

Culvert and Pipe Phasing



Barney Blackburn, PE, CPESC, CPSWQ
NCDOT – Roadside Environmental Unit
Soil & Water Engineering Section Supervisor

NCDOT Culvert Phasing Process

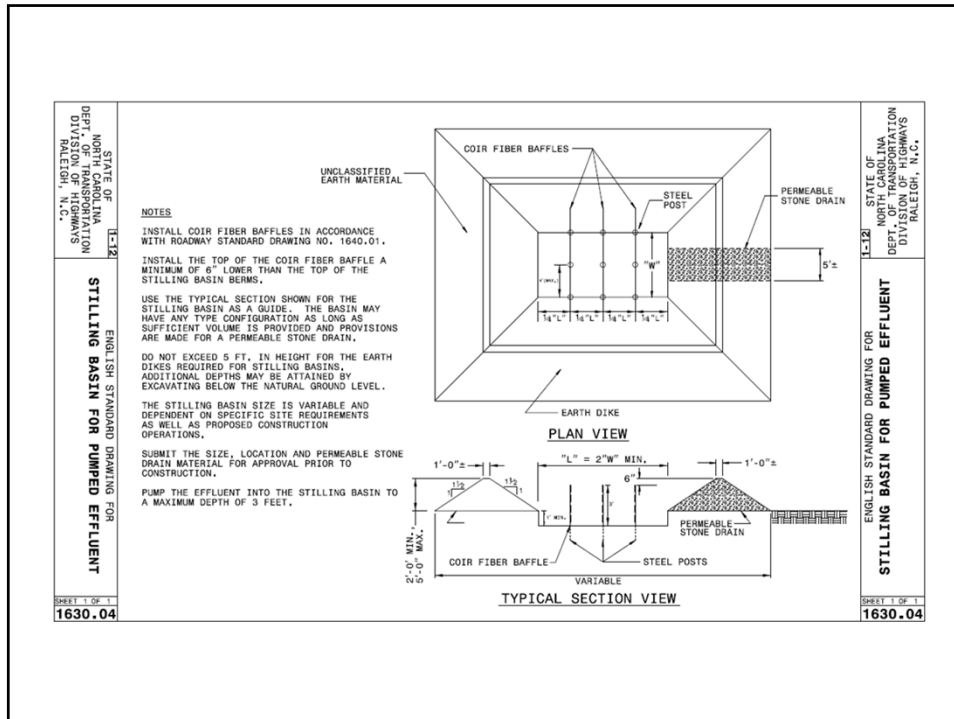
- Hydraulics Unit:
 - Culvert Survey Report (CSR)
 - Permit Drawings and Impact Summary
- Hydraulics and Roadside Environmental Units:
 - Develop Culvert Construction Sequence
- Roadside Environmental Unit:
 - Include Culvert Construction Sequence in Erosion Control Plans

Components of Culvert Phasings

- Stilling Basin or Silt Bag
- Impervious Dike
- Temporary Pipe
- Temporary Channel Change

Stilling Basin Design

- Volume (ft³) = Width of Stream Channel (ft.) x (Length of Culvert (ft.) + 20 ft. (10 ft. on Each Side)) x Depth of Water in Stream (ft.)
- Typically used for Volumes > 100 CY (2700 ft³)
- Freeboard = 6 inches (Minimum)
- Design Permeable Stone Drain to Dewater at a Slow Rate
- Add Volume to Required Volume of Sediment Basins



Stilling Basin Volume Design

- Formula for Stilling Basin Volume:

$$\text{Volume} = \frac{d}{3} \left[W_{\text{top}} L_{\text{top}} + W_{\text{base}} L_{\text{base}} + \left(\frac{W_{\text{top}} L_{\text{base}} + W_{\text{base}} L_{\text{top}}}{2} \right) \right]$$

+

$$W_{\text{base}} L_{\text{base}} \times 1 \text{ ft.}$$

- $d = 3 - 5 \text{ ft.}$
- Side Slope = 1.5:1

Stilling & Sediment Basin Design

- Example of Stilling Basin as Sediment Basin:
 - Required Volume for Sediment Basin = 1800 ft³
 - Required Volume for Stilling Basin = 1500 ft³
 - Provided Volume of Sediment Basin = 2820 ft³
- Additional Volume Needed for Sediment Basin =
$$1800 + 1500 - 2820 = \underline{480 \text{ ft}^3}$$

