Stream Restoration Designer/Contractor Interface

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Jennings Environmental

NC STATE UNIVERSITY
Department of Biological and Agricultural Engineering

North State ENVIRONMENTAL

Beeson Creek, Kernersville, NC

Presentation Outline

1. What is stream restoration?
2. Project components
3. Permitting
4. Case study: Beeson Creek

Darrell Westmoreland, CEO
North State Environmental, Inc.
holding a crayfish

What is Stream Restoration?

Adjusting physical, biological, and chemical conditions to set the stream ecosystem on a trajectory toward improved ecological functions and services

Beeson Creek, Kernersville, NC

Stream Restoration IS Erosion Control

Streambank erosion and headcutting may be the source of more than half of a watershed's sediment loading

Grassy Creek, Spruce Pine, NC

Outcomes of Restoration

- Water quality & habitats
- Natural flow regimes
- Recreation & aesthetics
- Public enthusiasm

Stream Restoration Project Components

- Channel & floodplain morphology (Fluvial Geomorphology)
- In-stream structures (grade control, bank protection, bedform)
- Streambank bio-engineering and native riparian buffers
- Watershed management

Grassy Creek Spruce Pine, NC

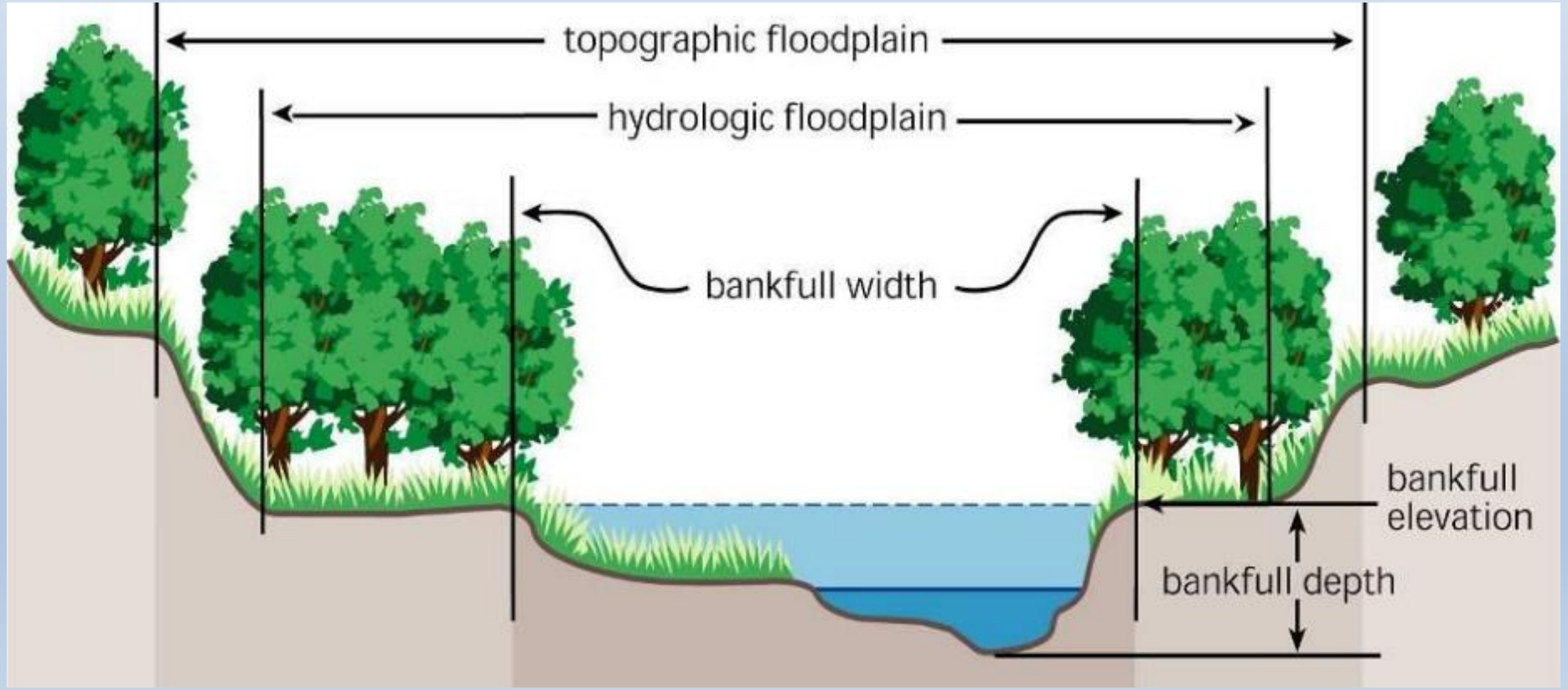
Fluvial Geomorphology

- How are stream channels & floodplains shaped by flowing water?
- How to restore natural equilibrium to disturbed stream systems?
- How to manage flood flows and sediment transport?

Grassy Creek Spruce Pine, NC

Bankfull Channel Stage

"corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work results in the average morphologic characteristics" *(Dunne and Leopold,1978)*



Stream Corridor Restoration: Principles, Processes, and Practices. 1998. Federal Interagency Stream Restoration Working Group.

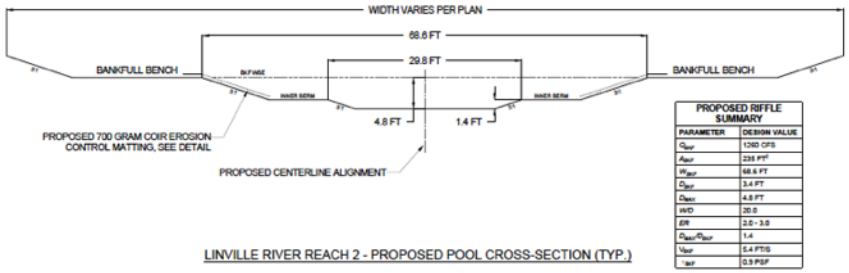
Reference Streams:

- Floodplain connection
- Vegetation
- Bedform diversity
- Freely-formed pattern

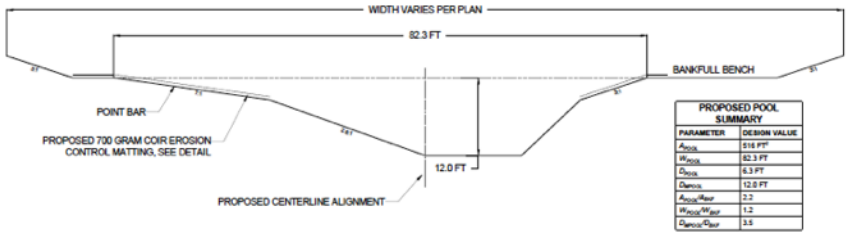
Similar climate, geology, soils, hydrology, sediment supply, vegetation

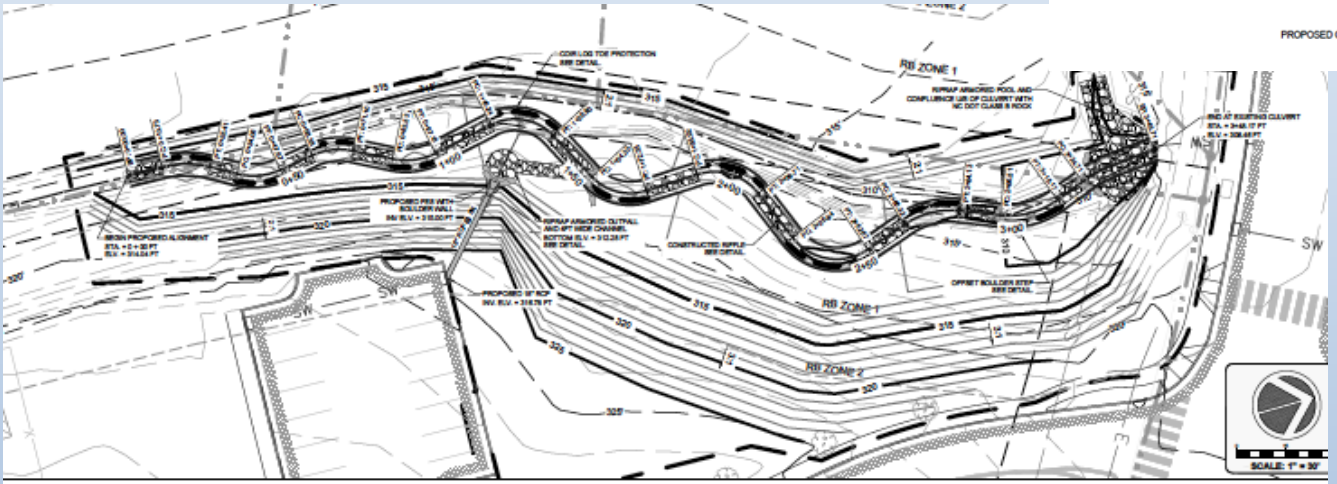
Design Plans Based on:

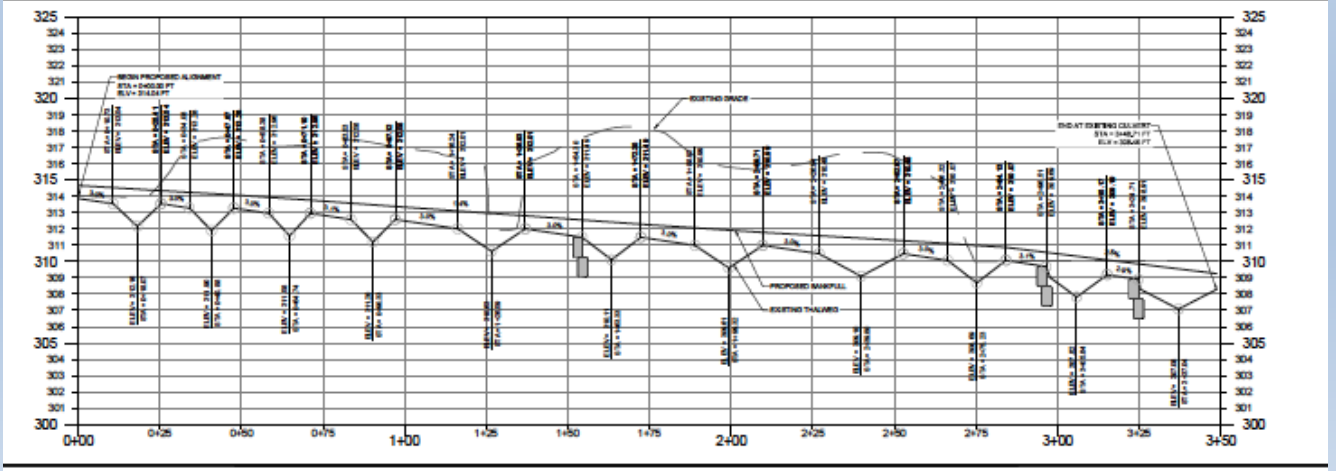
- Hydrology & Hydraulics
- Constraints
- Reference Geomorphology



LINVILLE RIVER REACH 2 - PROPOSED POOL CROSS-SECTION (TYP.)



