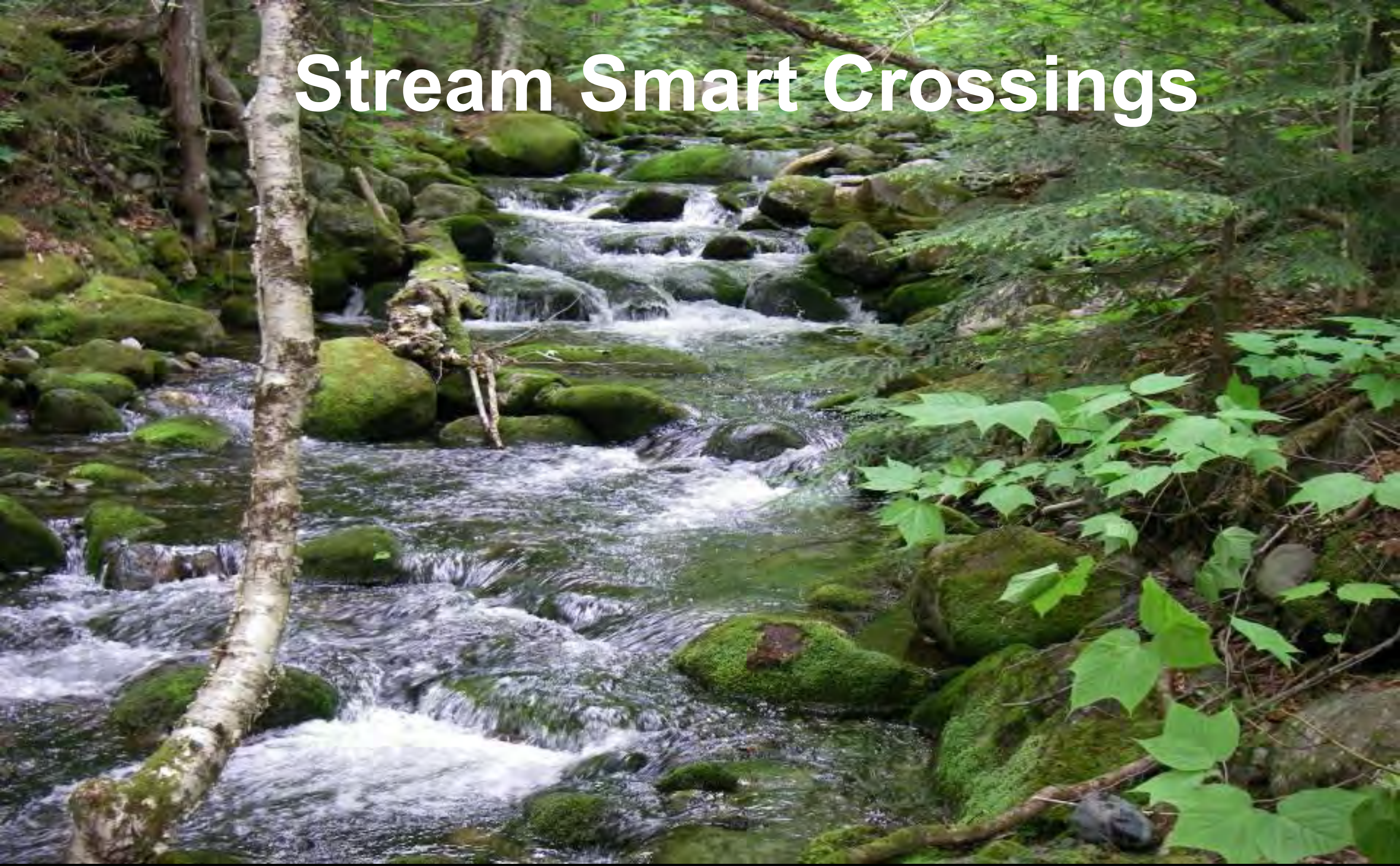
Stream Smart Crossings



The Golden Rule:
Let the stream act like a stream

Stream Smart Road Crossing Workshop Partners

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Stream Smart Crossings…

Maintain fish and wildlife habitat

while protecting roads and public safety.

Stream Smart Options

1) **Avoid** creating a crossing
2) **Remove** the crossing
3) **Open bottom** structure that spans or exceeds channel
   – Abutments for temporary bridge
   – Bridge or 3-sided box culvert
   – Arch culvert
4) **Embedded** culvert
5) **Hydraulic designs**

Open bottom structures

Temporary Bridge Deck

Bridge

Bottomless Box Culvert

Arch Culvert

Embedded pipes

Embedded box culvert

Liners don’t achieve Stream Smart outcomes!

Rules of Thumb (4 S's)