Stilling Basin Placement

- Inside Perimeter EC Devices
- Level Ground
- Locate to Avoid Pumping Across Stream
- Avoid Placing in Locations of Sediment Basins

Stilling Basin Construction

- Construct Above Ground with Length:Width Ratio of 2:1
- Install 3 Coir Fiber Baffles
- Excavate 1 ft. Below Ground for Permanent Pool
- Stabilize Interior and Exterior Slopes
- Use Small Grade Stone (NCDOT Class A & B, No. 57)

Stilling Basin



Stilling Basin with Geotextile Liner



Stilling Basin with Flashboard Riser

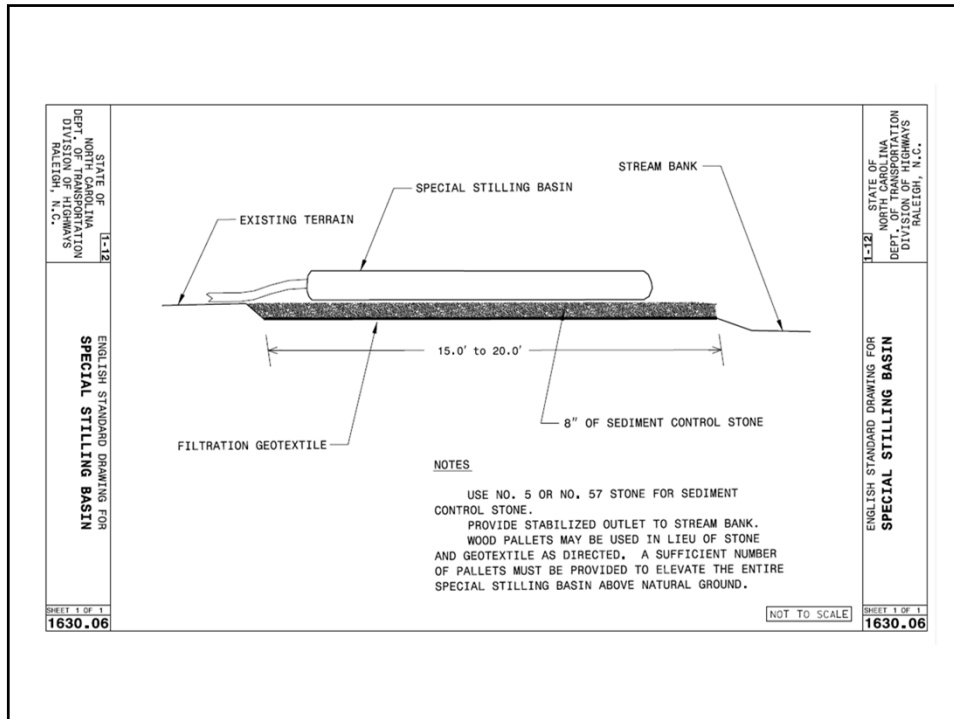


Flashboard Riser



Silt Bag Design & Placement

- Maximum Pumping Rate of 80 gal/min/sf
- Typically, Volumes less than 100 CY (2700 ft³)
- Place Inside Perimeter EC Devices
- Place on Level Ground
- Locate to Avoid Pumping Across Stream



Silt Bag Installation

- Install Geotextile (NCDOT Type 2) under Bag
- Place No. 57 Stone or Wood Pallets under Bag
- Always Keep Extra Bag(s) Onsite!
- Flocculants and Polymers will Clog Pores of Bag

Silt Bag



Impervious Dike

- Dike Types:
 - Sand Bags
 - Sheet Piling
 - Stone with Polypropylene
- Used in Stream Channel at Upstream and Downstream of Site
- Used to Anchor Temporary Pipes
- Used to Create Side of Temporary Channel

Sand Bags



Sheet Piles



Stone with Geotextile



Temporary Pipe Design & Construction

- Design to Average Daily Flow (ADF)
- Common Sizes: 15", 18" and 24"
- Anchor Ends with Impervious Dikes
- Used Primarily for Culvert Extensions

Temporary Pipe



Temporary Channel Design

- Design to Carry Average Daily Flow (ADF)
- Use Maximum of 2:1 Side Slopes
- Design as Base Ditch
- Don't Design in Areas of Existing Fill Slopes!