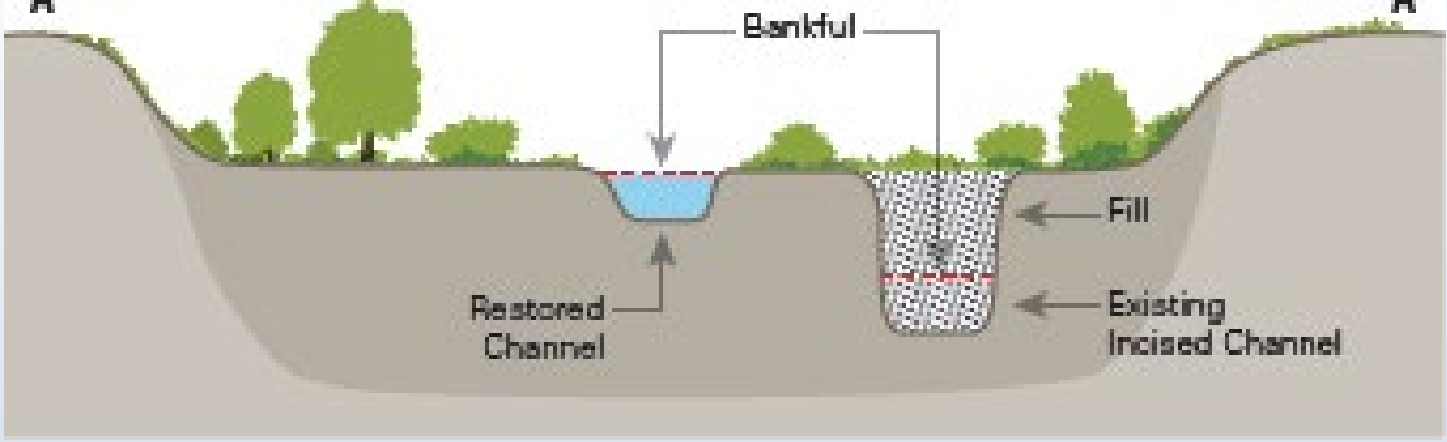




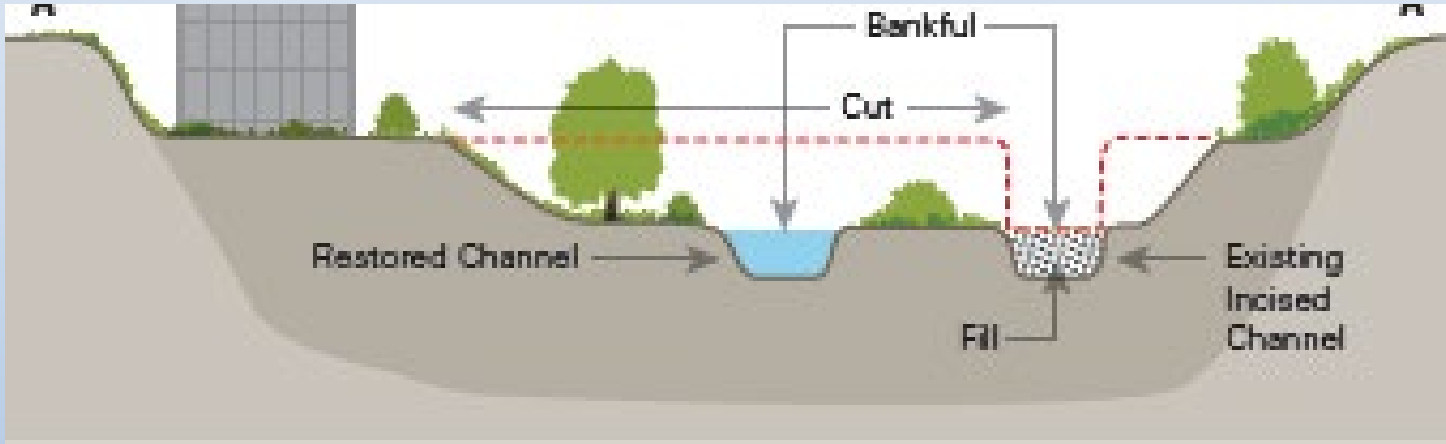
- Dimension
- Pattern
- Profile
- Substrate
- Soil strength

Floodplain Connection

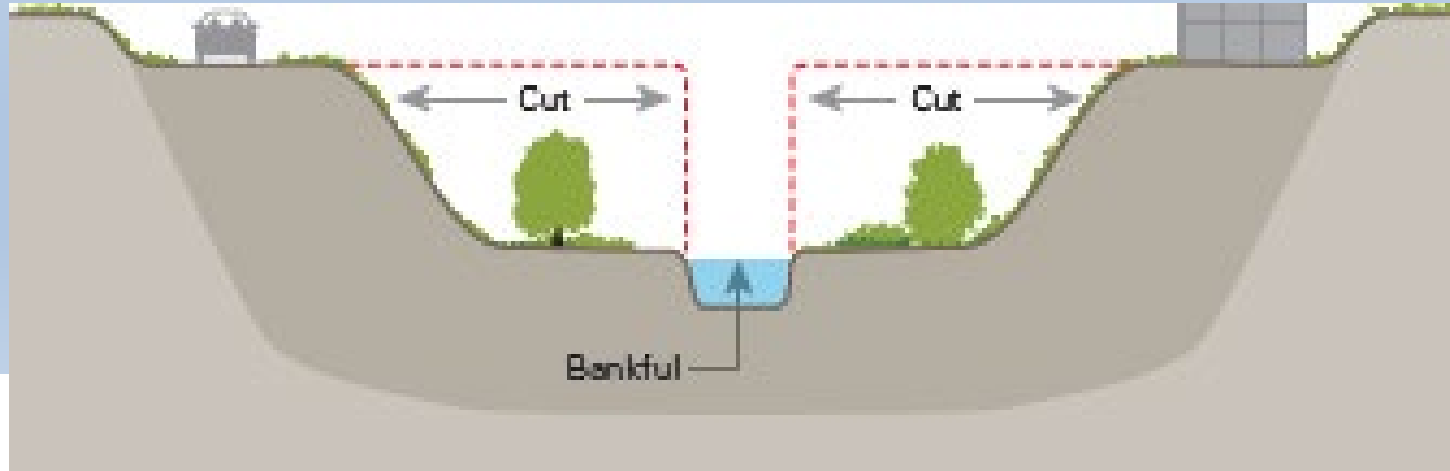
Priority 1



Priority 2



Priority 3



Harman, W., R. Starr. 2011. Natural Channel Design Review Checklist. US Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD and US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division. Washington, D.C. EPA 843-B-12-005

Purlear Creek Restoration, Wilkes County, NC

- Priority 1 & 2 floodplain connection
- 3300 ft channel realignment
- In-stream log habitat structures
- Native riparian vegetation
- Brook trout re-introduction

Purlear Creek

2016

- Floodplain connection
- Dimension
- Pattern
- Profile
- Vegetation

In-stream Structures (Rocks & Logs)

- Grade control
- Near-bank shear stress reduction
- Sediment transport
- Habitat Enhancement

Successful Structures

- Properly designed and located
- Low profile
- Constructed to withstand stress
- Excellent vegetation

Constructed Riffle: Rocks and Logs

Vanes *(Boulder or Log)*

- Oriented upstream at 20-30 degrees from bank tangent
- Sloping up from channel invert at 3-5 % arm toward bank
- May control grade using J-hook (< 0.5 ft drop)
- May need footers, sills, geotextile to avoid piping/washout

Boulder Cross Vane with Logs Integrated into Footer

Ability Access Fishing Deck: North Toe River

J-Hook Log Vane

STATION 2+00 meander bend streambank protection and scour pool maintenance

Before

After

Toe Wood Revetment

- streambank protection
- habitat enhancement

November, 2015

August, 2016

Environmental Permits

1. US Army Corps of Engineers (Clean Water Act Section 404)
2. NC Division of Water Resources (Clean Water Act Section 401)

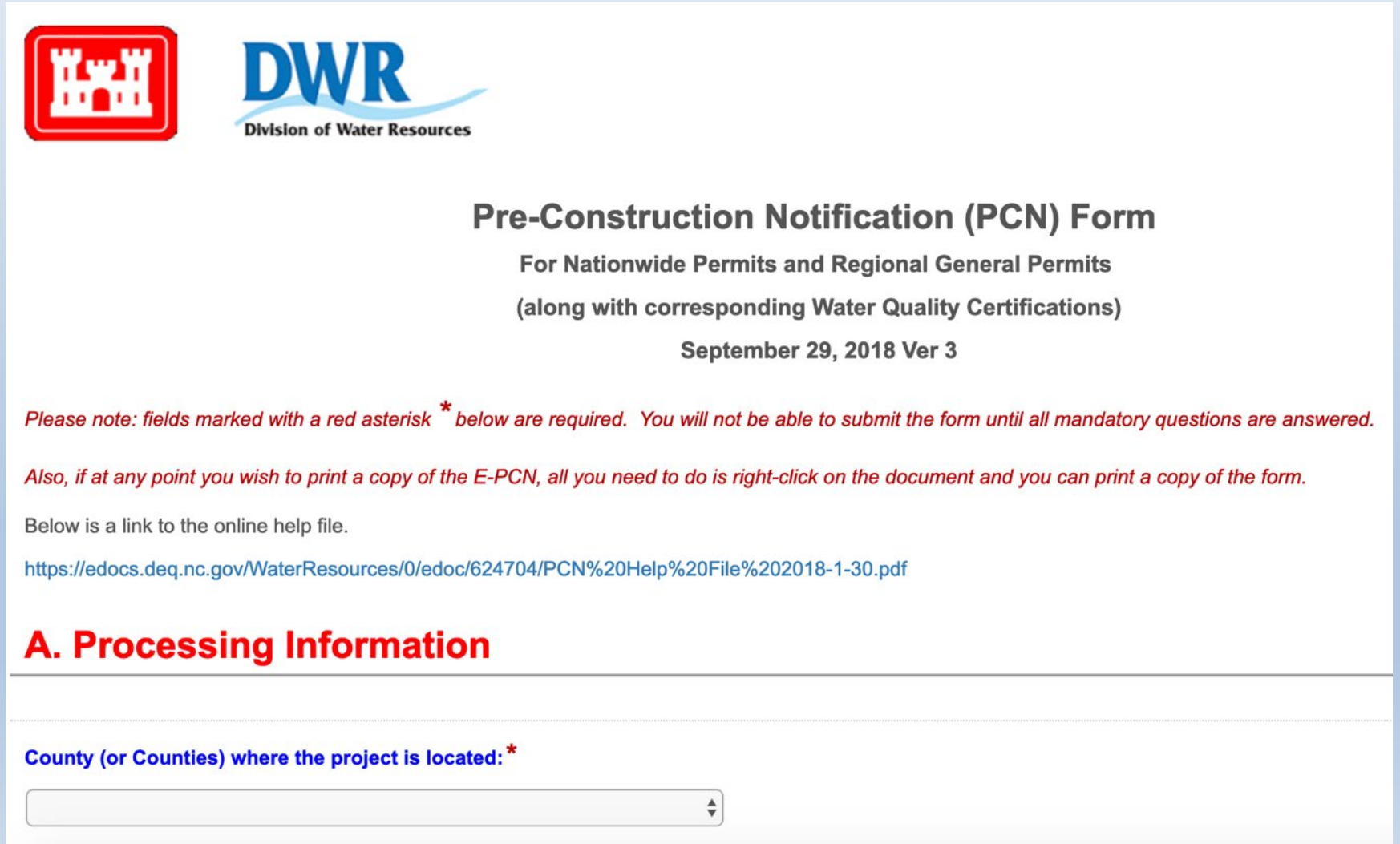
Scale of impacts to wetlands[1], waters[1], and streams[2]	Fee Schedule
Major[3] water quality applications: Greater than or equal to one acre of wetlands/ waters AND/OR greater than or equal to 150 feet of streams (intermittent or perennial)	$570.00
Minor[3] water quality applications: Less than one acre of wetlands/waters AND less than 150 feet of streams (intermittent or perennial)	$240.00

Check should be made payable to "N.C. Division of Water Resources"

Environmental Permits

401/404 Pre-Construction Notification (PCN)

https://edocs.deq.nc.gov/Forms/Pre-Construction_Notification_Form



DWR
Division of Water Resources

Pre-Construction Notification (PCN) Form

For Nationwide Permits and Regional General Permits

(along with corresponding Water Quality Certifications)

September 29, 2018 Ver 3

*Please note: fields marked with a red asterisk * below are required. You will not be able to submit the form until all mandatory questions are answered.*

Also, if at any point you wish to print a copy of the E-PCN, all you need to do is right-click on the document and you can print a copy of the form.

