Value Engineering

FINAL REPORT

PROJECT:

BLACK ROCK DAM MODIFICATION

DATE: APRIL 22, 1993

Conducted Under Cooperative Agreement with:
THE ZUNI TRIBE
Safety of Dams Program
Zuni Indian Reservation

UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Reclamation
Denver Office

VALUE ENGINEERING STUDY
PROJECT:

BLACK ROCK DAM MODIFICATION

VE TEAM MEMBERS

NAME	TITLE/DISCIPLINE	OFFICE/PHONE NO.
Sam Martin	VE Team Leader - Civil Engineer	Quality Management (D-3520) (303) 674-6900
Frank Jackmauh	Structural Engineer - Concrete Dams	Concrete Dams Branch (D-3110) (303) 236-2949
Mike Higgins	Civil Engineer - Construction Estimator	Estimates and Technical Services (D-3521) (303) 236-3982
Cletus King	Geologist - Engineering Geology	Geology Branch (D-3610) (303) 236-8441
Bob Scavuzzo	Geotechnical Engineer - Soil Testing	Soil Technology Team (D-3735) (303) 236-4324
John Anevski	Representative BIA Area Coordinator	BIA Representative Dam Safety Office (406) 657-6782
Dan Carr	Representative BIA Area Coordinator	BIA Representative Dam Safety Office (505) 766-3167
August Mueller	Safety of Dams Engineer Zuni Tribe	Tribe Representative Pueblo of Zuni (505) 278-4491

PROJECT DESCRIPTION

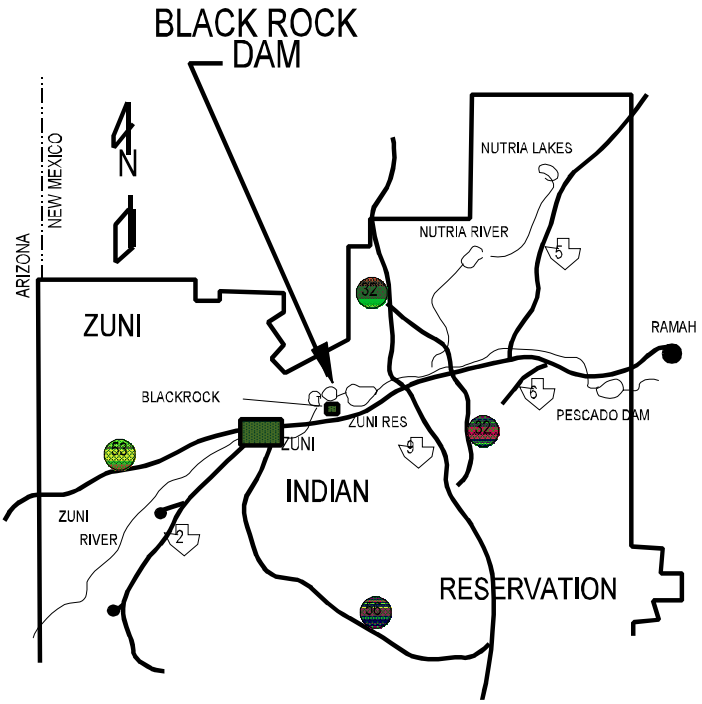
Black Rock Dam is located in a narrow canyon on the Zuni Indian Reservation on the Zuni River in west central New Mexico immediately upstream from the town of Black Rock. The dam was initially constructed in 1908 and has had several repairs and modifications since then. The original reservoir capacity was 15,000 acre-ft; however, sedimentation has reduced the present reservoir capacity to about 2,300 acre-ft. The dam height above the original streambed is about 80 feet and the structural height is 110 feet. The drainage basin contributing to the reservoir is about 633 mi^2. The dam is classified as a high hazard dam.

The dam was constructed using a combination of hydraulic fill (estimated to be 60,000 yd^3), on the upstream side, and rockfill (estimated to be 40,000 yd^3), on the downstream side. The crest length is 780 feet and the crest width is about 20 feet at an elevation of 6446 feet. The downstream face consists of hand-placed stepped masonry blocks, and the upstream face is protected by layers of gravel and hand-placed riprap. The spillway is an ungated ogee section with a crest length of 171 feet at a crest elevation of 6436 feet. The spillway is located on the left abutment, has a concrete- lined floor with masonry walls, and has a maximum capacity of 6,000 ft^3/s (a 20-year recurrence interval storm). The outlet works is on the right abutment and primarily diverts irrigation releases. It also serves for the reservoir's evacuation requirements. The outlet works is comprised of a 6-foot diameter tunnel with a 2-foot manually-operated slide gate enclosed within a gate tower. There is no power at the dam; however, power is available nearby.

The foundation of the dam generally consists of alluvial material and terrace deposits. The abutments consist of alluvial and eolian soil deposits overlaid by intensely stratified basaltic and alluvial deposits. The basaltic rock is relatively strong and the soil deposits are composed primarily of sand, silt, and clay.

The dam has several identified dam safety deficiencies that require corrective action: overtopping due to inadequate spillway capacity, uncontrolled foundation seepage, and piping through cracks in the outlet works tunnel lining. Foundation seepage has been exacerbated by flooding difficulties during project construction and three partial failures of the structure. Due to the effective height of the dam, the probable failure of the outlet tower during the maximum credible earthquake (MCE) is not considered to be a dam safety issue; however, as it is expected to fail during the MCE, has deteriorated, and affects several project requirements, replacement of the outlet tower is desired.