<u>**Span the stream**</u>

Set elevation right

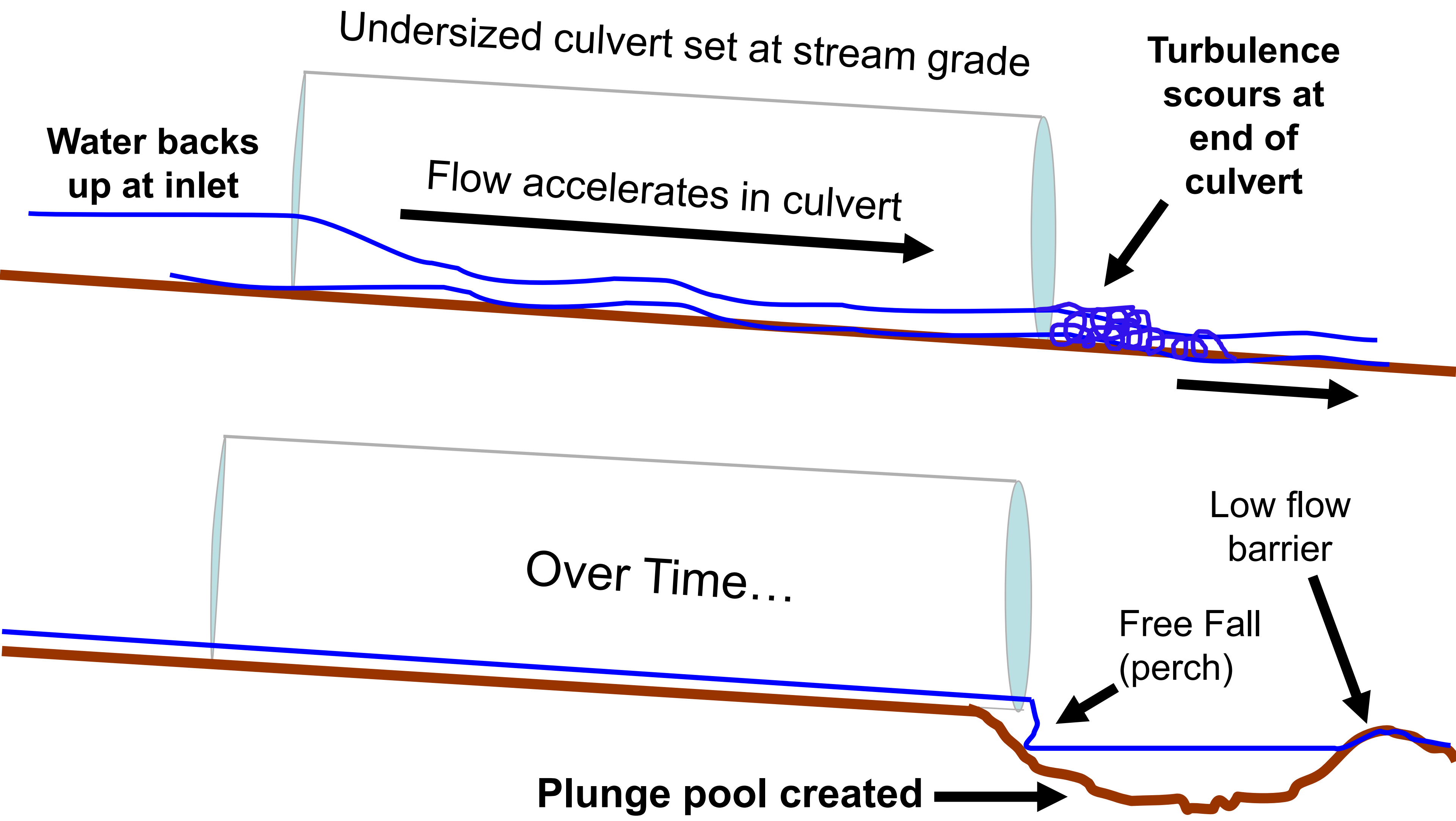
Slope and skew match stream

Substrate in the crossing

Don’t pinch the stream

Span the stream (and exceed it where possible)

How undersized culverts constrict stream flow and become perched



Real World – Blanchard

2008

2010

Rules of Thumb (4 S's)

Span the stream

Set elevation right

Slope and skew match
stream

Substrate in the crossing

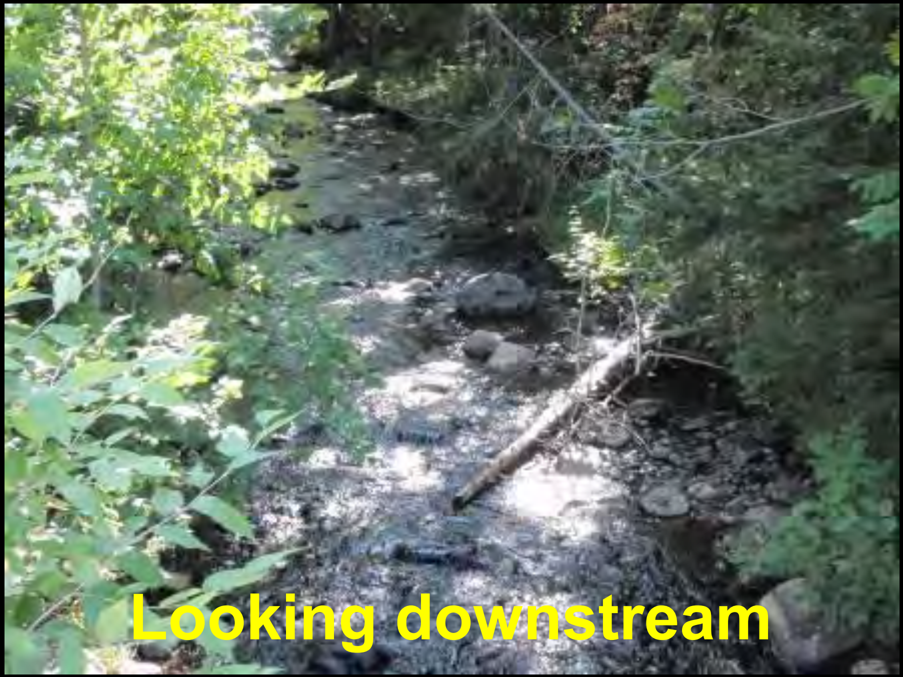
Set elevation right

Upstream

Indicators of elevation problems

A stream channel rediscovered!