Below is a link to the online help file.

https://edocs.deq.nc.gov/WaterResources/0/edoc/624704/PCN%20Help%20File%202018-1-30.pdf

A. Processing Information

County (or Counties) where the project is located: *

Environmental Permits

USACE Nationwide Permit 27 for Aquatic Habitat Restoration

http://saw-reg.usace.army.mil/NWP2017/2017NWP27.pdf

- Reference-based habitat restoration
- Natural stream morphology
- In-stream habitat logs & rocks
- Native plants

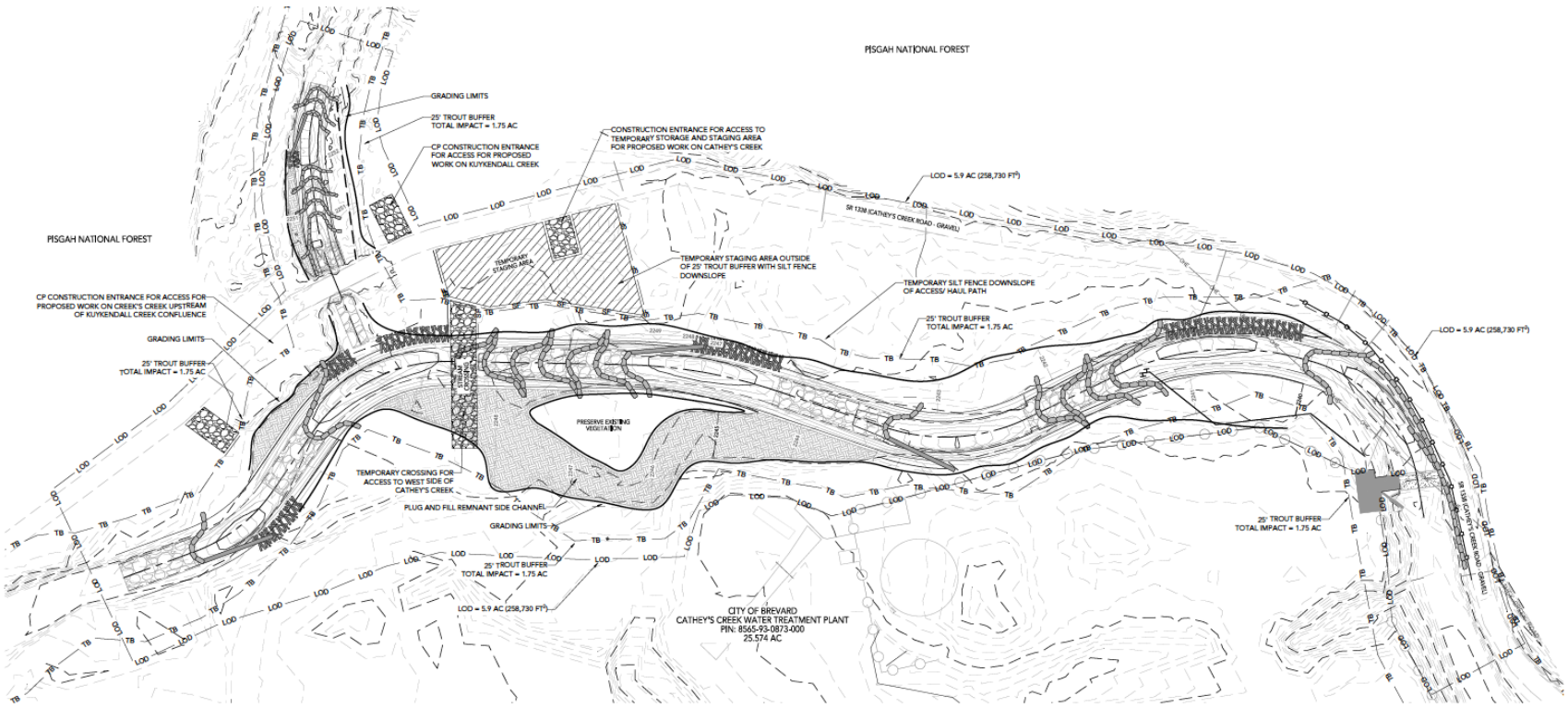
NATIONWIDE PERMIT 27
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
FINAL NOTICE OF ISSUANCE AND MODIFICATION OF NATIONWIDE PERMITS
FEDERAL REGISTER
AUTHORIZED MARCH 19, 2017

Aquatic Habitat Restoration, Enhancement, and Establishment Activities. Activities in waters of the United States associated with the restoration, enhancement, and establishment of tidal and non-tidal wetlands and riparian areas, the restoration and enhancement of non-tidal streams and other non-tidal open waters, and the rehabilitation or enhancement of tidal streams, tidal wetlands, and tidal open waters, provided those activities result in net increases in aquatic resource functions and services.

To be authorized by this NWP, the aquatic habitat restoration, enhancement, or establishment activity must be planned, designed, and implemented so that it results in aquatic habitat that resembles an ecological reference. An ecological reference may be based on the characteristics of an intact aquatic habitat or riparian area of the same type that exists in the region. An ecological reference may be based on a conceptual model developed from regional ecological knowledge of the target aquatic habitat type or riparian area.

To the extent that a Corps permit is required, activities authorized by this NWP include, but are not limited to: the removal of accumulated sediments; the installation, removal, and maintenance of small water control structures, dikes, and berms, as well as discharges of dredged or fill material to restore appropriate stream channel configurations after small water control structures, dikes, and berms, are removed; the installation of current deflectors; the enhancement, rehabilitation, or re-establishment of riffle and pool stream structure; the placement of in-stream habitat structures; modifications of the stream bed and/or banks to enhance, rehabilitate, or re-establish stream meanders; the removal of stream barriers, such as undersized culverts, fords, and grade control structures; the backfilling of artificial channels; the removal of existing drainage structures, such as drain tiles, and the filling, blocking, or reshaping of drainage ditches to restore wetland hydrology; the installation of structures or fills necessary to restore or enhance wetland or stream hydrology; the construction of small nesting islands; the construction of open water areas; the construction of oyster habitat over unvegetated bottom in tidal waters; shellfish seeding; activities needed to reestablish vegetation, including plowing or discing for seed bed preparation and the planting of appropriate wetland species; re-establishment of submerged aquatic vegetation in areas where those plant communities previously existed; re-establishment of tidal wetlands in tidal waters where those wetlands previously existed; mechanized land clearing to remove non-native invasive, exotic, or nuisance vegetation; and other related activities. Only native plant species should be planted at the site.

Erosion & Sediment Control Plan



EROSION AND SEDIMENTATION CONTROL MEASURES

DURING PROJECT IMPLEMENTATION, EROSION CONTROL MEASURES WILL BE IMPLEMENTED TO REDUCE SEDIMENTATION INTO KUYKENDALL AND CATHEY'S CREEKS. EFFORTS WILL BE MADE TO LIMIT AND EXPEDITE EQUIPMENT TIME IN THE STREAM CHANNEL. WHEN POSSIBLE, WORK WILL OCCUR FROM THE STREAMBANKS. THE DESIGN ATTEMPTS TO MINIMIZE SEDIMENTATION AND OTHER POTENTIALLY NEGATIVE IMPACTS THROUGH THE FOLLOWING PRACTICES:

1. CONSTRUCTION SHALL OCCUR BETWEEN APRIL 16 AND OCTOBER 14. A TROUT BUFFER DISTURBANCE MORATORIUM IS IN EFFECT FROM OCTOBER 15 TO APRIL 15 FOR BOTH CATHEY'S CREEK AND KUYKENDALL CREEK.
2. CONTRACTOR SHALL CONTACT NORTH CAROLINA WILDLIFE RESOURCE COMMISSION AT LEAST TWO (2) WEEKS PRIOR TO MOBILIZATION AND CONSTRUCTION ACTIVITIES TO SCHEDULE A PRE-CONSTRUCTION MEETING WITH NCWRC, THE CONTRACTOR AND THE ENGINEER.
3. SENSITIVE AQUATIC SPECIES MAY BE LOCATED WITHIN THE PROJECT AREA. NCWRC WILL PERFORM A SURVEY TO DETERMINE IF RELOCATION OF SENSITIVE AQUATIC ORGANISMS IS NECESSARY.
4. CONSTRUCTION ACTIVITIES SHALL OCCUR IN THE WET WITHOUT THE USE OF A TEMPORARY PUMP AROUND SYSTEM TO PREVENT DRYING OUT SENSITIVE AQUATIC ORGANISMS AND HABITATS. SEE NOTE 11 FOR ADDITIONAL IN-STREAM WET WORKING REQUIREMENTS.
5. EXCAVATION AND GRADING ON THE SITE IS BALANCED. NO EARTH SHOULD BE REMOVED FROM THE LOD.
6. THE CONTRACTOR WILL BE REQUIRED TO STAGE AND STORE EQUIPMENT AND MATERIALS OUTSIDE THE TROUT BUFFER (AT LEAST 25 FEET FROM TOPS OF BANKS).
7. ALL TREES, UTILITIES AND OTHER SITE FEATURES WILL BE PROTECTED UNLESS MARKED FOR REMOVAL OR RELOCATION.
8. EQUIPMENT WILL BE WELL-MAINTAINED, CLEANED PRIOR TO MOBILIZATION, AND CHECKED DAILY FOR LEAKS OF PETROLEUM PRODUCTS.
9. FUELING WILL BE PERFORMED IN A CONTAINED AREA AWAY FROM SURFACE WATER.
10. THE CONTRACTOR WILL BE REQUIRED TO STAGE WORK SUCH THAT DISTURBED AREAS WILL BE STABILIZED IN PHASES WITH SEEDING, MULCH AND BIODEGRADABLE (COIR) EROSION CONTROL MATTING (WHERE APPROPRIATE) WITHIN THREE (3) DAYS.
11. WHEN WORKING IN WET CONDITIONS IT THE CHANNEL, THE CONTRACTOR SHALL SHALL USE GRAVEL AND COBBLE TO CREATE A BERM THAT DIVERTS FLOW AROUND THE THE WORK AREA SUCH THAT INSTREAM FLOWS DO NOT INTERACT WITH DISTURBED EARTH AND CONSTRUCTION MATERIALS.
12. CONSTRUCTION SCHEDULING AND STAGING WILL BE TIMED TO MINIMIZE THE AMOUNT OF TIME SPENT WORKING IN THE STREAM CHANNEL.
13. ALL GRADING WORK ADJACENT TO STREAM WATERS WILL BE CONDUCTED IN A DRY WORK AREA TO THE EXTENT POSSIBLE.
14. TO THE EXTENT POSSIBLE, CONSTRUCTION WILL BE TIMED TO OCCUR DURING TIMES OF LOW FLOW.
15. CONSTRUCTION ACTIVITIES SHALL NOT OCCUR IN THE CHANNEL DURING WET WEATHER OR STORMFLOWS.
16. APPROPRIATELY SIZED EQUIPMENT WILL BE UTILIZED TO PREVENT EXCESSIVE COMPACTING AND MINIMIZE CLEARING.