GENERAL SITE LOCATION



ORIGINAL CONSTRUCTION - PLAN

ORIGINAL CONCEPT - DAM SECTION

ORIGINAL CONCEPT - OUTLET TOWER

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SPECIAL CRITERIA

USERS:
! The dam and reservoir are owned by the Bureau of Indian Affairs. The Zuni Tribe operates and maintains the structure.
CODES:
! Safety of Dams modifications must conform to Bureau of Indian Affairs safety criteria (which are almost identical to the Bureau of Reclamation's safety criteria).
RESTRICTIONS:
! The modifications should address dam safety issues. Other issues are examined if they fall within the general guidelines of correcting dam safety identified issues that could affect public safety, or if the issues are specific to be within guidelines specified by the BIA.
! The dam has been designated a historic structure by the state. The right abutment has many archeological sites that restrict activities.
! The irrigation season operations should remain unencumbered as much as practicable by the construction activities. Therefore, construction during the period between May to August is less desirable than other periods. (Construction should be limited as much as possible to those activities that may be accomplished without disruption to the normal reservoir operations.)
DESIGN HISTORY: (RESPONSIBILITIES, COMMITMENTS, STATUS, ETC.
! The original structure was designed and constructed by the Bureau of Indian Affairs. The dam was damaged during construction by a flood in 1905. Partial failure due to seepage occurred in 1909, 1932, and 1936. Corrective measures were taken after each event. Additional enhancements and corrective measures have been constructed throughout the project's life.

! The dam safety examinations related to this concept design were initially completed in 1982 with subsequent investigations continuing throughout the preliminary analyses. The last inspection on record was conducted in 1991. The dam's condition is rated as poor, since the dam cannot safely pass floods that can be reasonably expected to occur at the site during the structure's life.

SPECCRIT.TAB

DESCRIPTION OF PRESENT DESIGN

PRESENT DESIGN

The dam safety deficiencies corrections at Black Rock Dam consist of four major construction features:

Modification of Existing Spillway. Due to the design of the dam, it is believed the dam can withstand overtopping by 5 feet during the probable maximum flood (PMF) event. By extending the existing spillway along the left abutment 170 feet, the modified existing spillway will contain overtopping to no more than 5 feet during a PMF event. (The modified spillway capacity before overtopping occurs is 50% of the PMF event.) The overtopping requires the addition of protection for the toe and groins; however, the data and cost information for this protection were not available during the study.

Outlet Works Rehabilitation.

Outlet Works Tower Replacement. Complete replacement of the outlet tower to correct both the current degraded condition and its potential failure during the MCE is proposed.

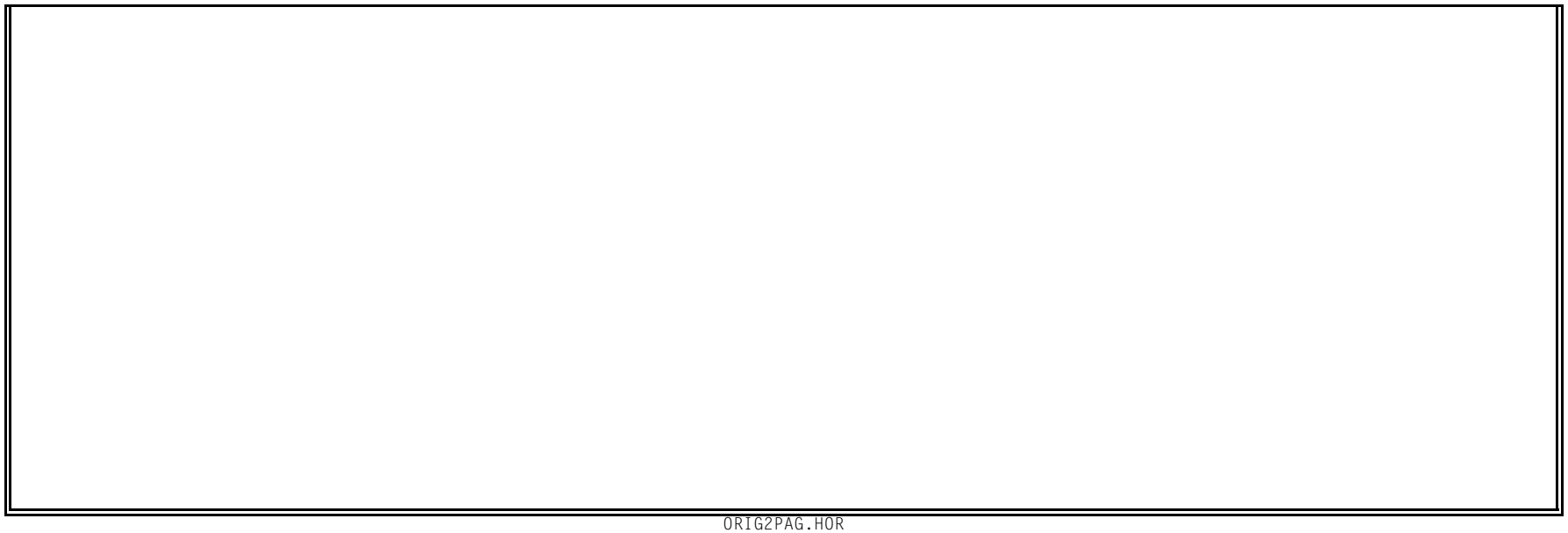
Outlet Works Tunnel Steel Lining. Lining of the outlet works tunnel with a steel liner is proposed to correct the piping into the tunnel from the dam embankment. Void behind the liner will be grouted. The steel liner provides structural strength but is subject to corrosion.

Raise Dam. The dam will be raised a total of 3 feet to prevent overtopping during lesser flood events to allow storage of portions of the inflow design flood and the PMF.