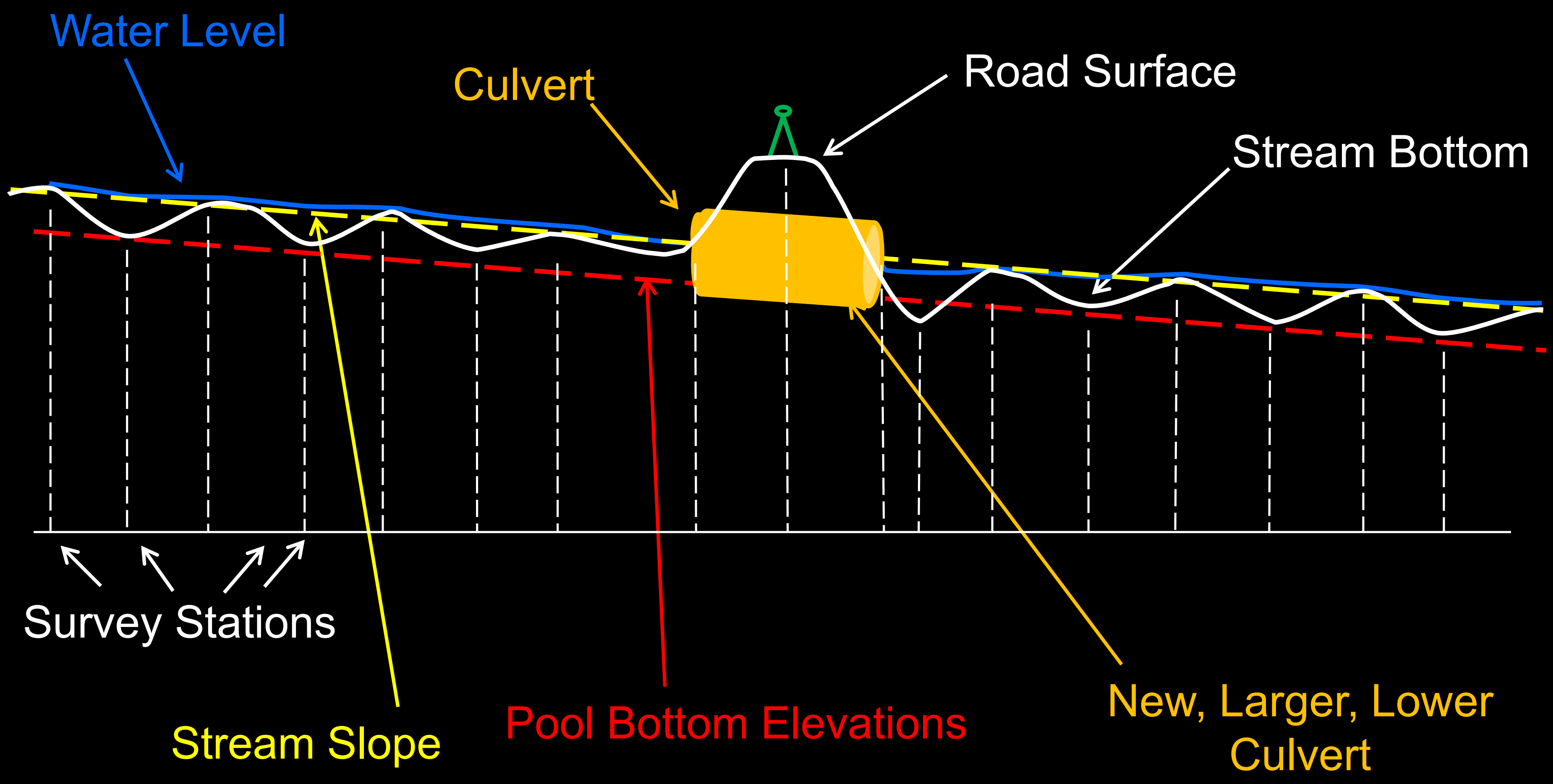
Indicators of correct elevation



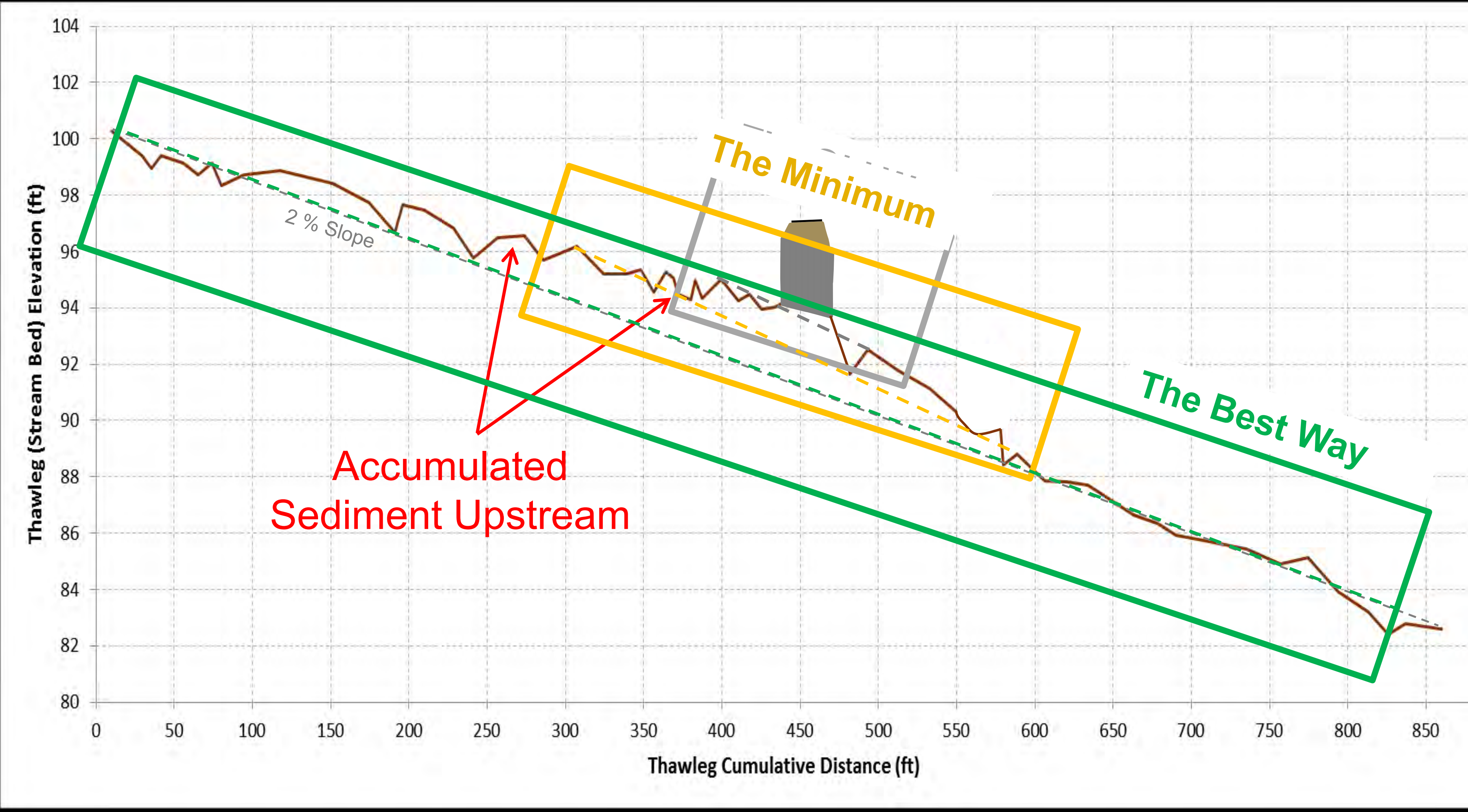
Seamless inlets and outlets

Stream Profile

Used to find correct elevation and slope



Stream Profile Example



Rules of Thumb (4 S's)