Temporary Channel Construction

- Line with Geotextile (NCDOT Type 4)
- Protect Top of Channel with:
 - Berms
 - Silt Fence
 - Impervious Dike

Berm at Top of Temporary Diversion



Silt Fence with Temporary Diversion



Types of Culvert Phasings

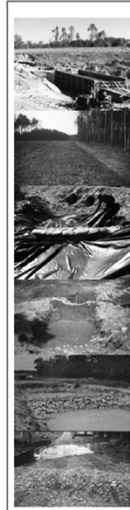
- Pump and Dike
- Dike Only
- Dike and Pipe
- Dike and Temporary Channel

**BEST MANAGEMENT PRACTICES
FOR
CONSTRUCTION
AND
MAINTENANCE
ACTIVITIES**

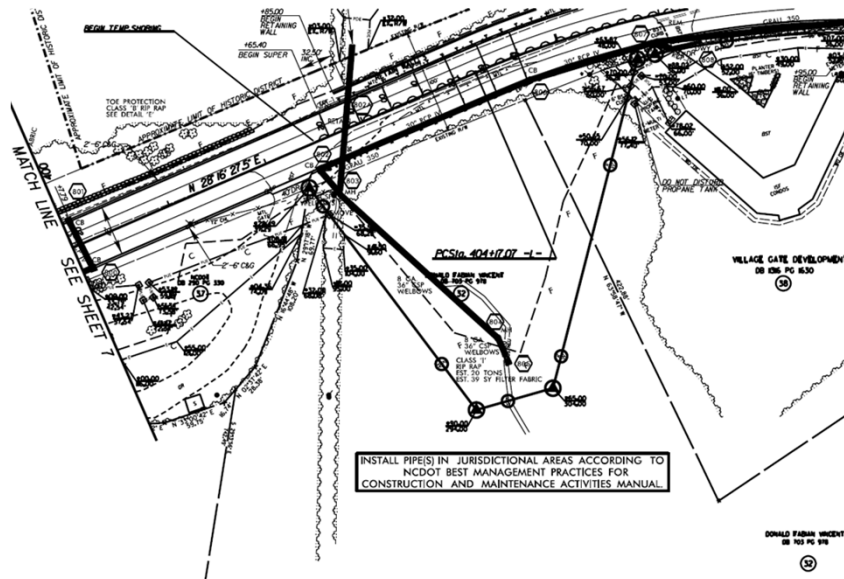
NORTH CAROLINA DEPARTMENT
OF TRANSPORTATION



