Post-Flood Emergency Stream Intervention Training

Water Quality Improvement Projects – Round IX
Training Pilot Grant

by

Delaware County Soil & Water Conservation District
Stream Corridor Management Program

- This presentation is located on the Delaware County Soil and Water Conservation District's website:

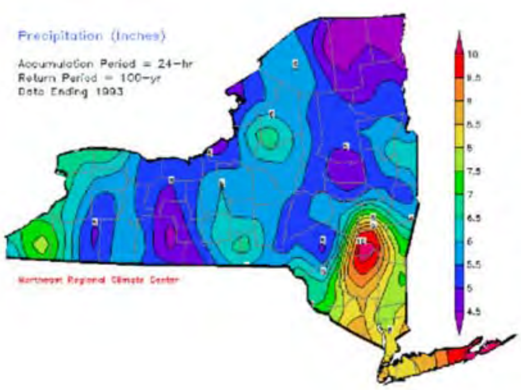
www.dcswcd.org
or
http://dcswcd.org/Stream%20Program/Training%20Manual%202012/Presentation%20AA_Print%20Contact%20Sheet.pdf

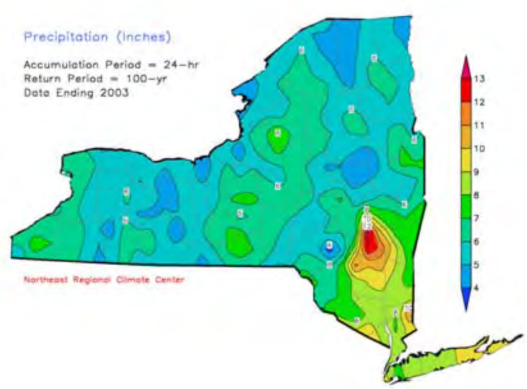
Overview

- Precipitation
- Stream Mechanics
- Stream Types
- Floodplains
- Stream Instability
- Unstable Channels
- Avulsion
- Flood Response
- Channel Sizing
- Classroom Examples
- Work Methods
- Bioengineering Techniques
- Natural Channel Design Structures
- De-watering
- Questions

Precipitation

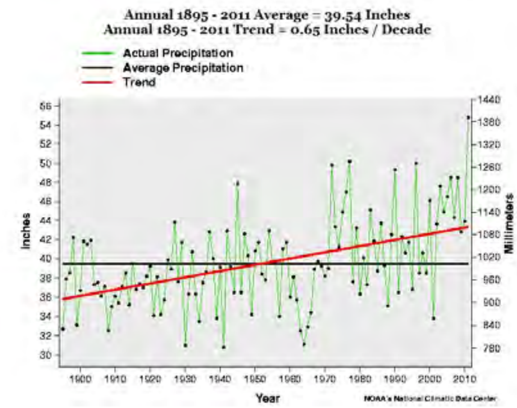
Graydon





Catskill Climate (Precipitation)

- High rainfall compared to rest of state
- Climate change causes increasing precipitation levels and variability (more extremes)
  - Streams are adjusting to increase flows
- Difficult to predict local severity of forecasted rain event



Tropical Storm Irene

August 28, 2011

Tropical Storm Sandy

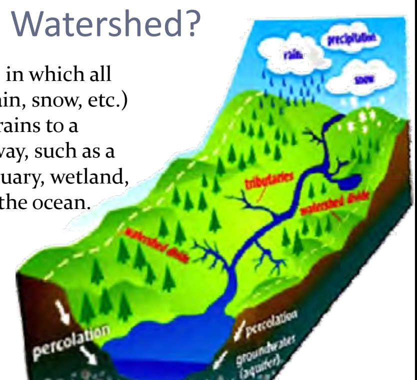
October 29,2012

Stream Mechanics

Tom

What is a Watershed?

The area of land in which all precipitation (rain, snow, etc.) that falls on it drains to a common waterway, such as a stream, lake, estuary, wetland, aquifer, or even the ocean.



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Adapted from EPA Website, 2009

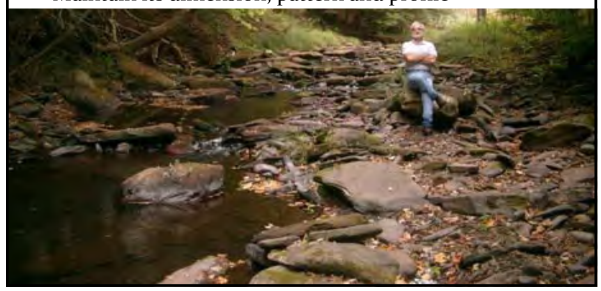
Why Do Streams Look the Way They Do?

- Geology
  - Slope
  - Soils
- Amount of water
  - Timing
  - Duration
  - Magnitude
- Landuse
  - Vegetation
  - Infrastructure

"The river is the carpenter of its own edifice"
-- Luna Leopold, 1994

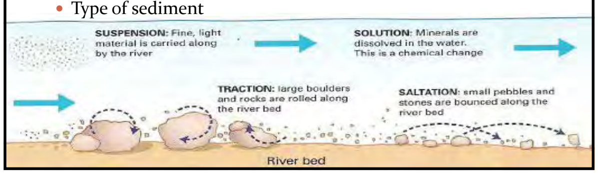
Streams obey certain physical laws

- Properly size itself to transport water and sediment
- Maintain its dimension, pattern and profile



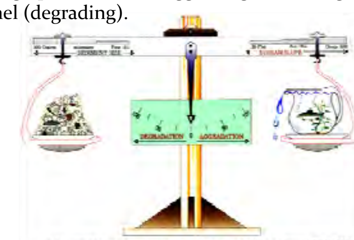
Streams Move More Than Water

- As water moves over the land it picks up sediment, forming the stream channel
- Streams create and maintain their shape and size themselves, a result of:
  - Volume of water
  - Amount of sediment
  - Type of sediment



Sediment Balance

- Streams are said to be in equilibrium when the volume of water is enough to transport the available sediment without building up the channel (aggrading) or cutting down the channel (degrading).



Adapted from Applied River Morphology, Dave Rosgen, 1996

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Sediment Balance

- Based on their ability to transport sediment, streams adjust their:
  - Shape
  - Slope
  - Size

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Sediment Balance

- Shear Stress
  - Measure of the force that makes the sediment move
    - The deeper the water the greater the stress
    - The steeper the stream the greater the stress

Need to take these factors into account

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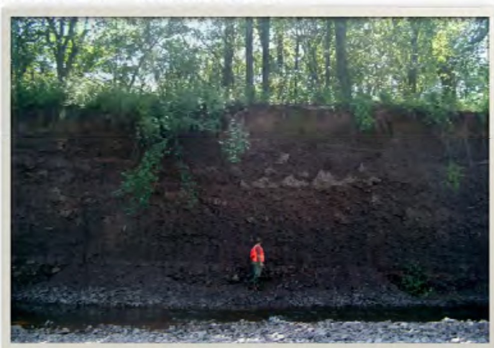
How does the sediment stay in balance?

- Erosion:
  - The wearing away of rocks, sediment and soils by the action of water, wind or a glacier.
    - Degradation
- Deposition:
  - The accumulation or laying down of matter by a natural process.
    - Aggradation

Examples of Erosion

- Streambank
- Mass Failures
- Lateral Migration
- Hoof shear
- Bedrock weathering

Erosion – Streambank



Erosion – Mass failures

Erosion – Mass failures

Erosion – Mass failures

Erosion – Lateral Migration

Erosion – Hoof Shear

Erosion – Bedrock Weathering

Examples of Deposition

- Center bar
- Transverse bar
- Side bar
- Point bar
- Mouth of tributary
- Undersized Hydraulic Structure
- On the floodplain
- Point Bar

Deposition – Center Bar

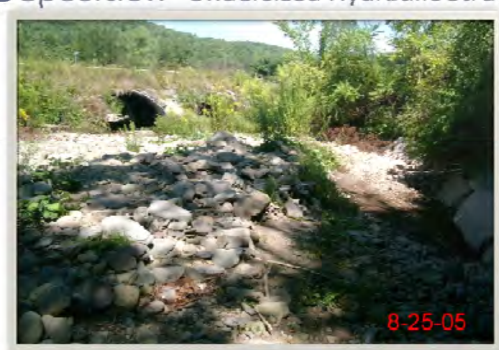
Deposition – Transverse Bar

Deposition – Side Bar

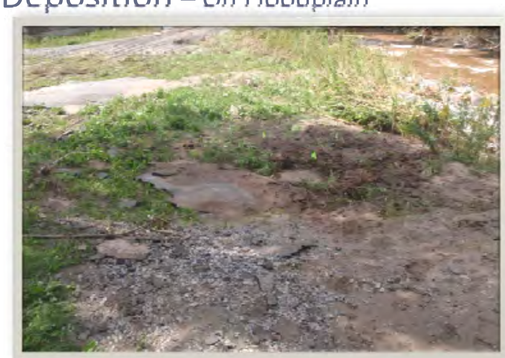
Deposition – Mouth of Tributary

Deposition – Undersized Hydraulic Structure

Deposition – Undersized Hydraulic Structure

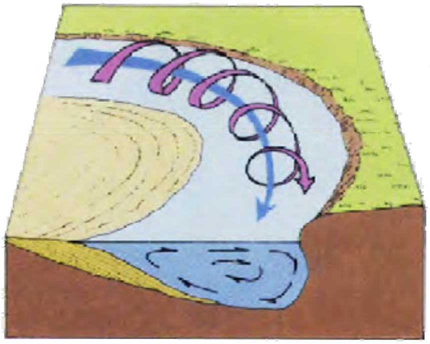


Deposition – On Floodplain



Deposition – Point Bar

Point Bar Formation



Stream Types

Graydon

Two Main Stream Types

- **Step - Pool Sequence** - streams are usually found in the headwaters or on steep slopes
- **Riffle - Pool Sequence** - streams are usually found in the broad valleys and on flat slopes

