Session 7: Construction of Repairs Or Removal – Hiring an Engineer Consultant, Costs, and Funding Options

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What Will Be Covered in Session 7

- The Rehabilitation or Removal Process
  - Hiring a consulting engineer
- Typical dam repair costs
  - Typical cost case study
- Funding opportunities

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Session 7 Learning Objectives

- How to retain a qualified professional engineer consultant for repair and/or inspection purposes
- Identify typical dam repair costs
- Identify potential Federal, State, and local funding sources

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Before Action – Study and Alternative Analyses

- Dam inspection and identification of deficiencies and associated risks.
- Alternatives Analysis: Weigh options based on goals of owner
  - Dam Rehabilitation: The restoration of various elements of an existing dam to bring it into compliance with dam safety and environmental regulations, standards, current dam safety practice, and the needs of the owner.
  - Dam Removal: the process of demolishing a dam and restoring the site and river to free-flowing conditions

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Before Action – Study and Alternative Analyses (Cont.)

- Dam Rehabilitation
  - Pros:
    - Retain beneficial use of reservoir (recreation, flood control, storage)
    - Address deficiencies to reduce risk and protect investment as well as public downstream from dam.
  - Cons:
    - Typically higher long-term costs (current construction, ongoing O&M, future rehabilitation, etc.)
    - Ownership responsibility, liability, and risk remains
    - Environmental Damage (water quality, habitat, fish passage, river health)

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Before Action – Study and Alternative Analyses (Cont.)

- Dam Removal
  - Pros:
    - Restore free-flowing stream and natural conditions to the site
    - Improve environmental conditions such as water quality, habitat, fish passage, river health
    - No ongoing O&M or responsibility/liability associated with dam ownership
  - Cons:
    - Loss of beneficial use of reservoir

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Before Action – Alternative Analyses (Cont.)

- Summary
  - Where the beneficial uses of the reservoir, such as recreation, water supply, or flood control, etc. outweigh the disadvantages of the dam, dam rehabilitation is the best approach.
  - In cases where there is little or no beneficial use or the dam has been abandoned or is no longer needed, dam removal is the best approach.
  - Every dam, owner, and case is unique. An effective alternatives analysis examines all considerations and options available.

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Other Options for Dealing with Rehabilitation or Removal Issues

- Phased repair program
- Transfer of ownership
- Phased dam removal
- Decrease size of dam and impoundment - A smaller dam will decrease the downstream damage potential and may change the regulatory requirements

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Dam Rehabilitation
The Process of Getting the Job Done

Step 1: Meet with potential engineering consultants and receive proposals (three recommended)

Step 2: Select engineering consultant (contracting)

Step 3: Engineering consultant begins design process

- Surveying and Inspection
- Natural Resources Assessment
- Hydrologic and Hydraulic Analyses
- Geotechnical Investigations
- Stability Analyses
- Preliminary Plans and Review of Plans with Regulators
- Final Plans

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Dam Rehabilitation
The Process of Getting the Job Done

Step 4: Permitting (local, state and/or federal Dam Safety and environmental permitting)

Step 5: Construction Bidding (three recommended)

Step 6: Owner hires contractor upon recommendation of consultant

Step 7: Construction

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The Process of Getting the Job Done

Tasks	Months																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hire a Consultant																		
Surveying & Inspection																		
Geotechnical/Stability																		
Const. Drawings																		
Permitting																		
Hire a Contractor																		
Construction																		

***Time frames are offered as an example and can vary depending on project complexities, time of year, owner objectives, regulatory requirements, etc.*

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Need for Retaining Professional Engineers

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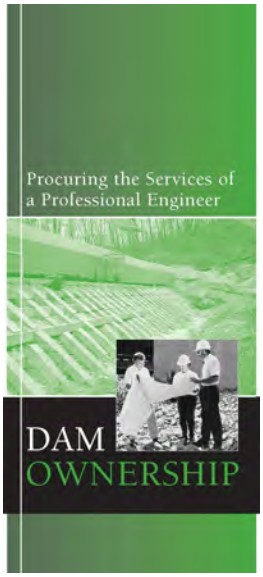
Need for Retaining Professional Engineer

Refer to the ASDSO brochure:

Procuring the Services of a Professional Engineer

damsafety.org/dam-owners



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Need for Retaining a Professional Engineer

- **Any activities that require a Dam Safety Order**
  - Material change, alteration, repair, reconstruction, new construction, breach, removal, etc.

