

# Stream Smart Costs & Benefits

That's great, but is it  
worth it??



# Vermont - Hurricane Irene

- 8/2011: 1,000+ culverts damaged or destroyed
- Major storm not a design storm.
- But still, Stream Smart culverts on Green Mountain National Forest fared far better.



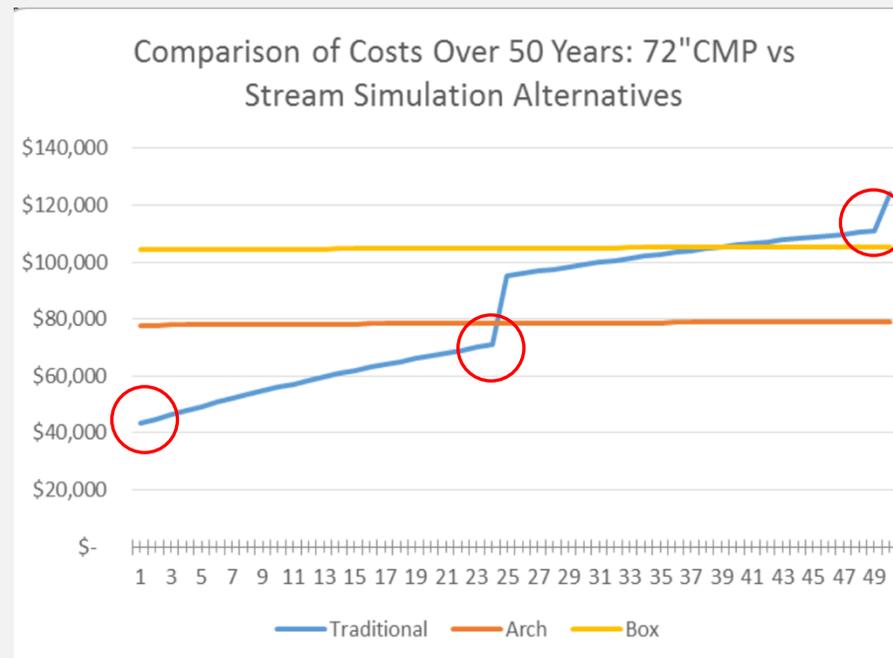
Photo: Dan McKinley, GMNF

# Upfront costs v. Long-term costs

“In addition to their ecological benefits, ecological design culverts could have lower fiscal costs than hydraulic culverts because of increased flood resiliency and reduced debris accumulation, which in turn reduce the need for periodic maintenance and replacement.” *Fisheries 2017*

On average, upgrade of the 3 culverts in the study was **38% less expensive** than in-kind replacement and maintenance over 30 years.

“Economic and Community Benefits from Stream Barrier Removal Projects in Massachusetts” 2015. Dept. of Ecological Restoration





# Stream Smart Solutions

24' concrete arch  
58' bridge

State Road



# Stream Smart Solutions

8' CMP  
24' open bottom CM arch

Rural Local Road





# Stream Smart Solutions

3' metal pipe  
18' span on modular  
concrete blocks



Private Forest Road



## What makes a solution Stream Smart?

12' "pipe arch"  
26' concrete arch

- Passes fish and other organisms
- Passes sediment & woody material
- Maintains natural channel characteristics



# Key Steps in Designing Stream Smart Crossings



**The Golden Rule:  
Let the stream act like a stream**

# Stream Smart Options by Preference

- 1) **Avoid** creating a crossing
- 2) **Remove** the crossing
- 3) **Open bottom** structure that spans the channel
  - Bridge
  - Bottomless / 3-sided box culvert
  - Arch culvert
- 4) **Embedded** culvert