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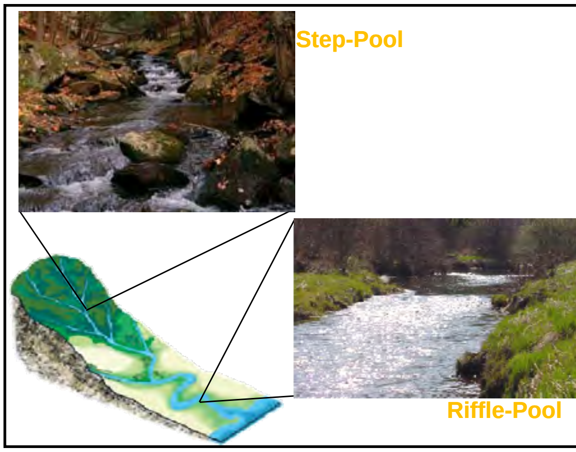
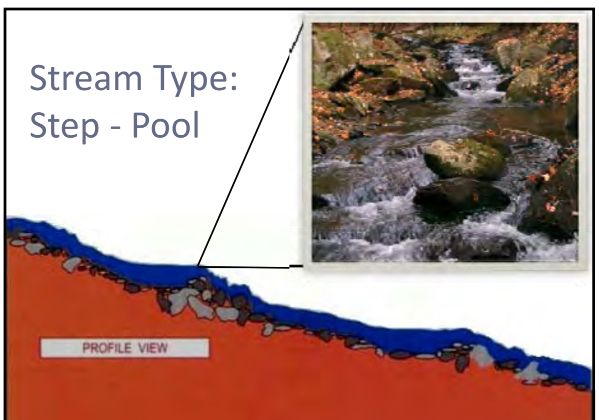
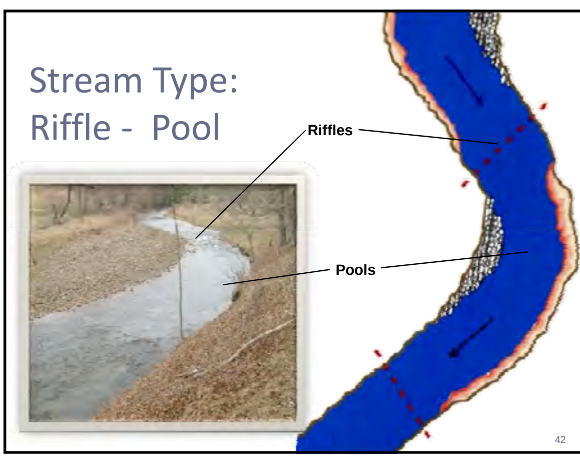


Stream Type: Step - Pool



Adapted from Applied River Morphology, Dave Rosgen, 1996

Stream Type: Riffle - Pool



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Floodplains

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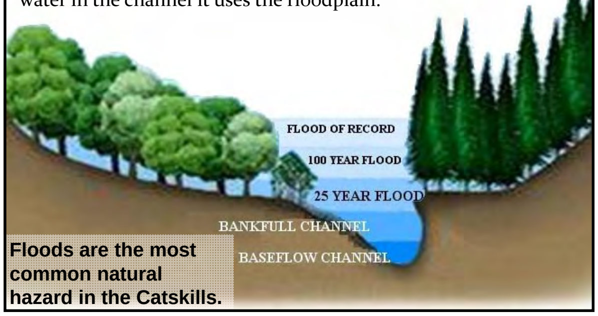
Floodplain Definition

- *The floodplain is the area bordering a stream, constructed by the river and inundated during periods of high flow.*

Flood Stage

When volume of water is such that the stream cannot contain the water in the channel it uses the floodplain.



Floods are the most common natural hazard in the Catskills.

Floodplain Function

- Energy dissipation during flooding events
  - Velocity and energy decreases
- Lowers flood peaks due to storage and infiltration
  - Water released more slowly downstream
- Provide a place for debris and sediment to be deposited
  - Natural process of topsoil formation

Floodplain Function – Cont.

- Reduce the flood stage (height of flood water)
- Traps fine sediments
  - Keeps that material out of the bed
  - Provides a growth medium
  - Better vegetation stabilizes the floodplain

Ouleout Creek near Franklin, NY – 2006

Stream Instability

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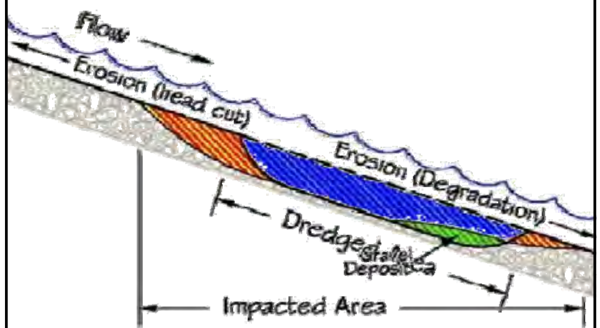
How do streams become unstable?

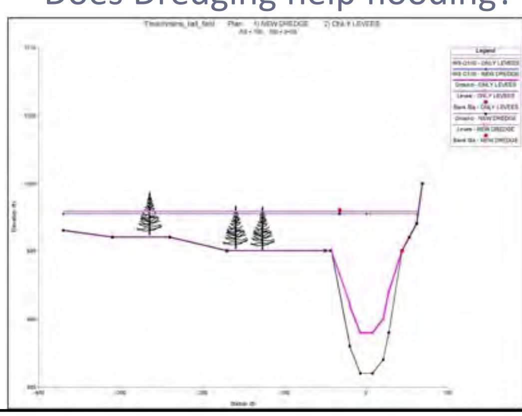
- Dredging
- Channel Straightening
- Berms
- Disconnecting floodplain from the channel
- Development on the Floodplain

Dredging

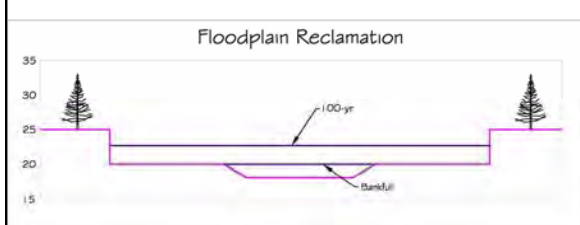


After R. Hey, 2003

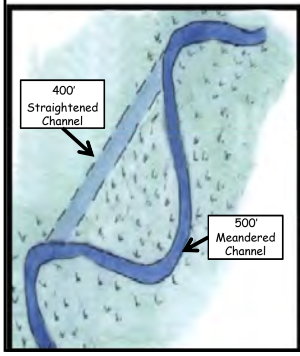
Does Dredging help flooding?



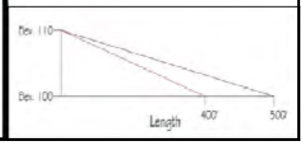
Channel Modifications



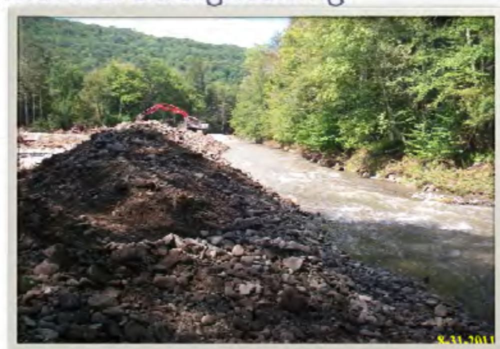
Channel Straightening



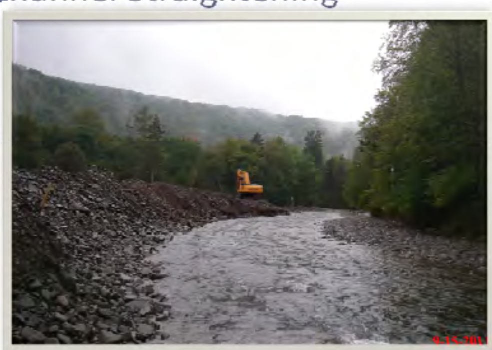
- Shorter distance means a steeper slope
- A steeper slope increases velocity
- A steeper slope increases erosion on the streambank and bed



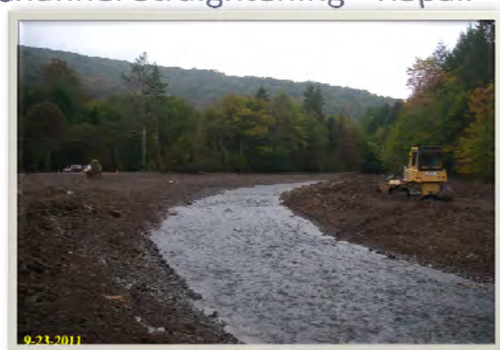
Channel Straightening



Channel Straightening



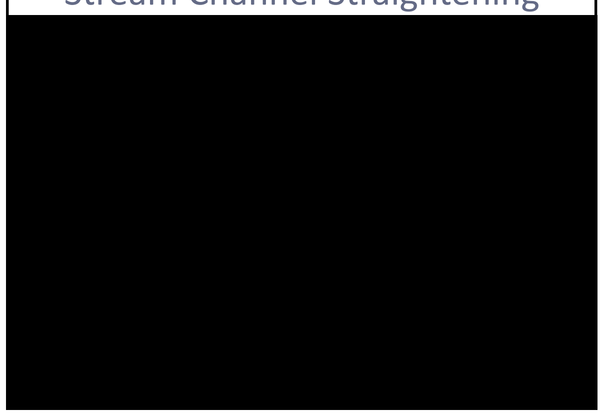
Channel Straightening - Repair



Stream Table Demo

Straightening
Dredging

Stream Channel Straightening

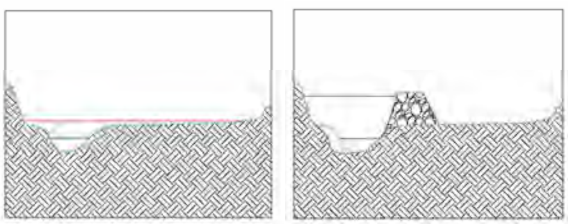


Dredging

Another Example of Dredging

Berms Definition

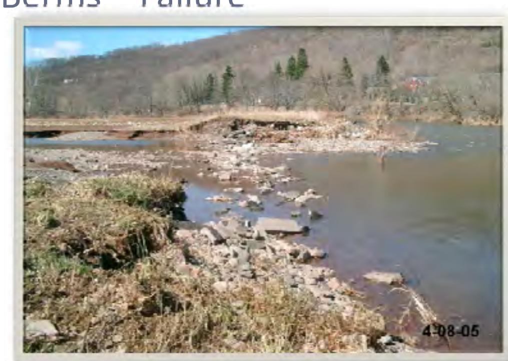
An earthen embankment or wall, usually built to provide protection or a result of side casting during stream channel dredging



