Participant Guide

Session 7: Repair Projects – Hiring an Engineer Consultant, Costs, and Funding Options

What Will Be Covered in Session 7

- Typical Dam Repair Costs
- Four categories
- Typical cost case study
- Funding Opportunities
- The Rehabilitation Process

Session 7 Learning Objectives

- Identify typical dam repair costs
- Identify Federal, State, and local funding sources
- How to retain a qualified professional engineer for dam safety services

Materials

- Powerpoints Session 7
- Refer to Appendices B, G, H & I

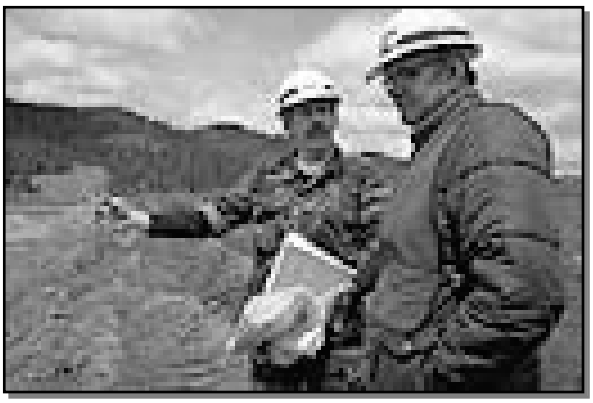
The Process of Getting the Job Done

Step 1: Meet with potential consultant and receive proposals (three recommended)
Step 2: Pick consultant (contracting)
Step 3: Consultant begins design process
- Surveying
- Geotechnical Investigations
- Preliminary Plans and Review of Plans
- Final Plans

Step 4: Permitting Begins (local, state and/or federal)
Step 5: Consultant gets construction bids (three recommended)
Step 6: Owner hires contractor upon recommendation of consultant
Step 7: Construction

This process will normally take a year or more. For example, permitting alone may take 6 months or more.

Guidelines for Retaining Professional Engineers



A qualified engineer provides up to date knowledge of best design practices and strategies to meet the dam safety construction standards of the state's dam safety laws and regulations. Also, they provide monitoring of the repair construction to ensure that remediation is performed in compliance with approved plans and specifications. This is necessary so that the owner does not receive an unsafe or inferior product, which could result in the need to make the repair more than once, or result in **dam failure, loss of life, or damage** to downstream property.

Typical Problems Requiring a Professional Engineer:

- Inadequate discharge/storage capacity
- Severe spillway deterioration
- Questions of dam instabilities
- Embankment slides
  - Deep seated
  - Shallow (surfacial)
- Seepage (large volume of flow, sediment transport)
- Large cracks in the embankment (longitudinal or transverse)
- Sinkholes
- Severe erosion of the upstream slope

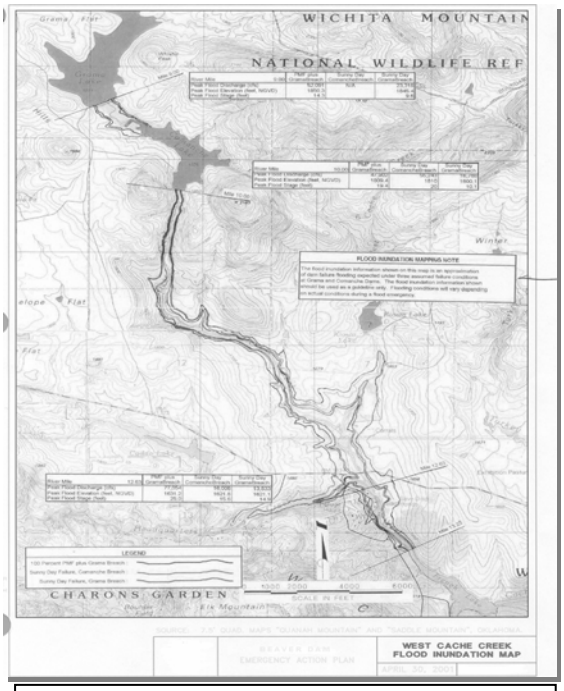
Inadequate Storage Capacity

Severe outlet deterioration

Typical Problems Requiring a Professional Engineer:

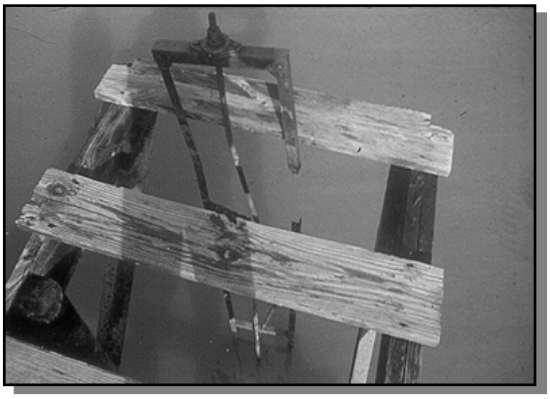
- Lack of, or inadequate, outlet erosion control structure
- Lack of, or inoperable, lake (or bottom) drain
- Need for an EAP or inundation maps

Seepage



Inundation Map

Large crack in the embankment



No lake drain or inoperable lake drain

How Do You Find a Qualified Engineer?

Contact the state dam safety program and ask for the list of engineers that have done work in the state or that have requested to be placed on the engineers list.

- Contact the state board of registration or the State Consulting Engineers Council for a list of registered engineering companies in your area.
- Look in the local phone directory under “engineers.”

What Qualities Should I Look for in an Engineer?

- The engineer should have a strong background in civil, agricultural, geotechnical, or water resources engineering (depending on the type of repairs that are necessary)
- The engineer should be familiar with the state dam safety laws and rules.
- The engineer should have experience in the design of dams and hydraulic structures.
- The engineer should have sufficient manpower and capabilities for the job.
- What are the engineer’s specialties? For example:
  - Hydrology
  - Hydraulics
  - Geotechnical Engineering
- The engineer should provide a list of dams that have been worked on.

The engineer must be registered in the state in which the dam is located.

During the Project

- Don't be afraid to ask a lot of questions of **YOUR** engineer.

- 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

  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

  Take many pictures

  Document conversations with the engineer and contractor

Typical Dam Repair Costs

National Cost of Dam Safety Rehabilitation for Four Categories

(Chart developed by ASDSO Committee on Repair Funding—methodology discussed in Chapter 7 Attachment 1)

Height-Based Group	Cost Estimate	Total Cost
Group 1 – less than or equal to 15 feet	$210,413/dam	$1.514 billion
Group 2 – 16 to 25 feet	$463,623/dam	$5.448 billion
Group 3 – 26 to 50 feet	$1,236,027/dam	$15.498 billion
Group 4 – greater than 50 feet	$6,659,877/dam	$13.735 billion

Table shown to emphasize typical cost per project.

Cost may vary depending on local differences but could use logic diagram and apply other typical cost.

Spreadsheet data shown for each size category in ASDSO report.

Note: This is a national average.

Typical Dam Repair Costs – Example 1

An example of the rehabilitation of a typical small dam in Ohio (22 feet high); almost all elements of the dam were involved: spillway, embankment, and lake (or bottom) drain.

Description of repair activity:

The spillway is replaced. The old concrete culvert and concrete chute is to be replaced with new concrete culvert (7 feet high by 14 feet wide) and an outlet chute and concrete stilling basin. The embankment is to be raised 6 feet in elevation. The lake (or bottom) drain is to be replaced.

Typical Dam Repair Costs – Example 1 Cost Estimate

Remove existing spillway lump sum:	$10,000
New fill 14,000 yards @ $6/yd:	$84,000
6,000 yards @ $4/yd:	$24,000
Concrete inlet to culvert 17 yards@$600/yd:	$10,200
Concrete culvert 183 yards @ $600/yd:	$110,000
Concrete stilling basin 36 yards @ $600/yd:	$21,600
Roadway lump sum:	$20,000
Drain replacement lump sum:	$20,000
Diversion lump sum:	$2,000
Dredging 5,000 yards @ $6/yd:	$30,000
Contingencies and miscellaneous, riprap, and drainage material:	$50,000
Total:	$381,800

This was a major reconstruction so numbers are high but in contrast this is really not a very large dam. Often major rehabs cost more than it would to built a new dam.