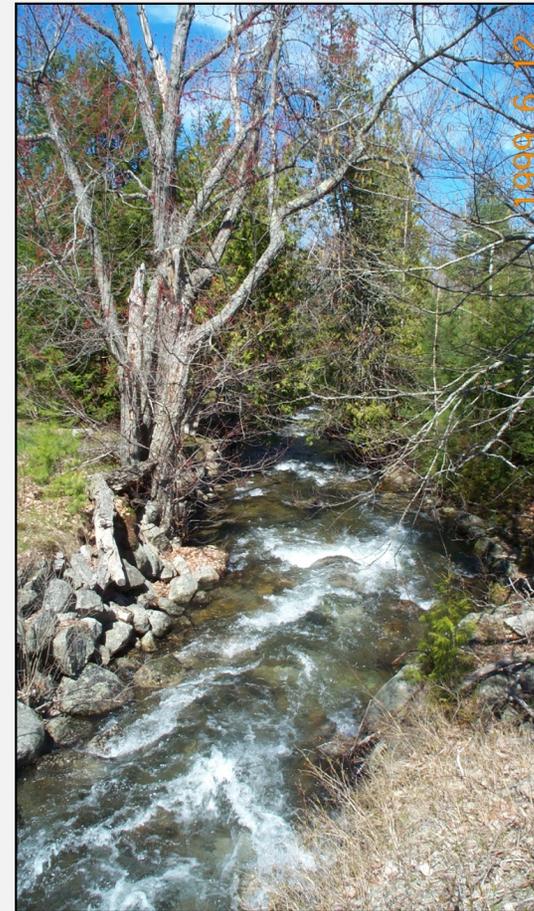
# Rules of Thumb

**Span the stream width**

**Set the elevation right**

**Slope & skew match stream**

**Substrate in the crossing**



# Field Survey & Assessment

- **Stream Profile**

- Bed elevations
- Reach Slope
- Scour potential
- Footer depth
- Road /structure height

- **Cross Sections**

- Bankfull width, depth
- **Substrate** characterization
  - Stream bed material size
  - Key features



# Field Survey & Assessment

## Bankfull Width:

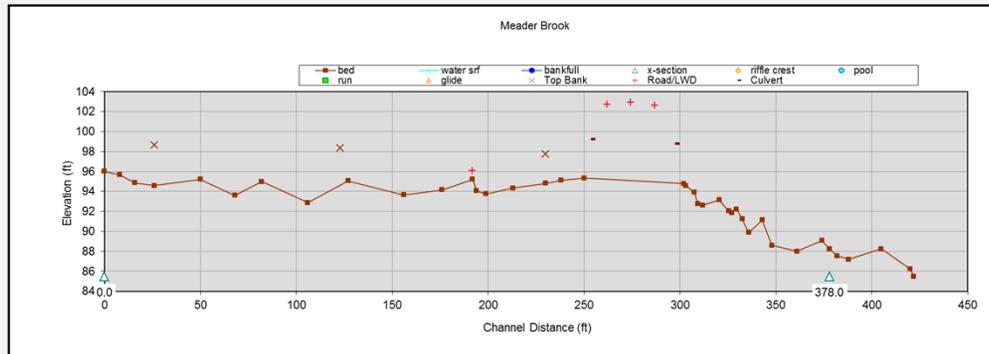
- Width of natural channel before it floods
- Approximate dominant channel-forming flow
- Measure upstream and downstream of crossing in an **Undisturbed** location, and average measurements



