RECLAMATION

Managing Water in the West

Value Engineering
Final Report

San Acacia Fish Passage

Conducted for the Bureau of Reclamation, Albuquerque Area Office, Upper Colorado Region

U.S. Department of the Interior
Bureau of Reclamation
Albuquerque Area Office
Albuquerque, New Mexico

March 15, 2007

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Executive Summary

The Value Study Team (Team) met on March 13, 2007, for a 4-day study of the San Acacia Fish Passage. San Acacia Dam is a barrier to the upstream movement of Rio Grande Silvery Minnow (RGSM) due to the dam's gates when the water is checked and because of degradation that has occurred downstream of the diversion dam over recent years. A fish bypass device would allow for better RGSM distribution within the river system upstream of the diversion dam and address the requirements stated in the March 2003 Biological Opinion by the U.S. Fish and Wildlife Service. A total of two independent proposals are presented in this Value Engineering Report and are summarized below. The proposals take into account the concerns from the U.S. Fish and Wildlife Service, the Middle Rio Grande Conservancy District (MRGCD), and other stakeholders with a vested interest in the area.

Baseline: A conceptual design was completed in September 2004 with two alternatives for the fish passage. Alternative 1 has an appraisal level cost estimate of $11,792,000 and Alternative 2 has an appraisal level cost estimate of $9,698,000. Alternative 2 was chosen as the preferred alternative because of lower construction costs and better engineering design features. Both conceptual designs were Low Gradient Roughened Channel and Boulder Weir Fishways which is considered to be one of the most acceptable ways of providing fish passage. The Value Engineering Team decided to create Proposal 1 to improve upon the September 2004 preferred alternative and to use $9,698,000 as the baseline for Proposal 1.

In 2006, Reclamation hired HDR/Fishpro to produce a preliminary design report (August 2006) which contains more alternative designs for a fish passage. The HDR/Fishpro report offered eight alternatives. They recommended and produced cost estimates for three of the eight alternatives. The alternative most acceptable to Reclamation was the Baffled Fishway Concept which has an estimated cost of $1,652,000. The baseline concept price for Proposal 2, the Baffled Fishway, has been adjusted to $1,669,000 to reflect site conditions not considered by HDR/Fishpro.

Independent Proposals: The following proposals are for the most part independent of each other. It is possible that some concepts between proposals may be combined.

Proposal No. 1: Use a naturalized fish channel with a Bernal Entrance. The estimated savings of this proposal is $4,122,000 when compared to Alternative 2 of the September 2004 report. However, this proposal has no savings when compared to the Baffled Fishway.

Proposal No. 2: Use a gate, pipe, and lock system to attract and transport the fish. The estimated savings of this proposal is $1,059,000 when compared to the Baffled Fishway.

Other Ideas: The Team identified additional ideas, some of which may have value for further consideration and development and are listed in the "Disposition of Ideas" table near the end of this report.

Value Study Team Members

Name/Title/Discipline	Address/Phone Number
Jay Bytheway Civil Engineer VE Team Leader	Bureau of Reclamation Provo Area Office 302 East 1860 South Provo, UT 84606-7317 Phone: 801-379-1218 Fax: 801-379-1159 E-mail: jbytheway@uc.usbr.gov
Ken Sayer Civil Engineer	Bureau of Reclamation Denver Federal Center Denver, CO 80225-0007 Phone: 303-445-3125 Fax: 303-445-6491 E-mail: ksayer@do.usbr.gov
Steve Hiebert Biologist	Bureau of Reclamation Denver Federal Center Denver, CO 80225-0007 Phone: 303-445-2206 Fax: 303-445-6328 E-mail: shiebert@do.usbr.gov
Mark Nemeth, PHD Hydraulic Engineer	Bureau of Reclamation Albuquerque Area Office 555 Broadway NE, Suite 100 Albuquerque, NM 87102 Phone: 505-462-3629 Fax: 505-462-3791 E-mail: mnemeth@uc.usbr.gov
Cord Everetts	Bureau of Reclamation Albuquerque Area Office 555 Broadway NE, Suite 100 Albuquerque, NM 87102 Phone: 505-462-3619 Fax: 505-462-3791 E-mail: ceveretts@uc.usbr.gov

Value Method Process

The Value Method is a decision making process, originally developed in 1943 by Larry Miles, to creatively develop alternatives that satisfy essential functions at the highest value. It has many applications, but is most often used as a management or problem-solving tool.