Geomembrane Liner. An impervious geomembrane liner will be placed over the upstream dam face and left and right abutments. The liner will limit the seepage through the dam and abutments and increase the seepage path substantially. A geotextile in the reservoir bed is required to allow construction equipment to move within the bed area. The existing riprap will be removed and stockpiled and the subgrade will be smoothed before membrane placement. A soil covering over the membrane will be required and the bedding and riprap will be replaced for wave action protection.

ORIGINAL CONCEPT - GEOMEMBRANE/DAM SECTION

ORIGINAL CONCEPT - GEOMEMBRANE/ABUTMENT SECTION



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ORIGINAL CONCEPT - OUTLET WORKS TOWER REPLACEMENT

ORIGINAL CONCEPT - SPILLWAY

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PLACE COST MODEL HERE

FUNCTION ANALYSIS

PROJECT: BLACK ROCK DAM MODIFICATION

COMPONENT	VERB (ACTIVE)	NOUN (MEASURABLE)
SPILLWAY MODIFICATION	Support Pass Create Limit Prevent Increase Protect	Load Water Void Overtopping Erosion Capacity Structure
SEEPAGE CONTROL	Replace Fill Control Prevent Remove Stabilize Stabilize Limit Create Place Place Protect	Riprap Void Seepage Erosion Water Embankment Soil Piping Void Geotextile Membrane Membrane
OUTLET WORKS TOWER	Prevent Create Fill Facilitate Evacuate Direct Control Construct Destruct	Failure Void Void Maintenance Reservoir Flow Discharge Tower Tower
OUTLET WORKS LINING	Pass Prevent Install Support Fill	Water Piping Pipe Load Voids
RAISE DAM	Increase Limit Prevent Save Prevent Place Place	Storage Overtopping Failure Lives Erosion Concrete Rock
MOBILIZATION	Gather Enable	Resources Construction

FUNCANAL.TAB

COST MODEL AND ESTIMATE INFORMATION

The study team cost model is based on the conceptual design estimates provided by the design team for the preferred project conceptual. This cost model is developed by the VE team and is used to focus on features with the greatest potential for savings and to highlight areas of value mismatch.

Unit prices are reviewed by the Estimates and Technical Analysis Section, D-3521, to ensure reliability and applicability.

Cost savings and the original design concept estimates are of the same general level of development. It is recognized that these costs may vary as final designs are pursued.

FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST)

The study team used the function analysis process to generate a FAST diagram showing the critical functions for the design and the secondary functions not on the critical path. The use of the function analysis, and the resulting FAST diagram, allowed the VE study team to identify the critical functions that must be performed to accomplish the conceptual design purposes. Following this VE process helped the study team in understanding the project, and allowed the team to concentrate their efforts on features most critical to the project purposes.

FAST DIAGRAM FROM 123 PRINTOUT

VALUE ENGINEERING - DISPOSITION OF IDEAS
BLACK ROCK DAM MODIFICATION
CONCEPTUAL DESIGN

OTHER VE ELEMENTS CONSIDERED AS POTENTIAL PROPOSALS		
IDEA	PURPOSE	DISPOSITION
! Grout injection of the rock embankment	Stabilize embankment during overtopping.	Developed and submitted as VE proposal alternative.
! RCC or soil cement	Stabilize embankment during overtopping.	Submitted as an item for further study.
! Raise dam	Contain floodwater within reservoir.	Not considered economically viable.
! Increase existing spillway capacity	Use gates or other method to increase discharge capacity.	Combined with another item for further study.
! Caisson placement	Use caisson method to install tower.	Developed and submitted as VE proposal alternative.
! Brace cuts	Use steel or soil column mixing to create hole to place outlet structure.	Developed and submitted as VE proposal alternative.
! Auxiliary spillway	Use the right abutment as an auxiliary spillway.	Submitted as an item for further study.
! Size pipe to existing requirements	Size pipe to pass the current demand flows and not the old projected flows.	Tribe has strong objections. Potential cost savings are low.
! Single bay tower with chamber bay for mixing.	Reduce the cost of the tower by reducing the required scale of the tower.	Potential cost savings below other features developed further.
! Upstream detention dams	Store flood waters upstream and pass flood over longer period.	Materials to build may not be present. Potential for cost savings appear poor.
! Freeze the ground around the outlet works tower	Using freezing method to avoid large excavation and backfill costs.	Potential for savings appear low when compared to other developed features.

OTHER VE ELEMENTS CONSIDERED AS POTENTIAL PROPOSALS		
IDEA	PURPOSE	DISPOSITION
! Dredge pumps	Add water and use sediment pumps to excavate sediments.	Water is not available during construction period in quantities sufficient to make this feasible.
! Steeper slope or piles	Use piles or excavate nearer to embankment to reduce outlet tower costs.	Site is not geologically compatible with this concept.
! Increase reservoir capacity	Excavated reservoir sediments and use storage to hold more of flood waters.	Volume is insufficient to be of significant storage to help in PMF event. Cost is prohibitive.
! Clay liner	Use clay as liner in place of geomembrane.	Material is unavailable nearby. Cost is prohibitive.
! Toe drain, internal drains, or filters	Use toe drain in place of geomembrane.	Not economically viable.
! Foundation injection grouting	Seal foundation to seepage.	Not economically viable.
! Cutoff walls	Seal embankment and foundation seepage.	Not economically viable.
! Tunnel spillway	Use a tunnel to provide additional spill capacity.	Not economically viable.
! Increase size of outlet works	Use more of the outlet works flow capacity to reduce spillway size, etc.	Not economically viable.
! Metal or precast outlet tower	Drive a precast or metal tower into sediment at new location to avoid costs and problems.	Developed and submitted as a VE proposal alternative.
! Allow failure of tower and pump if it ever fails	MCE may not actually fail tower totally and if it does, pumps costs are reasonable.	Deemed unacceptable to the tribe.