Fill material cost in this estimate is probably on the low side. Cost of placing fill depends on how far it has to be hauled or how easy to get.

Note costs of concrete ($600/cubic yard) include forming, rebar, etc. This was a long culvert/chute type spillway and requires a lot of concrete ($140,000). A pipe and riser type spillway would cost less probably between $25,000 to 75,000 but is limited in capacity.

Dredging was required because the dam was raised by adding material to the upstream slope. Often it is not possible to raise the height of a dam by just adding material to top of the dam.

Add:

Survey – Surveying crew of three in field for two days and office preparation of topography, etc. : $4,000

Subsurface investigation – Three 70-foot soil test borings, two borrow area test pits, standard Proctor compaction tests, and geotechnical report: $4,450

Boring program for this site was minimal, but would typically be more extensive.

Design engineering – Usually 10–15% of cost estimate: $38,000

Total project cost for this example was $428,250: including $50,000 for engineering services

Not included is cost of construction supervision by the design engineer, and construction materials testing. This cost is estimated at $15,000 to $20,000.

This example compares with the *National Cost of Dam Safety Rehabilitation* table shown previously.

Typical Repair Costs: Example 2

Overtopping Protection

State requirements for using overtopping protection as a recommended option vary. Be sure to check with your state requirements.

The following costs were developed based on a fictitious dam with the following dimensions:

- 20 feet high
- 300 feet long
- 15 foot wide crest
- 2H:1V upstream and downstream slopes
- a 30 foot long run-out apron

These dimensions result in 27,000 sq. ft. (3,000 sq. yd.) of surface area to be armored.

The following items were assumed to be identical for each of the overtopping alternatives and not included in the cost estimate:

- An under-drain system
- Cutoff along upstream and downstream edges of armor
- Bedrock abutments

Types of Overtopping Protection

Overtopping Protection Materials	Unit Cost	Limitations
Roller Compacted Concrete (RCC)	$8.00 to $12.00 per sf	Usually produced on-site, so large staging area needed for plant and materials.
Articulated Concrete Blocks	$9.00 to $12.00 per sf	Lab studies show stable for up to 4 feet of overtopping depth.
Conventional Cast-in-Place Concrete (reinforced)	$22 to $35 per sf	Difficult to place on 2H:1V slope. Attention must be made to joint placement and details.
Gabions	$15 to $20 per sf	Baskets are subject to long term corrosion and vandalism. Overtopping depths typically limited to 4 feet or less.

For this size dam a total project cost for overtopping protection can range from $250,000 to over $500,000 - at least as much, if not more than a major rehab - and is usually not recommended. It is typically approved only as a last option.

Articulate Concrete Blocks

RCC Placement

Cast-In Place Concrete

Gabions

Potential Funding Sources: State Loan and Grant Programs

Which states have state loan or grant programs?

Refer to List in Attachment 2.

What is Available in Your State?

Attachment 2 lists states that currently have loan or grant programs as well as information about each program.

What is ASDSO doing to assist states in setting up loan/grant programs?

ASDSO has developed a model law and model regulations to help states set up their own loan and/or grant programs. ASDSO is supporting a federal dam rehabilitation loan fund bill (Currently two bills are circulating in Congress: HR 3224 and S. 2238). Call ASDSO at 859-257-5140 or visit the website for more information: www.damsafety.org.

Potential Funding Sources: Federal Initiatives

- National Dam Rehabilitation and Repair Act: Currently two bills are circulating in Congress: HR 1105 and S. 2444 (2006). Check ASDSO website for updates. www.damsafety.org
- The Small Watershed Rehabilitation Act offers grants to dams built under several federal programs by the Natural Resources Conservation Service. For more information go to https://www.nrcs.usda.gov/programs-initiatives/watershed-rehabilitation

Potential Funding Sources: Local Funding

City/County parks and recreation departments

Lakefront homeowners associations

Other Options

Phased repair program

Decrease size of dam and impoundment - A smaller dam will decrease the hazard potential and may change the regulatory requirements

Dam removal

Transfer ownership

Phased Repair Program – Owners may check with State dam safety officials to determine the feasibility of a phased repair program. Repair costs can be budgeted over an extended period using this method.