The study process follows a job plan that provides a reliable, structured approach to the conclusion. Initially, the Team examined the component features of the program, project, or activity to define the critical functions (performed or desired), governing criteria, and associated costs. Using creativity (brainstorming) techniques, the Team suggested alternative ideas and solutions to perform those functions, consistent with the identified criteria, at a lower cost or with an increase in long-term value. The ideas were evaluated, analyzed, and prioritized, and the best ideas were developed to a level suitable for comparison, decision making, and adoption.

This report is the result of a formal Value Study by a team comprised of people with the diversity, expertise, and independence needed to creatively attack the issues. The team members bring a depth of experience and understanding of the discipline they represent and an open and independent inquiry of the issues under study, to creatively solve the problems at hand. Ideally, the team members have not been notably involved in the issues prior to the study. The Team applied the Value Method to the issues and supporting information, and took a "fresh look" at the problems to create alternatives that fulfill the client's needs at the greatest value.

Current Description

San Acacia Diversion Dam is located on the Rio Grande approximately 16 miles north of Socorro, New Mexico. The dam was built in 1934 by the MRGCD and rehabilitated in the 1950s by Reclamation. The dam is listed on the national historic register. The left dam abutment and river embankment contain significant archeological sites. The dam presently provides diversions for the Socorro Main Canal operated by MRGCD and Low Flow Conveyance Channel (LFCC) operated by Reclamation. The diversion dam provides grade control within the Rio Grande at this location by preventing downstream degradation from extending upstream of the dam.

The need for a fish passage or methods to allow the RGSM to move upstream of the dam is addressed in the 2003 Biological Opinion from the U.S. Fish and Wildlife Service .

The dam is a barrier to the upstream movement of RGSM due to the dam's gates when the water is checked and because of degradation that has occurred downstream of the diversion dam over recent years. An alternative to allow the RGSM to travel upstream of the diversion dam is to construct a fish passage that bypasses the dam.

The Technical Services Division of the Albuquerque Area Office has provided conceptual designs for the bypass channel in a report dated September 2004. The scope of the report included providing the hydraulic characteristic of the bypass channel and the type of fish channel entrance and exit structure to be used.

In 2006, Reclamation hired HDR/Fishpro to produce a preliminary design report dated August 2006 which contains more alternative designs for a fish passage. The HDR/Fishpro report offered eight alternatives which are as follows:

1. Dam Removal
2. Lock and Braille
3. Low Gradient Roughened Channel and Boulder Weir Fishway
4. Trap and Haul
5. Baffled Fishway
6. Fish Pump and Lock
7. Fish Trap and Lift
8. Technical Fishway

