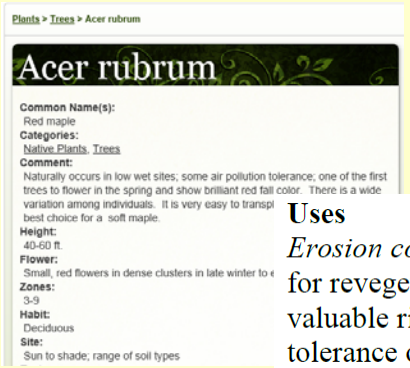
Streambank Stabilization

- **Brush Mattress**
  - **Live cuttings off dormant species**
  - **Installed in criss-cross pattern on bank**
  - **Anchored with wire & wooden stakes**
  - **Same species as live stakes**



Floodplain Stabilization

- **Select Trees & Shrubs by:**
  - **Physiographic region**
  - **Wetland indicator status**
  - **Landscape position**
  - **Soils**


Plants > Trees > Acer rubrum

Acer rubrum

Common Name(s):
Red maple
Categories:
Native Plants, Trees
Comment:
Naturally occurs in low wet sites; some air pollution tolerance; one of the first trees to flower in the spring and show brilliant red fall color. There is a wide variation among individuals. It is very easy to transpl
best choice for a soft maple.
Height:
40-60 ft.
Flower:
Small, red flowers in dense clusters in late winter to
Zones:
3-9
Habit:
Deciduous
Site:
Sun to shade; range of soil types

Uses

Erosion control: Red maple is available in quantity for revegetation work and landscaping. It is a valuable riparian buffer plant due mostly to it's tolerance of wetter soils.

Floodplain Stabilization

Mountain Riparian Species

TREES	SMALL TREES/SHRUBS	HERBACEOUS	GRAMINOIDS AND FERNS
Acer negundo box elder	*Aesculus sylvatica* painted buckeye	*Arisaema triphyllum* jack-in-the-pulpit	*Andropogon gerardii** big bluestem
Acer rubrum red maple	*Alnus serrulata* tag alder	*Asclepias incarnata* swamp milkweed	*Arundinaria gigantea* river cane
Acer saccharinum silver maple	*Amelanchier arborea* common serviceberry	*Bidens frondosa*	*Athyrium filix-femina* ssp. *asplenioides*
Betula lenta cherry birch	*Aronia arbutifolia (Photinia pyrifolia)* red chokeberry		
Betula nigra river birch	*Aronia melanocarpa (Photinia melanocarpa* black chokeberry		
Carya cordiformis bitternut hickory	*Asimina triloba* common pawpaw		

Let's Review

- **Required information for E&SC plan submittal**
  - **Detailed construction sequence**
  - **Equipment travel corridors**
  - **Clearing & grubbing**
  - **Temporary stream crossings**
  - **Stockpile areas**
  - **Construction in dry methods—diversions & dewatering**
  - **Minimize time and footprint of disturbance**
  - **Appropriately placed E&SC measures**
  - **Special site restrictions**
  - **Stabilization**

Stone Sizes

	Min. (inches)	Median (inches)	Max. (inches)
Sediment Control Stone (washed, no fines) No.5/No. 57	~3/8	½-3/4	1.5
Structure Stone--Class A	2	4	6
" " --Class B	5	8	12
" " --Class I	5	10	17
" " --Class II	9	14	23