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Bridging the Gap: Designing Ecologically Sound and Cost-Efficient Stream Crossings for Ground-Mounted Solar Projects

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About Us

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Company Profile

- For over 35 years, Beals and Thomas, Inc. (B+T) has been providing professional civil engineering, landscape architecture, land surveying, environmental planning, permitting, and wetlands consulting that support the development and conservation of land and water resources throughout New England.
- B+T Renewable Energy Experience:
  - 60+ projects
  - 150+ MW across MA
  - 30+ municipalities
  - 6 Projects with stream crossings

Presentation Overview

- Solar Site Access Challenges
- Characteristics of Good Stream Crossings
- Regulatory Requirements
- Client and Designer Considerations
- Typical Stream Crossing Options
- Cost Comparison Case Study
- Timber Bridge Construction Sequence
- Timber Bridge Examples
- York Bridge Concepts
- Round Table Discussion

Site Access Challenges

- Large sites & long access roads
- Limited frontage
- Steep slopes and topographic constraints
- Adequate turning movements
- Unavoidable stream and wetland crossings

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Characteristics of Good Stream Crossings

- Spans the stream and banks (including braided channels)
- Maintains comparable water velocities
- Has a natural streambed
- No observable change in stream channel

"Safe, stable stream crossings can accommodate wildlife and protect stream health while reducing expensive erosion and structural damage."

– Massachusetts Stream Crossing Handbook

MA River and Stream Crossing Standards

- Two Standards: General and Optimum

  Balance cost and logistics with degree of stream protection warranted in sensitive habitats

- Three Goals of Standards:
  1. Fish and Aquatic Organism Passage
  2. River and Stream Continuity
  3. Wildlife Passage

- Full Aquatic Organism Passage (AOP) is achieved when a crossing allows unrestricted movement of all aquatic organisms indigenous to the water body

- Crossings that achieve full AOP are expected to maintain more natural river hydrology and transport of sediment and woody debris

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Stream Crossing Standards Summary

	General Standards	Optimal Standards
Structure Type	Open-bottom span preferred	Bridge
Embedment	If a culvert, then it should be embedded: • A minimum of 2 feet for all culverts • A minimum of 2 feet and at least 25 percent for round pipe culverts • When embedment material includes elements > 15 inches in diameter, embedment depths should be at least twice the D_{84} of the embedment material	N/A
Crossing Span	Minimum: 1.2 x bank full-width	Minimum: 1.2 x bank full-width
Substrate	Matches stream substrate	Matches stream substrate
Water Depth & Velocity	Matches water depth & velocity in natural stream over a range of flows	Matches water depth & velocity in natural stream over a range of flows
Openness (& height)	Openness: 0.82 ft. (0.25 m)	Conditions that inhibit wildlife passage over road • Openness: 2.46 ft (0.75 m) • Height: 8 ft (2.4 m) Otherwise • Openness: 1.64 ft (0.5 m) • Height: 6 ft (1.8 m)
Banks	• On both sides of the stream • Match the horizontal profile of the existing stream and banks • Constructed so as not to hinder use by riverine wildlife	• On both sides of the stream • Match the horizontal profile of the existing stream and banks • Constructed so as not to hinder use by wildlife • Sufficient headroom for wildlife

MASSACHUSETTS RIVER AND STREAM CROSSING STANDARDS

Developed by the

RIVER AND STREAM CONTINUITY PARTNERSHIP

Including:

University of Massachusetts Amherst
The Nature Conservancy
Massachusetts Division of Ecological Restoration-Riverways Program
American Rivers