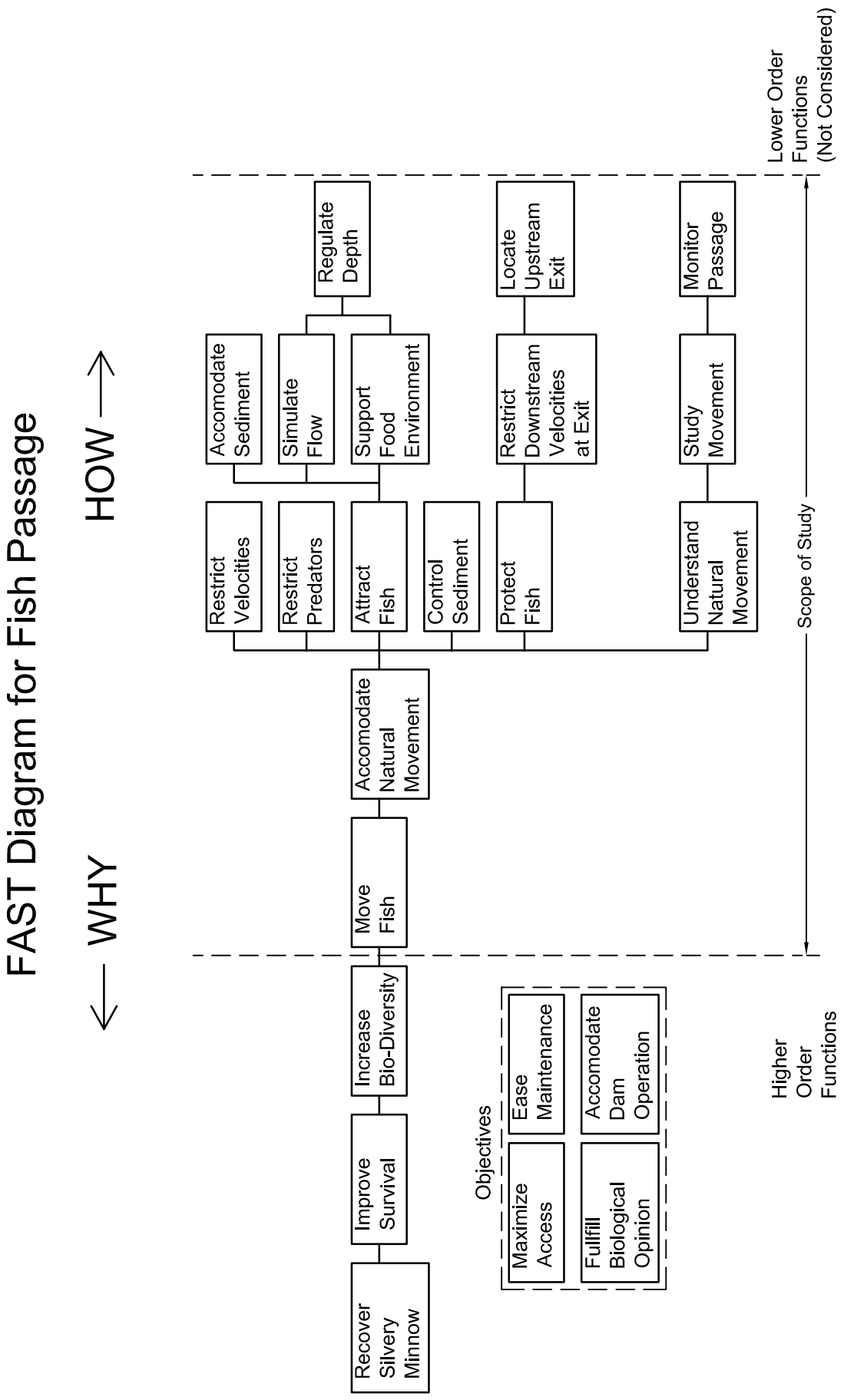
They recommended and produced cost estimates for three of the eight alternatives which are the Baffled Fishway, Fish Trap and Lift, and Fish Pump and Lock. The alternative most acceptable to Reclamation was the Baffled Fishway Concept.

Function Analysis

Component	Active Verb	Measurable Noun
Overall Project	**Fulfill**	**Biological Opinion**
Fish Passage	**Move**	**Fish**
	Restrict	Velocities
	Ease	Maintenance
	Restrict	Predators
	Monitor	Passage
	Accommodate	Sediment
	Protect	Fish
Downstream Entrance	**Attract**	**Fish**
	Maximize	Access
Upstream Exit	**Restrict**	**Downstream Velocities at Exit**
	Locate	Upstream Exit

Function Analysis System Technique (FAST)

The Value Study Team used the function-analysis process to generate a Function Analysis System Technique (FAST) diagram, designed to describe the present solution from a functional point of view. The FAST diagram helped the Team identify those design features that support critical functions and those that satisfy noncritical objectives. The FAST diagram also helped the Team focus on potential value mismatches and generate a common understanding of how project objectives are met by the present solution.


FAST Diagram for Fish Passage
WHY
HOW
Recover Silvery Minnow
Improve Survival
Increase Bio-Diversity
Move Fish
Accomodate Natural Movement
Restrict Velocities
Restrict Predators
Attract Fish
Control Sediment
Protect Fish
Understand Natural Movement
Accomodate Sediment
Simulate Flow
Support Food Environment
Regulate Depth
Restrict Downstream Velocities at Exit
Locate Upstream Exit
Study Movement
Monitor Passage
Objectives
Maximize Access
Ease Maintenance
Fullfill Biological Opinion
Accomodate Dam Operation
Higher Order Functions
Scope of Study
Lower Order Functions (Not Considered)

Value Engineering Proposals

Proposal No. 1 Naturalized Channel

Description

Proposal: Install a naturalized channel through the eastern most bay in San Acacia Diversion Dam.