OTHER VE ELEMENTS CONSIDERED AS POTENTIAL PROPOSALS		
IDEA	PURPOSE	DISPOSITION
! Blast tower	Demolition of tower would be quick and would not have as much equipment requirements.	Typical demolition procedures are believed to be less costly than blasting procedures.
! Grout the groin areas	Groin and toe need protection in overtopping event.	Submitted as an item for further study.

VEIDEAS.TAB

BLACK ROCK DAM MODIFICATION
CONCEPTUAL DESIGN

DESIGN TEAM BRIEFING

8:3Ø a.m., MONDAY, NOVEMBER 3Ø, 1992
Room 67-1Ø5Ø

NAME	CODE/OFFICE	PHONE
Sam Martin	SAMI, LLC FOR: D-3520, Value Engineering	(303) 674-6900
Cletus King	D-361O, Geology Branch	(303) 236-8441
Chuck Cooper	D-311O, Concrete Dams Branch	(303) 236-9012
Bruce Feinberg	D-311O, Concrete Dams Branch	(303) 236-0472
Bill Fiedler	D-311O, Concrete Dams Branch	(303) 236-4013
Frank Jackmauh	D-311O, Concrete Dams Branch	(303) 236-2949
Mike Higgins	D-3521, Estimates	(303) 236-3982
Perry Hensley	D-362O, Geotechnical Engineering and Embankment Dams	(303) 236-5904
Tuti Tierney	D-362O, Geotechnical Engineering and Embankment Dams	(303) 236-9733
John Wilson	D-362O, Geotechnical Engineering and Embankment Dams	(303) 236-3900
Bob Scavuzzo	D-3735, Soil Testing Team, FOR D-3620	(303) 236-4324
Rodney Danzeisen	D-33OO, Dam Safety Office	(303) 236-8481
Robert E. Lewis	Governor, Pueblo of Zuni	(505) 782-4481
Dan Carr	BIA, Dam Safety Ofc, Albuquerque, NM	(505) 766-3167
John Anevski	BIA, Billings, MT	(406) 657-6782

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INFORMATION/DATA DOCUMENTS CONSULTED

DOCUMENT (Name, Author, Dates, etc.)	INFORMATION RECEIVED/USED

Underground Structure, Design and Construction, 1991, Ed. R.S Sinha	Ground freezing (Chapter 9, pgs 351-402)
Biotechnical Slope Protection and Erosion Control, Donald W. Gray and Andrew T. Leiser	Gabion walls (Chapter 5.2.2, pgs 93-94 and Appendix 1-A, pgs 231-233)
PROCEEDINGS-Rapid Excavation and Tunneling Conference, Los Angeles, CA, June 11-14, 1989, Ed. Robert A. Pond and Patrick B. Kenny	Excavation methods (Construction Management and Team Effort, Soft Ground Tunnel Project, Alexandra, Egypt, by Chaitanya "Tony" Mittal, pgs 223-228)

DOCUMENT.REC

CONSULTATION RECORD

CONSULTANT (Name,Title, Company)	CONTACT INFO (Telephone, address)	MAIN TOPIC DISCUSSED AND INFORMATION RECEIVED
John Cyganiewicz Civil Engineer, D-3620	Bldg 67, Rm 960 (303) 236-3897	Clay liners and injection grouting
David Achterberg Civil Engineer Dam Safety Office	Bldg 67, Rm 1368 (303) 236-8600	BOR Dam Safety will only pay for raising the dam to contain the PMF without freeboard
Matt Sheskier Civil Engineer, D-3620	Bldg 67, Rm 942 (303) 236-3895	Clay liners and injection grouting
Ed Gray Civil Engineer, D-3620	Bldg 67, Rm 900 (303) 236-8548	Clay liners and injection grouting
Peter Aberle Civil Engineer, D-3500	Bldg 67, Rm 1300 (303) 236-6825	Injection grouting, grouting procedures.
Bob Dewey Civil Engineer, D-3620	Bldg 67, Rm 942 (303) 236-3867	Geotextiles
Tom McDaniel Civil Engineer, D-3620	Bldg 67, Rm 900 (303) 236-3870	Caissons
Bruce Feinberg Civil Engineer, D-3110	Bldg 67, Rm 1202 (303) 236-0472	Tower excavation, overtopping protection using "shingles" as per the Colorado State study
John Wilson Civil Engineer, D-3620	Bldg 67, Rm 942 (303) 236-3900	Existing design parameters

David Elkins Civil Engineer, D-3620	Bldg 67, Rm 960 (303) 236-9725	Slope stability
David Gillette Civil Engineer, D-3620	Bldg 67, Rm 960 (303) 236-3864	Slope Stability
Raghupati Sinha Technical Spec, D-3620	Bldg 67, Rm 942 (303) 236-3994	Ground freezing methods, caissons
Mike Romansky Civil Engineer, D-3620	Bldg 67, Rm 916 (303) 236-3858	Caissons
Bill Fiedler Civil Engineer, D-3110	Bldg 67, Rm 1220 (303) 236-4013	Auxiliary spillway in right dike, different PMF routings
Glenn Smoak Civil Engineer, D-3743	Bldg 56 (303) 236-6103	Injection grouting of blocks on downstream face of dam
Gary Donat Civil Engineer, D-3510	Bldg 67, Rm 1300 (303) 236-4211	Soil freezing operations for outlet works tower excavation.