March 1, 2006
Revised March 1, 2011

Source: *Massachusetts River and Stream Crossing Standards*

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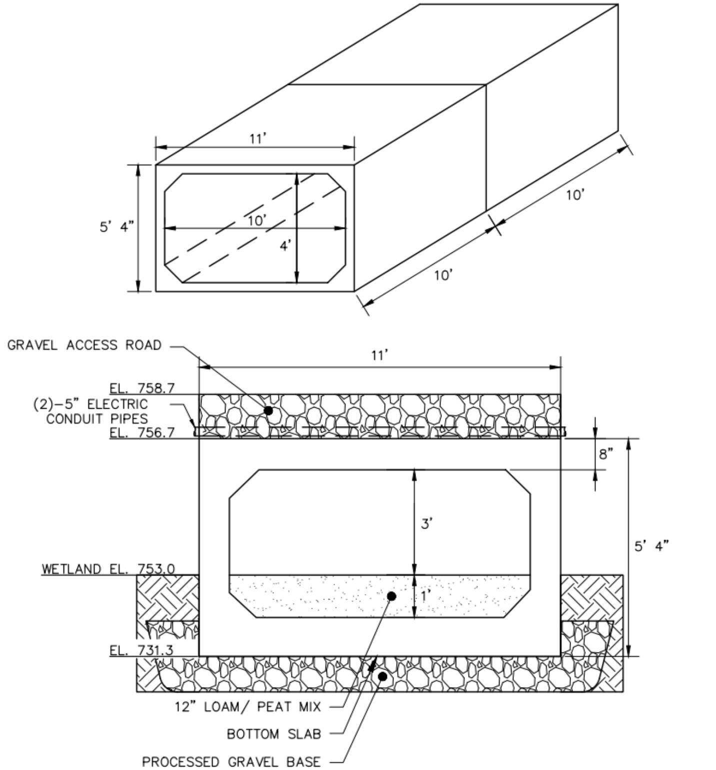
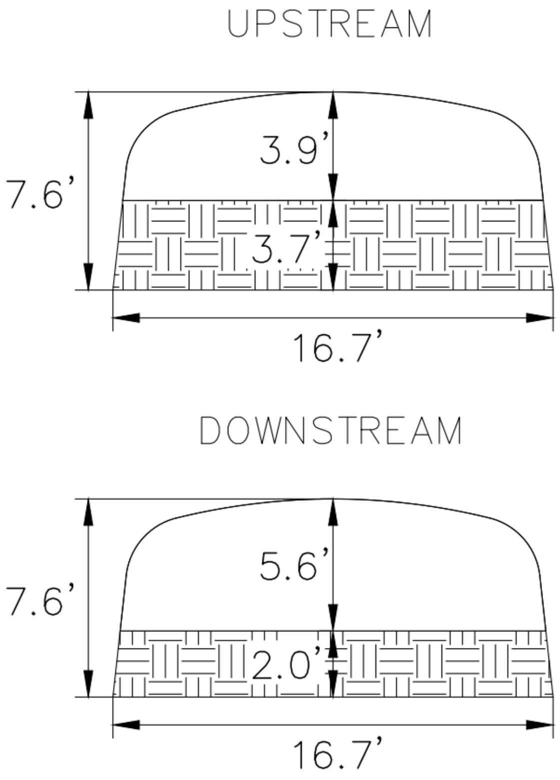
Client and Designer Considerations