August 2003

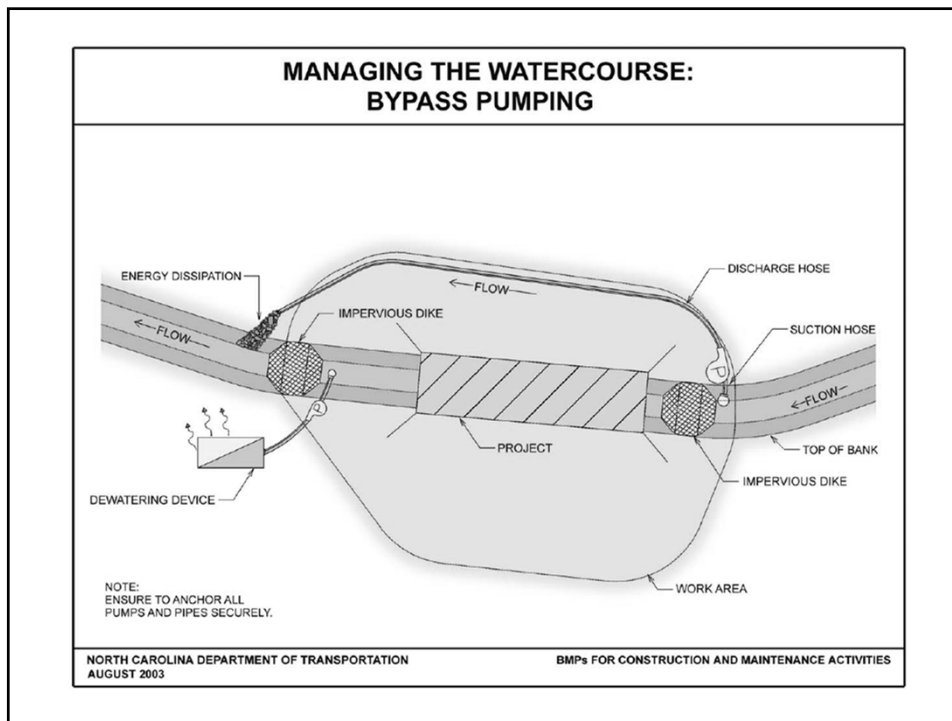


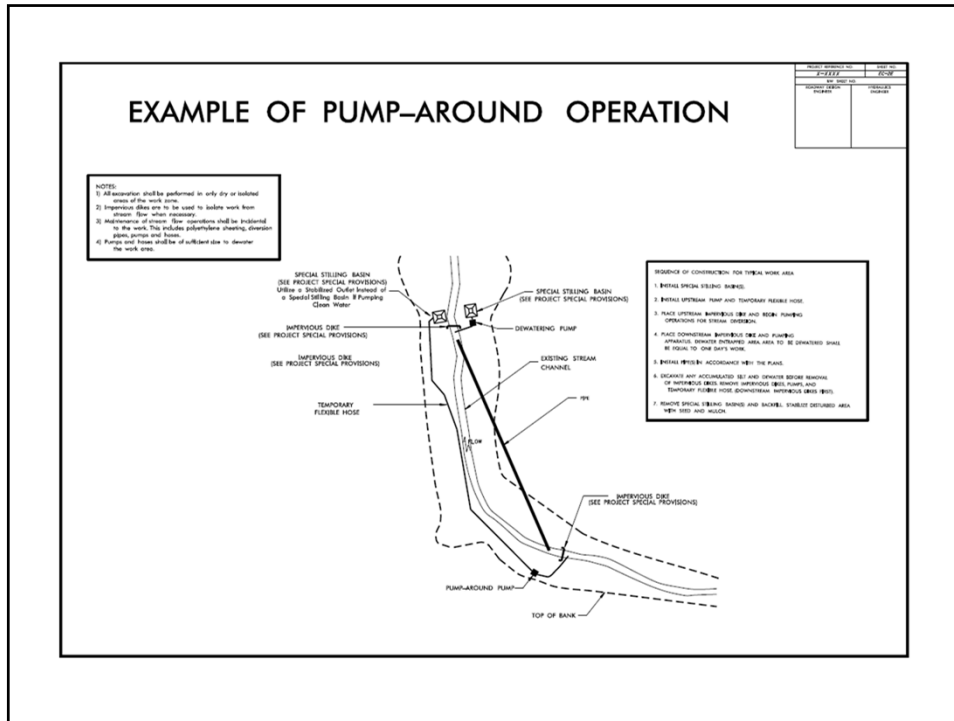
Phasing Per BMP Manual Note



Pump and Dike

- Short Duration Process (Max. 5 days!)
- Use for Pipe Installation
- Include Pump-Around Detail in the Plans
- Reference BMP Manual with Note