Berms

Berms

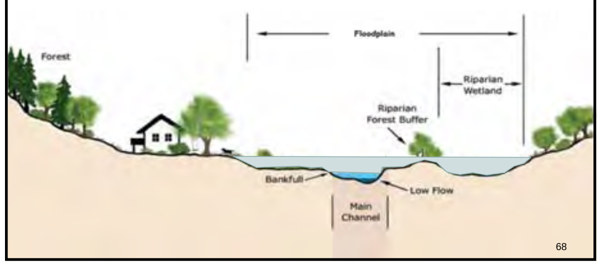
Berms – Failure



Berms – Failure

Floodplain

The floodplain is part of the river during storm conditions



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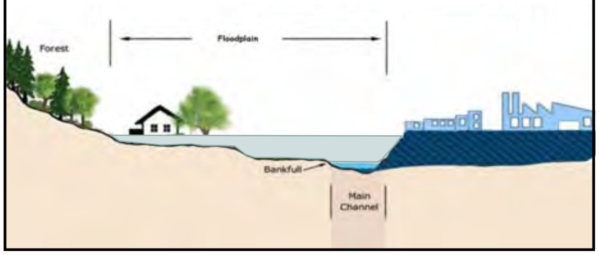
Today's Floodplains are not necessarily Tomorrow's floodplain

If large areas of the floodplain are filled, then there will be an increase in the land area needed to store flood waters. This means your home, farm, or business may be impacted.



When the channel is disconnected from the floodplain…

- Velocity and energy of Stream increases
- Erosion increases
- More damage to infrastructure from debris
- The flood stage is higher

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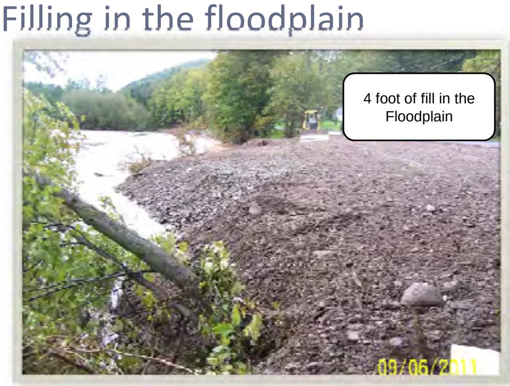
Filling in the floodplain



Development on the Floodplain

- Buildings
- Bridge approaches
- Roads
- Parking lots
- Etc.

When the floodplain is developed…

- More threat to life and property
- Velocity and energy increases
- Erosion increases
- More damage to infrastructure
- The flood stage downstream is higher
- Higher cost of flood damage
- Increased flood insurance

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Unstable Channels

Tom

General Channel Responses to Instabilities

- Instability progresses **downstream** when there is a change in local sediment supply
  - **Increased supply** (landslide or gravel rich tributary) results in deposition downstream
  - **Decreased supply** (as from a dam or concrete or heavy stone lined channel) results in downstream erosion

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General Channel Responses to Instabilities

- Instability progresses **upstream** when there is a change in local channel form
  - **An incised channel** (dredged or severely down-cut) results in bed erosion upstream
    - Usually in the form of a head-cut
  - **An aggraded channel** (as from a dam or overly wide) will result in deposition upstream

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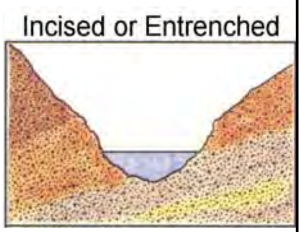
Incised or Entrenched Channels

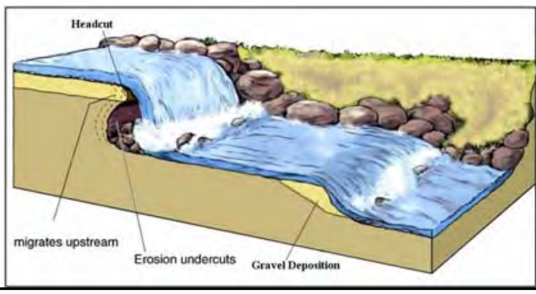
- Streams that cannot access their floodplain at the bankfull flow are said to be incised or entrenched
- Incised streams display high velocities & erosive forces during floods
- Incised streams are almost always unstable



After Rosgen 1996

Headcut Definition

- Instability that progress ***upstream*** and ***downstream*** from a local disturbance.



Headcut

Stream Table

Headcut

Headcut in Profile

Headcut & Floodplain Disconnect

Avulsion

Tom

Avulsions Definition

- Avulsions are where the stream is no longer in its original channel
- Is it …
  - A threat to water quality ?
  - A threat to property?
  - A better alignment?
- Is it possible to work with this new alignment?

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Avulsions

- Do **NOT** work if there is no immediate danger to property or necessary infrastructure
- *Notify the municipality and local SWCD that there is an avulsion*

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Avulsions

- Do work if property or infrastructure is in danger
- Ask for assistance from local SWCD or NYSDEC office
- If the repair must be made immediately
  - Bring the “new” bank up to the same elevation as the existing ground
  - Armor with large rocks if any are available
  - Notify local SWCD or NYSDEC office of the repair immediately
- *This repair will be temporary and will require careful monitoring*

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Platte Kill avulsion 2009

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Platte Kill avulsion 2011

West Brook avulsion 2006

West Brook avulsion 2011 - Realignment

Flood Response

Graydon

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Flood Response

- Immediate Priority Items
- High Priority Items
- Assessment
- Repair
- Documentation and Further Needs

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Immediate Priority

- *Immediate priority items are those facilities and infrastructure which need to be repaired and/or kept open in order that further recovery may be allowed to continue, or to prevent immediate loss of human life*

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Immediate Priority Items

- During or right after a flood some things must be done, including, but not necessarily limited to:
  - Opening clogged bridges
  - Opening closed roads
  - Keeping important installations functioning:

- Power Plants
- Fire Stations
- Rescue Centers
- Hospitals
- Water Wells & Systems
- Sewage Treatment Plants & Systems

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Flood Repair

"Emergencies" – obvious problems

- Bridges plugged
- Roads severely damaged/closed
- Buildings (especially inhabited buildings) endangered

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High Priority Items

- High priority items are those items that are necessary for the first part of the cleanup process
- This course concentrates on getting channels back into some acceptable condition
  - Open clogged channels
  - Put avulsed channels back in place
  - Stabilize actively eroding streambanks
  - Stabilize (even if only temporarily) landslides
  - *Return the channel to a condition such that the natural processes of streams can begin to return it to its natural state*

Assess the Stream Channels

- To decide where to work and where not to work
- To decide where to work first
- To identify the equipment and work force that will be required
- To identify reaches that require technical assistance

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Where to Work – Channel Problems

- Actively eroding high banks
  - Eroding bank is heading toward infrastructure or homes
  - High sediment load from eroding bank
  - Another "small flood" would "blow out" the bank
- Channel blocks
- Debris at culverts
- Undermined revetments
- Impaired channel capacity

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Actively eroding high banks

Channel Block

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Debris at a Culverts

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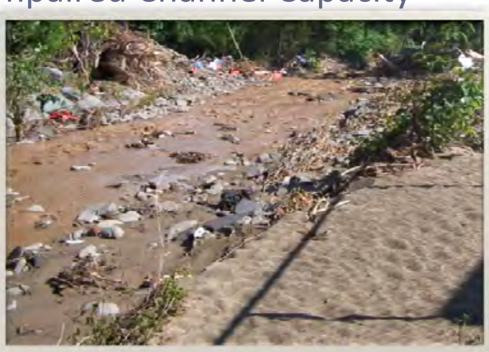
Undermined Revetment

- Revetment may become undermined due to:
  - Improper installation depth
  - Stream downcutting

Impaired Channel Capacity



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Where Not to Work

- The channel dimensions are ok, or there has been little damage
- Banks are stable
- The channel bottom is imbricated
  - The gravel is "shingled" and is difficult to move
  - Moving the gravel around loosens it and erosion at the reach and deposition downstream

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Caution – Steep Streams

- If the slope is over 4% the stream *will* probably be a step-pool system
- If the slope is 2-4% it *could* be a step-pool system
- If debris jam, remove debris
- Don't try and clean the channel except for gravel material or logs at a debris jam

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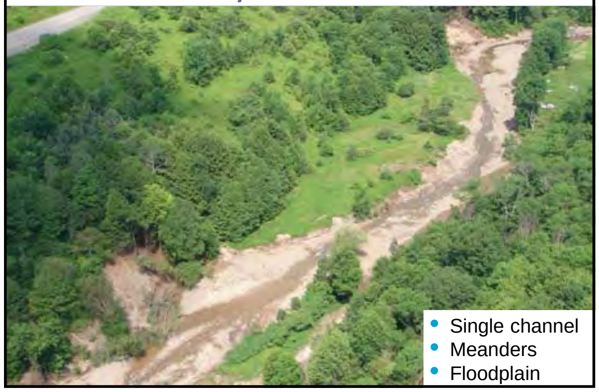
Would you work here?



- Single channel
- Meanders
- Floodplain

Would you work here?

- Single channel
- Some meander
- Stable banks

Is this what you would do here?

The lack of a floodplain will cause the stream to build one to maintain its natural functions.