Span the stream

Set elevation right

Slope and skew match stream

<u>Substrate in the crossing</u>

Substrate in the crossing

Stream Smart Sizing

Step 1: Field Assessment

- Stream profile
- Bed characterization
- Stream cross-section

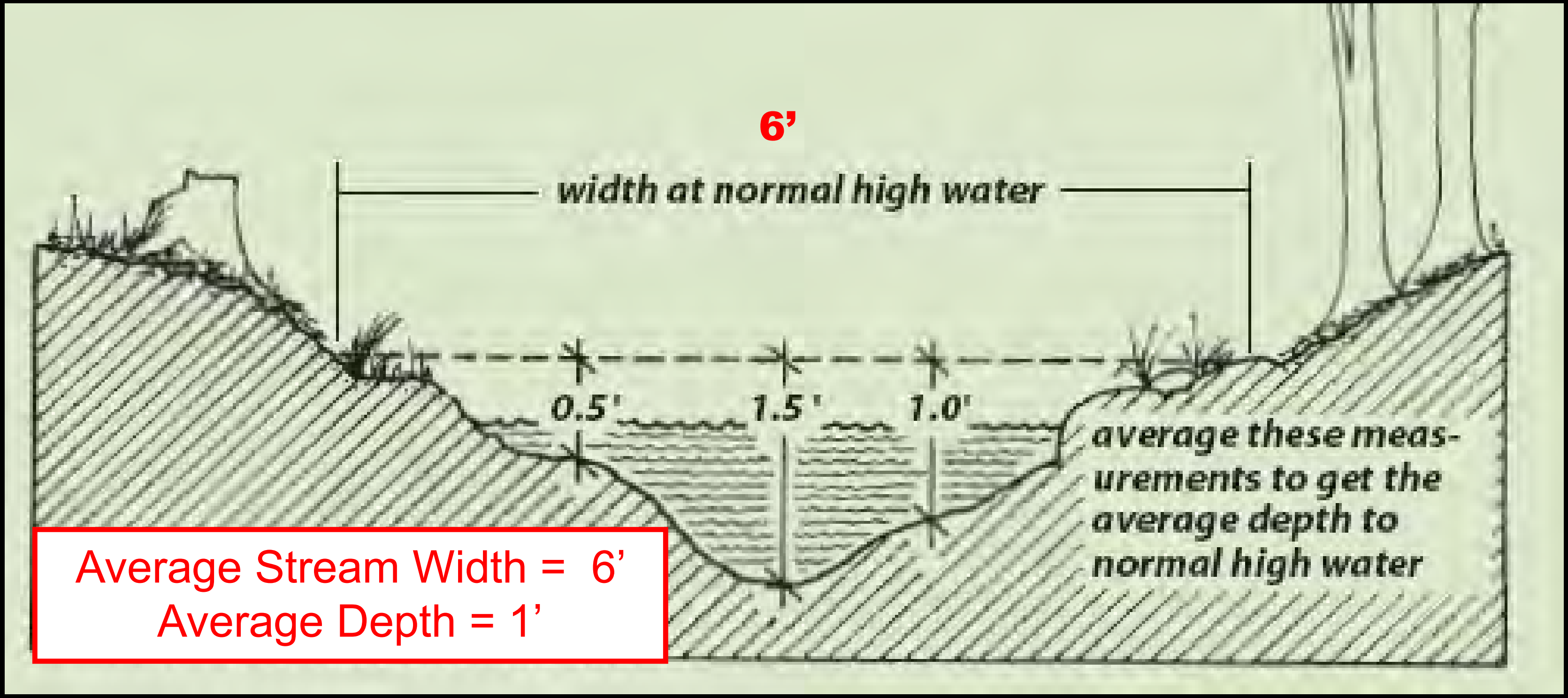
Step 2: Project Design

- Structure Choice
- Hydrology
- Hydraulics

Step 1: Field Assessment

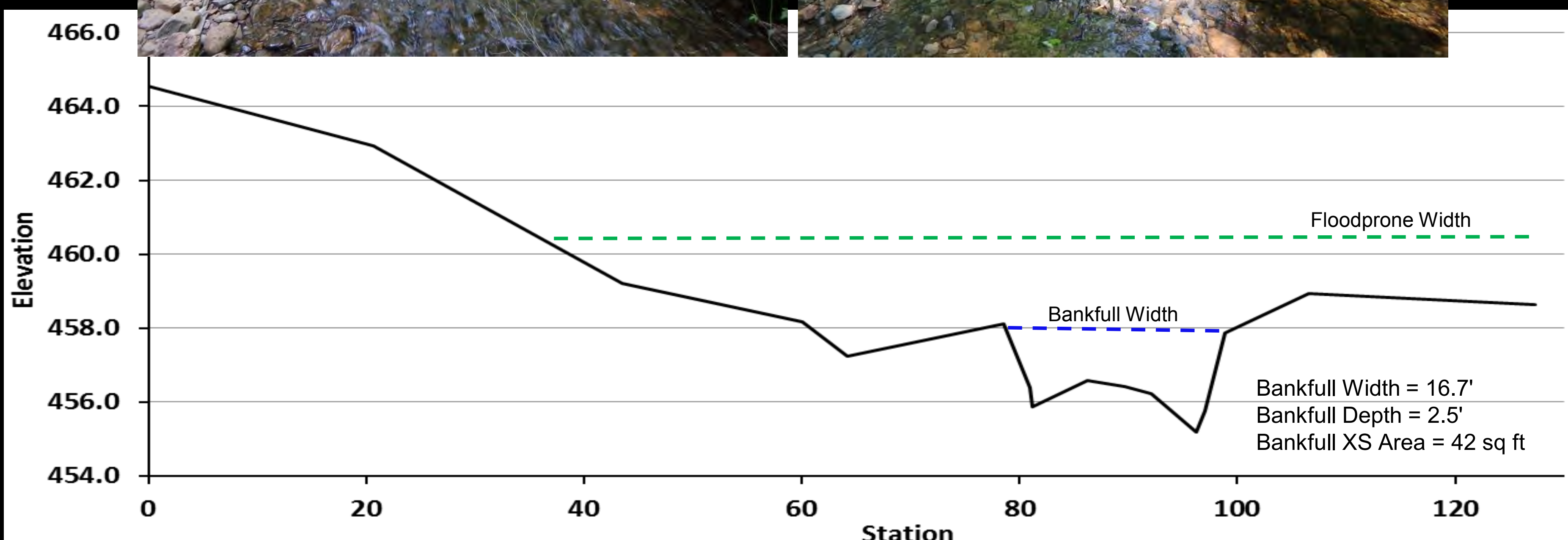