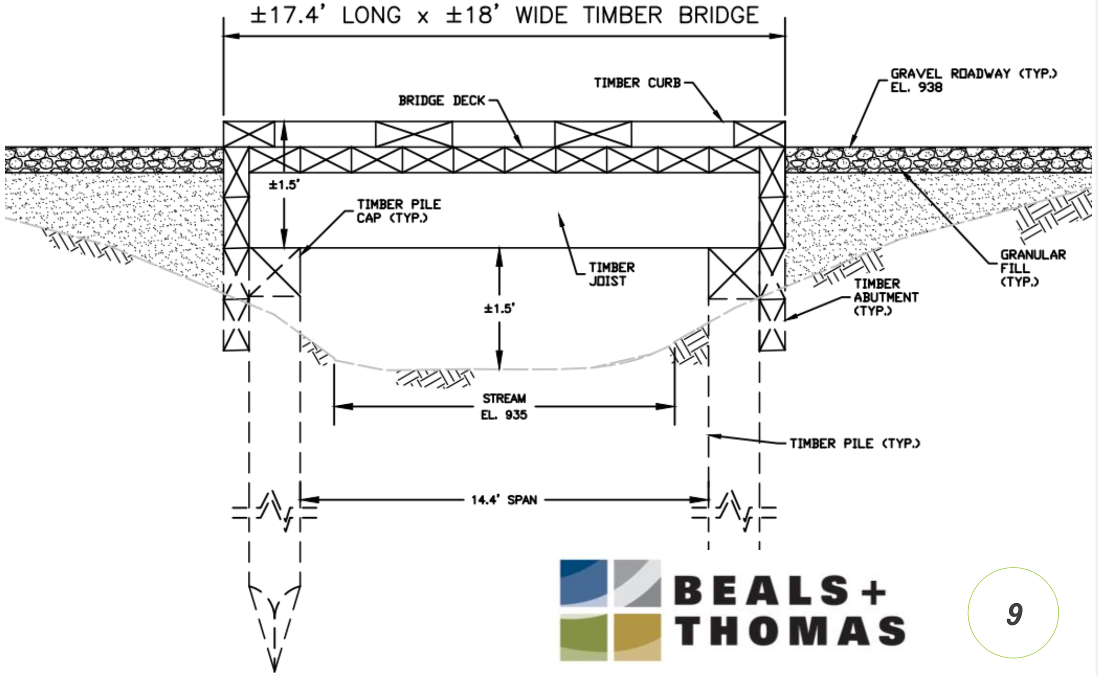
- Stream Crossing Standards
- Dimensional & Load Rating
  - Span Length & Clear Width
  - Construction Equipment, Emergency Response, Battery Storage
- Geotechnical
  - Geotechnical Borings
  - Depth of Organics, Unsuitables, Refusal
- Cost & Schedule
  - Structural Design
  - Materials, Equipment, Labor
  - Site Contractor Support
  - Timeframe for Delivery/Construction/Installation
- Uncertainty
  - Based on Extent of Data Available
  - Potential for Delays or Change Orders

Typical Stream Crossing Options

- Access to solar array area can be challenging and may include unavoidable stream crossings
  - Try to avoid implementing stream or wetland crossing, if practicable, through careful site plan design
- Common types of Stream Crossings:
  - Open or Closed Bottom Concrete Box Culvert
  - Aluminum Box or Structural Plate
  - Timber Bridge







Open or Closed Bottom Concrete Box Culvert

Design and Permitting Considerations:

- New versus replacement crossing
- Temporary resource area impacts
- Load rating

Construction Considerations:

- Temporary cofferdams or flow bypass
- Excavation dewatering
- Excavation of peat, organics, and other unsuitables
- Excavation for concrete footers or bedding/base material
- Recreate natural stream bed within structure

- Equipment & Labor
  - Excavation and earthmoving
  - Crane access

Aluminum Box or Structural Plate

Design and Permitting Considerations:

- Lightweight, wide span, low rise
- Variable geometry and limitations

Construction Considerations:

- Temporary cofferdams or flow bypass
- Excavation dewatering
- Excavation of peat, organics, and other unsuitables
- Excavation for footers or bedding/base material
- Recreate natural stream bed within structure

- Equipment & Labor
  - Excavation and earthmoving

Timber Bridge

Design and Permitting Considerations:

- Extremely customizable
- Integrated wingwall, guiderail and curbing options
- Depth to bedrock challenges – drilling/concrete footers

Construction Considerations:

- No need for temporary cofferdams or flow bypass
- No excavation dewatering
- No excavation of peat, organics, and other unsuitables
- No excavation for footers or base material
- Timber pile driving with vibratory hammer
- Recreate natural stream bed within structure
- Ease of electrical conduit installation

- Equipment & Labor
  - Minimal equipment need
  - Single excavator or mini-excavator
  - Labor driven – primarily carpentry