CONSULT.REC

VALUE ENGINEERING - ALTERNATIVE EVALUATION

PROJECT: Black Rock Dam

COMPONENT: Spillway Modification/Dam Crest Raise

FUNCTION: Overtopping Protection

NO.	SELECTED ALTERNATIVES	ADVANTAGES	DISADVANTAGES
1	! Low pressure grouting of existing downstream rockfill to provide a 10 foot grout blanket under existing stepped masonry blocks.	! Provides downstream slope protection/stability during PMF overtopping event. ! Maintains desired dam aesthetics.	! Labor intensive work required for joint cleanup and grouting.

DESCRIPTION OF VE PROPOSAL

VE PROPOSAL NO. 1 DESCRIPTION

PROPOSAL NO. 1. GROUT EXISTING ROCK EMBANKMENT UNDER MASONRY BLOCKS

Proposal Description

Provide overtopping protection by low pressure grouting of downstream rockfill under existing stepped masonry blocks along with some protection of dam crest, dam groins, and at the toe of the dam.

Proposal Specific Items

! Eliminates the need to modify the existing spillway in conjunction with a dam crest raise while withstanding the estimated dam overtopping during a PMF event.

! Proposal will maintain the structural and visual aesthetics of the dam.

BRDPRPOS.DES

IMPLEMENTATION OF PROPOSAL NO. 1

CRITICAL ITEMS TO CONSIDER:
! Grout mix design must be adequate to provide necessary sealing for site specific jointing conditions.
! The VE proposal is based on 40% voids in dam downstream rockfill - changes in this assumption significantly change cost estimates.
! Work must be performed using low pressure grouting techniques to minimize disturbance of the embankment.
PROBLEMS AND HOW THEY CAN BE OVERCOME:
! A thixotropic agent must be used in the grout mix design to achieve 10 foot grout blanket.
! Low pressure grouting techniques must be used to prevent movement of stepped masonry blocks.
PROCEDURES: (WHO DOES WHAT)
! The Reclamation Concrete Technology Team will evaluate grout mix design with regard to workability and sealing characteristics.
! Possible Reclamation Hydraulic laboratory testing to further evaluate low pressure grouting technique under estimated 10-foot PMF overtopping event.
SUMMATION OF BENEFITS AND DRAWBACKS OF THE VE PROPOSAL:
Advantages: Grouting of downstream slope provides protection and stability during PMF overtopping event while maintaining desired structural and visual aesthetics.
Disadvantages: Performance of thixotropic agent in grout mix design during extended freeze/thaw cycles over dam lifetime is not fully known.

BRDPLMEN.TAB

VALUE ENGINEERING PROPOSAL NO. 1

PROJECT: Black Rock Dam	
COMPONENT: Spillway Modification/ Dam Raise	FUNCTION: Overtopping Protection

ORIGINAL CONCEPT	VE CONCEPT
! Modification of existing spillway in conjunction with a 3-foot dam crest raise to allow 5 feet of overtopping during a PMF event with no downstream protection.	! Do not modify existing spillway or raise dam crest and provide adequate downstream overtopping protection by low pressure grouting.

COST ITEMS	NON-RECURRING*	LIFE CYCLE*
ORIGINAL CONCEPT	$10,500,000	
VE CONCEPT (-)	$ 9,400,000	
SAVINGS	$ 1,100,000	
NUMBER OF UNITS (X)	1	
TOTAL SAVINGS	$ 1,100,000	
VE STUDY COSTS (-)	$ 20,000	
IMPLEMENTATION COSTS (-)	$ 40,000	
NET SAVINGS	$ 1,040,000	

* CHOOSE ONE METHOD - USE NON-RECURRING IF LIFE CYCLE COSTING DOES NOT APPLY.

BRDPROP.TAB

ORIGINAL CONCEPT - Spillway Modification

VE PROPOSAL NO. 1 - Grout rock under masonry block face

ORVE2PAG.HOR

VALUE ENGINEERING - ALTERNATIVE EVALUATION

PROJECT: BLACK ROCK DAM			
COMPONENT: OUTLET WORKS TOWER REPLACEMENT		FUNCTION: CONTROL WATER	
NO.	SELECTED ALTERNATIVES	ADVANTAGES	DISADVANTAGES
2	! Use caisson in place of open excavation and new tower.	! Reduces amount of material requiring excavation. ! Working in a caisson system is safer than an open cut procedure of excavation. ! No formwork, reinforcement, or concrete placement in field is required.	! Caisson procedure will add the need of a specialty contractor to perform the work.

3	! Use braced cut instead of open excavation.	! Reduces amount of material requiring excavation. ! Working in a caisson system is safer than an open cut procedure of excavation.	! Caisson procedure will add the need of a specialty contractor to perform the work. ! Braces will interfere with some types of work, e.g., excavation and driving piles (if required).

ALTEVAL.TAB

DESCRIPTION OF VE PROPOSAL

VE PROPOSAL DESCRIPTION NO. 2

PROPOSAL NO. 1. USE PRECAST CONCRETE CAISSON FOR THE OUTLET WORKS

Proposal Description

Use a 10-foot diameter precast concrete caisson for the outlet works tower.

Proposal Specific Items

! The caisson would be dropped into the ground as the excavation is advanced by clamshell. A steel shoe would be required on the bottom edge of the caisson. From the bottom of the pipe elevation, excavation may be performed by jetting. The jets would be attached to the outside of the caisson.

! The connections between the segments of the caisson need to be waterproofed and attached firmly locking the segments together. If the segments are not firmly attached and separate due to differential settlement, the gate rod could bend.

! Two alternatives may be used for connecting to the existing outlet pipe.

1) Use a slotted side on the caisson that would fit over the existing pipe. Once the pipe is reached in the excavation, the side would be opened on the caisson. The disadvantage to this is lowering the caisson in the exact position, which could be very difficult.

2) When the caisson reaches the pipe, the pipe is excavated by the clamshell and the caisson is lowered over it. Once the caisson is in its final position, the side is opened at the pipe location and connected.