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Need for Retaining a Professional Engineer

- **Typical problems that require the expertise of an engineer:**
  - Inadequate discharge/storage capacity
  - Severe spillway deterioration
  - Embankment slope failure or stability issue
  - Seepage
  - Sink holes

Need for Retaining a Professional Engineer

- **Typical problems that require the expertise of an engineer:**
  - Tree and root system removal
  - Large cracks in the embankment
  - Severe erosion of the upstream slope
  - Inadequate or lack of outlet erosion control structure
  - No lake drain or inoperable lake drain

Need for Retaining a Professional Engineer

- Severe erosion of the upstream slope

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Need for Retaining a Professional Engineer

- Tree and root system removal

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Need for Retaining a Professional Engineer

- Severe spillway deterioration

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Need for Retaining a Professional Engineer

- Sinkholes

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Need for Retaining a Professional Engineer

- Uncontrolled seepage or leakage

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How To Find a Qualified Engineer?

- Dam Safety Engineering is a subset of Civil Engineering and typically combines expertise in geotechnical, hydrologic/hydraulic, and structural engineering.
- Commonly, a dam safety project will be analyzed and designed by a team of engineers with a member from each of the above disciplines.

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How To Find a Qualified Engineer?

- Contact the Qualified Engineer that has provided dam safety compliance assistance in the past
- Advertise a Request for Qualifications/Proposals
- Contact your State Dam Safety Program
- Contact the State Board of Registration
- Contact State Consulting Engineers Council
- Internet search

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Qualities to Look for in Professional Engineers

- Company should have a strong background in civil, geotechnical, water resources, or structural engineering
- Company should be familiar with the state dam safety laws and rules
- Company should have experience in design of dams and hydraulic structures

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Qualities to Look for in Professional Engineers (Cont.)

- Company should provide a list of dams that it has worked on of similar scope and scale to your project
- Company must employ engineers that are registered in state in which dam is located

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Typical Dam Repair Costs

Total national need for dam safety rehabilitation

Height-Based Group	Cost Estimate	Total Cost
Group 1 – less than or equal to 15 feet	$351,640/dam	$2.273 billion
Group 2 – 16 to 25 feet	$827,616/dam	$8.130 billion
Group 3 – 26 to 50 feet	$2,147,088/dam	$22.569 billion
Group 4 – greater than 50 feet	$11,272,720/dam	$18.485 billion

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Dam Rehabilitation

- Costs can vary widely, dependent on factors such as:
  - size, type, location, and accessibly of dam and reservoir
  - Project risk/dam hazard classification
  - Extent of needed rehabilitation, repairs versus replacement
  - Foundation conditions
  - Control of water requirements (drain reservoir vs cofferdam)
  - Weather conditions

Typical Dam Repair Costs – Example 1

Rehabilitate of a water supply dam earthen embankment dam with a concrete spillway chute (39 feet high)

Typical Dam Repair Costs – Example 1

- Selectively remove and replace spillway chute panels, crack and spall repair
- Provide a new drainage system beneath a portion of the chute
- Minor vegetation removal
- Minor regrading

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Typical Dam Repair Costs – Example 1

- Total Engineering and Permitting Cost: $ 167,500
- Total Construction Cost: $ 1,845,700

- Rhode Island (2017)

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Typical Dam Repair Costs – Example 2

Provide overtopping at an earthen embankment dam and replace the spillway pipe (7 feet high)

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Typical Dam Repair Costs – Example 2

- Vegetation clearing
- Remove and replace spillway conduit
- Provide buttress and filter at the downstream side
- Provide overtopping protection

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Typical Dam Repair Costs – Example 2

- Total Engineering and Permitting Cost: $ 59,000
- Total Construction Cost: $ 608,600
- Rhode Island (2017)

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Typical Dam Removal Costs Example 1

- Low head/Run-of-river dam in poor condition.

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Typical Dam Removal Costs – Example 1

Removal of a run of river dam (6 feet high)

- Remove minimal sediment
- Construct canal diversion berm
- Stabilize eroding river channel
- Remove entire concrete & stone dam

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Typical Dam Removal Costs – Example 1

- Total Project Cost - $670,000
- Rhode Island in 2016

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Typical Dam Removal Costs – Example 2

- Removal of a run of river dam (20 feet high)
- Integral with mill building
- Upstream bridge impacts
- Poor access

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Typical Dam Removal Costs – Example 2

Example: Removal of a run of river dam (20 feet high)

- Construct access
- Remove substantial contaminated sediment
- Construct new RR bridge pier
- Construct building concrete retaining walls
- Remove entire concrete & stone dam

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Typical Dam Removal Costs – Example 2

- New Railroad bridge pier
- Temporary support structure
- Oil pipeline protection

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Typical Dam Removal Costs – Example 2

Removal of a run of river dam (20 feet high)

- Total Project Cost $5,800,000
- CT in 2017

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Typical Dam Removal Costs – Example 3

Removal of a grist mill dam (9 feet high)

- Remove minimal sediment
- Relocate special species of concern
- Remove portion of stone dam
- Construct new channel at dam

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Typical Dam Removal Costs – Example 3