Proposal Description: Fish bypass at San Acacia Diversion Dam could be achieved by constructing a naturalized channel. The bed would consist of grouted riprap. To reduce flow velocity and provide diversity in the flow pattern, reinforced concrete pipe baffles would be installed, protruding vertically from the channel bed. This channel would pass through the eastern most bay of the dam. Geometric characteristics are as follows:

- trapezoidal channel with 2:1 (H:V) side slopes
- channel gradient at 1.0 percent (slope = −0.01)
- bottom channel width of 4 feet
- pipe baffle diameter of 2 feet
- pipe baffle length of 6.85 to 8.0 feet, extending approximately 5 feet above the channel invert
- longitudinal distance between pipe baffles of 10 feet
- transverse spacing between pipe baffles of approximately 1 foot; five pipes would be installed at each cross-section
- average water depth in the fish bypass channel between 3 and 4 feet
- maximum water surface head (H) of 17 feet (checked water surface behind dam)

The fish passage channel would be separated from the main Rio Grande channel by a berm with a crest height 5 feet above the fish passage channel invert. The berm would have a top width of 12 feet and 2:1 (H:V) side slopes. The berm and fish passage channel would be covered with 3-foot-thick grouted riprap, extending from 6 feet below the Rio Grande channel invert (on the river side) to the top of the historical bankline on the east side of the river.

The approximate fish passage channel length is 800 feet upstream and 800 feet downstream of the diversion dam. It will run along the eastern edge of the current Rio Grande channel, passing through the easternmost bay of San Acacia Dam. Optionally, the distance downstream of the dam could be shortened by removing the dam sill where the channel passes through San Acacia Diversion Dam.

The design for the entrance (Bernal Entrance) at the downstream end of the fish bypass channel is a single row of sheet pile starting at the entranceway to the fish bypass channel that is driven on a 30 degree arching pathway to the right river embankment. The sheet pile row would have notches of various heights to allow for different flow conditions in the river. At the entrance to the fish bypass channel is a series of large boulders (4-foot by 5-foot) which would be placed between the sheet pile and the left river embankment to create a tranquil flow condition between the fish bypass channel entrance and the river. The sheet pile would also direct the RGSM to the approximate location of the entrance for the fish bypass channel.

The exit structure is located approximately 800 feet upstream of the dam. The fish exit is a cast-in-place concrete structure using gates and structure location to allow for changing water elevations. The diversion dam upstream pool elevations are dependent on the check water surface used by MRGCD during the irrigation season, LFCC diversions, and normal non-irrigation depths behind the diversion dam. These water surface depths can vary up to 7.0 feet. A channel with a bottom width of 4 to 6 feet would be excavated from the fish exit structure to the active river channel, extending through the large bar on the east side of the Rio Grande upstream of the dam. A portion of the bar near the dam would be removed, and a gate would be installed in the fish bypass channel slightly upstream of the dam to allow fish to exit during periods of low flow.

Advantages	**Disadvantages**
• None Identified.	• None Identified.

Potential Risks

None can be identified at this time.

Cost Items	**One Time Costs**
Original Baseline Concept	$9,698,000
Value Concept	$5,566,000
Savings	$4,132,000
Value Study Costs	$10,000
Implementation Costs	$0
Net Savings	**$4,122,000**

Proposal No. 2 Pipe, Valve, and Lock System

Description

Proposal. Install a pipe and valve fish passage system. The system attracts Rio Grande RGSM into a vertical pipe (stack) that is periodically filled with water that in turn lifts the fish to the release levels at the checked and unchecked Rio Grande behind the dam.

Proposal Description: The concept uses a 5-foot diameter horizontal pipe that is below the dam and provides the attraction water in the river below the dam. This pipe would extend into the tailwater below the dam for over 100 feet. The flowing water in the pipe guides the fish up the pipe to a vertical lift stack that fills with water. A general flow in the pipe should be between 1 and 1.2 feet per second. Prior to filling the vertical pipe stack, the horizontal pipe is closed at the stack base, trapping fish that ascended the horizontal pipe and entered at the bottom of the stack. At this time the vertical pipe is filled with water, lifting the trapped fish. At the fish exit level there will be an inflow of water to further guide fish out of the vertical pipe and out into the Rio Grande upstream of the dam. There would be two different fish exit elevations on the vertical stack to accommodate fish passage at checked and unchecked operations, or an alternate open flume that will accommodate several exit elevations.

Critical Items to Consider

The success of this proposal is based on fish being attracted to and actively swimming upstream in the intake pipe to the base of the vertical stack.

Albuquerque Bio-Park (Chris Altenbach at 505-848-7128) has captive brood fish and the facilities to perform controlled experiments to verify and potentially improve the operations of this proposal.

Two basic experiments would need to be performed to gain an understanding how RGSMs would use the horizontal pipe. These experiments could also provide insight into improving this project. A (scale) model could be constructed within the Bio-Park and fish trials performed under conditions expected in this project. Preliminary information from a 12 foot flume test previously performed at the Bio-Park indicates the fish move quickest in a smooth floor flume rather than when boulders and turbulence are present.