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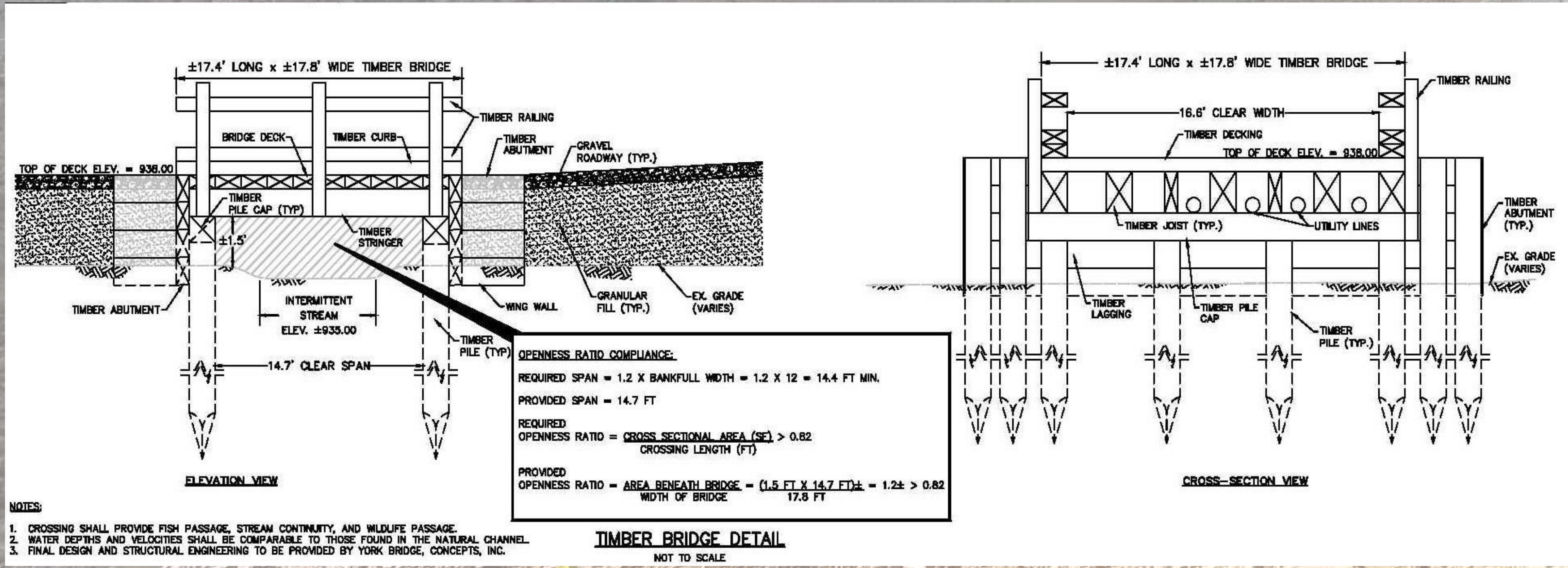
Cost Comparison Case Study

Required Span = 14.4 ft min; Clear Width = 16 ft; Load Rating = HS20-44

Aluminum Arch:		Timber Bridge:	
Design/Materials:	$28,800	Design/Materials:	$84,420
GC/Sitework:	$63,400	GC/Sitework:	$0
Total =	$92,200	Total =	$84,420

Savings of $7,780±



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Timber Bridge Construction Sequence

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Finished Timber Bridge Stream Crossings

Winchendon, MA

Finished Timber Bridge Stream Crossings

Douglas, MA

Finished Timber Bridge Stream Crossings

Wales, MA

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FIRE LANE


PRE K


STOP
FIRE
LANE


The Mount Washington
Resort
OMNI HOTELS & RESORTS


BARE COVE MARINA


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BRIDGE CONCEPTS
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Round Table Discussion

- Thoughts on utilizing timber bridges for solar stream crossings?

- What types of stream crossing options do you typically recommend?

- Other design or construction considerations?

- General Q&A?

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