# Field Survey & Assessment

## Stream Profile

determines elevations and slope

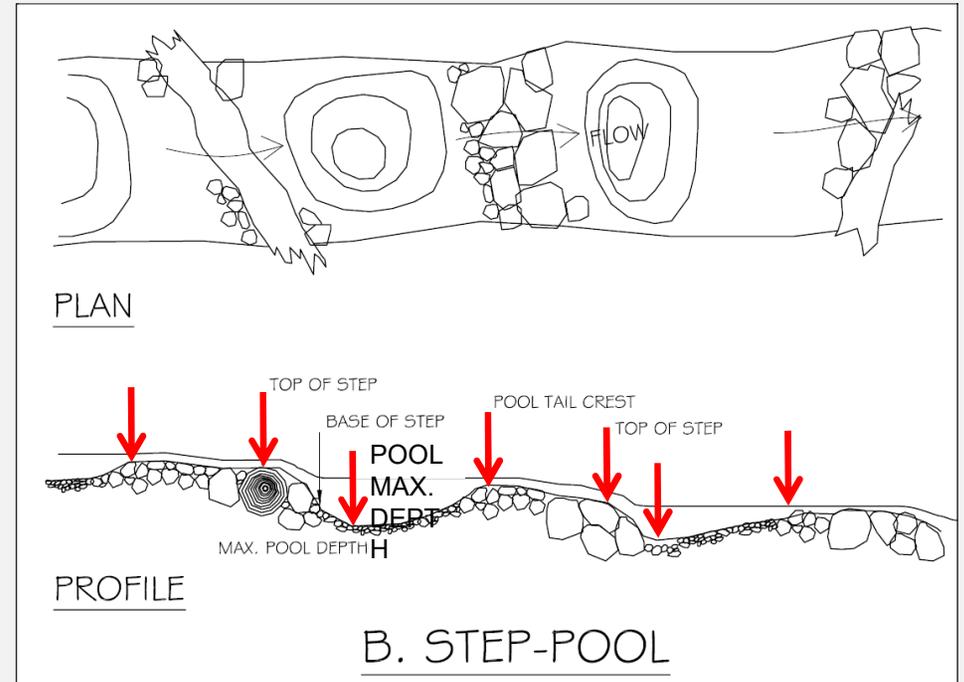
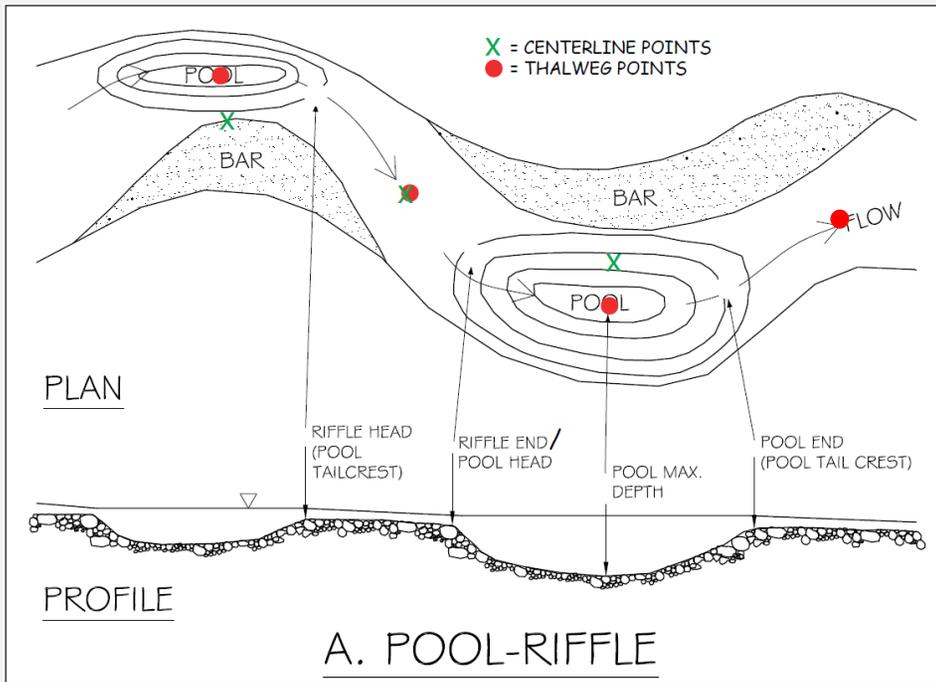


Measure ***well up and downstream*** from existing crossing - 20-30 times the width of the stream in distance