The second test would involve investigating the fish's tolerance to pressure. The vertical stack has potential to have 4-6 psi of water pressure at the bottom, and if fish were to remain there for any duration, they would be exposed to these pressures. Tests on survival or even subtle effects of pressure exposure would be

valuable in understanding how to harmlessly transport fish at this project.

Additional Project Features

Some additional features of this concept include a gravity water filling control for the vertical stack. This needs to be a gradual process so fish can orient to the filling column (maybe stay near the surface). In addition this filling should be with "non-entrained air" water and should be filled from the stack bottom. Free dropping water into the stack could scare fish and keep them near the bottom and not near the top where the discharge guide flows would be detected.

A controlled, screened "leakage" near the base of the vertical stack into the horizontal attraction pipe will provide continued attraction flow. Inflow of water at the fish exit will maintain a flow that RGSMs will orient to and continue swimming upstream and out the exit.

A large mesh trash rack at the fish exit would reduce debris in the plumbing from upstream and a narrow trash rack grate at the fish entrance should reduce predator (fish, avian, and mammal) access to the pipe.

Advantages	Disadvantages
• Overall cost savings. • Sedimentation is less of a concern than with the passage channel and can be handled easier. • Fish entrance can be adjusted easier for projected down cutting below dam. • No major moving parts.	• Unknown fish behavior movements through long horizontal entrance pipe. • Research is needed to verify fish use and any potential harm from pressure changes.

Potential Risks

Fish attraction and use might not mimic results from Bio-Park laboratory experiments.

Cost Items	One Time Costs
Original Baseline Concept	$1,669,000
Value Concept	$600,000
Savings	$1,069,000
Value Study Costs	$10,000
Implementation Costs	$0
Net Savings	**$1,059,000**

Disposition of Ideas

Value Study Elements Considered as Potential Proposals and Their Disposition	
Idea	**Disposition**
Bait Fish	Not practical
Use a Decoy	Never been tried no data on this method
Use Pheromones	Technology is not yet available
Lighting	Incorporated in the pipe, valve, and lock system.
Use edge effect	Incorporated in the proposals as part of the design.
Bernal Entrance from the September 2004 report	Good idea and has been incorporated into proposal one.
Eliminate alternate pathways	This is basically the Bernal Entrance
Locate entrance close to dam	Not needed is using the Bernal Entrance
Acoustic System	Not good enough to develop and may have a negative effect
Additional attraction flow	Incorporated in the proposals as much as possible
Fish Wheel	Needs R&D
Cut concrete apron on dam	Adds expense
Cart on wheels and bait	Not practical
Grouted Riprap	Part of Proposal No. 1
Use LFCC	Difficult to implement
Sheet pile maze	Good idea that may need to be looked at further
Grade Reducing Facility	Expensive
Rotating Lock	Needs R&D
Orifice Ladder	May not work for the RGSM

Data and Documents Consulted

Title, Author, and Date	Information
Conceptual Design for San Acacia Fish Passage Structure By: Mr. Rudy Bernal and Mr. Cord R. Everetts United States Department of Interior Bureau of Reclamation Albuquerque Area Office Technical Service Division Design and Construction Group September 2004	Source for original conceptual design information and the base concept for Proposal No. 1
Study and Preliminary Design Development of a Fish Passage Facility for San Acacia Diversion Dam By: HDR/FishPro August 2006	Source for original conceptual design information and the base concept for Proposal No. 2

Value Study Team Presentation Attendance List

Friday, March 16, 2007

Name	**Organization/Phone Number**
Karl Martin	Bureau of Reclamation Phone: 505-462-3609
Frank Montoya	Bureau of Reclamation Phone: 505-462-3615
Cord Everetts	Bureau of Reclamation Phone: 505-462-3619
Jay Bytheway	Bureau of Reclamation Phone: 801-379-1218
Ken Sayer	Bureau of Reclamation TSC Phone: 303-445-3125
Rudy Bernal	Bureau of Reclamation Phone: 505-462-3616
Kevin Doyle	Tetra Tech Phone: 505-466-0454
Charles Fischer	Bureau of Reclamation Phone: 505-462-3656
Michael Porter	Bureau of Reclamation Phone: 505-462-3596
Steve Hiebert	Bureau of Reclamation TSC Phone: 303-445-2206
Cheryl Rolland	Bureau of Reclamation Phone: 505-462-3631
Robert Padilla	Bureau of Reclamation Phone: 505-462-3626
Carolyn Donnelly	Bureau of Reclamation Phone: 505-462-3632
Gary Davis	Bureau of Reclamation Phone: 505-792-2091