- 9 ft high stone-faced earthen dam with stone spillway
- 1 acre pond

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Typical Dam Removal Costs – Example 3

Removal of a grist mill dam (9 feet high)

- Total Project Cost - $320,000
- CT in 2010

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Types of Overtopping Protection and Costs

Overtopping	Unit Cost	Limitations
Roller Compacted Concrete (RCC)	$10.00 to $15.00 per sf	Usually produced on-site, so large staging area needed for plant and materials.
Articulated Concrete Blocks	$11.00 to $15.00 per sf	Lab studies show stable for up to 4 feet of overtopping depth.
Conventional Cast-in-Place Concrete (reinforced)	$27 to $42 per sf	Difficult to place on 2H:1V slope. Attention must be made to joint placement and details.
Gabions	$18 to $24 per sf	Baskets are subject to long term corrosion and vandalism. Overtopping depths typically limited to 4 feet or less.

(2005 Costs)

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Types of Overtopping Protection and Costs: Examples

Roller Compacted Concrete (RCC)

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Types of Overtopping Protection

Articulated Concrete Block

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Types of Overtopping Protection

Cast-In-Place Concrete

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Types of Overtopping Protection

Gabions

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During the Project

- Don't be afraid to ask a lot of questions of YOUR engineer during planning & design.
- During construction:
  - Ensure that your engineer implements a thorough construction inspection program that includes input from the design engineer
  - Construction oversight of critical phases of construction

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During the Project

Examples of Critical Phases of Construction:

- Foundation Preparation
- Outlet Works Construction
- Testing of Materials (e.g. concrete testing, placement and compaction of soils)
- Internal Drainage

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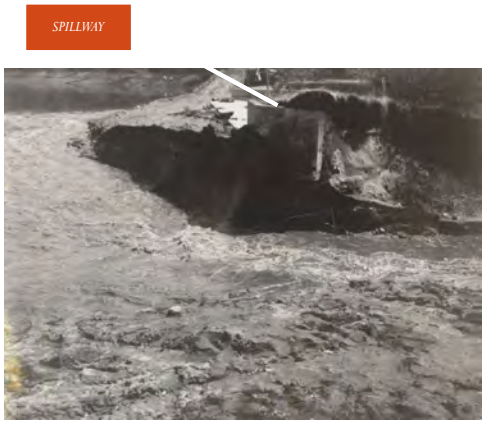
During the Project

- During construction:
  - The dam is particularly vulnerable to damage from flood events
  - The Contractor is responsible to protect the dam
  - The Contractor and Engineer should be reviewing the flood forecast



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During the Project

- During construction:
  - Take many pictures
  - Document conversations with the engineer and contractor

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Dam Removal

- Costs can vary widely, dependent on factors such as:
  - size, location, and accessibly of dam and reservoir
  - Amount, physical, and chemical characteristics of sediment in impoundment
  - Amount of river restoration work that is necessary
  - Weather conditions

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Dam Removal Considerations

- Enough of the existing dam must be removed so that it no longer impounds water under normal and storm conditions.
- Dynamic equilibrium of the stream is restored.
- Estimation of volume sediment trapped by dam.
  - Percentage to be removed vs percentage to be released
  - Coarse vs fine grained sediment
  - Potential for contamination of sediment

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Dam Removal Considerations

- Infrastructure upstream impacted by removal (i.e. bridge abutments, underground utilities)
- Dam Removal phasing
  - Staged dam removal/water control/sediment removal/river restoration

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Potential Funding Sources: State Programs For Rehabilitation and Removal

Rehabilitation (very limited):

- Unsafe Dam Revolving Loan Fund
  - Requires dam go through Unsafe Dam Proceedings and be found Unsafe (worst of the worst). Potentially eligible for up to $50,000 in loan funding for dam rehabilitation or up to 25% grant, 75% loan for dam removal

Removal:

- DEC Clean Water/Ecosystem Restoration Grants
- Water Infrastructure Sponsorship Program (WISPr)

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Potential Funding Sources: Federal Programs For Rehabilitation and Removal

Rehabilitation:

- FEMA High Hazard Potential Dam Grant
- USDA NRCS Small Watershed Rehabilitation grants
- Homeland Security Funds for Dam Security

Removal:

- EPA Watershed Initiative Grants
- US Fish & Wildlife
- NOAA
- Non-Government Organizations (NGOs – Trout Unlimited, Nature Conservancy, American Rivers, etc.)

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What ASDSO Is Doing?

- Supporting passage of a Federal Dam Rehabilitation Financing Solutions Program (ASDSO Report on *National Cost of Dam Rehabilitation*) – HR 1770 & S. 732 (See CD)
- Support federal safety policies: the National Dam Safety Act and the National Levee Safety Act
- Working to Strengthen State Programs and encouraging states to launch loan/grant programs for dam rehabilitation.

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