*10' wide stream = 400-600' profile  
(longer if possible!)*

# Field Survey & Assessment

## Stream Profile

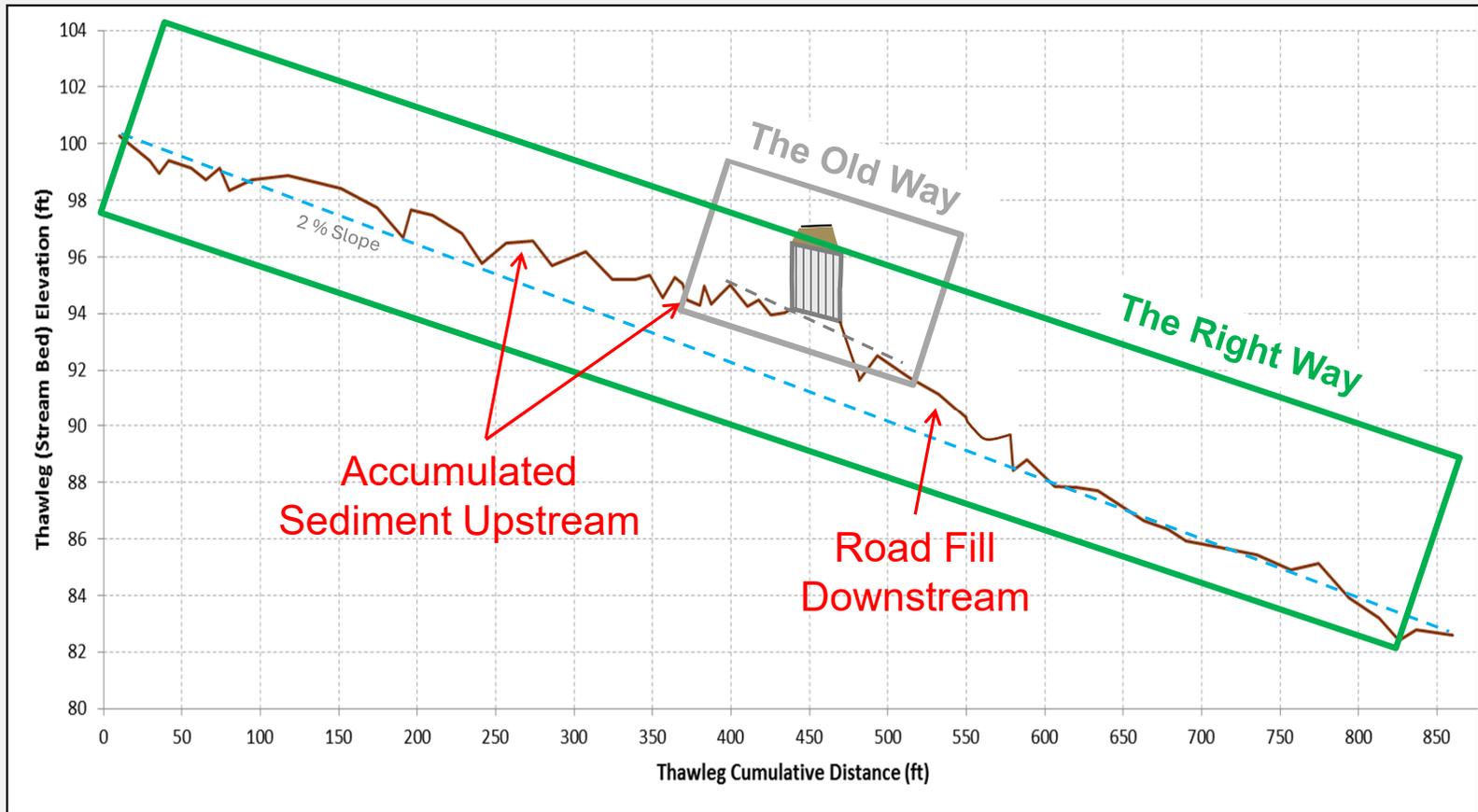


[http://www.fs.fed.us/eng/pubs/pdf/StreamSimulation/lo\\_res/Chapter5a.pdf](http://www.fs.fed.us/eng/pubs/pdf/StreamSimulation/lo_res/Chapter5a.pdf)

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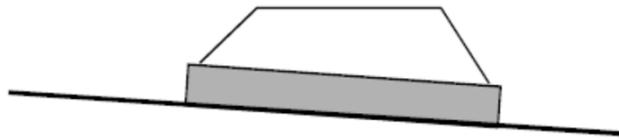
# Field Survey & Assessment