Drawings

PROPOSAL 1

SITE PLAN

100 0 100 200 300
SCALE OF FEET

NOTE

1. Aerial photography taken June, 2005.

ABBREVIATIONS

CFS ..... Cubic Feet per Second
EG ..... Existing Ground
LFCC ..... Low Flow Conveyance Channel
LRD ..... Lemitar Riverside Drain
OG ..... Original Ground
SLA ..... San Lorenzo Arroyo

VE VALUE ENGINEERING PAYS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA REACH

SAN ACACIA DIVERSION DAM
NATURALIZE CHANNEL PASSAGEWAY

PLAN VIEW

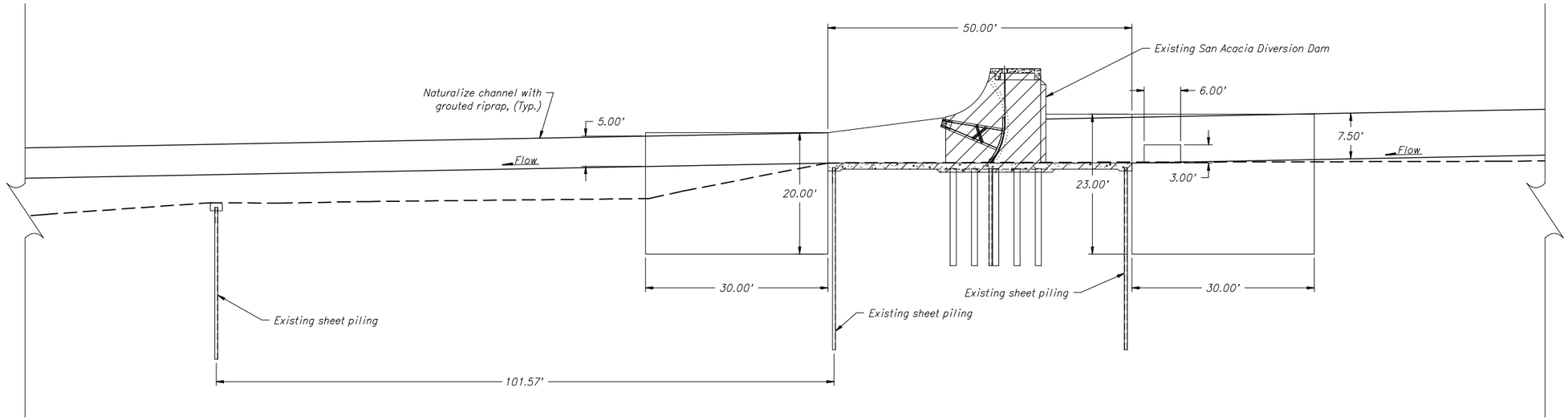
CADD SYSTEM	CADD FILENAME
CADSYS	F1LNAM
ALBUQUERQUE, NEW MEXICO	MARCH, 2007

SHEET 1 OF 2

PROPOSAL 1

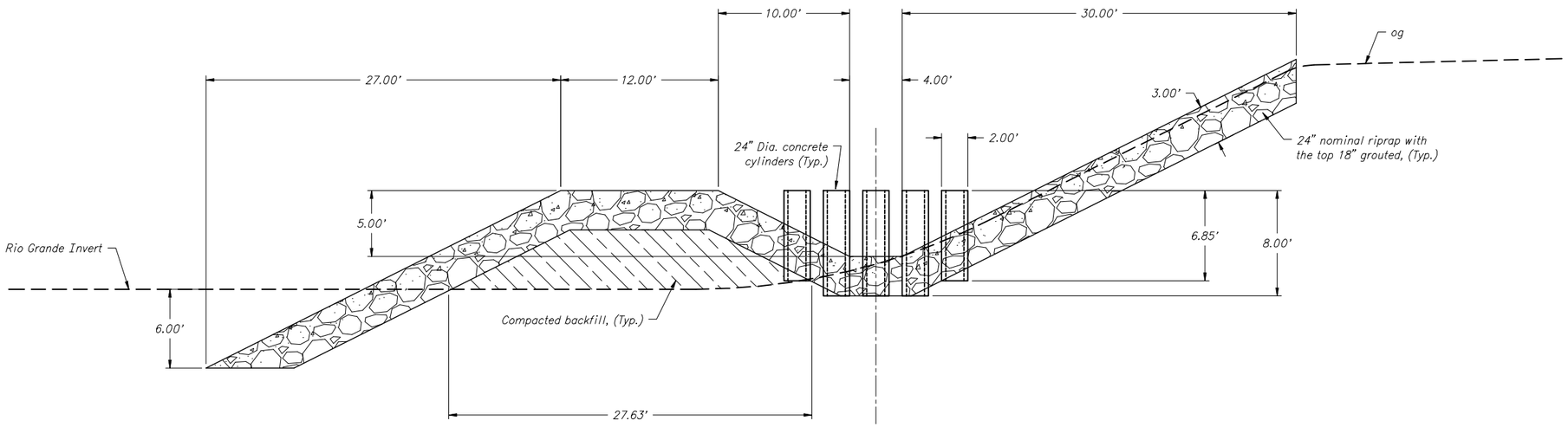
PLDATE
PLOTTED BY
USER

PROPOSAL 1



TYPICAL CHANNEL PROFILE

10 0 10 20 30
SCALE OF FEET



TYPICAL CHANNEL CROSS SECTION

5 0 5 10 15
SCALE OF FEET

NOTE

1. Cross section data May, 2003.

ABBREVIATIONS

CFS ..... Cubic Feet per Second
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OG ..... Original Ground
SLA ..... San Lorenzo Arroyo

VALUE ENGINEERING PAYS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA REACH