! The caisson may be able to be used as a friction pile; if not, then it could be supported by piles driven through the caisson or by a longer caisson. This alternative includes piles and a pile cap.

! Dewatering may be required on the final design method. The dewatering may be performed at the bottom of the caisson. The jets mentioned above may be able to perform the dewatering.

IMPLEMENTATION OF PROPOSAL NO 2

CRITICAL ITEMS TO CONSIDER:
! The outlet tower is used to control the flow of water through the embankment.
! If improperly founded, the tower could fail during the MCE.
! The cost estimate obtained within the study appeared low to the study team. However, only one caisson is proposed and the cost estimate may be closer than it appeared during the study session. (Even if the costs were to double, this alternative is still an excellent savings.)
PROBLEMS AND HOW THEY CAN BE OVERCOME:
! The designers need to evaluate if piles are required for the foundations.
! The method for seating the caisson the last 20 feet needs to be evaluated by jetting or excavation.
! Dewatering (working in the dry) or placement of a cutoff floor by tremieing needs to be evaluated.
PROCEDURES: (WHO DOES WHAT)
! Future explorations are required to determine the foundation material for the caisson.
SUMMATION OF BENEFITS AND DRAWBACKS OF THE VE PROPOSAL:
Advantages: This alternative avoids the large number of unknowns related to the excavation of the silt and mobility in getting to the site with a large amount of heavy equipment. A new intake structure and foundation for it is constructed. (The current intake structure is near the end of its service life and it may be impossible to use the existing foundation without significant modifications.)
Disadvantages: The only known drawback found by the study team is the need for a specialty contractor.

IMPLEMEN.TAB

VALUE ENGINEERING PROPOSAL NO 2

PROJECT: Black Rock Dam	
COMPONENT: Outlet Works Tower	FUNCTION: Control Water

ORIGINAL CONCEPT	VE CONCEPT
! Excavate the silt around the existing tower at a 6(H):1(V) slope to about a 40-foot depth. ! Remove existing tower and replace with new two bay tower, using existing pile foundation. Use 36-inch gates and tie into relined pipe. ! Backfill silt around tower. Notes: ! No estimate was included for dewatering. Dewatering for this concept may be necessary. ! The wood piles in the existing foundation may have reached the end of their useful life. If this concept is carried to further design stages, further study will be required.	! Insert a temporary bulkhead in existing outlet pipe to prevent inflow of silt. ! Simultaneously place 10-foot diameter precast concrete caisson and excavate silt from inside caisson. ! Break existing pipe with clamshell. Caisson will extend pass pipe approximately 20 feet. ! At bottom of pipe elevation, jetting may be possible to advance caisson. The other option would possibly require excavation to bottom of caisson elevation (20 feet below pipe elevation). If this material is excavated out, it will need to be backfilled after caisson installation. ! Caisson may be adequate as self-contained foundation by using side friction or end friction; if not, piles need to be installed inside of caisson or a deeper caisson. Piles are included in this alternative. ! After caisson and piles are installed, install pilecap and floor of tower. Two options: 1) without dewatering, tremie concrete down to form a seal and pile cap; or 2) dewater from inside or outside of caisson, and work "in the dry." Dewatering is not factored in the cost estimate.

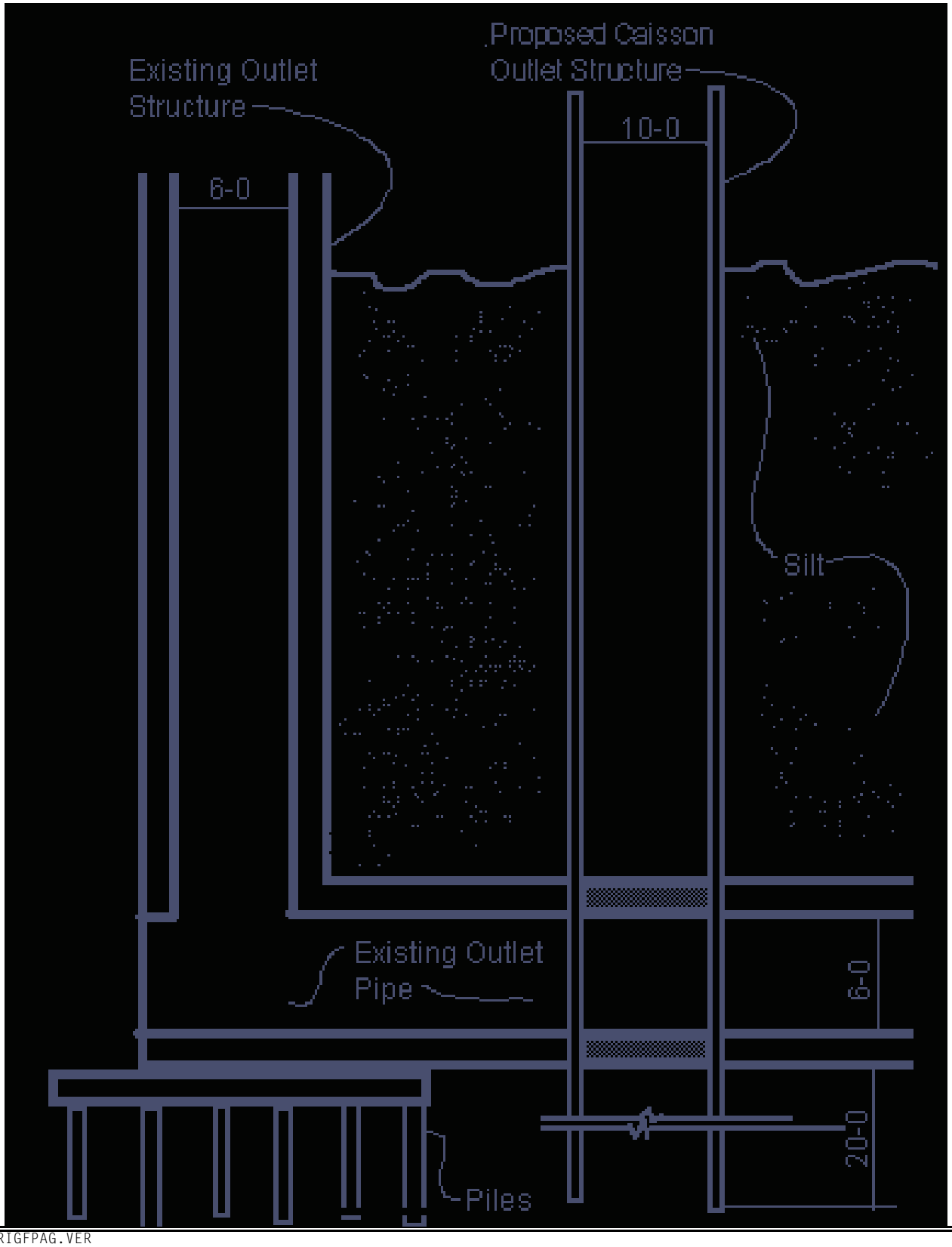
COST ITEMS	NON-RECURRING*	LIFE CYCLE*
ORIGINAL CONCEPT	$10,500,000	
VE CONCEPT (-)	$8,757,000	
SAVINGS	$1,743,000	
NUMBER OF UNITS (X)	1	
TOTAL SAVINGS	$1,743,000	