This downstream adjustment created a head-cut upstream…

This slope was actively migrating as the stream continued to lower its bed to adjust its profile. This increased potential risk to those downstream.

Post-Flood Work

- Improper post-flood work can negatively affect:
  - Stream function
  - Stream stability
  - Aquatic habitat
  - Water quality
  - Local resources
- Improper post-flood work can add costs to future repair

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Understanding Imbrication

- As storm flows subside bed material overlap and become wedged together like shingles
- Caused by water velocity
- Materials are less mobile

Understanding Imbrication

Rearranging the bed & banks loosens the material and makes it more transportable

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Post-Flood Problem Itemization Sheet

- This is located in **Appendix A** in Training Manual
- It lists problems commonly found after a flood
- Use a sheet for each stream reach
- Check off problems; add any notes/sketches that are necessary
- Customize the sheet to suit your needs
- Photos should be taken during the assessment

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Post-Flood Problem Itemization Sheet

- The advantages to using the sheet are:
  - Identify the location, number & types of problems on each reach
  - Identify the most severely impacted reaches (keep in mind that some streams or reaches may not be impacted at all)
  - Prioritize work on the most severely impacted reaches
  - Determine manpower & equipment needs
  - Revision of priorities may be required throughout assessment period

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Post-Flood Problem Itemization Sheet

- The sheets can serve as a record:
  - That can document work done for state or federal reimbursement
  - This document can be attached to a permit application as additional information
  - To document work done under an emergency permit

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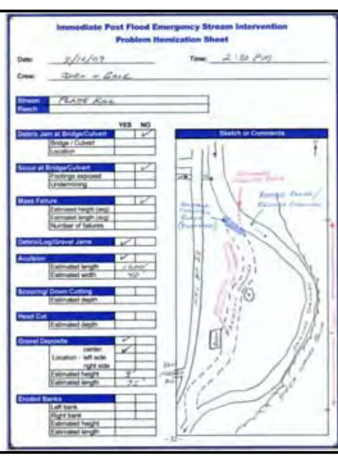

Immediate Post Flood Emergency Stream Intervention
Problem Itemization Sheet

Date:

Time:

Crew:

Stream

Reach

	YES	NO
Debris Jam at Bridge/Culvert		✓
Bridge / Culvert		
Location		
Scour at Bridge/Culvert		✓
Footings exposed		
Undermining		
Mass Failure		✓
Estimated height (avg)		
Estimated length (avg)		
Number of failures		
Debris/Log/Gravel Jams	✓	
Avulsion	✓	
Estimated length		
Estimated width		
Scouring/ Down Cutting		
Estimated depth		
Head Cut		
Estimated depth		
Gravel Deposits	✓	
Location - center	✓	
Location - left side		
Location - right side		
Estimated height		
Estimated length		
Eroded Banks		
Left bank		
Right bank		
Estimated height		
Estimated length		

Sketch or Comments

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Further Documentation

- Recommended documentation during construction:
  - Before & After photos
  - Description of the work
    - Date
    - Time
    - Equipment
    - Material
    - Labor Force

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Further Documentation

- Post Construction Review
  - Was the work performed satisfactorily & completely, and meet the needs identified on the Post-Flood Problem Itemization Sheet?
- Contact local SWCD or NYSDEC offices for assistance with:
  - Vegetation
  - Structures
  - Long Term Monitoring

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Channel Sizing

Tom

Bankfull Flow

- Bankfull flow is the channel forming discharge

"The bankfull stage corresponds to the discharge at which the channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing the work that results in the average morphologic characteristics of the channel."

Dunne and Leopold, 1978

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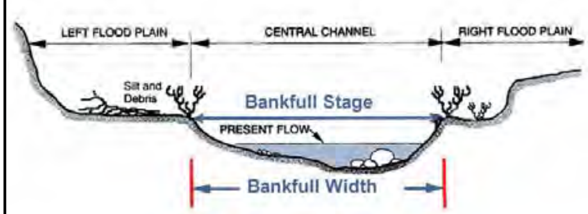
Bankfull Flow



Adapted from Newbury & Gaboury, 1993

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Channel Forming Discharge

- Channel forming discharge, effective discharge, & bankfull all have the same meaning
- In Delaware County the channel forming discharge is approximately equal to the 1.5 year storm
- The regional curves that give information about the size of the channel are based on the bankfull or channel forming discharge

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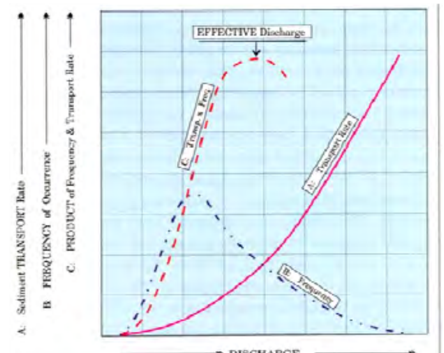
Effective Discharge

How the stream is created and maintained



After Wolman and Miller, 1960

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Using an Existing Stable Reach

- Use of the tables may not be required
- A relatively undamaged reach may exist either upstream or downstream
- Measure the undamaged reach **AT A RIFFLE** & duplicate it in the damaged reach (draw a sketch)
  - Bankfull width and depth, floodplain width, bottom width, meander curve radius, and stream slope
- Call your local SWCD or NYSDEC office for assistance

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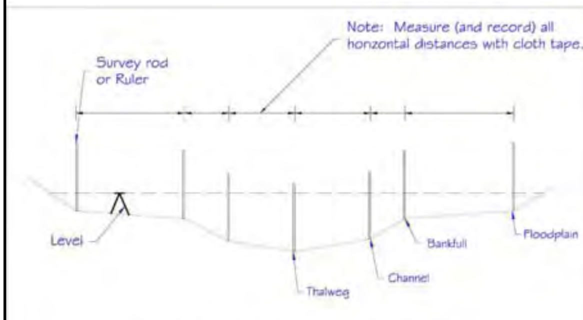
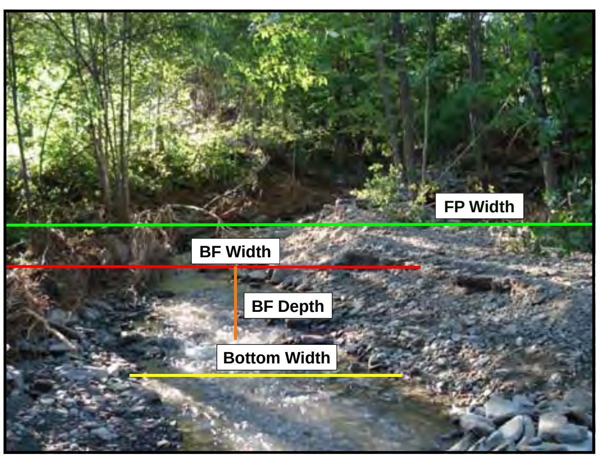
Using an Existing Stable Reach



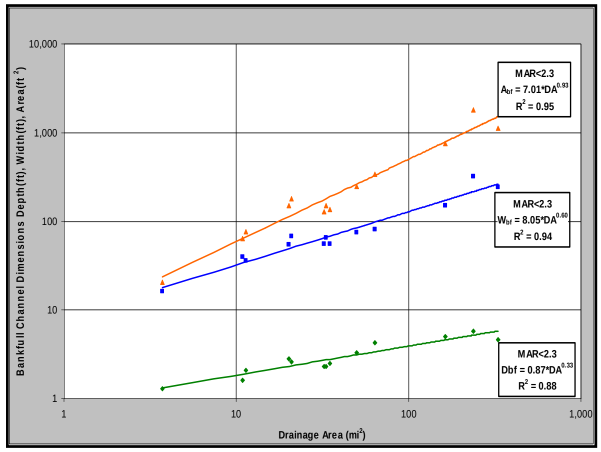
Points to measure on a stable riffle cross section

142



Regional Curves

- Based on USGS Data
- Information given is based on Drainage Area
- Represents the size & cross section of natural streams in this region
- Dimensions given – Bankfull Dimensions
  - Cross sectional area
  - Bankfull top width
  - Average bankfull depth (mean depth)



Regional Curves

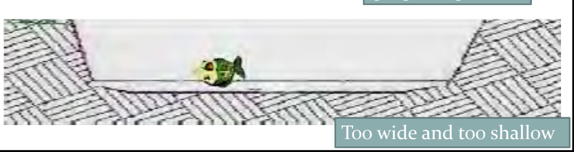
- After a flood the channel dimensions have often been changed – **too big** or **too small**
- Sometimes it is difficult to determine the original size of the stream
- Use the Regional Curves to get reasonable bankfull dimensions

Regional Curves

- Proper width and depth are important
- For hydraulics
  - Sized to carry the bankfull flow
  - Moves the proper size and amount of sediment
  - Avoids erosion
  - Avoids deposition
- For the environment

Regional Curves

- Channel dimensions and aquatic habitat



Find Bankfull Channel Dimensions

- Tables have been provided that give the suggested **construction dimensions** in the Training Manual
- You need to know –
  - The drainage area at your site (square miles)
  - What basin you are in

What is a Drainage Area?

The drainage area is the area of the watershed that flows to the point that you are working.

Find Bankfull Channel Dimensions

- Drainage Area can be found:
  - Static maps for New York State are being developed
  - Streamstats New York:
    http://water.usgs.gov/osw/streamstats/new_york.html
  - Instructions for use are on the left side of the webpage. Click on State Applications to access New York
    - See **Appendix D** for the version that is up and running now
  - Streamstats New York will provide regional curve data that can be used with the tables provided to generate construction dimensions

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Classroom Examples

Gale

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Classroom Example #1 (page 24)

- Flooding has occurred in Woodhull, NY in the south Branch of Tuscarora Creek and repair work is needed on a small stretch of stream. There is a bridge ¼ mile downstream of the affected area with a drainage area of 19.6 square miles.

- Find the following:
  - Bankfull width
  - Bankfull depth
  - Bankfull area
  - Floodplain width

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1. Find the Drainage Area (D.A.)