## Stream Profile

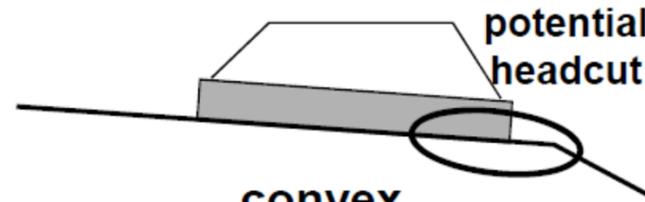


## Channel Slope Considerations: Longitudinal Profile Shapes, Assessment

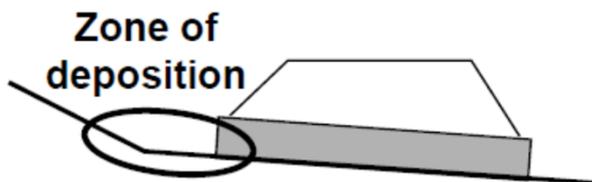
ideal, preferred setting



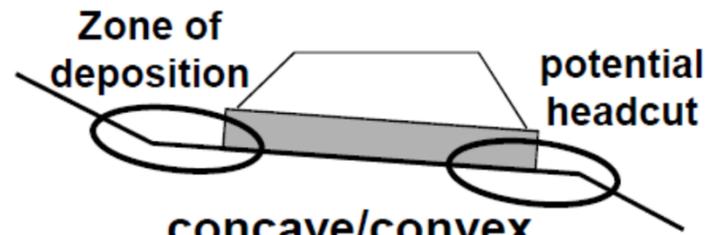
uniform



convex



concave



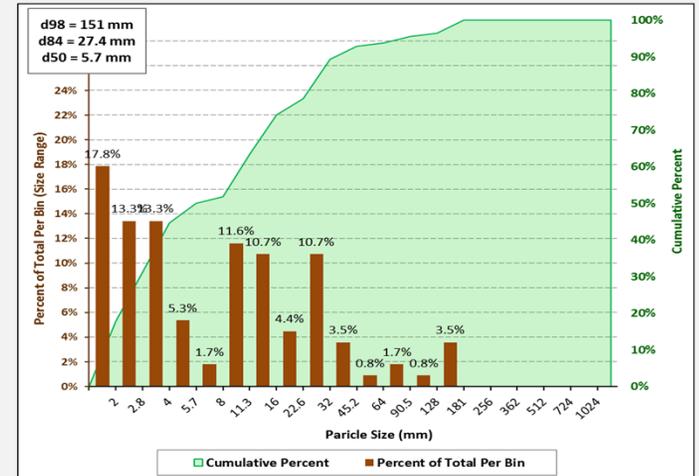
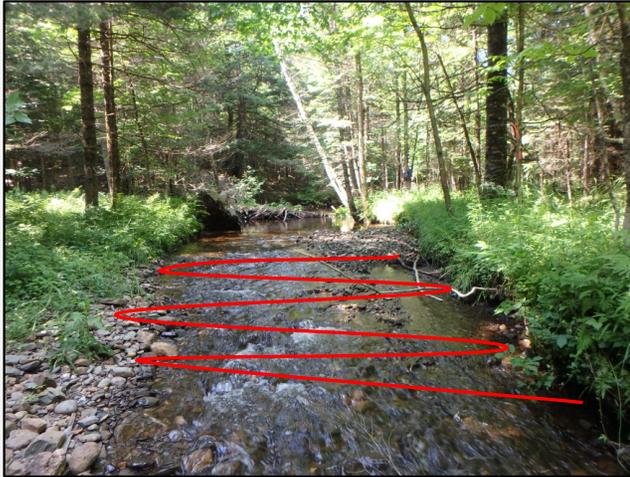
concave/convex

**WARNING:**

Interpreting stream profiles and designing for non-uniform settings requires extra thought and analysis.