VE STUDY COSTS (-)	$20,000	
IMPLEMENTATION COSTS (-)	$10,000	
NET SAVINGS	$1,713,000	

* CHOOSE ONE METHOD - USE NONRECURRING IF LIFE CYCLE COSTING DOES NOT APPLY.

VEPROP.TAB

VE PROPOSAL NO. 2 - Caisson Tower



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DESCRIPTION OF VE PROPOSAL

VE PROPOSAL DESCRIPTION NO. 3

PROPOSAL NO 3. BRACE CUT EXCAVATION OF OUTLET TOWER

Proposal Description

Use a braced cut excavation method in place of 6(H):1(V) sloped open excavation.

Proposal Specific Items

! Soldier beams and lagging may be required and may be too deep for sheet piles. This proposal used soldier beams.

! Dewatering is expected to be required.

! Excavation takes place within the brace cut and proceeds to the existing foundation.

! Existing conduit has lagging placed around it and then the conduit is cut and removed.

! Existing tower is demolished and removed as a part of the excavation material.

VEPROPOS.DES

IMPLEMENTATION OF PROPOSAL NO. 3

CRITICAL ITEMS TO CONSIDER:
! The outlet tower is used to control the flow of water through the embankment.
! If improperly founded, the tower could fail during the MCE.
PROBLEMS AND HOW THEY CAN BE OVERCOME:
! The designers need to evaluate if piles are required for the foundations.
! The bracing used for the walls could interfere with the work. If driving piles are determined to be required to support the foundation, bracing may not be feasible.
! Dewatering (working in the dry) will probably be required.
PROCEDURES: (WHO DOES WHAT)
! Future explorations are required to determine the foundation material of the soldier beams and tower structure.
SUMMATION OF BENEFITS AND DRAWBACKS OF THE VE PROPOSAL:
<u>Advantages</u>: This alternative avoids the large number of unknowns related to the excavation of the silt and mobility in getting to the site with a large amount of heavy equipment.
<u>Disadvantages</u>: A specialty contractor will be required. The interference from the bracing will inhibit some operations.