Determine the stream cross-section to set the opening area of the crossing

Measure both upstream and downstream of crossing in an undisturbed location, and average measurements

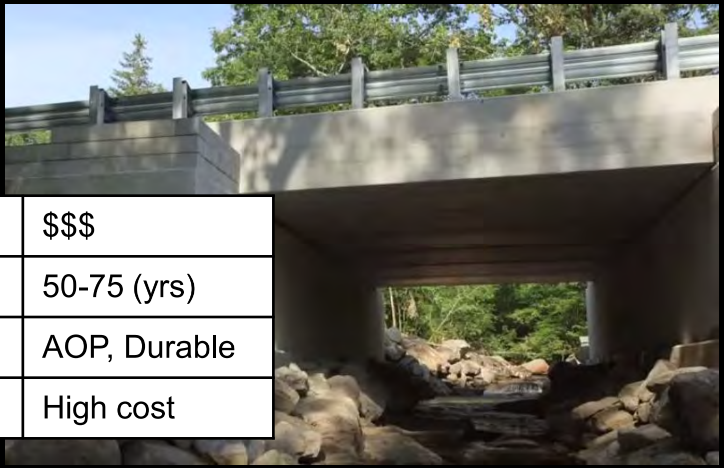


Step 1: Field Assessment

Cross-section

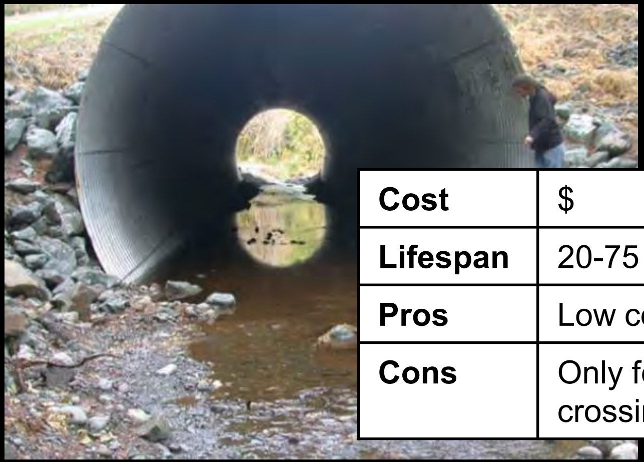


Step 2: Structure Choice



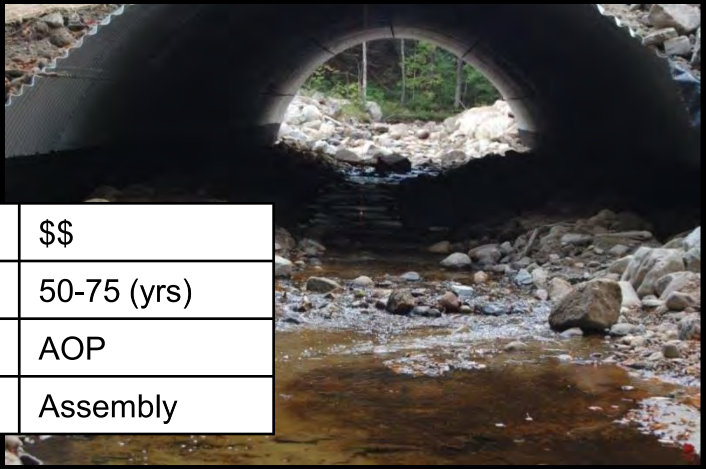
Cost	$$$
Lifespan	50-75 (yrs)
Pros	AOP, Durable
Cons	High cost