- Drainage area at the bridge is 19.6 square miles
  - Use the appropriate Regional Bank-full Hydraulic Geometry Table from Appendix C
  - Use 20.0 square miles

155

2. Select the Proper Table (Appendix C)

- There is a table for each of the Hydrologic Regions in New York State

- Woodhull is located in the Southern Tier Region

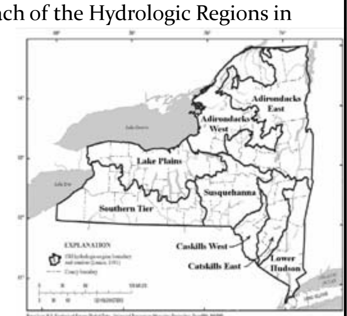


Figure 3.7 Hydrologic Regions in New York State

3. Find the Construction Dimensions

- Enter the table at the correct D.A. in the left hand column
- Read across & note the construction dimensions

Southern Tier Region

Bank Full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

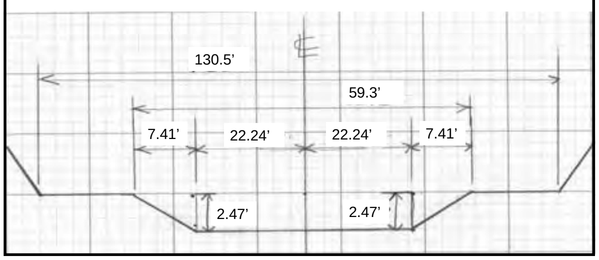
DA (sq. mile)	Bank-Full Area (sq. ft)	Bank-Full Width (ft)	Bank-Full Depth (ft)	Construction Dimensions					
				channel side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1.0	17.60	16.90	1.04	3:1	1.38	4.13	4.32	16.90	37.18
2.5	32.28	24.81	1.30	3:1	1.62	4.85	7.56	24.81	54.58
5.0	51.08	33.17	1.54	3:1	1.85	5.55	11.04	33.17	72.98
7.5	66.80	39.31	1.70	3:1	2.01	6.02	13.63	39.31	86.49
10.0	80.82	44.35	1.82	3:1	2.13	6.39	15.78	44.35	97.57
12.5	93.68	48.70	1.93	3:1	2.23	6.70	17.65	48.70	107.13
15.0	105.70	52.56	2.01	3:1	2.32	6.96	19.32	52.56	115.64
17.5	117.06	56.07	2.09	3:1	2.40	7.20	20.84	56.07	123.35
20.0	127.88	59.30	2.16	3:1	2.47	7.41	22.24	59.30	130.45

Answer to Example #1

- Bankfull width = 59.30 ft.
- Bankfull depth = 2.16 ft.
- Bankfull area = 127.88 $ft.^2$
- Floodplain width (FP) = 130.45 ft.

Classroom Example #1

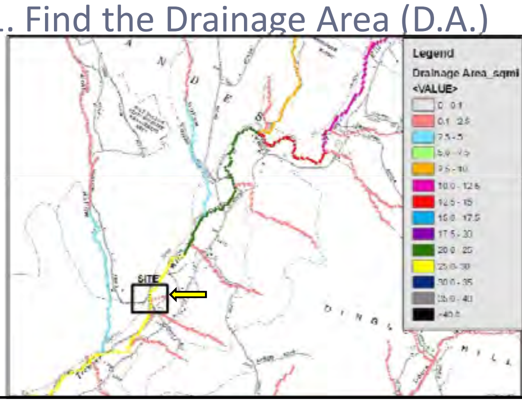
- It is highly recommended that you prepare a sketch of the proposed cross section to use during stake out & construction



Classroom Example #2 (page 25)

- Flooding has occurred in Andes, NY on a portion of the Tremper Kill stream near Wolf Hollow Road.
- Find the following:
  - Drainage Area
  - Construction Dimensions

1. Find the Drainage Area (D.A.)



1. Find the Drainage Area (D.A.) Cont.

- On the map, the reach is coded YELLOW
- The key tells us that this is between 25-30 square miles
- Wolf Hollow road intersection is near the upper end of the reach – use 25 square miles

2. Select the Proper Table (Appendix C)

- There is a table for each of the Hydrologic Regions in New York State
- Andes is located in the Catskill West Region

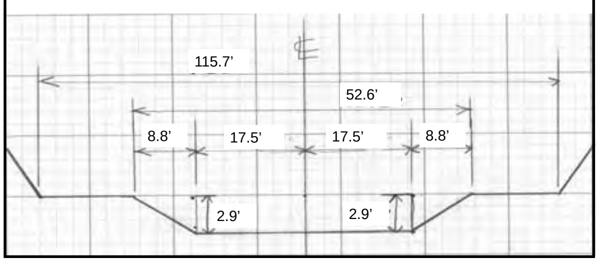
3. Find the Construction Dimensions

- Enter the table at the correct D.A. in the left hand column
- Read across & note the construction dimensions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1	7.2	9.1	0.8	2:1	1.0	2.1	2.5	9.1	20.0
2.5	16.3	15.0	1.1	3:1	1.6	4.8	2.7	15.0	33.0
5	30.4	21.9	1.4	3:1	1.9	5.6	5.3	21.9	48.1
7.5	43.6	27.3	1.6	3:1	2.1	6.2	7.4	27.3	60.0
10	56.4	31.9	1.8	3:1	2.2	6.7	9.2	31.9	70.2
12.5	68.9	36.0	1.9	3:1	2.4	7.2	10.9	36.0	79.3
15	81.1	39.8	2.0	3:1	2.5	7.5	12.4	39.8	87.6
17.5	93.0	43.3	2.2	3:1	2.6	7.9	13.8	43.3	95.3
e20	104.8	46.6	2.3	3:1	2.7	8.2	15.1	46.6	102.5
22.5	116.5	49.7	2.3	3:1	2.8	8.5	16.3	49.7	109.2
25	128.0	52.6	2.4	3:1	2.9	8.8	17.5	52.6	115.7
27.5	139.3	55.4	2.5	3:1	3.0	9.0	18.7	55.4	121.9
30	150.6	58.1	2.6	3:1	3.1	9.3	19.8	58.1	127.8

Classroom Example #2

- It is highly recommended that you prepare a sketch of the proposed cross section to use during stake out & construction



Work Methods

Graydon

Limiting Gravel Removal

- Do **NOT** remove gravel to such a depth that the channel is disconnected from the floodplain
- Do **NOT** remove point bars
  - Removing them may increase deposition & destabilize the system
  - If you think a point bar has grown too large ask for advice from local SWCD or NYSDEC

Limiting Gravel Removal

- Generally, center bars & side bars can be safely removed
- Do **NOT** over excavate or over-widen
- If the center bars & side bars are **NOT** a product of the flood leave them alone. You have more important things to do

Reconnecting to the Floodplain

- The provided tables give you the dimension for the floodplain
- The elevation of the floodplain is at the bankfull elevation
- The channel is automatically reconnected to the floodplain
- If there is not enough room available for the recommended width, make the floodplain as wide as you can

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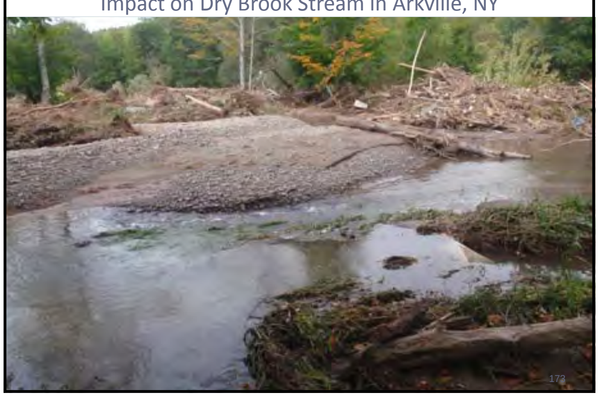
Due to the lack of room, there is floodplain on one side of the channel only

2011 Hurricane Irene

Impact on Dry Brook Stream in Arkville, NY



Root Wads

- Root wads can be used to stabilize the streambank
- Use debris trees that are conveniently located nearby
- The bottom of the root ball should be below the channel grade
- Brace with boulders or other large logs

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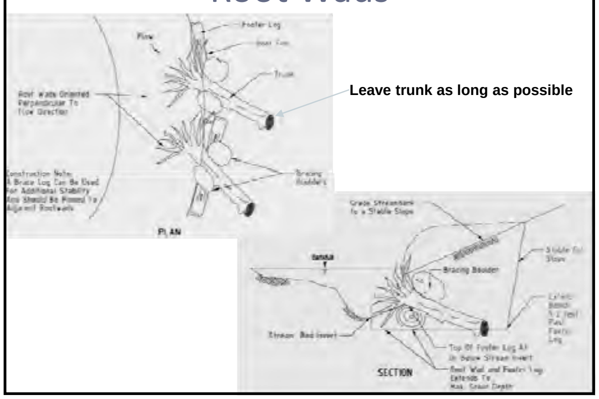
Root Wads



Root wads were placed in two layers with large rocks to hold them in place.