SAN ACACIA DIVERSION DAM
NATURALIZE CHANNEL PASSAGEWAY

PROFILE AND SECTIONS

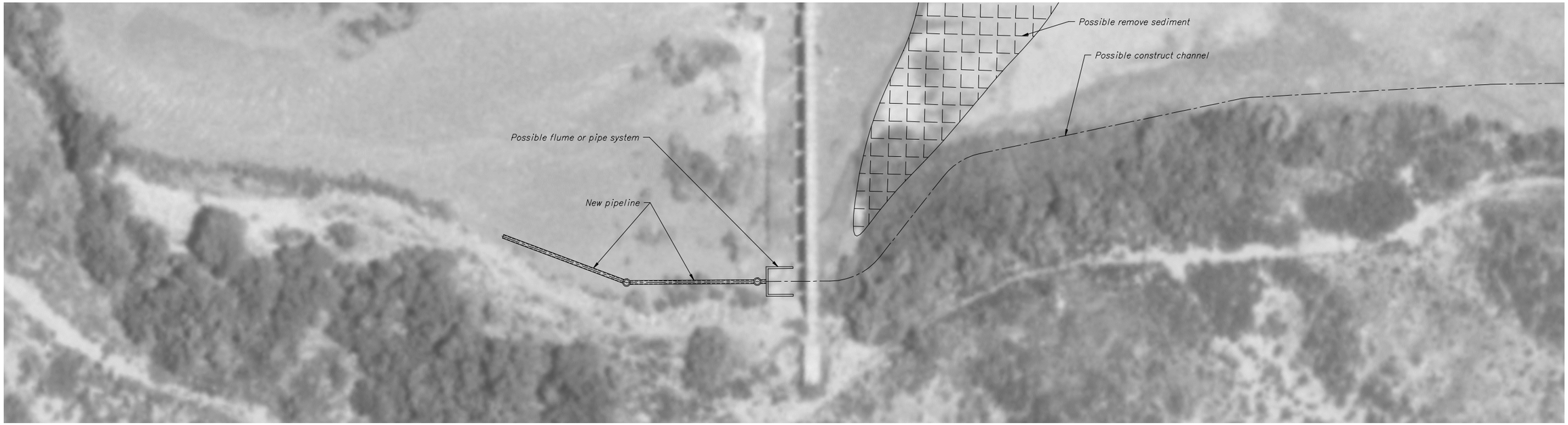
CADD SYSTEM	CADD FILENAME
CADSYS	FILNAM
ALBUQUERQUE, NEW MEXICO	SEPTEMBER, 2005

SHEET 2 OF 2

PROPOSAL 1

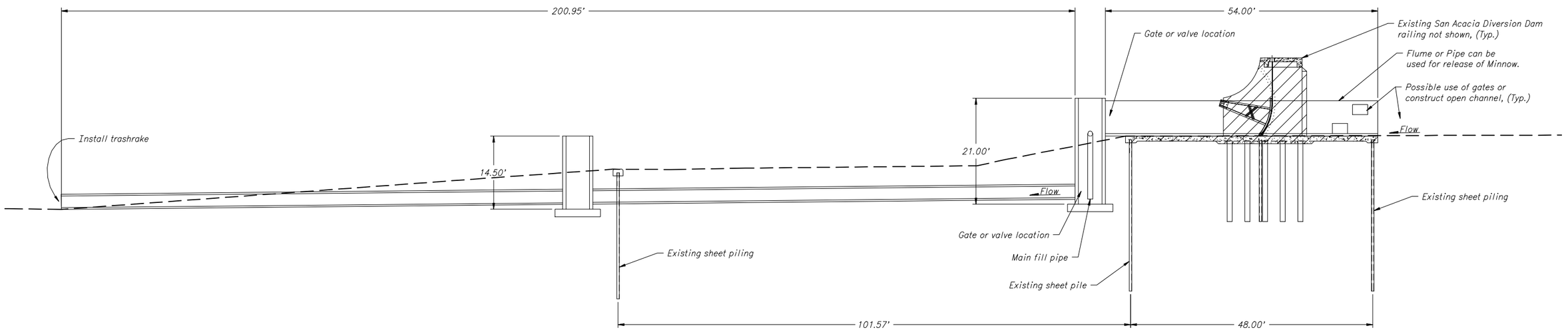
PLDATE
PLOTTED BY
USER

PROPOSAL 2



SITE PLAN

40 0 40 80 120
SCALE OF FEET



SITE PLAN

10 0 10 20 30
SCALE OF FEET

ABBREVIATIONS

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LRD ..... Lemitar Riverside Drain
OG ..... Original Ground
SLA ..... San Lorenzo Arroyo

NOTES

1. Aerial photography taken June, 2005.
2. Cross Section Data taken May, 2003.
3. All gates or valves are not shown. This Pipe and Valve system is gravity flow.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA REACH

SAN ACACIA DIVERSION DAM
PIPE AND VALVE SYSTEM

PLAN VIEW AND TYPICAL PROFILE

CADD SYSTEM	CADD FILENAME
CADSYS	FILNAM
ALBUQUERQUE, NEW MEXICO	MARCH, 2007

PROPOSAL 2

FILNAME
PLOTTED BY
USER

Appendix A - Cost Estimates

CODE: D-8140

ESTIMATE WORKSHEET

FEATURE: **PROPOSAL 1**

San Acacia Naturalized Channel

PROJECT
San Acacia Fish Passage - Value Engineering Study

DIVISION

UNIT

filename: G:\VALUE_EN\San Acacia Dam Fish Passage\San Acacia Fish\[Fish Lift Hiebert.xls

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Upstream of dam - channel construction items					
		excavation		29,185	cy	$6	$175,110