Bridge



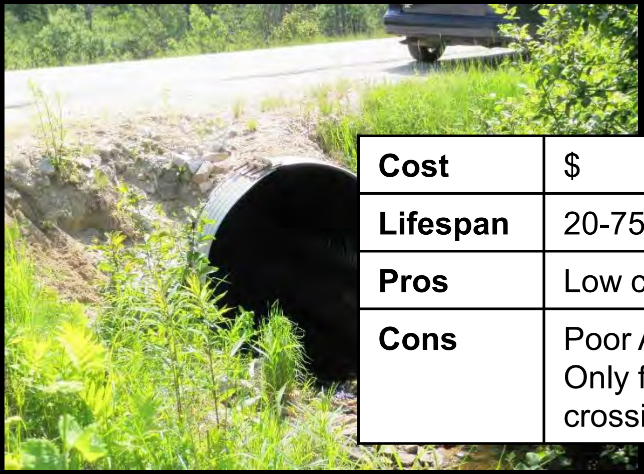
Cost	$
Lifespan	20-75 (yrs)
Pros	Low cost
Cons	Only for small crossings

Embedded Pipe



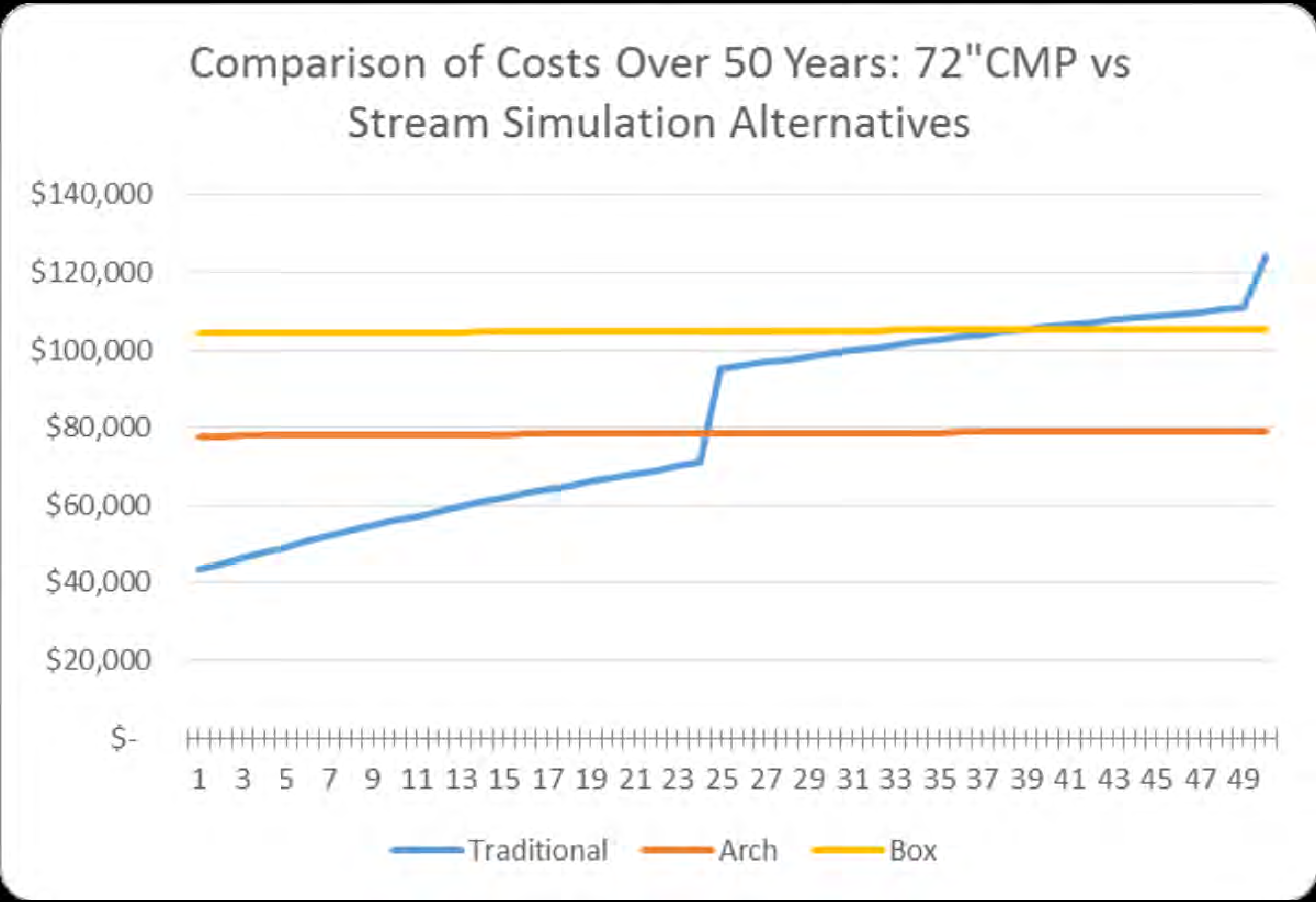
Cost	$$
Lifespan	50-75 (yrs)
Pros	AOP
Cons	Assembly

Open Bottom Arch



Cost	$
Lifespan	20-75 (yrs)
Pros	Low cost
Cons	Poor AOP Only for small crossings

Traditional Pipe



Comparison of Costs Over 50 Years: 72"CMP vs Stream Simulation Alternatives
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$-
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49
Traditional
Arch
Box