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Vegetation

- Vegetation holds the streambanks together
- For emergency work, there is no time to plant trees and shrubs
- Grass will provide short term stability and prevent fine sediment runoff
- Seed and mulch or hydroseed (this will be a NYSDEC permit condition)

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Vegetation

- After repair if there is an absence of woody vegetation on the banks inform local SWCD, NYSDEC, and the local municipality
- A proper vegetation plan can be designed & implemented later

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De-watering

Graydon

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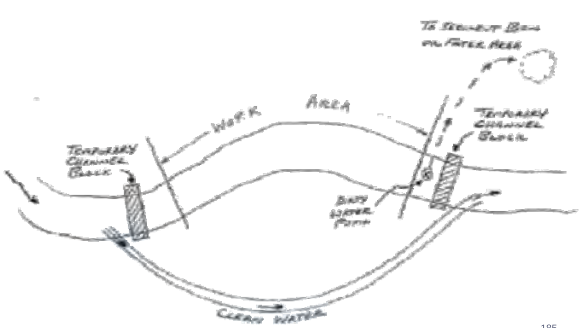
Must isolate the work area

General Work Area Schematic



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De-watering – Avulsion

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De-watering – Avulsion

De-watering – Point Bar

Diversion – General Rules

- Place the barrier as close to the work area as possible without interfering with the operations
  - This maximizes area open to flow
- Plan the staging of your barrier – minimize the number of times the barrier will have to be moved
- The ends of the barrier will have to tied in to the bank or placed high enough so that they cannot be outflanked by the water

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Diversion – Barrier

Pumping Around

Pumping Around

- Generally only done on small streams
  - Dave Post farm (DA = 3 mi²)
    - Planned on pumping 5 cfs
    - Actually pumped 15 cfs
- May be done on short term projects during known periods of low flow
  - Combination of bypass and pumping

Pump Capacities

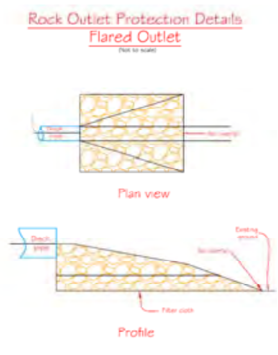
Pump Size	Max Capacity CFS	Max Capacity GPM
2"	0.5	216
3"	0.7	300
4"	1.6	700
6"	4.5	2000
8"	7	3200
10"	7.8	3500
12"	10	4500

Source: Godwin Pump, CD Series Dri-Prime

Pumping Around

- Place the pipe outlet at a well vegetated area
- Construct the energy dissipater
- Check frequently to be sure that the device is working and that no erosion is occurring
- Clean water in sheet flow enters the stream – *only!*

Pump Outlet Protection



- Leave rock loose and "jumbled"
- Adjust elevation of pipe if necessary
- Add rock and cloth if necessary
- *Intent is to induce sheet flow and avoid erosion*

Diversion or Pumping Around

- No turbid water may leave the site
- Cause no erosion
- Check your operation often!
- If have any problems, **stop and repair at once!**

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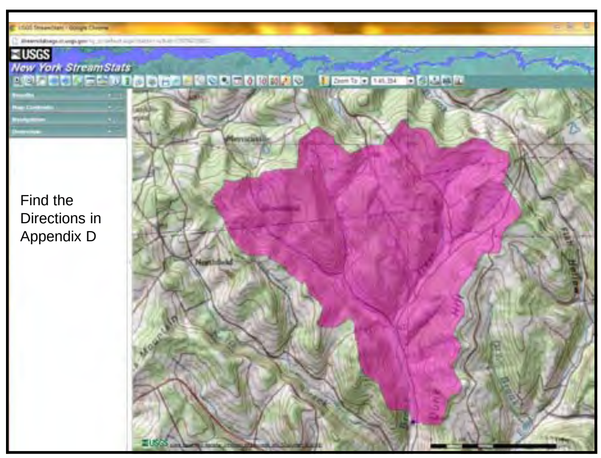
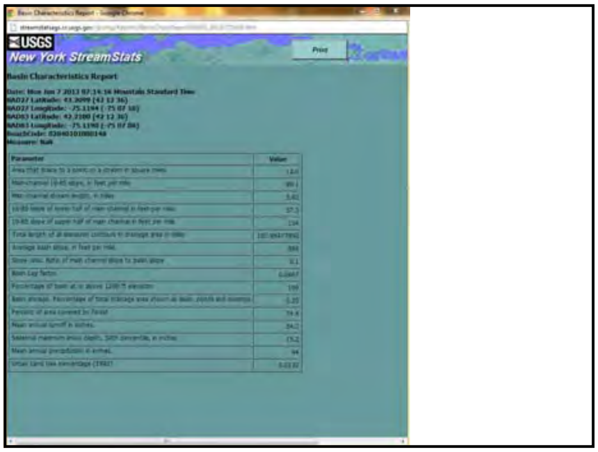
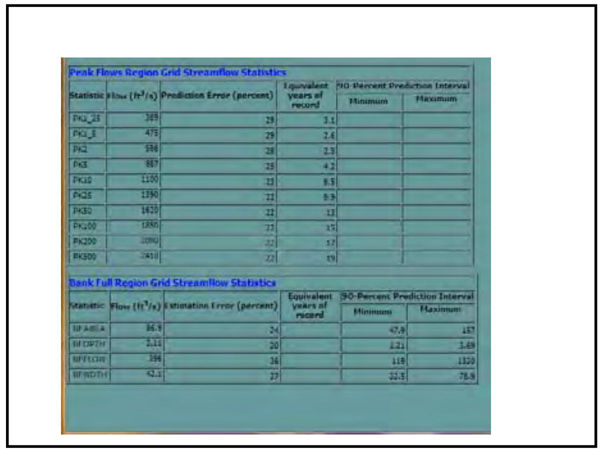
Project Sites

Gale

West Brook – Before





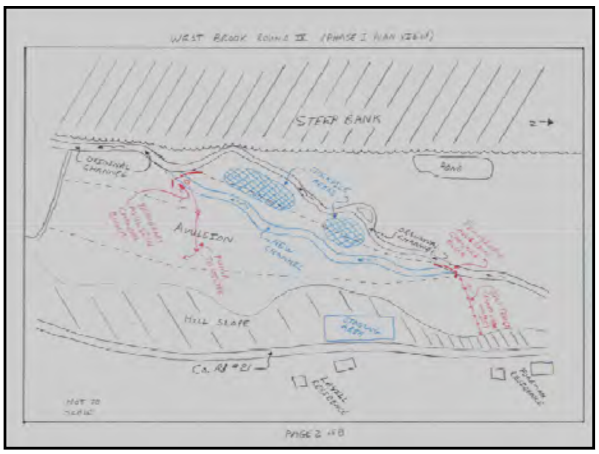


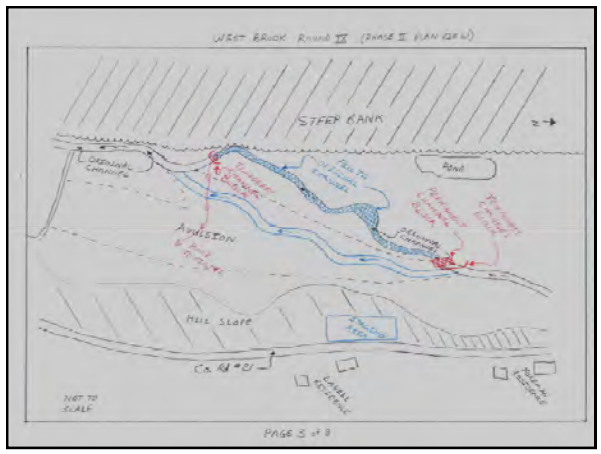
Peak Flows Region Grid Streamflow Statistics

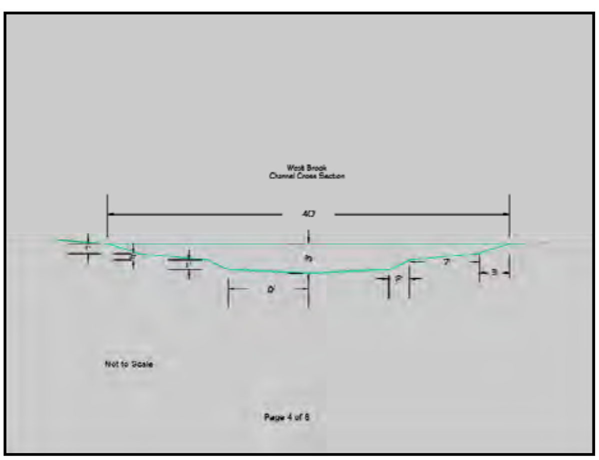
Statistic	Flow (ft³/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval Minimum	90-Percent Prediction Interval Maximum
PK1_25	389	29	3.1		
PK1_5	475	29	2.6		
PK2	586	28	2.3		
PK5	867	25	4.2		
PK10	1100	23	6.5		
PK25	1390	22	9.9		
PK50	1620	22	13		
PK100	1850	22	15		
PK200	2090	22	17		
PK500	2410	22	19		

Bank Full Region Grid Streamflow Statistics

Statistic	Flow (ft³/s)	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval Minimum	90-Percent Prediction Interval Maximum
BFAREA	86.9	24		47.9	157
BFDPTH	2.11	20		1.21	3.69
BFFLOW	396	36		119	1320
BFWDTH	42.1	27		22.5	78.9

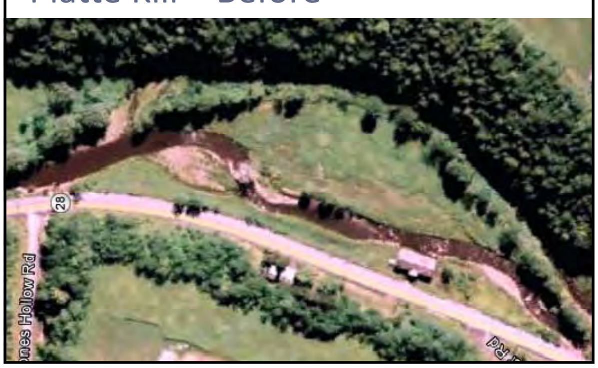


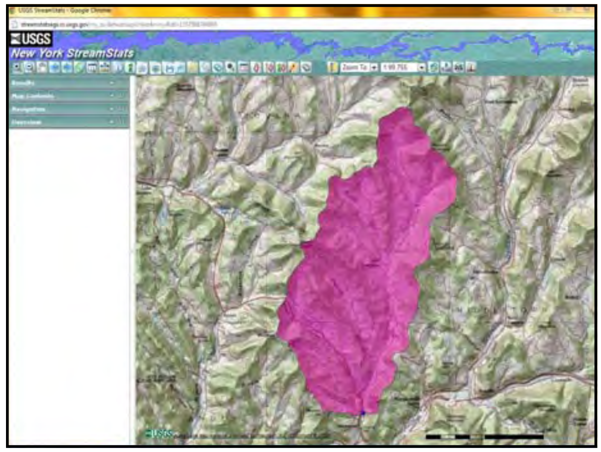


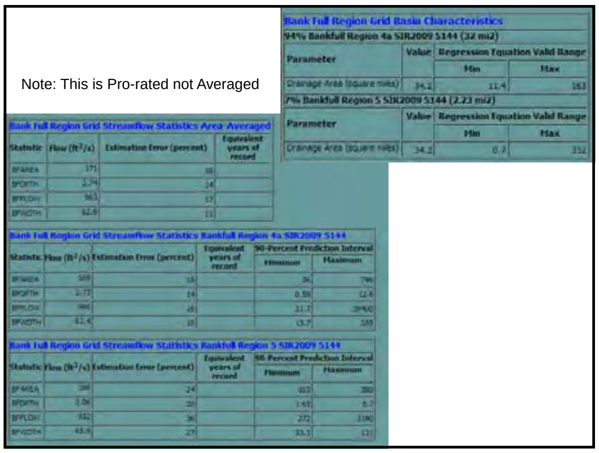


West Brook – After

Platte Kill – Before







Note: This is Pro-rated not Averaged

Bank Full Region Grid Basin Characteristics

94% Bankfull Region 4a SIR2009 5144 (32 mi2)