SITE ACCESS AND STAGING

ACCESS TO THE WORK AREAS SHALL OCCUR THROUGH THE CONSTRUCTION ENTRANCES LOCATED OFF OF SR1338 (CATHEY'S CREEK ROAD). CONSTRUCTION TRAFFIC WITHIN THE LOD SHALL OCCUR OUTSIDE THE 25' TROUT BUFFER TO THE MAXIMUM EXTENT PRACTICAL. A FORD CROSSING WILL BE ESTABLISHED TO MOVE CONSTRUCTION MATERIALS, EQUIPMENT AND EXCAVATED EARTH TO AND FROM THE NORTHEAST TO THE SOUTHWEST SIDE OF CATHEY'S CREEK.

SILT FENCE

PRIOR TO ANY SOIL DISTURBANCE AND HAULING, APPROXIMATELY 830 FEET OF SILT FENCE WILL BE INSTALLED ON THE SITE AS INDICATED IN THE CONSTRUCTION DOCUMENTS. SILT FENCE WILL BE LOCATED ALONG THE DOWNSTREAM SIDE OF THE ACCESS AND STAGING AREAS. AT THE END OF THE PROJECT, WHEN ALL DISTURBED AREAS HAVE BEEN STABILIZED, ALL SILT FENCE WILL BE REMOVED. MATERIAL SPECIFICATIONS, INSTALLATION PROCEDURES, AND MAINTENANCE SHALL CONFORM TO SECTION 6.62 OF THE NORTH CAROLINA SEDIMENT CONTROL PLANNING AND DESIGN MANUAL, INCLUDING THE CONSTRUCTION DETAIL BELOW.

STREAMBANK MATTING

700 GRAM COIR FIBER MATTING WILL BE USED ALONG NEWLY GRADED STREAM BANK SECTIONS. MATTING WILL NOT CONTAIN SYNTHETIC (PLASTIC) MATERIALS. MATTINS WILL BE INSTALLED BEGINNING AT THE TOE OF STREAMBANK TO 4 FT (MIN.) BEYOND THE BANKFULL STAGE. A COMBINATION OF 12-INCH AND 24-INCH WOODEN STAKES WILL BE USED TO SECURE THE MATTING IN PLACE.BELOW.

CONSTRUCTION SCHEDULE

1. OBTAIN EROSION AND SEDIMENTATION CONTROL PLAN APPROVAL AND ALL OTHER APPLICABLE PERMITS.
2. NOTIFY INSPECTOR FROM DEQ REGIONAL OFFICE PRIOR TO DISTURBANCE.
3. POST CERTIFICATE OF APPROVAL FOR LAND DISTURBANCE AT SITE.
4. INSTALL RAIN GAUGE AND PREPARE INSPECTION FORMS AS DESCRIBED ABOVE.
5. FLAG THE WORK LIMITS AND STAKE OUT THE EXTENTS AND ELEVATIONS OF THE PROJECT.
6. LOCATE ALL UNDERGROUND UTILITIES WITHIN THE WORKSITE.
7. HOLD PRE-CONSTRUCTION MEETING PRIOR TO STARTING CONSTRUCTION.
8. INSTALL CONSTRUCTION ENTRANCES, SILT FENCE AND STREAM CROSSING PER THE ATTACHED PLAN SHEETS AND DETAILS.
9. INSPECT EROSION AND SEDIMENTATION CONTROL PRACTICES DAILY AND AFTER SIGNIFICANT RAINFALL EVENTS. MAKE NEEDED REPAIRS IMMEDIATELY.
10. ACQUIRE AND STORE MATERIALS FOR STREAM WORK (E.G., BOULDERS, LOGS, WOODY DEBRIS) AT LEAST 25 FEET FROM THE TOP OF BANK.
11. INSTALL TEMPORARY STREAM CROSSING AS SHOWN ON PLAN SHEETS. STABILIZE ALL DISTURBED AREA IN VICINITY OF CROSSING WITH GROUND COVER AND EROSION CONTROL MATTING TO PREVENT SEDIMENTATION DOWNSTREAM.
12. TO THE EXTENT PRACTICABLE, WORK ITERATIVELY FROM UPSTREAM TO DOWNSTREAM THROUGHOUT THE PROJECT REACHES. CONTRACTOR SHALL LIMIT STREAMBANK DISTURBANCE TO AREAS THAT CAN BE COMPLETED AND STABILIZED DURING ONE DAY OF WORK. DURING EACH ZONE OF DISTURBANCE, FOLLOW THE FOLLOWING STEPS:
    - 12.1. AS NEEDED TO IMPLEMENT BANK GRADING, REMOVE VEGETATION. DO NOT REMOVE HEALTHY, NATIVE VEGETATION FROM AREAS WHERE NO GRADING OR STRUCTURE INSTALLATION WILL OCCUR. STOCKPILE VEGETATION FOR REPLANTING, AS APPROPRIATE.
    - 12.2. AS SHOWN ON PLANS, REALIGN CHANNEL. ENSURE CONSTRUCTED SLOPES ARE GRADED AT A 3:1 SLOPE OR FLATTER, UNLESS DIRECTED OTHERWISE BY THE FIELD ENGINEER. WHEN POSSIBLE, PERFORM WORK FROM STREAMBANKS IN ORDER TO MINIMIZE TIME SPENT WORKING IN THE CHANNEL.
    - 12.3. INSTALL IN-STREAM STRUCTURES, BEDFORM FEATURES, AND STREAMBANK PROTECTION PER THE PLANS. WHEN POSSIBLE, PERFORM WORK FROM STREAMBANKS IN ORDER TO MINIMIZE TIME SPENT WORKING IN THE CHANNEL.
    - 12.4. INSTALL COIR STREAMBANK MATTING AND TEMPORARY SEEDING ON ALL DISTURBED SURFACES ON THE STREAMBANK TO 4 FT (MIN) BEYOND THE BANKFULL STAGE.
13. ANY AREA DISTURBED WITHIN 25 FEET FROM THE TOP OF THE STREAM BANK SHALL BE PROVIDED WITH TEMPORARY GROUND COVER SPECIFIED IN THE VEGETATION PLAN WITHIN 10 CALENDAR DAYS, UNLESS SUPERSEDED BY THE CONDITIONS OF GENERAL STORMWATER PERMIT NCG 010000.
14. ONCE SITE IS STABILIZED AND CONSTRUCTION ACTIVITIES ARE COMPLETED, REMOVE AND DISPOSE OF ALL NON-BIODEGRADABLE EROSION CONTROL DEVICES.
15. NOTIFY INSPECTOR FROM DEQ OFFICE AFTER STABILIZATION.
16. WHEN APPROPRIATE, INSTALL PERMANENT VEGETATION PER PLANTING PLANS.

MAINTENANCE OF EROSION AND SEDIMENTATION CONTROL MEASURES

ALL EROSION CONTROL AND SEDIMENTATION MEASURES WILL BE INSPECTED DAILY AND AFTER SIGNIFICANT RAIN EVENTS BY THE ON SITE ENGINEER AND THE CONTRACTOR. THE CONTRACTOR WILL ASSURE THAT ALL INSTALLATIONS ARE FUNCTIONING PROPERLY AT THE END OF EACH WORK DAY. INSPECTION REQUIREMENTS, AS DETAILED IN THE STORMWATER SECTION, WILL BE FOLLOWED.

ONCE THE SITE IS STABILIZED, ALL NON-BIODEGRADABLE EROSION CONTROL MEASURES WILL BE REMOVED AND PROPERLY DISPOSED OF BY THE CONTRACTOR.

Jennings Environmental
7 SAMUEL ASHE DRIVE
ASHEVILLE, NC 28805
(828) 645-4700
NC FIRM P-1932

CATHEY'S CEEK WTP INTAKE REHAB. & STEAM RESTOR.
TRANSYLVANIA COUNTY - NORTH CAROLINA

E&SC PLAN

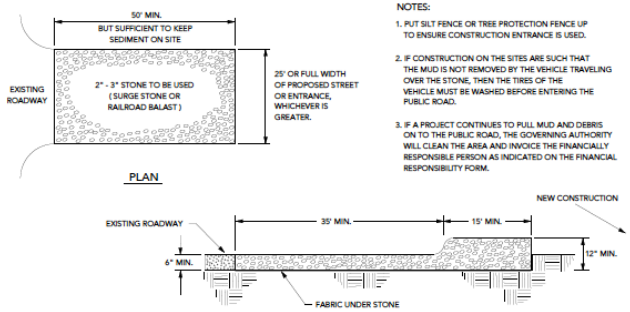
NORTH CAROLINA PROFESSIONAL SEAL 025454 ENGINEER GREGORY D. JENNINGS

FINAL DRAWING FOR REVIEW ONLY

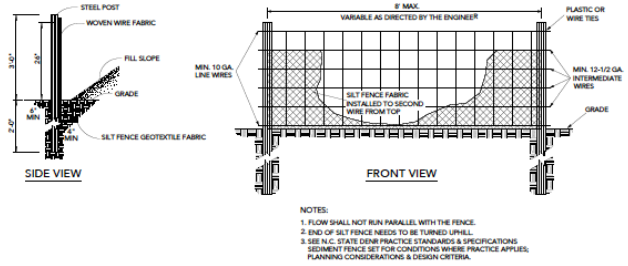
REVISIONS:
08/01/2019
DATE: 08/30/2019
PLOT SIZE: 24" x 36"
SCALE: 1" = 80'
H.D.: NAD83 (NCSP)
V.D.: NAVD88
JE PID: 4304
H-SRP-D-17-0127