Stream-Smart:
Small bridge on low volume road

Stream-Smart: Concrete Arch Culvert

Before

After

Stream-Smart: Embedded Box Culvert

Before

After

Step 2: Hydrology

USGS StreamStats

Hydrology & Hydraulic Analysis

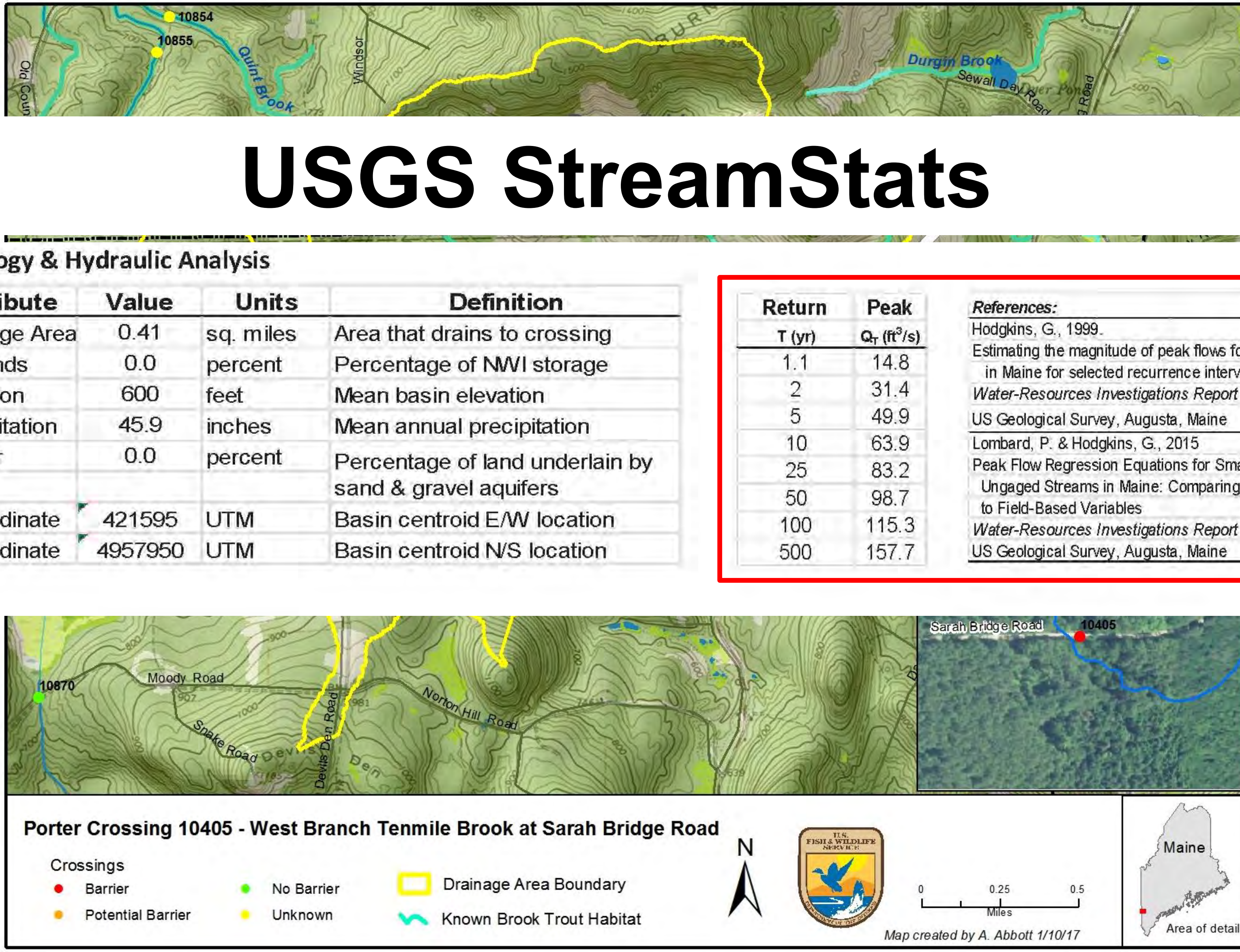
Attribute	Value	Units	Definition
Drainage Area	0.41	sq. miles	Area that drains to crossing
Wetlands	0.0	percent	Percentage of NWI storage
Elevation	600	feet	Mean basin elevation
Precipitation	45.9	inches	Mean annual precipitation
Aquifer	0.0	percent	Percentage of land underlain by sand & gravel aquifers
X-coordinate	421595	UTM	Basin centroid E/W location
Y-coordinate	4957950	UTM	Basin centroid N/S location

Return T (yr)	Peak Q_T (ft^3/s)
1.1	14.8
2	31.4
5	49.9
10	63.9
25	83.2
50	98.7
100	115.3
500	157.7

References:

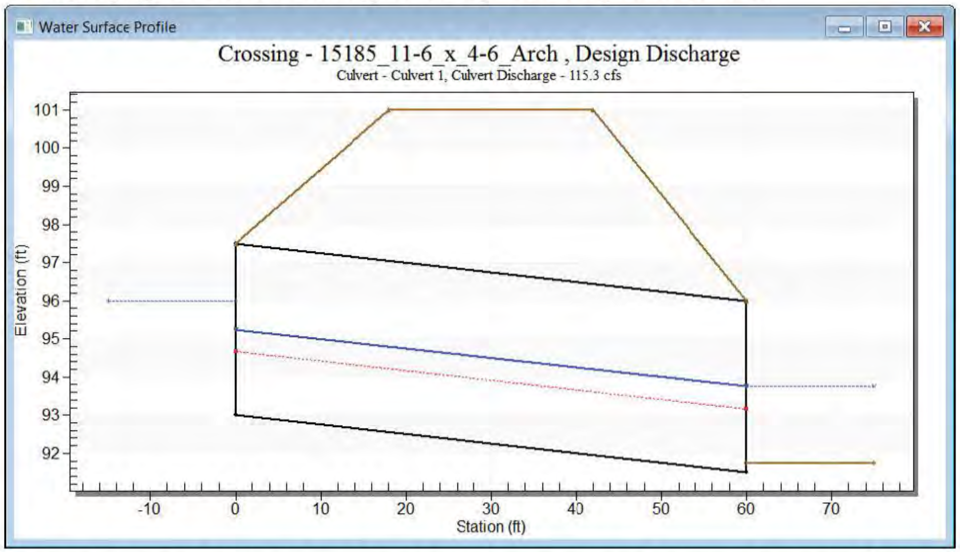
Hodgkins, G., 1999.
Estimating the magnitude of peak flows for streams in Maine for selected recurrence intervals
Water-Resources Investigations Report 99-4008
US Geological Survey, Augusta, Maine