Parameter	Value	Regression Equation Valid Range Min	Regression Equation Valid Range Max
Drainage Area (square miles)	34.2	11.4	183

7% Bankfull Region 5 SIR2009 5144 (2.23 mi2)

Parameter	Value	Regression Equation Valid Range Min	Regression Equation Valid Range Max
Drainage Area (square miles)	34.2	0.7	332

Bank Full Region Grid Streamflow Statistics Area-Averaged

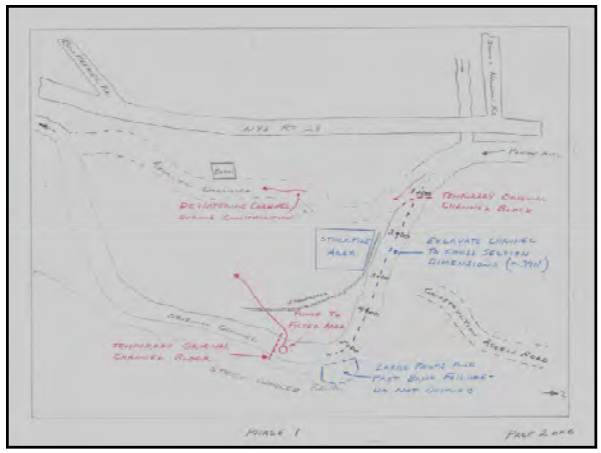
Statistic	Flow (ft^3/s)	Estimation Error (percent)	Equivalent years of record
BFAREA	171	18	
BFDPTH	2.74	14	
BFFLOW	963	17	
BFWDTH	62.6	11	

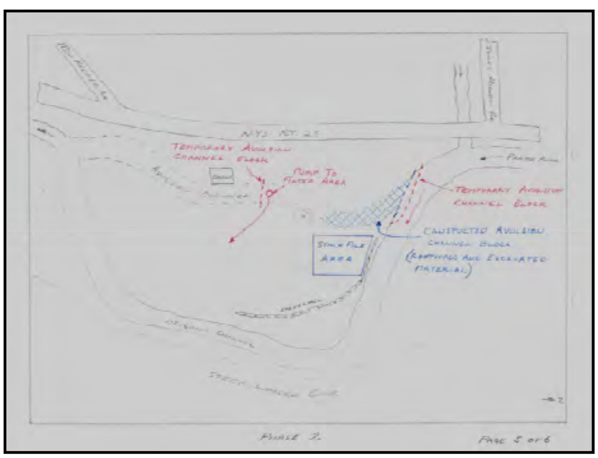
Bank Full Region Grid Streamflow Statistics Bankfull Region 4a SIR2009 5144

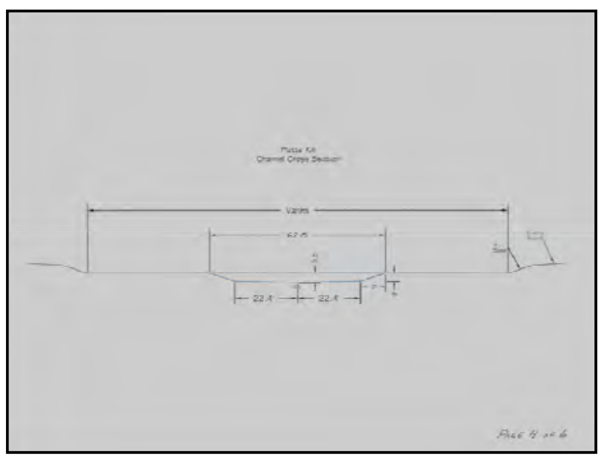
Statistic	Flow (ft^3/s)	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval Minimum	90-Percent Prediction Interval Maximum
BFAREA	169	13		36	796
BFDPTH	2.72	14		0.59	12.6
BFFLOW	986	16		31.7	2900
BFWDTH	62.4	15		15.7	155

Bank Full Region Grid Streamflow Statistics Bankfull Region 5 SIR2009 5144

Statistic	Flow (ft^3/s)	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval Minimum	90-Percent Prediction Interval Maximum
BFAREA	198	24		103	380
BFDPTH	3.06	20		1.65	5.7
BFFLOW	932	36		272	3190
BFWDTH	65.9	27		33.1	131

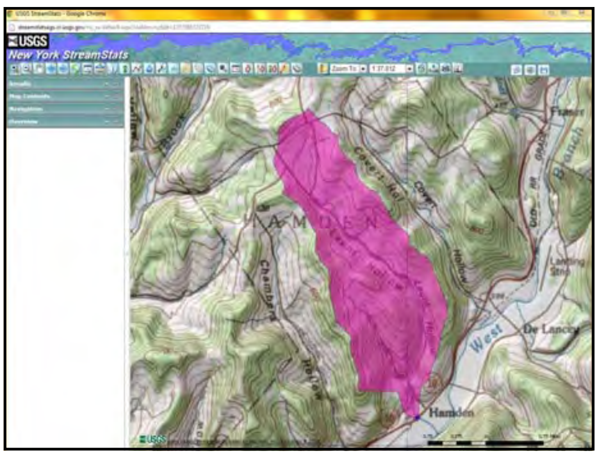


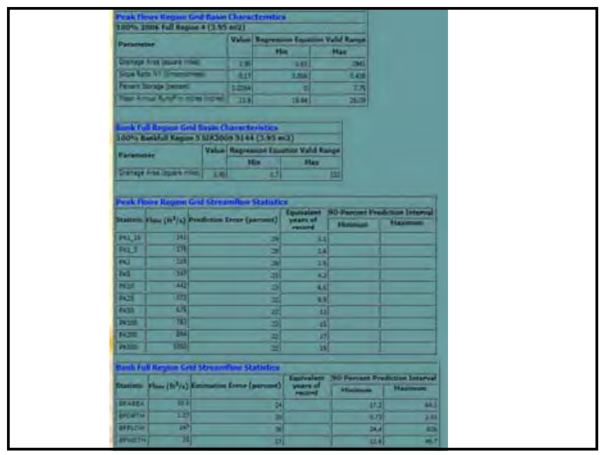




Platte Kill – After

Launt Hollow – Before





Peak Flows Region Grid Basin Characteristics
100% 2006 Full Region 4 (3.95 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Bank Full Region Grid Basin Characteristics
100% Bankfull Region 5 SIR2009 5144 (3.95 mi2)

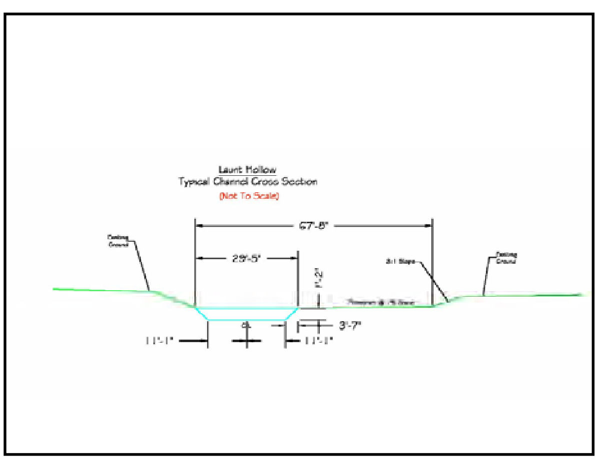
Parameter	Value	Regression Equation Valid Range	
		Min	Max
[illegible]	[illegible]	[illegible]	[illegible]

Peak Flows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]		

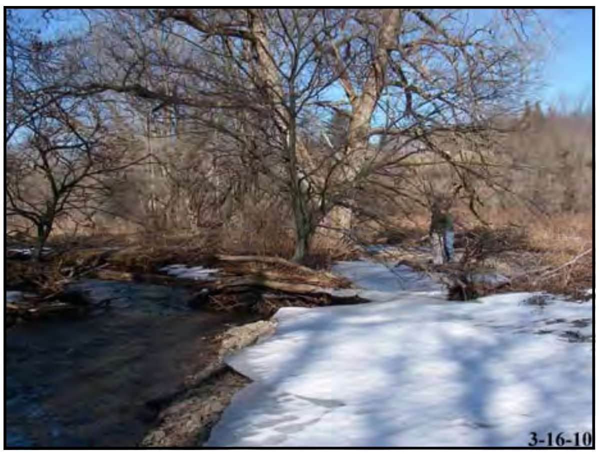
Bank Full Region Grid Streamflow Statistics