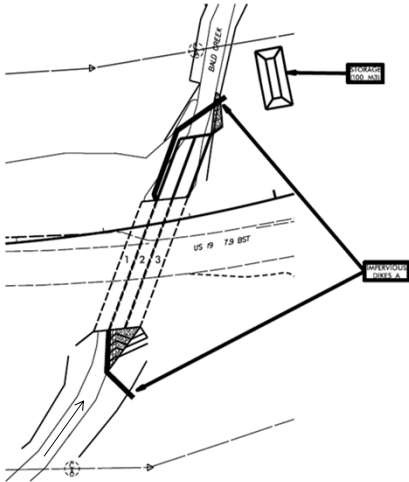




Impervious Dike Phasing

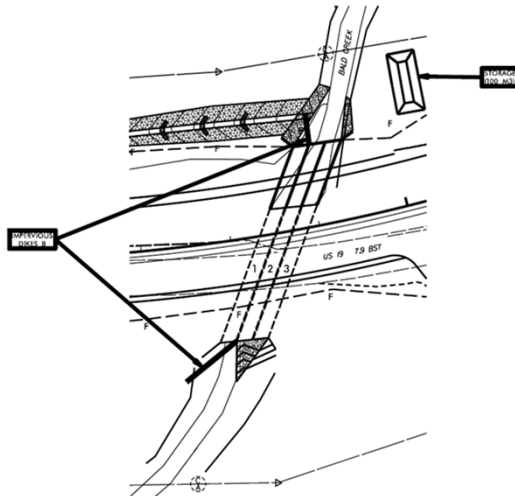
- Short Duration Process
- Use for Pipe Installation/Culvert Extension
- Include Dewatering Details in Phasing
- Do not Block Channel with Dike!

Culvert Extension with Dike



1. CONSTRUCT STILLING BASIN (100 H3).
2. CONSTRUCT IMPERVIOUS DIKES A, DIVERTING FLOW THROUGH BARREL 1.
3. REMOVE EXISTING HEADWALL AND CONSTRUCT EXTENSIONS FOR BARRELS 2 AND 3.
4. CONSTRUCT PORTION OF PROPOSED HEADWALL AND PORTION OF INLETOUTLET CHANNEL IMPROVEMENTS.
5. REMOVE IMPERVIOUS DIKES A.

Culvert Extension with Dike

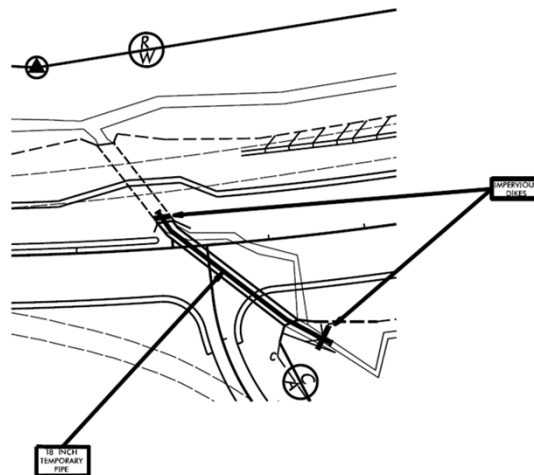


6. CONSTRUCT IMPERVIOUS DIKES B, DIVERTING FLOW THROUGH BARRELS 2 AND 3.
7. CONSTRUCT EXTENSION FOR BARREL 1, REMAINDER OF PROPOSED HEADWALL, AND REMAINDER OF INLETOUTLET CHANNEL IMPROVEMENTS.
8. REMOVE IMPERVIOUS DIKES B AND STILLING BASIN.
9. COMPLETE ROADWAY.

Temporary Pipe Phasing

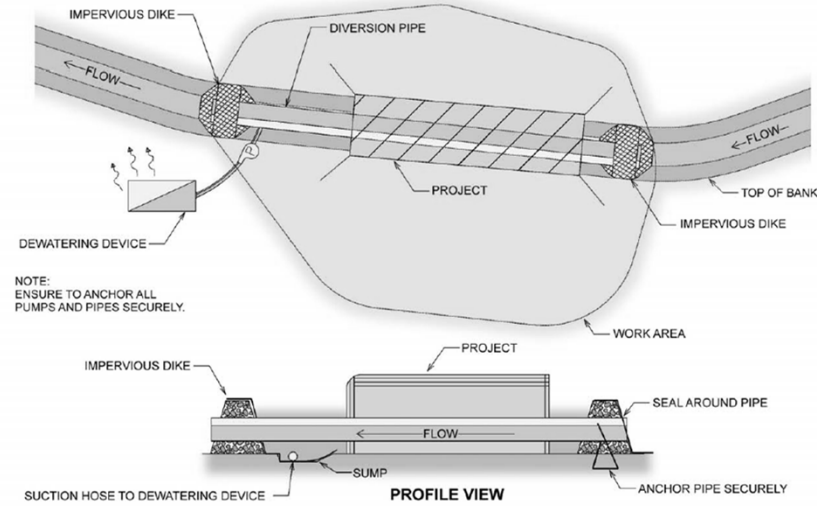
- Use for Pipe Installation/Culvert Extension
- Can be Utilized for New Culverts
- Include Dewatering Details in Phasing
- Anchor Pipe(s) with Impervious Dike