Lombard, P. & Hodgkins, G., 2015
Peak Flow Regression Equations for Small, Ungaged Streams in Maine: Comparing Map-Based to Field-Based Variables
Water-Resources Investigations Report 2015-5049
US Geological Survey, Augusta, Maine



Step 2: Hydraulics

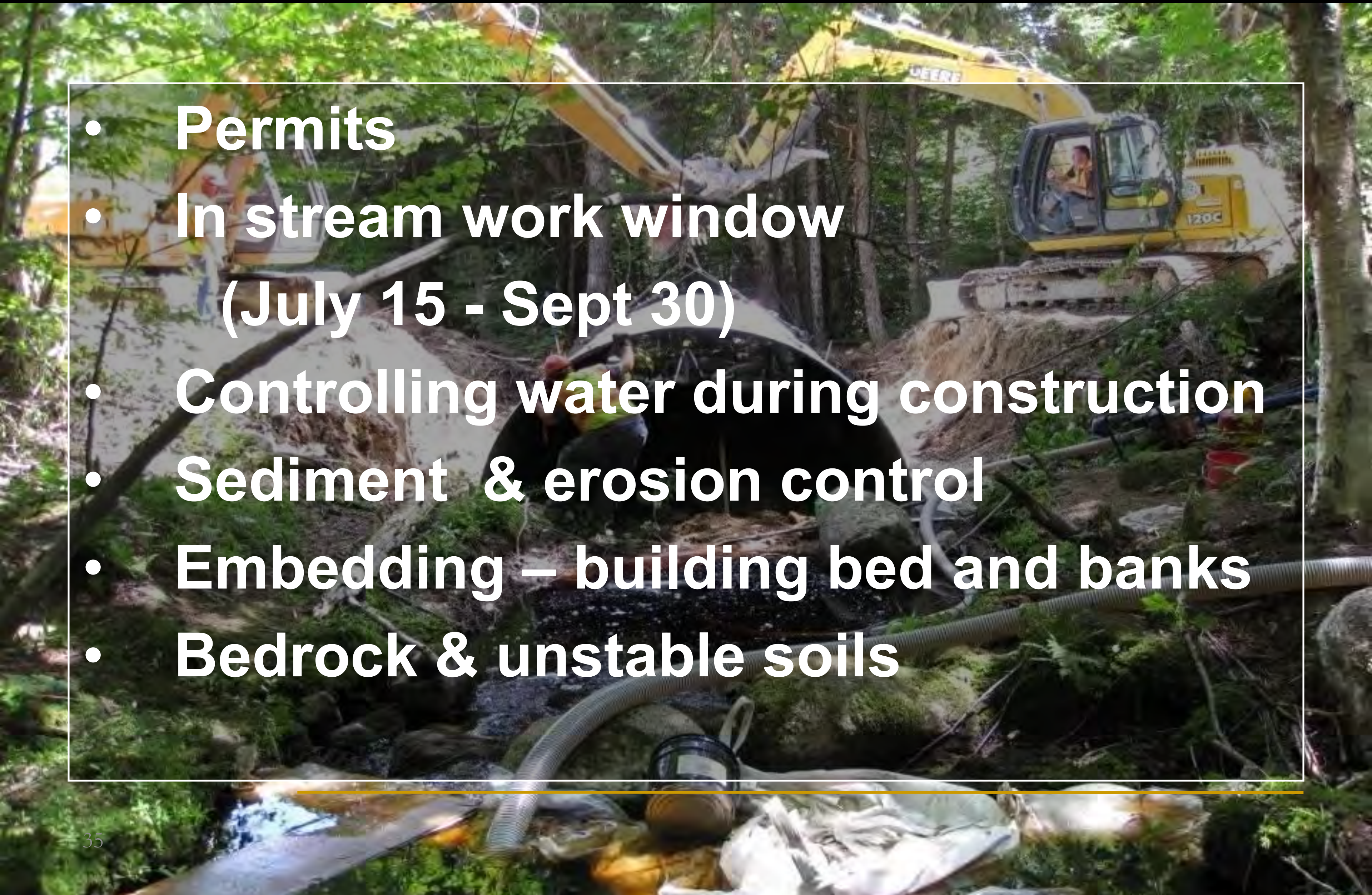
HY-8 Hydraulic Analysis Program of the U.S. Federal Highway Administration provides results for the above peak flow estimates for the proposed crossing design, and indicates that the crossing as proposed will successfully pass the expected 100-year storm event.



Discharge Names	Culvert Discharge	Headwate Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Outlet Depth (ft)	Outlet Velocity (ft/s)
1 year	14.80	93.90	0.62	0.90	3-M1t	0.91	1.71
2 year	31.40	94.44	1.15	1.44	3-M1t	1.23	2.66
5 year	49.90	94.56	1.56~	0.00	3-M1t	1.51	3.36
10 year	63.90	94.81	1.81~	0.00	3-M1t	1.74	3.66
25 year	83.20	95.12	2.12~	0.00	3-M1t	1.98	4.13
50 year	98.70	95.71	2.37	2.71	3-M1t	2.12	4.57
100 year	115.30	95.99	2.67	2.99	3-M1t	2.25	5.01
500 year	157.70	96.70	3.42	3.70	3-M2t	2.56	6.04

Note that prediction errors are quite large when using regression equations to estimate flows and bankfull widths based on drainage area. It is best to account for potentially larger flows at these return intervals.

Design & Installation Considerations



- Permits
- In stream work window
  (July 15 - Sept 30)
- Controlling water during construction
- Sediment & erosion control
- Embedding – building bed and banks
- Bedrock & unstable soils

Controlling Water

When might you seek help?

- Complicated legacy effects
- When you can't find natural channel
- Tidal streams
- Safety or traffic issues

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Substrate in the crossing

The Golden Rule:
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