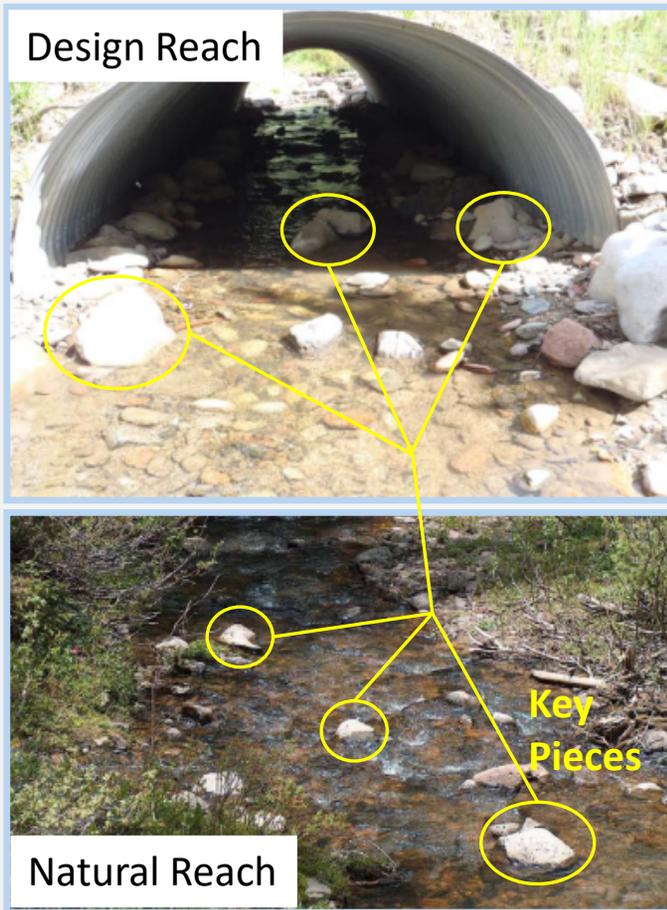
# Field Survey & Assessment

## Substrate (Pebble Counts)



# Field Survey & Assessment

## Substrate (Key features)



## Substrate in the crossing





# Stream Smart Crossings: Connecticut Regulatory Requirements

# Connecticut Stream Crossing Permits

- Inland Wetlands & Watercourses (IWW - Town Agencies)
- Connecticut Department of Energy & Environmental Protection (CTDEEP)
- U.S. Army Corps of Engineers (the Corps)





# CT DEEP Contacts

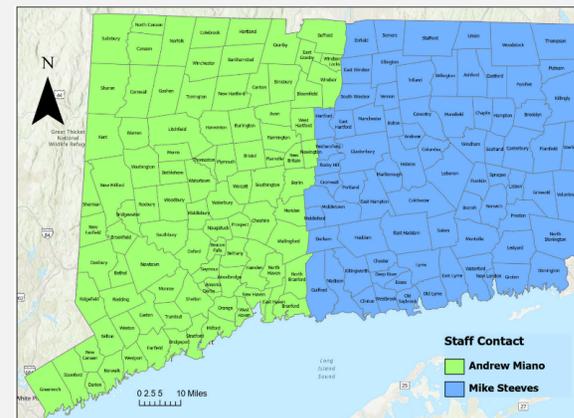
## LWRD - Land & Water Resource Division

- (860) 424 – 3019/DEEP.LWRDRegulatory@ct.gov:
  - General Questions to LWRD
- (860) 424 – 3003/ DEEP.OPPD@ct.gov:
  - Start Permitting Process

## Fisheries

Eastern District (959) 867-4510

Western District (959) 995-1273



## CT Stream Crossing Permits

Pre-application coordination with LWRD staff  
is ***strongly recommended!***

Email: [DEEP.OPPD@ct.gov](mailto:DEEP.OPPD@ct.gov)

*Additional Steps are also required BEFORE  
submitting permit applications*

*Remember that there can be special features or exceptions  
for projects best identified early in the permitting process!*

*Note that each step in the process requires some amount of  
lead time, so start early and build in extra time!*

# CT Stream Crossing Guidelines



CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION

Inland Fisheries Division  
Habitat Conservation and Enhancement Program

## Stream Crossing Guidelines



February 26, 2008

### ➤ GRADIENT

The culvert gradient should be no steeper than the streambed gradient upstream or downstream of the culvert matching the overall stream gradient as closely as possible. Gradient for sunken culverts should not exceed 3%. Bottomless arch culverts or clear span bridges should be utilized in all cases where gradient exceeds 3%.

### ➤ ALIGNMENT

Culvert alignment should be similar to that of the stream and not placed at a skew. This will ensure proper water conveyance and will protect against excessive channel erosion or scour.

### ➤ LENGTH

Culvert length should be as short as possible. Vertical headwalls rather than fill slopes are recommended at the culvert inlet and outlet to reduce the total culvert length (Figure 8). Narrowing and lowering the roadway along with steepening embankments can also help reduce culvert length.

### ➤ WIDTH

The culvert should have a width that spans an area 1.2 times the bankfull width of the stream. In Connecticut streams, bankfull width equates to the channel width wetted at the 1.5 to 2 year storm frequency flow. This standard also applies to arch (bottomless) culverts.

### ➤ CORRUGATED CULVERTS

Corrugated culverts are preferred over smooth culverts since the corrugations create a roughness that aids in the retention of streambed material. Metal culverts are least preferred due to longevity concerns with rusting.