3.1

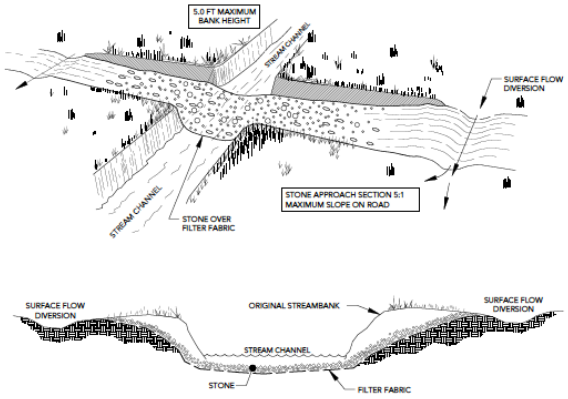
Erosion & Sediment Control Plan



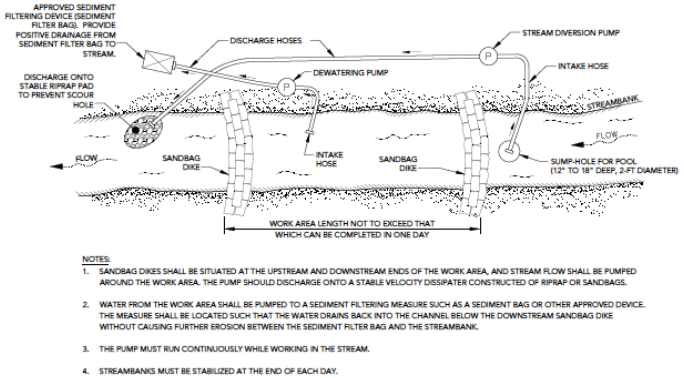
CONSTRUCTION ENTRANCE



SILT FENCE



TEMPORARY STREAM FORD CROSSING



TEMPORARY PUMP AROUND SYSTEM

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919.800.4770
NC FIRM P-1312

CATHEY'S CEEK WTP INTAKE REHAB. & STEAM RESTOR.
TRANSYLVANIA COUNTY - NORTH CAROLINA

E&SC PLAN: E&SC DETAILS

NORTH CAROLINA PROFESSIONAL SEAL 032464 ENGINEER GREGORY D. JENNINGS

FINAL DRAWING FOR REVIEW ONLY

REVISIONS:
08/01/2019
DATE: 08/30/2019
PLOT SIZE: 24" x 36"
NTS
H.D.: NAD83 (NCSP)
V.D.: NAVD88
JE PID: 4304
H-SRP-D-17-0127

3.2

Erosion & Sediment Control Plan

GROUND STABILIZATION AND MATERIALS HANDLING PRACTICES FOR COMPLIANCE WITH THE NCG01 CONSTRUCTION GENERAL PERMIT

Implementing the details and specifications on this plan sheet will result in the construction activity being considered compliant with the Ground Stabilization and Materials Handling sections of the NCG01 Construction General Permit (Sections E and F, respectively). The permittee shall comply with the Erosion and Sediment Control plan approved by the delegated authority having jurisdiction. All details and specifications shown on this sheet may not apply depending on site conditions and the delegated authority having jurisdiction.

SECTION E: GROUND STABILIZATION

Required Ground Stabilization Timeframes

Site Area Description	Stabilize within this many calendar days after ceasing land disturbance	Timeframe variations
(a) Perimeter dikes, swales, ditches, and perimeter slopes	7	None
(b) High Quality Water (HQW) Zones	7	None
(c) Slopes steeper than 3:1	7	If slopes are 10' or less in length and are not steeper than 2:1, 14 days are allowed
(d) Slopes 3:1 to 4:1	14	-7 days for slopes greater than 50' in length and with slopes steeper than 4:1 -7 days for perimeter dikes, swales, ditches, perimeter slopes and HQW Zones -10 days for Falls Lake Watershed
(e) Areas with slopes flatter than 4:1	14	-7 days for perimeter dikes, swales, ditches, perimeter slopes and HQW Zones -10 days for Falls Lake Watershed unless there is zero slope

Note: After the permanent cessation of construction activities, any areas with temporary ground stabilization shall be converted to permanent ground stabilization as soon as practicable but in no case longer than 90 calendar days after the last land disturbing activity. Temporary ground stabilization shall be maintained in a manner to render the surface stable against accelerated erosion until permanent ground stabilization is achieved.

GROUND STABILIZATION SPECIFICATION

Stabilize the ground sufficiently so that rain will not dislodge the soil. Use one of the techniques in the table below:

Temporary Stabilization	Permanent Stabilization
• Temporary grass seed covered with straw or other mulches and tackifiers • Hydroseeding • Rolled erosion control products with or without temporary grass seed • Appropriately applied straw or other mulch • Plastic sheeting	• Permanent grass seed covered with straw or other mulches and tackifiers • Geotextile fabrics such as permanent soil reinforcement matting • Hydroseeding • Shrubs or other permanent plantings covered with mulch • Uniform and evenly distributed ground cover sufficient to restrain erosion • Structural methods such as concrete, asphalt or retaining walls • Rolled erosion control products with grass seed

POLYACRYLAMIDES (PAMS) AND FLOCCULANTS

1. Select flocculants that are appropriate for the soils being exposed during construction, selecting from the *NC DWR List of Approved PAMS/Flocculants*.
2. Apply flocculants at or before the inlets to Erosion and Sediment Control Measures.
3. Apply flocculants at the concentrations specified in the *NC DWR List of Approved PAMS/Flocculants* and in accordance with the manufacturer's instructions.
4. Provide ponding area for containment of treated Stormwater before discharging offsite.
5. Store flocculants in leak-proof containers that are kept under storm-resistant cover or surrounded by secondary containment structures.

EQUIPMENT AND VEHICLE MAINTENANCE

1. Maintain vehicles and equipment to prevent discharge of fluids.
2. Provide drip pans under any stored equipment.
3. Identify leaks and repair as soon as feasible, or remove leaking equipment from the project.
4. Collect all spent fluids, store in separate containers and properly dispose as hazardous waste (recycle when possible).
5. Remove leaking vehicles and construction equipment from service until the problem has been corrected.
6. Bring used fuels, lubricants, coolants, hydraulic fluids and other petroleum products to a recycling or disposal center that handles these materials.

LITTER, BUILDING MATERIAL AND LAND CLEARING WASTE

1. Never bury or burn waste. Place litter and debris in approved waste containers.
2. Provide a sufficient number and size of waste containers (e.g dumpster, trash receptacle) on site to contain construction and domestic wastes.
3. Locate waste containers at least 50 feet away from storm drain inlets and surface waters unless no other alternatives are reasonably available.
4. Locate waste containers on areas that do not receive substantial amounts of runoff from upland areas and does not drain directly to a storm drain, stream or wetland.
5. Cover waste containers at the end of each workday and before storm events or provide secondary containment. Repair or replace damaged waste containers.
6. Anchor all lightweight items in waste containers during times of high winds.
7. Empty waste containers as needed to prevent overflow. Clean up immediately if containers overflow.
8. Dispose waste off-site at an approved disposal facility.
9. On business days, clean up and dispose of waste in designated waste containers.

PAINT AND OTHER LIQUID WASTE

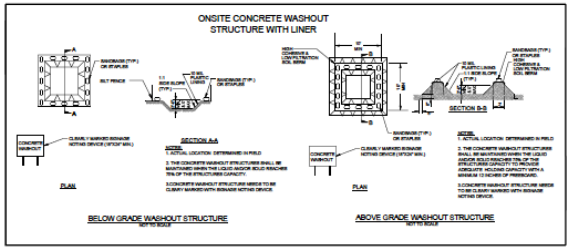
1. Do not dump paint and other liquid waste into storm drains, streams or wetlands.
2. Locate paint washouts at least 50 feet away from storm drain inlets and surface waters unless no other alternatives are reasonably available.
3. Contain liquid wastes in a controlled area.
4. Containment must be labeled, sized and placed appropriately for the needs of site.
5. Prevent the discharge of soaps, solvents, detergents and other liquid wastes from construction sites.

PORTABLE TOILETS

1. Install portable toilets on level ground, at least 50 feet away from storm drains, streams or wetlands unless there is no alternative reasonably available. If 50 foot offset is not attainable, provide relocation of portable toilet behind silt fence or place on a gravel pad and surround with sand bags.
2. Provide staking or anchoring of portable toilets during periods of high winds or in high foot traffic areas.
3. Monitor portable toilets for leaking and properly dispose of any leaked material. Utilize a licensed sanitary waste hauler to remove leaking portable toilets and replace with properly operating unit.

EARTHEN STOCKPILE MANAGEMENT

1. Show stockpile locations on plans. Locate earthen-material stockpile areas at least 50 feet away from storm drain inlets, sediment basins, perimeter sediment controls and surface waters unless it can be shown no other alternatives are reasonably available.
2. Protect stockpile with silt fence installed along toe of slope with a minimum offset of five feet from the toe of stockpile.
3. Provide stable stone access point when feasible.
4. Stabilize stockpile within the timeframes provided on this sheet and in accordance with the approved plan and any additional requirements. Soil stabilization is defined as vegetative, physical or chemical coverage techniques that will restrain accelerated erosion on disturbed soils for temporary or permanent control needs.



CONCRETE WASHOUTS

1. Do not discharge concrete or cement slurry from the site.
2. Dispose of, or recycle settled, hardened concrete residue in accordance with local and state solid waste regulations and at an approved facility.
3. Manage washout from mortar mixers in accordance with the above item and in addition place the mixer and associated materials on impervious barrier and within lot perimeter silt fence.
4. Install temporary concrete washouts per local requirements, where applicable. If an alternate method or product is to be used, contact your approval authority for review and approval. If local standard details are not available, use one of the two types of temporary concrete washouts provided on this detail.
5. Do not use concrete washouts for dewatering or storing defective curb or sidewalk sections. Stormwater accumulated within the washout may not be pumped into or discharged to the storm drain system or receiving surface waters. Liquid waste must be pumped out and removed from project.
6. Locate washouts at least 50 feet from storm drain inlets and surface waters unless it can be shown that no other alternatives are reasonably available. At a minimum, install protection of storm drain inlet(s) closest to the washout which could receive spills or overflow.
7. Locate washouts in an easily accessible area, on level ground and install a stone entrance pad in front of the washout. Additional controls may be required by the approving authority.
8. Install at least one sign directing concrete trucks to the washout within the project limits. Post signage on the washout itself to identify this location.
9. Remove leavings from the washout when at approximately 75% capacity to limit overflow events. Replace the tarp, sand bags or other temporary structural components when no longer functional. When utilizing alternative or proprietary products, follow manufacturer's instructions.
10. At the completion of the concrete work, remove remaining leavings and dispose of in an approved disposal facility. Fill pit, if applicable, and stabilize any disturbance caused by removal of washout.

HERBICIDES, PESTICIDES AND RODENTICIDES

1. Store and apply herbicides, pesticides and rodenticides in accordance with label restrictions.
2. Store herbicides, pesticides and rodenticides in their original containers with the label, which lists directions for use, ingredients and first aid steps in case of accidental poisoning.
3. Do not store herbicides, pesticides and rodenticides in areas where flooding is possible or where they may spill or leak into wells, stormwater drains, ground water or surface water. If a spill occurs, clean area immediately.
4. Do not stockpile these materials onsite.

HAZARDOUS AND TOXIC WASTE

1. Create designated hazardous waste collection areas on-site.
2. Place hazardous waste containers under cover or in secondary containment.
3. Do not store hazardous chemicals, drums or bagged materials directly on the ground.