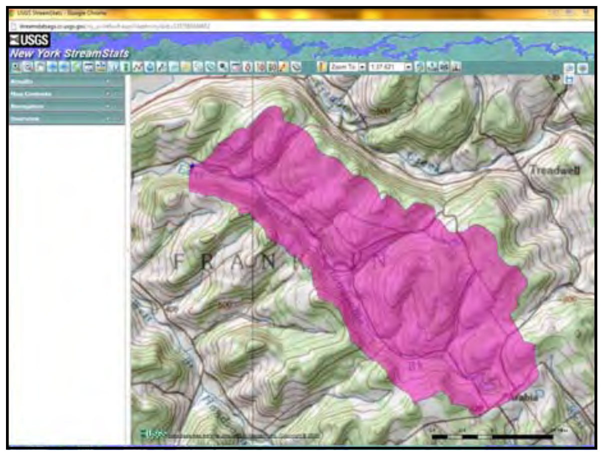
Statistic	Flow (ft^3/s)	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]

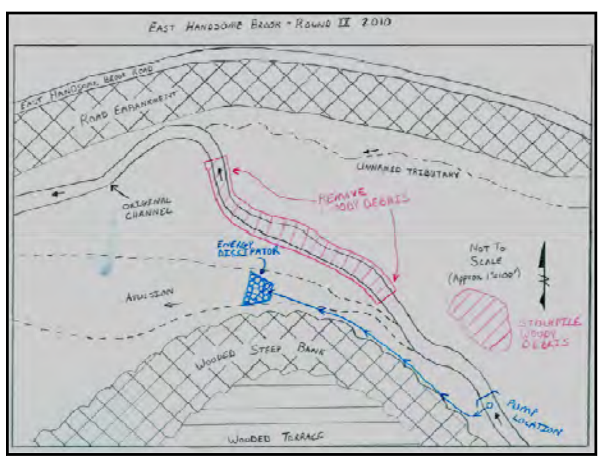


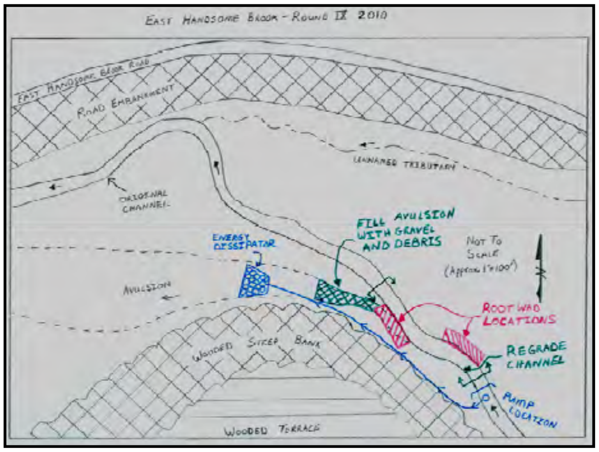
Launt Hollow – After

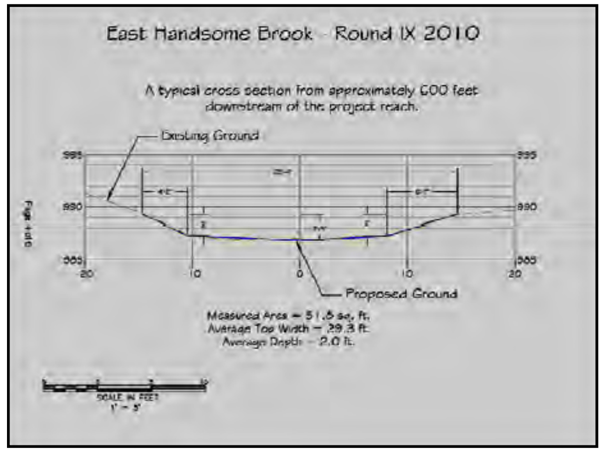
East Handsome Brook – Before








East Handsome Brook - Round IX 2010
East Handsome Brook Road
Road Embankment
Unnamed Tributary
Original Channel
Energy Dissipator
Fill Avulsion with Gravel and Debris
Not To Scale (Approx 1"=100')
Avulsion
Root Wad Locations
Regrade Channel
Wooded Steep Bank
Pump Location
Wooded Terrace


East Handsome Brook - Round IX 2010
A typical cross section from approximately 600 feet downstream of the project reach.
Existing Ground
Proposed Ground
Measured Area = 51.5 sq. ft.
Average Top Width = 29.3 ft.
Average Depth = 2.0 ft.
SCALE IN FEET


08-10-10


08-09-10


08-10-10


08-11-10

East Handsome Brook – After

Bioengineering Techniques

For Future Site Mitigation

Graydon

List of Bioengineering Techniques

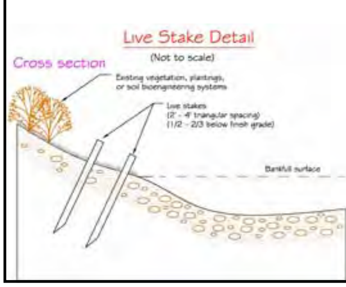
- Live Willow Stake
- Rip-rap Joint Planting
- Coconut Fiber Roll
- Live Fascine
- Brush Mattress
- Brush Layering
- Vegetated Geogrid
- Live Cribwall

Multiple techniques are often used together to produce a final solution.

* Reference: Details and pictures are from U.S Department of Agriculture Forest Service – A Soil Bioengineering Guide: for Streambank and Lakeshore Stabilization

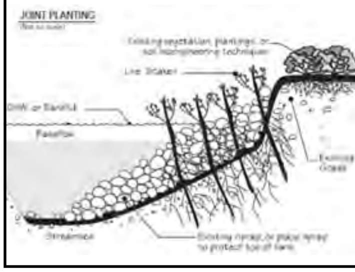
Live Willow Stakes

The placement of dormant woody plant cuttings into the bank as a method of stabilization by the root and above ground growth.



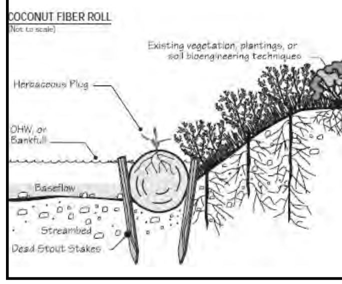
Rip-rap Joint Planting

Disguises and shades riprap, provides habitat and adds additional stabilization to streambank. Can be installed in open spaces between existing rocks or when rock is being placed. Material should be 1.5 inches or larger in diameter.



Coconut Fiber (Coir) Roll

Used on hillsides and low-gradient streams and waterbodies to protect the slope and toe. Can conform to bank contour and allows plants to grow in it.

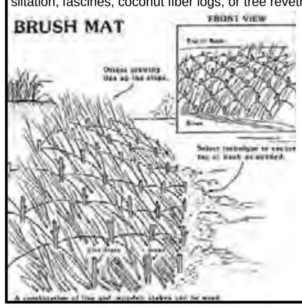


Live Fascine Placement

Bundles of live branches placed in trenches on the streambank to protect the toe of streambank, trap sediment, reduce slope steepness, and slow surface erosion.

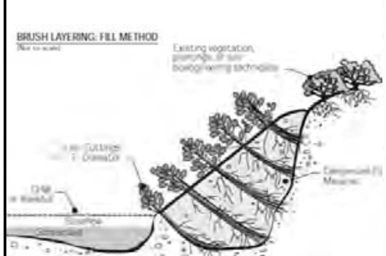
Brush Mattress

A layer of dormant branches laid on and secured to a bank surface offering an immediate bank coverage. Typically, it is combined with a toe stabilizing technique such as rock, root wads, live siltation, fascines, coconut fiber logs, or tree revetments.



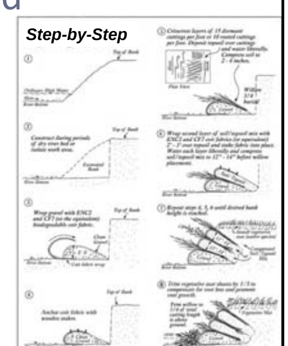
Brush Layering

Laying vegetative cuttings on horizontal benches that follow the contour of either an existing or filled bank (slope).



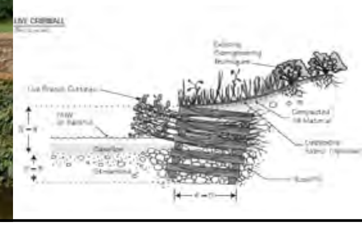
Vegetated Geogrid

Similar to Brush Layering plus erosion control fabric to wrap the soil between the layers. Live cuttings are placed between the geogrids, and a root structure is established to bind the soil within the geogrid. Can be used on severely eroded slopes up to 8 feet in height where the bank cannot be pulled back to a gentle slope.

Crib Wall

A live crib wall is used to rebuild a bank in a nearly vertical setting, but can also be tiered to create a less steep slope. It consists of a boxlike interlocking arrangement of untreated log or timber members. The structure is filled with rock at the bottom and soil beginning at the ordinary high-water mark or bankfull level. Layers of live branch cuttings root inside the crib structure and extend into the slope.



Hydraulic Structures

For Future Site Mitigation

Tom

- These structures are made of rocks or logs
  - Cross vanes
  - Straight vanes
  - J-hooks
  - Step-pools
  - Hardened Riffles
- If you think you need to install one or more of these contact your local SWCD or NYSDEC office for assistance

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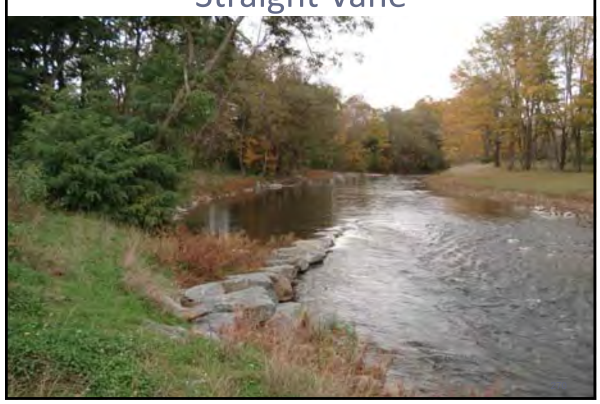
Cross Vane

Straight Vane



J-Hook

Step-pool

Hardened Riffle

Hardened Riffle

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Questions?

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