Removal is always an option - Some owners cannot afford to own a dam. Cost to remove a small, regulated earthen dam can be as much as $100,000. This figure includes necessary engineering services. There may also be environmental concerns associated with removal of a dam.

ATTACHMENT 1

NATIONAL COST OF DAM REHABILITATION

SUMMARY OF THE COST METHODOLOGY

ELIGIBILITY

All non-federally owned dams were determined eligible for proposed funding under this study. This will constitute a total eligibility of approximately 74,889 dams currently inventoried nationally.

METHODOLOGY & ESTIMATE

In order to facilitate the development of a national estimate, several baseline assumptions were made. First; that the working definition of a rehabilitation scope would include repair, replacement, and removal, second: that dam height would be the primary criteria in segmenting the National Inventory of Dams (NID)[1] into more manageable groups and third, that any estimate would exempt federal dams.

Dam height was selected because it was determined to be the single most effective indicator of over all size and cost of repair. The NID was divided into four height categories: dams less than or equal to 15 feet, between 16 and 25 feet, between 26 and 50 feet, and over 50 feet.

The next task was the development of specific logic diagrams for each group that would focus on percentages of dams that require some level of remedial measures. These potential measures would be taken in order and include the following:

- Deferred maintenance
- Detailed engineering assessment
- Hazard potential reclassification
- Physical improvements.

Deferred maintenance is defined as any maintenance activity that does not require formal engineered plans or the approval of a professional engineer.

The first step in this methodology exercise is to divide all dams within each category by the need for correcting deferred maintenance deficiencies. Typically, this would include tree cutting, slope clearing, patching concrete, gate repair, etc. Generally a contractor or heavy equipment would be necessary for this work. Conversely, other dams would be considered well maintained.

An engineering assessment is defined as including hydraulic/hydrologic, stability, and geotechnical analyses, and the development of alternatives, DAMBRK analysis, cost estimates, and any necessary instrumentation installation.

Estimates are made for the two groups: percentage of dams that require maintenance and the percentage, which do not. *Deferred maintenance* costs are assigned to those dams that do require maintenance.

The second step is to estimate for each of the two groups (maintenance or no maintenance) the percentage of dams that require an engineering assessment.

[1] The National Inventory of Dams is a database program administered by the US Army Corps of Engineers that houses information on dams regulated either by the federal government or state governments.

For dams requiring an *engineering assessment*, the estimated cost of such an assessment is assigned. For dams with no deferred maintenance and no need for an engineering assessment, no further breakdown is necessary and a $0 cost is assigned.

For dams that require maintenance but do not require an engineering assessment, no further breakdown is necessary and the cost of deferred maintenance is assigned as the final cost for the dams.

For dams in both maintenance categories that do require engineering assessments, the percentages are broken down into dams that would and would not require a change in hazard classification as a result of the assessment findings.

The next breakdown is an estimate of the percentages of dams; both ones that require a change in hazard classification and those that don't, which require remedial action. For each category, an estimated cost of the remedial action is assigned.

This completes the placement of dams into various treatment scenarios and the estimate of dams that will require remedial action. To complete the chart, the percentages are multiplied across the table to compute the total estimated percentage of dams in each treatment scenario. The cost of each dam grouping is figured by multiplying the total number of dams in the treatment scenario by the estimated cost of rehabilitation for that particular scenario. Average rehabilitation cost figures were determined based on collective experience of the committee and actual project histories. The total cost for rehabilitation of all dams in each height category is figured by adding all the costs in the total cost column.

The following table illustrates the conclusion of the analyses. Column 1 describes the four dam height categories. Column 2 shows the percentage of dams needing rehabilitation within each group. Column 3 shows costs associated with the rehabilitation work.

Height-Based Group	Cost Estimate	Total Cost
Group 1 – less than or equal to 15 feet	$210,413/dam	$1.514 billion
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RESULTS

Using this formula, it was estimated that it would costs $39.2 billion to rehabilitate all the dams in the U.S. identified as needing rehabilitation. In addition to this "hardcost" there will additional funding required for state and federal administrative costs.