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NC FIRM P-1932

CATHEY'S CREEK WTP INTAKE REHAB. & STEAM RESTOR.
TRANSYLVANIA COUNTY - NORTH CAROLINA

E&SC PLAN: GROUND STABILIZATION AND MATERIALS HANDLING

NORTH CAROLINA PROFESSIONAL SEAL 032464 ENGINEER GREGORY D. JENNINGS

FINAL DRAWING FOR REVIEW ONLY

REVISIONS:
08/01/2019
DATE: 08/30/2019
PLOT SIZE: 24" x 36"
NTS
H.D.: NAD83 (NCSP)
V.D.: NAVD88
JE PID: 4304
H-SRP-D-17-0127

Erosion & Sediment Control Plan

PART III
SELF-INSPECTION, RECORDKEEPING AND REPORTING

SECTION A: SELF-INSPECTION

Self-inspections are required during normal business hours in accordance with the table below. When adverse weather or site conditions would cause the safety of the inspection personnel to be in jeopardy, the inspection may be delayed until the next business day on which it is safe to perform the inspection. In addition, when a storm event of equal to or greater than 1.0 inch occurs outside of normal business hours, the self-inspection shall be performed upon the commencement of the next business day. Any time when inspections were delayed shall be noted in the Inspection Record.

Inspect	Frequency (during normal business hours)	Inspection records must include:
(1) Rain gauge maintained in good working order	Daily	Daily rainfall amounts. If no daily rain gauge observations are made during weekend or holiday periods, and no individual-day rainfall information is available, record the cumulative rain measurement for those un-attended days (and this will determine if a site inspection is needed). Days on which no rainfall occurred shall be recorded as "zero." The permittee may use another rain-monitoring device approved by the Division.
(2) E&SC Measures	At least once per 7 calendar days and within 24 hours of a rain event ≥ 1.0 inch in 24 hours	1. Identification of the measures inspected, 2. Date and time of the inspection, 3. Name of the person performing the inspection, 4. Ind cation of whether the measures were operating properly, 5. Description of maintenance needs for the measure, 6. Description, evidence, and date of corrective actions taken.
(3) Stormwater discharge outfalls (SDOs)	At least once per 7 calendar days and within 24 hours of a rain event ≥ 1.0 inch in 24 hours	1. Identification of the discharge outfalls inspected, 2. Date and time of the inspection, 3. Name of the person performing the inspection, 4. Evidence of indicators of stormwater pollution such as oil sheen, floating or suspended solids or discoloration, 5. Ind cation of visible sediment leaving the site, 6. Description, evidence, and date of corrective actions taken.
(4) Perimeter of site	At least once per 7 calendar days and within 24 hours of a rain event ≥ 1.0 inch in 24 hours	If visible sedimentation is found outside site limits, then a record of the following shall be made: 1. Actions taken to clean up or stabilize the sediment tha: has left the site limits, 2. Description, evidence, and date of corrective actions taken, and 3. An explanation as to the actions taken to control future releases.
(5) Streams or wetlands onsite or offsite (where accessible)	At least once per 7 calendar days and within 24 hours of a rain event ≥ 1.0 inch in 24 hours	If the stream or wetland has increased visible sedimentation or a stream has visible increased turbidity from the construction activity, then a record of the following shall be made: 1. Description, evidence and date of corrective actions taken, and 2. Records of the required reports to the appropriate Division Regional Office per Part III, Section C, Item (2)(a) of this permit of this permit.
(6) Ground stabilization measures	After each phase of grading	1. The phase of grading (installation of perimeter E&SC measures, clearing and grubbing, installation of storm drainage facilities, completion of all land-disturbing activity, construction or redevelopment, permanent ground cover). 2. Documentation that the required ground stabilization measures have been provided within the required timeframe or an assurance that they will be provided as soon as possible.

NOTE: The rain inspection resets the required 7 calendar day inspection requirement.

PART III
SELF-INSPECTION, RECORDKEEPING AND REPORTING

SECTION B: RECORDKEEPING

1. E&SC Plan Documentation

The approved E&SC plan as well as any approved deviation shall be kept on the site. The approved E&SC plan must be kept up-to-date throughout the coverage under this permit. The following items pertaining to the E&SC plan shall be documented in the manner described:

Item to Document	Documentation Requirements
(a) Each E&SC Measure has been installed and does not significantly deviate from the locations, dimensions and relative elevations shown on the approved E&SC Plan.	Initial and date each E&SC Measure on a copy of the approved E&SC Plan or complete, date and sign an inspection report that lists each E&SC Measure shown on the approved E&SC Plan. This documentation is required upon the initial installation of the E&SC Measures or if the E&SC Measures are modified after initial installation.
(b) A phase of grading has been completed.	Initial and date a copy of the approved E&SC Plan or complete, date and sign an inspection report to indicate completion of the construction phase.
(c) Ground cover is located and installed in accordance with the approved E&SC Plan.	Initial and date a copy of the approved E&SC Plan or complete, date and sign an inspection report to indicate compliance with approved ground cover specifications.
(d) The maintenance and repair requirements for all E&SC Measures have been performed.	Complete, date and sign an inspection report.
(e) Corrective actions have been taken to E&SC Measures.	Initial and date a copy of the approved E&SC Plan or complete, date and sign an inspection report to indicate the completion of the corrective action.

2. Additional Documentation

In addition to the E&SC Plan documents above, the following items shall be kept on the site

and available for agency inspectors at all times during normal business hours, unless the Division provides a site-specific exemption based on unique site conditions that make this requirement not practical:

(a) This general permit as well as the certificate of coverage, after it is received.

(b) Records of inspections made during the previous 30 days. The permittee shall record the required observations on the Inspection Record Form provided by the Division or a similar inspection form that includes all the required elements. Use of electronically-available records in lieu of the required paper copies will be allowed if shown to provide equal access and utility as the hard-copy records.

(c) All data used to complete the Notice of Intent and older inspection records shall be maintained for a period of three years after project completion and made available upon request. [40 CFR 122.41]

PART III
SELF-INSPECTION, RECORDKEEPING AND REPORTING

SECTION C: REPORTING

1. Occurrences that must be reported

Permittees shall report the following occurrences:

(a) Visible sediment deposition in a stream or wetland.

(b) Oil spills if:

- They are 25 gallons or more,
- They are less than 25 gallons but cannot be cleaned up within 24 hours,
- They cause sheen on surface waters (regardless of volume), or
- They are within 100 feet of surface waters (regardless of volume).

(a) Releases of hazardous substances in excess of reportable quantities under Section 311 of the Clean Water Act (Ref: 40 CFR 110.3 and 40 CFR 117.3) or Section 102 of CERCLA (Ref: 40 CFR 302.4) or G.S. 143-215.85.

(b) Anticipated bypasses and unanticipated bypasses.

(c) Noncompliance with the conditions of this permit that may endanger health or the environment.

2. Reporting Timeframes and Other Requirements

After a permittee becomes aware of an occurrence that must be reported, he shall contact the appropriate Division regional office within the timeframes and in accordance with the other requirements listed below. Occurrences outside normal business hours may also be reported to the Division's Emergency Response personnel at (800) 662-7956, (800) 858-0368 or (919) 733-3300.

Occurrence	Reporting Timeframes (After Discovery) and Other Requirements
(a) Visible sediment deposition in a stream or wetland	• ***Within 24 hours***, an oral or electronic notification. • ***Within 7 calendar days***, a report that contains a description of the sediment and actions taken to address the cause of the deposition. Division staff may waive the requirement for a written report on a case-by-case basis. • If the stream is named on the NC 303(d) list as impaired for sediment-related causes, the permittee may be required to perform additional monitoring, inspections or apply more stringent practices if staff determine that additional requirements are needed to assure compliance with the federal or state impaired-waters conditions.
(b) Oil spills and release of hazardous substances per Item 1(b)-(c) above	• ***Within 24 hours***, an oral or electronic notification. The notification shall include information about the date, time, nature, volume and location of the spill or release.
(c) Anticipated bypasses [40 CFR 122.41(m)(3)]	• ***A report at least ten days before the date of the bypass, if possible.*** The report shall include an evaluation of the anticipated quality and effect of the bypass.
(d) Unanticipated bypasses [40 CFR 122.41(m)(3)]	• ***Within 24 hours***, an oral or electronic notification. • ***Within 7 calendar days,*** a report that includes an evaluation of the quality and effect of the bypass.
(e) Noncompliance with the conditions of this permit that may endanger health or the environment[40 CFR 122.41(l)(7)]	• ***Within 24 hours***, an oral or electronic notification. • ***Within 7 calendar days***, a report that contains a description of the noncompliance, and its causes; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time noncompliance is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. [40 CFR 122.41(l)(6). • Division staff may waive the requirement for a written report on a case-by-case basis.

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CATHEY'S CREEK WTP INTAKE REHAB. & STEAM RESTOR.
TRANSYLVANIA COUNTY - NORTH CAROLINA

E&SC PLAN: SITE INSPECTIONS, RECORD KEEPING AND REPORTING

NORTH CAROLINA PROFESSIONAL SEAL 029454 ENGINEER GREGORY D. JENNINGS

FINAL DRAWING FOR REVIEW ONLY

REVISIONS:
08/01/2019
DATE: 08/30/2019
PLOT SIZE: 24" x 36"
NTS
H.D.: NAD83 (NCSP)
V.D.: NAVD88
JE PID: 4304
H-SRP-D-17-0127

3.4

1. Site Preparation

- Spill management plan
- Construction entrance
- Silt fence
- Staging & stockpile
- Temporary crossings
- Stream flow diversion or pump-around