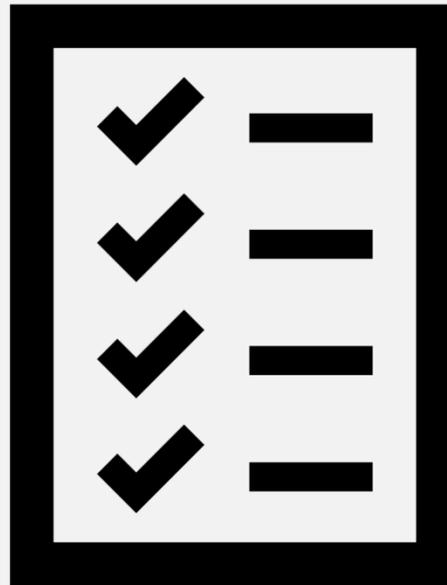
## Aquatic Life Movements & Management of Water Flows

No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody

The guidelines essentially point to Stream Smart principles and practices as the best way to meet permit standards

# Stream Smart Funding

- *Projects will be more likely to be funded if they have emerged from a watershed scale prioritization or watershed management plan.*

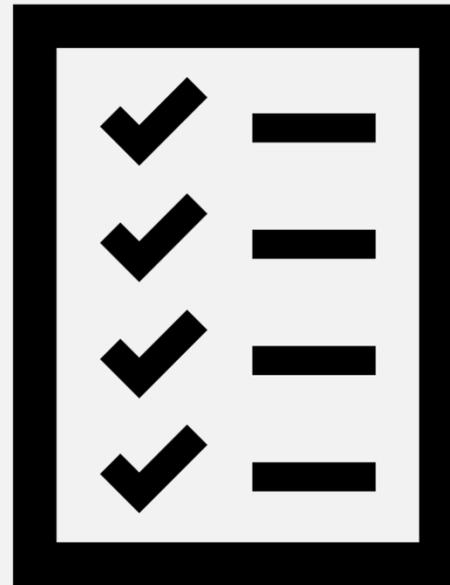


# Stream Smart Funding: Federal

- **US Fish & Wildlife Service**
  - **(1) National Fish Passage Program**
  - **(2) Partners for Fish and Wildlife**
- **National Fish & Wildlife Foundation**
  - **(3) LIS Future Fund**
    - **\$50K-\$1.5M**
  - **(4) Northeast Forest & Rivers Fund**
    - **\$75K-\$1M**
- **(5) Eastern Brook Trout Joint Venture**
- **(6) Restore America's Estuaries**
  - **\$200-\$500K, 30% match**
- **US DOT Federal Highway Administration**
  - **(7) National Culvert Removal, Replacement and Restoration Grant**
    - **\$100K-\$2M, 20% match**
  - **(8) Wildlife Crossing Pilot Program**
    - **\$200K-\$20M, 20% match**

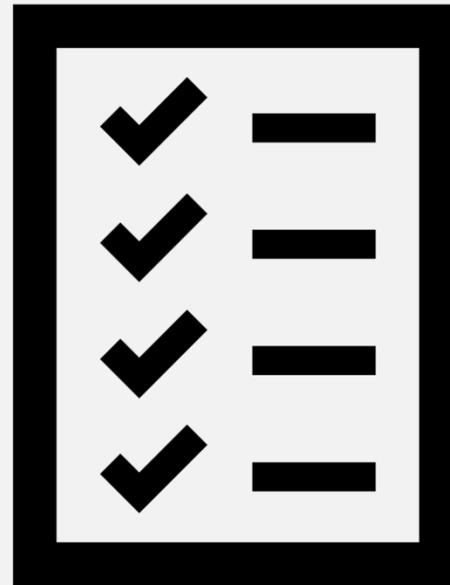
# Stream Smart Funding: Other Potential Federal Support

- USFS
- NRCS
  - Conservation Innovation Grants
  - Regional Conservation Partnership Program
- FEMA
  - Hazard Mitigation Grants
- NOAA
- USDOT FHWA
  - PROTECT
  - Bridge Investment Program
  - RAISE



# Stream Smart Funding: State

- (1) CTDEEP Climate Resilience Fund
  - \$300K-\$500K
- (2) CTDOT Local Bridge Program





# Stream Smart Road Crossings



**Interested in the 1-day Stream Smart training or  
1-week Stream Simulation?**