Phasing with Pipe and Dike



1. UTILIZE SPECIAL STILLING BASIN(S) DURING CULVERT CONSTRUCTION AS NEEDED.
2. CONSTRUCT IMPERVIOUS DIKES AND INSTALL 18 INCH TEMPORARY PIPE, DIVERTING FLOW THROUGH THE TEMPORARY PIPE.
3. CONSTRUCT CULVERT EXTENSION.
4. REMOVE IMPERVIOUS DIKES AND TEMPORARY PIPE.
5. CONSTRUCT ANY NECESSARY CHANNEL IMPROVEMENTS.
6. COMPLETE ROADWAY.

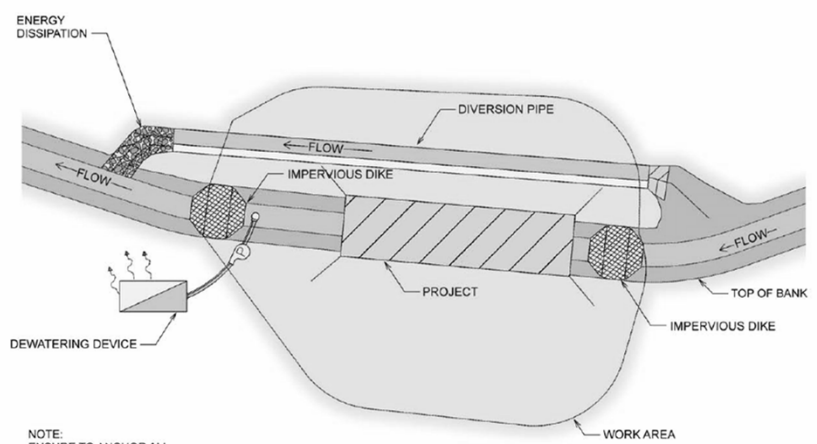
MANAGING THE WATERCOURSE: SUSPENDED BYPASS PIPE