CD110R
1330
KOMATSU

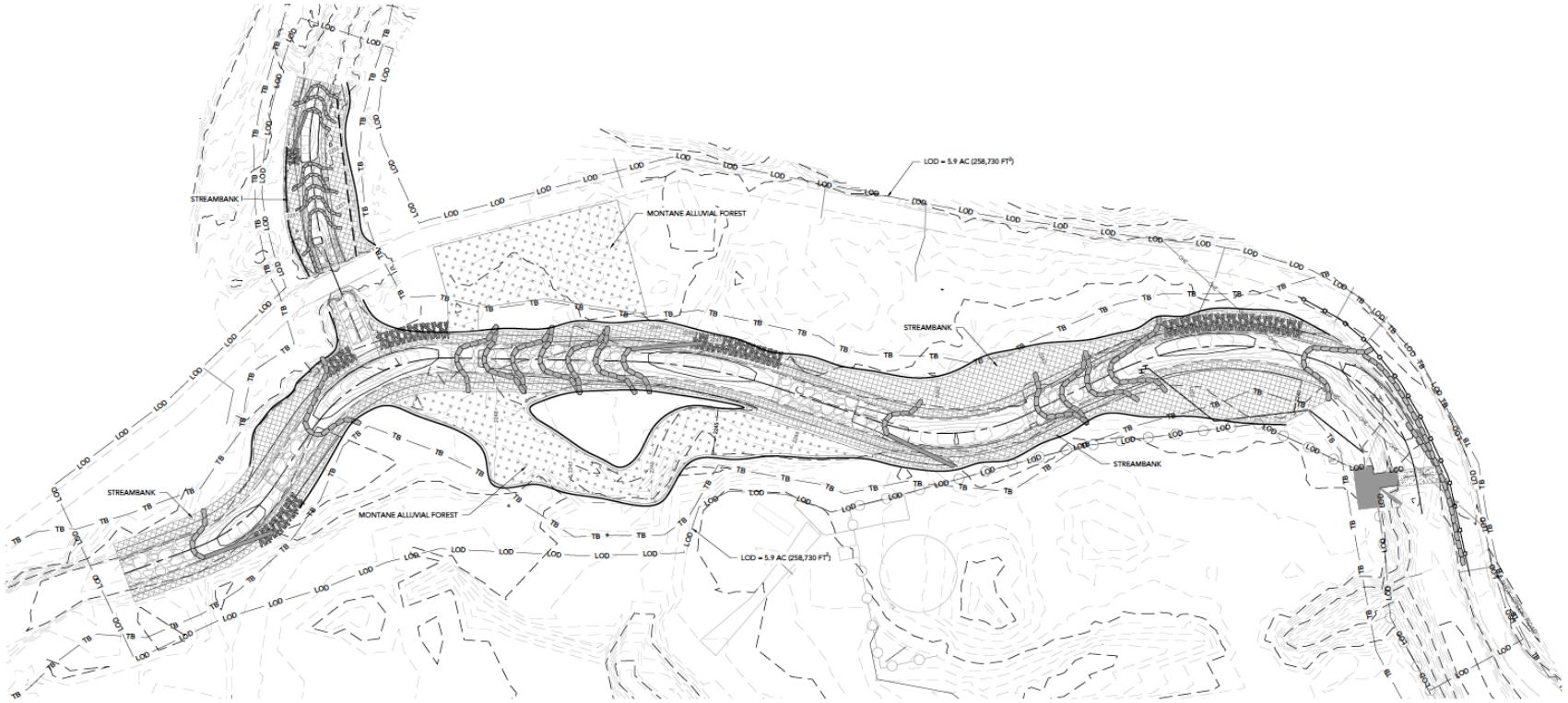
2. Grading

- Stage project to limit exposed areas
- Use temporary ground cover as soon as possible
- Keep stormwater runoff away from site
- Use track equipment to minimize compaction
- Staged construction phases to limit exposure

3. Site Stabilization

- Soil preparation to support plant growth
- Seed and straw mulch
- Biodegradable matting with wood stakes
- Permanent native vegetation (grasses, shrubs, trees)
- Prepare for rain!

Vegetation Plan



GENERAL RE-VEGETATION PLAN NOTES

1. SOIL PREPARATION ELEMENTS, TEMPORARY AND PERMANENT SEED AND GROUND COVER SHALL BE SPREAD OVER ALL AREAS WITHIN THE LOD THAT ARE DISTURBED DURING CONSTRUCTION.
2. LIVE STAKES, BARE ROOT STOCK AND CONTAINERIZED PLANTS SHALL BE LOCATED WHERE SHOWN ON PLAN.
3. ADJUSTMENTS TO THE VEGETATION PLAN SHALL BE MADE ONLY IF APPROVED BY THE TOWN OR ENGINEER.

BARE ROOTS

4. ALLOW BARE ROOTS TO SOAK IN WATER AN HOUR OR TWO BEFORE PLANTING. DO NOT SOAK THE ROOTS FOR MORE THAN 24 HOURS.
5. DIG A PLANTING PIT THAT IS THREE (3) TIMES WIDER THAN THE TREE'S CURRENT ROOT SYSTEM. SPREAD OUT ROOTS TO ENCOURAGE OUTWARD GROWTH.
6. KEEP THE TREE VERTICAL IN THE PLANTING PIT (PERPENDICULAR TO THE GROUND) SO THAT IT GROWS STRAIGHT.
7. REFILL THE PIT WITH NATIVE SOIL (WHAT WAS REMOVED AT DIGGING TIME), AND ANY OTHER SOIL AMENDMENTS.
8. GENTLY TAMP OUT ANY AIR POCKETS FROM THE SOIL ONCE THE PLANTING HOLE IS FILLED.

LIVE STAKES

9. LIVE STAKES MUST BE DORMANT WHEN CUT. KEEP LIVE STAKES MOIST UNTIL PLANTING. THE STAKE SHOULD BE PREPARED WITH THE BUDS POINTED UP, AND THE BOTTOM SHOULD BE CUT AT AN ANGLE FOR EASY INSERTION INTO THE GROUND.
10. LIVE STAKES SHOULD BE PLACED WITH $\frac{2}{3}$ TO $\frac{3}{4}$ OF THE LENGTH OF THE STAKE BELOW GROUND AND ANGLED DOWNSTREAM. ENSURE THE BASE OF THE LIVE STAKE WILL REACH THE WATER TABLE.
11. AN IRON BAR CAN BE USED TO MAKE A PILOT HOLE TO PREVENT BARK FROM BEING DAMAGED DURING INSTALLATION.
12. INSERT LIVE STAKES POINTED END FIRST INTO THE STREAMBANK.

CONTAINER STOCK

13. STOCK SHALL HAVE BEEN GROWN IN A CONTAINER LONG ENOUGH FOR THE ROOT SYSTEM TO HAVE DEVELOPED SUFFICIENTLY TO HOLD ITS SOIL TOGETHER ONCE REMOVED FROM THE CONTAINER.
14. CONTAINER PLANTS WILL NEED TO BE WATERED REGULARLY AND PLACED IN SHADY CONDITIONS UNTIL PLANTING OCCURS.CREATE PLANTING AREA FOR EACH PLANT AND EXCAVATE PIT.
15. THE DIAMETER OF THE PLANTING PITS FOR EACH PLANT SHOULD BE AT LEAST THREE TIMES THE DIAMETER OF THE ROOT MASS. SCARIFY THE PLANTING PIT PRIOR TO EACH PLANT INSTALLATION.
16. SET PLANTS UPRIGHT IN THE CENTER OF THE PIT. THE BOTTOM OF THE ROOT MASS SHOULD BE RESTING ON UNDISTURBED SOIL.
17. PLACE BACKFILL AROUND BASE AND SIDES OF ROOT MASS, AND WORK EACH LAYER TO SETTLE BACKFILL AND TO ELIMINATE VOIDS AND AIR POCKETS. WHEN PIT IS APPROXIMATELY $\frac{1}{4}$ FULL, WATER THOROUGHLY BEFORE PLACING REMAINDER OF THE BACKFILL. WATER AGAIN AFTER PLACING FINAL LAYER OF BACKFILL.

RIVERBANK AND RIPARIAN PLANTING SPECIFICATIONS

STREAMBANK - LIVE STAKES, BARE ROOT STOCK, CONTAINERIZED PLANTS OR TRANSPLANTS - 1.0 AC

SCIENTIFIC NAME	COMMON NAME	SIZE (CAL)	SPACING	QTY
Salix sericea	SILKY WILLOW	0.25" - 1.0"	2 FT - 4 FT O.C.	1,000
Cephalanthus occidentalis	BUTTON BUSH	0.50" - 1.0"	2 FT - 4 FT O.C.	1,000
Sambucus nigra ssp. canadensis	ELDERBERRY	0.25" - 1.0"	2 FT - 4 FT O.C.	1,000
Alnus serrulata	TAG ALDER	0.25" - 1.0"	2 FT - 4 FT O.C.	1,000
Cornus amomum	SILKY DOGWOOD	0.25" - 1.0"	2 FT - 4 FT O.C.	2,000

FLOODPLAIN - LIVE STAKES, BARE ROOT STOCK, CONTAINERIZED PLANTS OR TRANSPLANTS - 0.7 AC

SCIENTIFIC NAME	COMMON NAME	SIZE (CAL)	SPACING	QTY
Betula nigra	RIVER BIRCH	0.25" - 1.0"	4 FT - 6 FT O.C.	250
Platanus occidentalis	SYCAMORE	0.50" - 1.0"	4 FT - 6 FT O.C.	250
Liriodendron tulipifera	TULIP POPLAR	0.25" - 1.0"	4 FT - 6 FT O.C.	250
Carpinus caroliniana	IRONWOOD	0.25" - 1.0"	4 FT - 6 FT O.C.	250
Populus deltoides	EASTERN COTTONWOOD	0.25" - 1.0"	4 FT - 6 FT O.C.	250

PERMANENT SEEDING - 1.7 AC

SCIENTIFIC NAME	COMMON NAME	TYPE	APP. RATE	QTY
EARNMX - 304 (OR EQUIVALENT)	NC MOUNTAIN RIPARIAN SEED MIX	SEED	40 LBS / AC	70 LBS

TEMPORARY SEEDING, MULCH AND SOIL PREP - 1.7 AC

SCIENTIFIC NAME	COMMON NAME	TYPE	APP. RATE	QTY
Secale Cereale	RYE GRAIN	SEED	220 LBS / AC	375 LBS
——	GROUND AG. LIMESTONE	PELLET	2000 LBS / AC	3,400 LBS
——	10-10-10 FERTILIZER	PELLET	750 LBS / AC	1,300 LBS
——	WHEAT STRAW MULCH	STRAW	4000 LBS / AC	6,800 LBS

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CATHEY'S CEEK WTP INTAKE REHAB. & STEAM RESTOR.
TRANSYLVANIA COUNTY - NORTH CAROLINA

STABILIZATION AND RE-VEGETATION PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 036454 GREGORY D. JENNINGS

FINAL DRAWING FOR REVIEW ONLY

REVISIONS:
08/01/2019
DATE: 08/30/2019
PLOT SIZE: 24" x 36"
SCALE: 1" = 80'
H.D.: NAD83 (NCSP)
V.D.: NAVD88
JE PID: 4304
H-SRP-D-17-0127

5.1

Beeson Creek Restoration Design/Build
Ivey Redmon Sports Complex, Kernersville, NC

Greg Jennings, PhD, PE
Jennings Environmental PLLC
NC State University
greg@jenningsenv.com

Thanks to Wendi Hartup, Darrell Westmoreland, Brandon Spaugh, Riley Lecka, Corben Brewer, Jon Page, Jonathan Hinkle, Jason Zink, David Penrose

cleanwater MANAGEMENT TRUST FUND

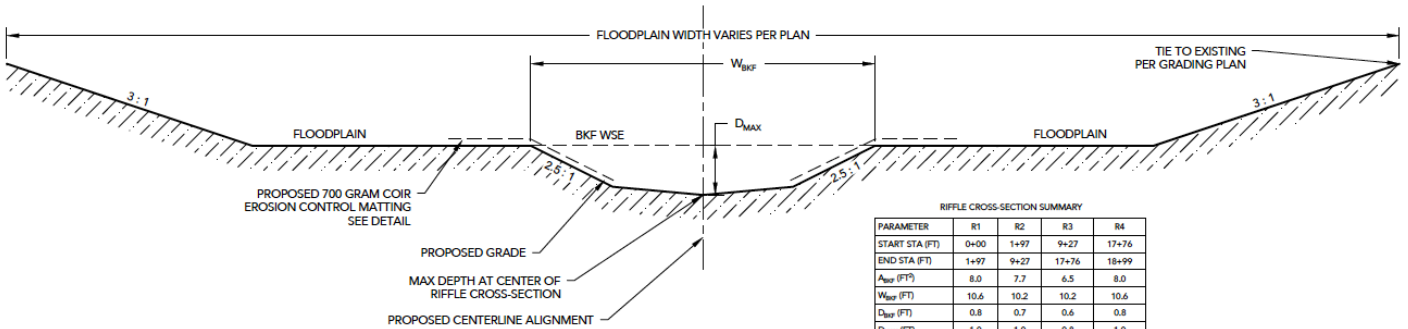
Jennings Environmental

North State ENVIRONMENTAL

Beeson Creek, Reach 4, Kernersville, NC

- 1,950 feet located mostly on Town property
- 0.33 square mile drainage area (42% developed)
- Channel incision 5 to 7 feet
- Priority 1 and 2 floodplain connection (ER = 4 to 6)