IMPLEMEN.TAB

VALUE ENGINEERING PROPOSAL NO. 3

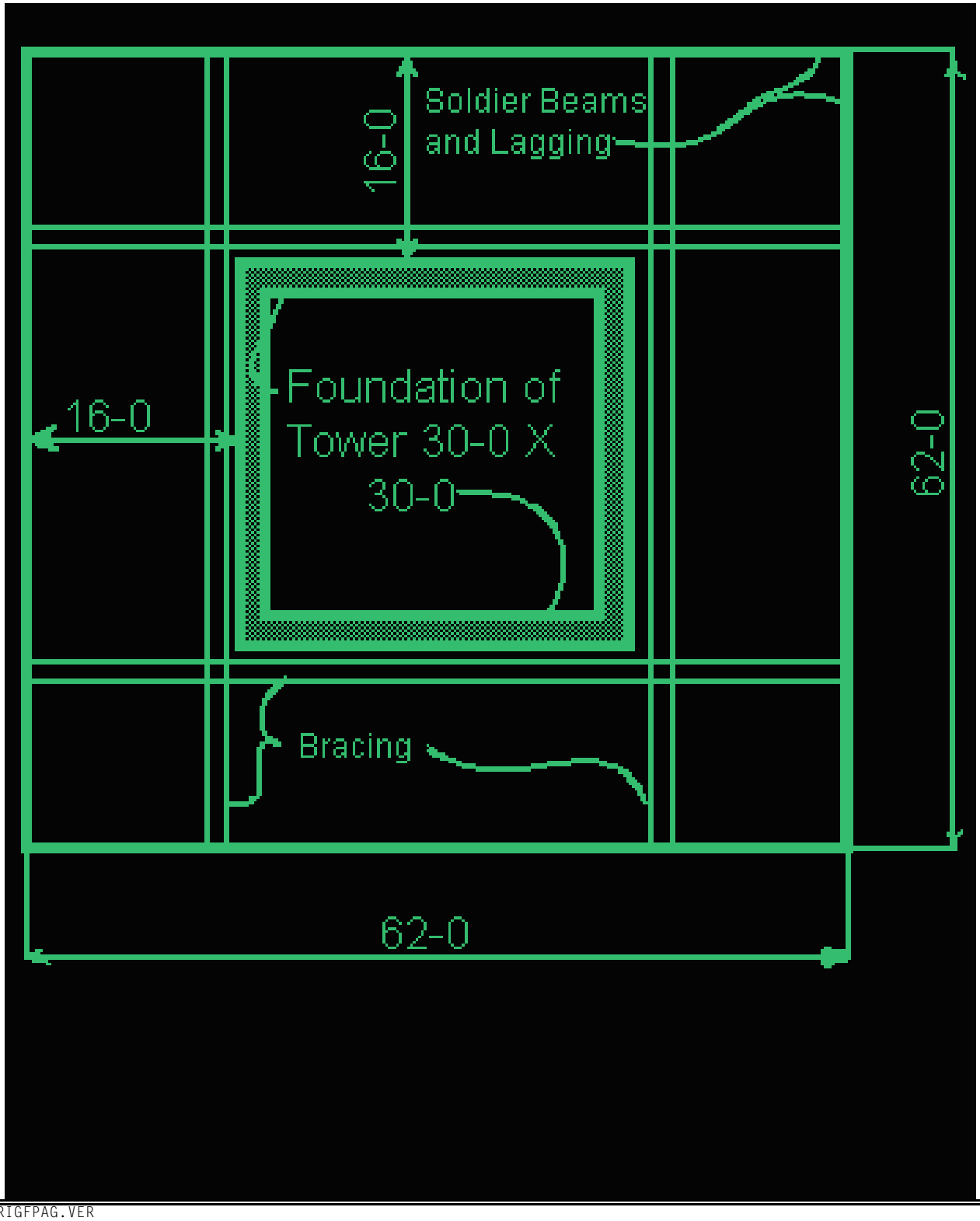
PROJECT: Black Rock Dam	
COMPONENT: Outlet Works Tower	FUNCTION: Replace Tower

ORIGINAL CONCEPT	VE CONCEPT
! Excavate the silt around the existing tower at a 6(H):1(V) slope to about a 40-foot depth. ! Remove existing tower and replace with new two bay tower, using existing pile foundation. Use 36-inch gates and tie into relined pipe. ! Backfill silt around tower. Notes: ! No estimate was included for dewatering. Dewatering for this concept may be necessary. ! The wood piles in the existing foundation may have reached the end of their useful life. If this concept is carried to further design stages, further study will be required.	! Drive soldier beams around existing tower (or new location). ! Excavate inside of beams. Insert lagging as the work progresses down. Dewater if necessary (not estimated in this proposal). ! Place lagging around existing conduit. Cut pipe and remove, and excavate to existing foundation. ! Remove existing tower and construct new. ! Backfill. ! Remove soldier piles.

COST ITEMS	NON-RECURRING*	LIFE CYCLE*
ORIGINAL CONCEPT	$10,500,000	
VE CONCEPT (-)	$9,547,450	
SAVINGS	$952,550	
NUMBER OF UNITS	1	
TOTAL SAVINGS	$952,550	
VE STUDY COSTS (-)	$20,000	
IMPLEMENTATION COSTS (-)	$10,000	
NET SAVINGS	$922,550	

* CHOOSE ONE METHOD - USE NONRECURRING IF LIFE CYCLE COSTING DOES NOT APPLY.
VEPROP.TAB

VE PROPOSAL NO. 3 - Brace Cut Excavation for Outlet Tower



ORIGFPAG.VER

VALUE ENGINEERING - ADDITIONAL ITEMS FOR STUDY

(A LISTING OF ITEMS WITH POTENTIAL FOR COST IMPROVEMENT)

PROJECT: Black Rock Dam

DESCRIPTION	ESTIMATE OF DOLLARS INVOLVED	REMARKS
The technical and economical merits of providing RCC overtopping protection to the downstream face, groin areas, and toe of Black Rock Dam should **NOT** be totally dismissed.	$1.5M to $2.2M	RCC would provide added stability to the downstream face of the dam and toe areas while insuring water-tightness. This overlay also could be wrapped around both groin areas thereby providing the much required armoring of these potential failure areas during an overtopping flood event. With the addition of a coloring agent to the RCC mix, this overlay could be made to blend into the natural basalt surroundings.

Auxiliary spillway on right abutment for floods greater than 50% of the PMF.	$500K to $1.5M	Use of an unlined auxiliary spillway with a crest elevation higher than the existing dam, and a width sized to allow flows from floods greater than 50% of the PMF to pass safely while reducing the flows overtopping the dam. Some training walls would be required to direct the flows away from the right groin area. A portion of this spillway, however, would require hardening of the base at elevations excavated below the bottom of the basalt caprock. RCC is recommended, colored to that of the existing basalt.

VEOTHER.STY

VALUE ENGINEERING - ADDITIONAL ITEMS FOR STUDY
(A LISTING OF ITEMS WITH POTENTIAL FOR COST IMPROVEMENT)

PROJECT: Black Rock Dam

DESCRIPTION	ESTIMATE OF DOLLARS INVOLVED	REMARKS
Placing roller compacted concrete on downstream face of dam for overtopping protection.	$1,650,000	Protection would safely withstand estimated overtopping of 10 feet and allow safe passage of PMF. Some protection at the dam groins and at the toe of the dam would be required.

BRDOTHER.STY

VE TEAM PRESENTATION
1:00 p.m., FRIDAY, DECEMBER 4, 1992
Room 67-1050

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BLACKROC.PRS