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
AUGUST 2003

BMPs FOR CONSTRUCTION AND MAINTENANCE ACTIVITIES

MANAGING THE WATERCOURSE: PIPED DIVERSION

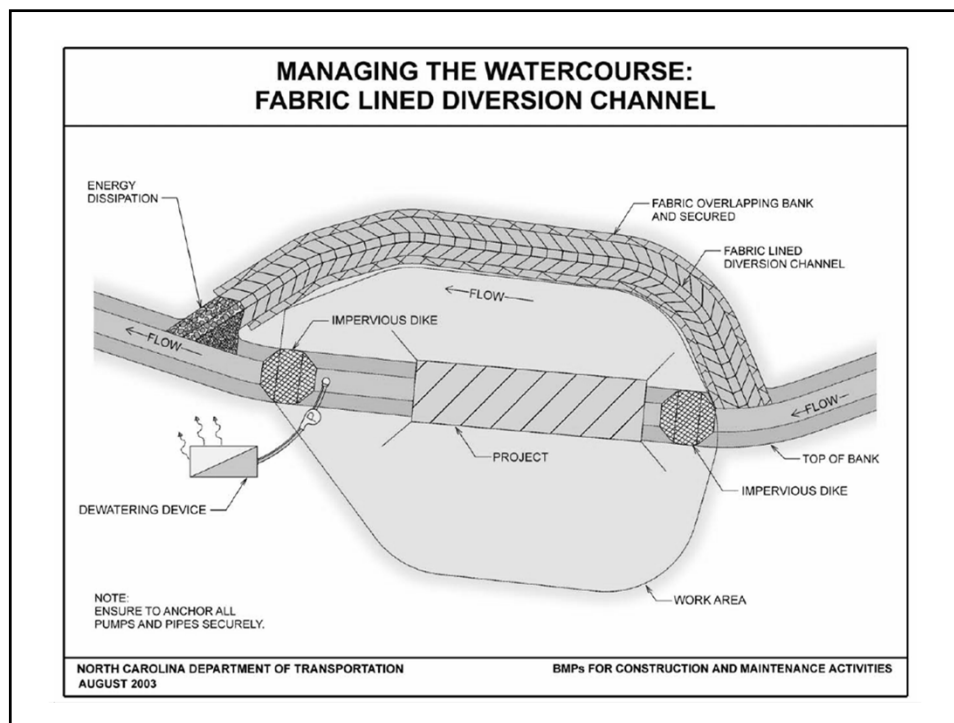


NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
AUGUST 2003

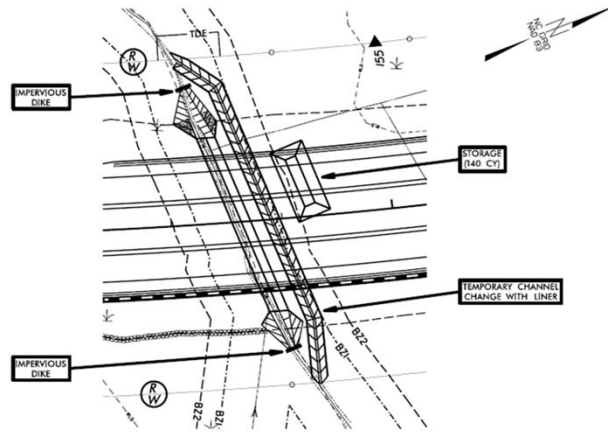
BMPs FOR CONSTRUCTION AND MAINTENANCE ACTIVITIES

Phasing with Temporary Channel

- Include Permit Impacts for Channel Tie-Ins
- Design/Build with Room to Install Wing Walls
- Include Channel Dimensions:
 - Base Width
 - Channel Depth
 - Side Slope Info

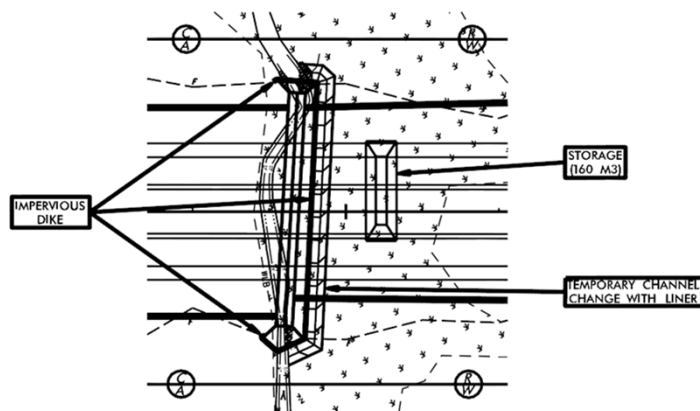


Phasing with Temporary Channel



1. CONSTRUCT STILLING BASIN (140 CY).
2. CONSTRUCT TEMPORARY CHANNEL CHANGE WITH LINER (2 FT. BASE, 3 FT. DEEP, 2:1 SIDE SLOPES).
3. CONSTRUCT IMPERVIOUS DIKES, DIVERTING FLOW THROUGH TEMPORARY CHANNEL CHANGE.
4. CONSTRUCT PROPOSED CULVERT AND INLET/OUTLET CHANNEL IMPROVEMENTS.
5. REMOVE IMPERVIOUS DIKES AND TEMPORARY CHANNEL CHANGE, DIVERTING FLOW THROUGH PROPOSED CULVERT.
6. REMOVE STILLING BASIN, AND COMPLETE ROADWAY.