The committee's work and the estimate methodology have undergone peer review by a wide range of dam safety practitioners and have the capability to be further refined in the future. Individual states can utilize the estimating formulas provided and can adopt enhancements for their particular dam inventories or priorities. The information contained within the provided national estimates should also be considered in discussions on National Funding Legislation.

Naturally, policymakers should consider these estimates in determining appropriate funding levels. Individual states should utilize these methodologies as a baseline estimating tool for their given inventories and should validate the calculated estimates by taking into account any state-specific factors. Also, these estimates include the preparation of necessary engineering and operation plans, which are vital components of the complete rehabilitation project.

ATTACHMENT 2

STATE DAM LOAN/GRANT FUNDING PROGRAM SUMMARY

STATE	PROGRAM TYPE	PROGRAM NAME	SOURCE OF FUNDING	ELIGIBILITY	LOAN/GRANT AMOUNT	TERM OF LOAN	EVALUATION CRITERIA	PERMITTING/ INSPECTION/ HOLD BACKS
AZ	Loan or grant	Dam Repair	Legislature, Lien fund, Inspection fees, filing fees, principle and interest from previous loans	State engineer determines dam to be dangerous to life, non-emergency	Loan- cost of project Grant – portion of cost of project	Up to 20 years at 3-6% interest, depending on length	Determined by State Engineer	
MD	Loan and planning assistance	Maryland Environmental Service	State Agency/Non-profit Corporation	Counties, utilities and private groups. Need to have established service district for water supply, resource reclamation, dredging or stormwater				
MA	Grants		Funding through DEM. In past $5 million. No new appropriation.	Local communities for repairs or removal	75% of the project, local share can be in-kind contributions			
NJ	Revolving loan fund New grant fund for municipally owned dams	Dam Restoration and Clean Water Trust Fund	$20 million - $5M for state high hazard dams $15 M loans. In 2000 an additional $9.5 was added.	Local units of governments, private owners can be co-applicants	Cost of project for loans Up to 100% for grants	Up to 20 years @2% assessed against real estate benefited	Priority ranking system for type/size of dam/ impoundment, hazard, magnitude of problem, etc…	Must be compliant with all state dam safety requirements
NM	Grant and Loan	Capital Improvemt. (CIP) Fund and ISC Irrig. Works Const. (IWCF) Fund	State Engineer, Legislature or Governor for CIP Fund and Interstate Stream Commission for IWCF Loan	Must be a “Political Subdivision” of the State	CIP Grant Varies IWCF Loan Varies	IWCF Loan up to 20 years @ 2.5%	Determined by ISC	

NY	grants	Clean Water/ Clean Air Bond Act	$17 M bonding	Municipality for dam safety projects	75% of eligible project (25% local match) $300,000 cap per project			
OH	Revolving loan fund	Ohio Water Developme nt Authority	Revolving loan fund	Owner must under mandate from ODNR. Dam Safety Loan Program – Local units of gov., state, districts Dam Safety Linked Deposit Program – private owners/org.	Cost of project	5-25 years at lower than market rate	Applicant needs user charges or revenue to cover loan payment	Must have inspection report and approval of plans from ODNR
PA	Revolving loan fund	Pennvest	Revolving loan fund, $2 billion from state general purpose funds	Projects associated with wastewater, water supply or stormwater	Up to cost of project	20-30 years at low interest		
UT	Loans or grants	Utah Board of Water Resources	$4.5 from general revenue and 0.8 cent sales tax (created originally to deal with flood control problems)	High hazard dam owners. Mandated repairs	80-95% grant for irrigation or water supply dams, loans or grants for other owners		Ranking by state engineer based on severity of deficiencies and population at risk	Can be used for non-structural alternatives.
WI	grants	DNR Municipal Dam Grant Program	$11.5 M of bonding over 10 years. Currently fully subscribed	Local units of government and Lake Districts	50-50 grants up to a $200,000 maximum for		Ranking by code criteria based on hazard, financial need and size	Must be under order or directive of DNR for dam safety deficiencies.