Stream Restoration Design Plan

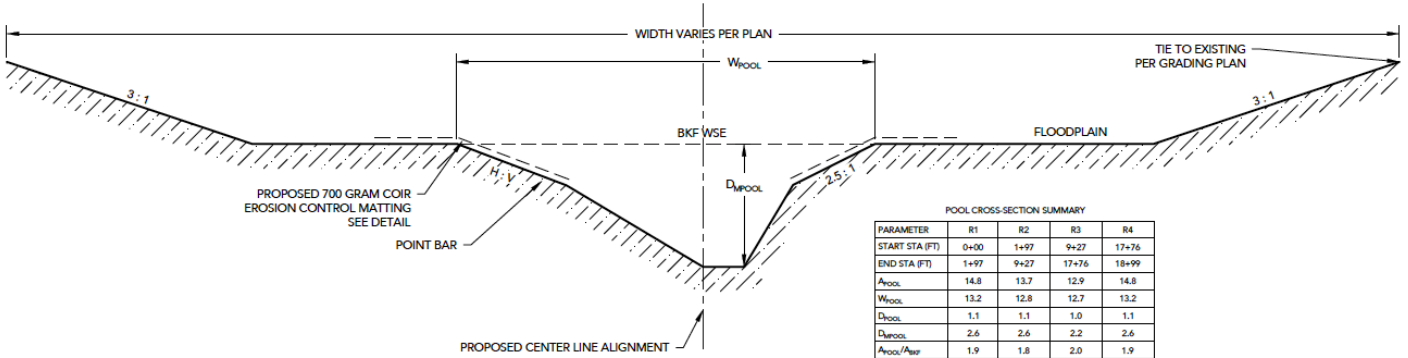


RIFFLE CROSS-SECTION SUMMARY

PARAMETER	R1	R2	R3	R4
START STA (FT)	0+00	1+97	9+27	17+76
END STA (FT)	1+97	9+27	17+76	18+99
A_{BKF} (FT^2)	8.0	7.7	6.5	8.0
W_{BKF} (FT)	10.6	10.2	10.2	10.6
D_{BKF} (FT)	0.8	0.7	0.6	0.8
D_{MAX} (FT)	1.0	1.0	0.8	1.0
W/D (FT)	14.0	13.9	16.0	14.0
D_{MAX}/D_{BKF}	1.3	1.3	1.2	1.3
S_e (FT/FT)	0.008	0.011	0.016	0.013

BEESON CREEK
RIFFLE CROSS-SECTION

NOT TO SCALE



POOL CROSS-SECTION SUMMARY

PARAMETER	R1	R2	R3	R4
START STA (FT)	0+00	1+97	9+27	17+76
END STA (FT)	1+97	9+27	17+76	18+99
A_{POOL}	14.8	13.7	12.9	14.8
W_{POOL}	13.2	12.8	12.7	13.2
D_{POOL}	1.1	1.1	1.0	1.1
D_{MPOOL}	2.6	2.6	2.2	2.6
A_{POOL}/A_{BKF}	1.9	1.8	2.0	1.9
W_{POOL}/W_{BKF}	1.3	1.3	1.2	1.2
D_{MPOOL}/D_{BKF}	3.5	3.5	3.5	3.5

BEESON CREEK
POOL CROSS-SECTION

NOT TO SCALE

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REACH 4: BEESON CREEK AT IVEY REDMON SPORTS CMPLX.
FORSYTH COUNTY - NORTH CAROLINA

STREAM RESTORATION: CHANNEL CROSS-SECTIONS

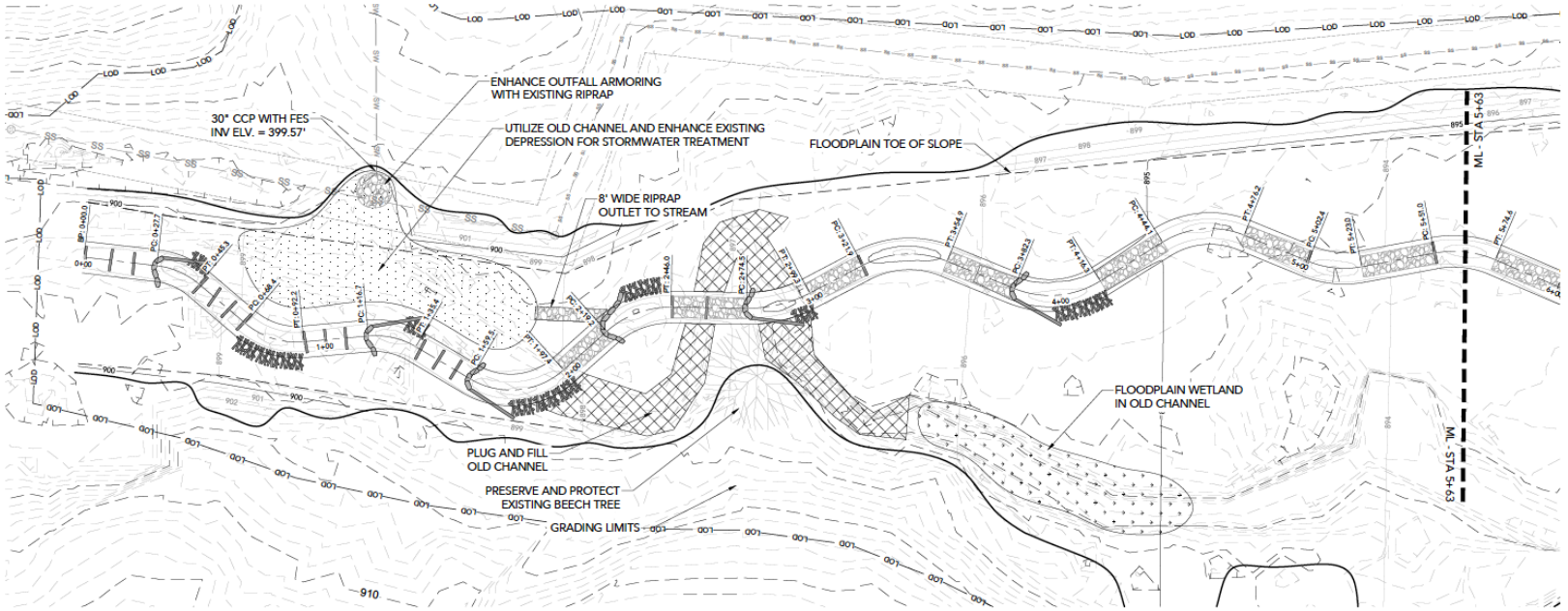
NORTH CAROLINA ENGINEERING SEAL 35494 GREGORY D. JENNINGS

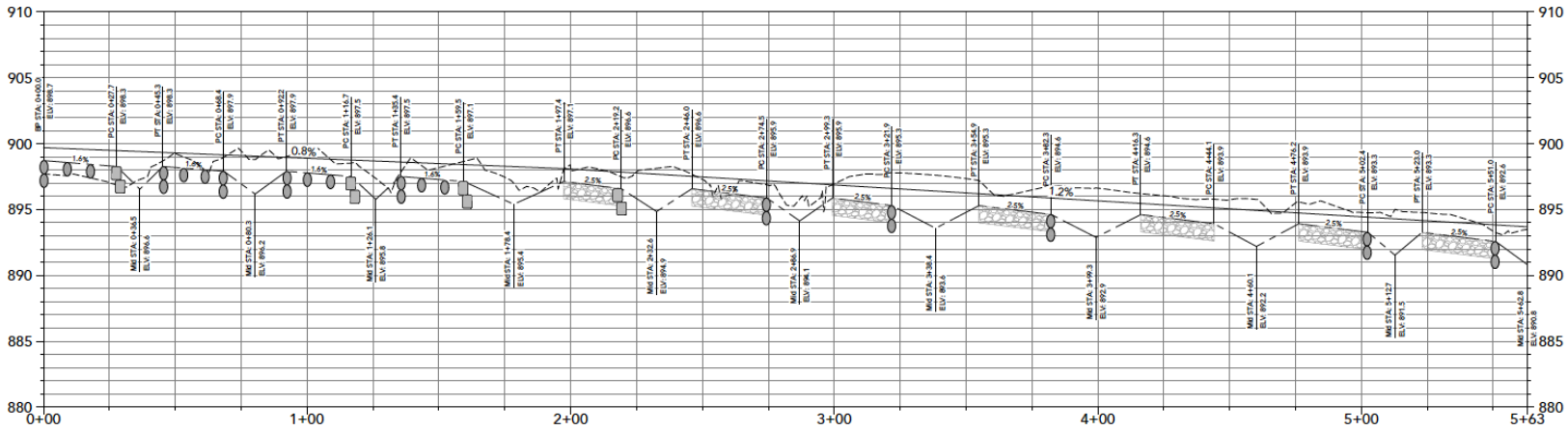
80% DESIGN

REVISIONS:
30%: 4/25/2018
60%: 6/15/2018
DATE: 2/19/2019
PLOT SIZE: 24" x 36"
SCALE: 1" = 10'
H.D.: NAD83 (NCSP)
V.D.: NAVD88
JE PID: 3302
PO#: 6577305

5.1

Stream Restoration Design Plan





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REACH 4: BEESON CREEK AT IVEY REDMON SPORTS CMPLX.
FORSYTH COUNTY - NORTH CAROLINA

STREAM RESTORATION: PLAN AND PROFILE STA 0+00 TO 5+63

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 16454 JEREMY D. JENNINGS

80% DESIGN

REVISIONS:
30%: 4/25/2018
60%: 6/15/2018
DATE: 2/19/2019
PLOT SIZE: 24" x 36"
SCALE: 1" = 20'
H.D.: NAD83 (NCSP)
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JE PID: 3302
PO#: 6577305

6.1

Implementation: March-April, 2019

- Off-line excavation
- Pump-around
- Silt fence
- Ground cover

Implementation: March-April, 2019

- Wood toe revetment
- Riffle rock
- Log and rock vanes
- Seed/straw/coir

Implementation: March-April, 2019

Implementation: March-April, 2019

- Millet
- Native riparian mix
- Live stakes
- Bare root trees/shrubs

Ecological Uplift: April, 2019

Stream Restoration Designer/Contractor Interface

- Communications !!!
- Common understanding of client and regulatory expectations
- Responsiveness and adaptive management

Thank you,
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