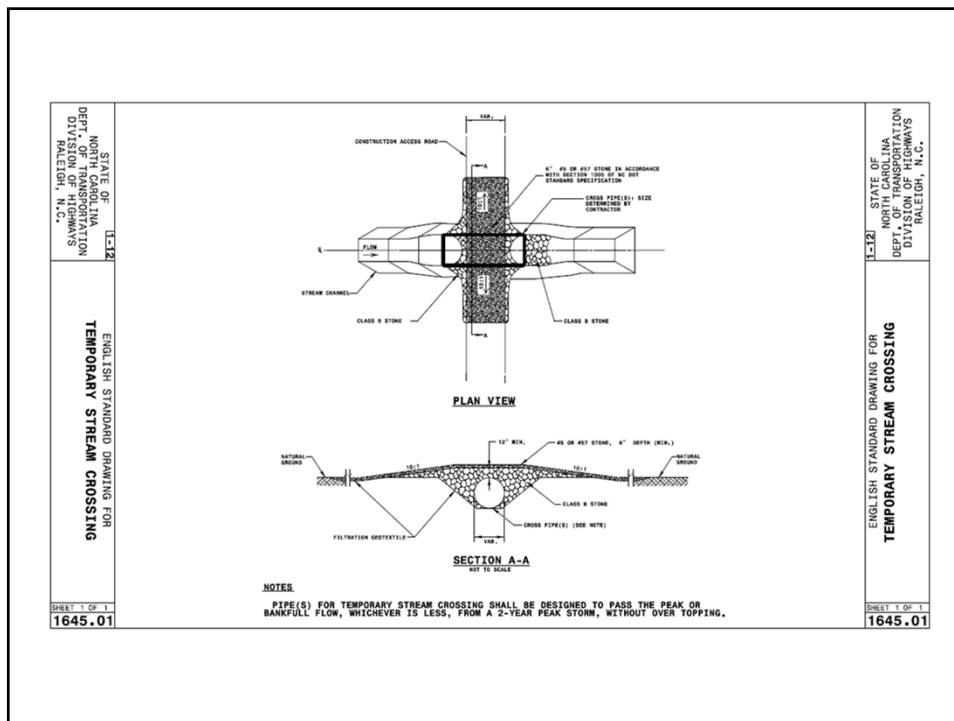
Impervious Dike with Channel



1. CONSTRUCT STILLING BASIN (160 M3).
2. CONSTRUCT IMPERVIOUS DIKE AND TEMPORARY CHANNEL CHANGE WITH LINER (2.5M BASE, 1M DEEP, 2:1 SIDE SLOPE), DIVERTING FLOW.
3. CONSTRUCT PROPOSED CULVERT.
4. REMOVE IMPERVIOUS DIKE AND TEMPORARY CHANNEL CHANGE, ALLOWING FLOW THROUGH CULVERT.
5. COMPLETE ANY NECESSARY INLET/OUTLET CHANNEL IMPROVEMENTS.
6. REMOVE STILLING BASIN.
7. COMPLETE ROADWAY.

Temporary Stream Crossing Design & Construction

- Design to Carry 2-yr Storm
- More than One Pipe can be Used
- Install Geotextile (Type 2) under Pipe(s) and Stone
- Use Class B and No. 57 Stone



Stream Crossing at Diversion



Stabilization for Culverts

- Seed and Mat in Timely Manner
- Mat Slopes (Straw, Excelsior, Permanent)
- Place Coir Fiber Mat on Stream Banks at Inlet
- Protect Seeded Area with Temporary EC Devices

Stabilized Slopes



Enhancements for Stilling Basins

- Coir Fiber Baffles
- Pumping Water from Top of Basin Water
- Permanent Pool
- Flocculants

Flocculant Incorporation



Flocculant Incorporation



Considerations for Culvert Phasing

- Develop in Conjunction with EC Plan
- Culvert Phasing a Recommendation and Dependent on:
 - Contractor
 - Site Conditions
- Include Details in Construction Sequence

NCDOT Web Site Links

- REU Soil & Water Engineering Section
http://www.ncdot.org/doh/operations/dp_chief_eng/roadside/soil_water/
- NCDOT BMP Manual
<http://www.ncdot.gov/doh/forms/files/BMPMANUAL.pdf>
- NCDOT Hydraulics Unit
<http://www.ncdot.org/doh/preconstruct/highway/hydro/>

Questions?