		backfill		17,562	cy	$6	$105,372
		compacted backfill		266	cy	$10	$2,660
		channel embankment		17,296	cy	$6	$103,776
		pressure grouting under dam		1	ls	$90,000	$90,000
		reinforced concrete wall		29	cy	$1,200	$34,800
		furnish/place 24" riprap		275	cy	$55	$15,125
		grout for riprap		75	cy	$200	$15,000
		furnish/place geotextile		275	cy	$5	$1,375
		furnish/place concrete baffle cylinders		405	ea	$1,000	$405,000
		Non-check water surface items					
		excavation		4,630	cy	$6	$27,780
		backfill		5,022	cy	$6	$30,132
		compacted backfill		578	cy	$10	$5,780
		channel embankment		4,444	cy	$6	$26,664
		reinf. Concrete outlet structure		349	cy	$1,200	$418,800
		trashracks, misc metal		1	ls	$405,000	$405,000
		Checked water surface items					
		excavation		4,815	cy	$6	$28,890
		backfill		5,306	cy	$6	$31,836
		compacted backfill		408	cy	$10	$4,080
		channel embankment		4,897	cy	$6	$29,382
		reinf. Concrete outlet structure		479	cy	$1,200	$574,800
		Downstream of dam - channel constuction items					
		excavation		31,065	cy	$6	$186,390
		backfill		14,562	cy	$6	$87,372
		compacted backfill		266	cy	$10	$2,660
		channel embankment		14,296	cy	$6	$85,776
		sheet pile		1	ls	$530,000	$530,000
		furnish/place 24" riprap		275	cy	$55	$15,125
		grout for riprap		75	cy	$200	$15,000
		furnish/place geotextile		275	sy	$5	$1,375
		furnish/place concrete baffle cylinders		400	ea	$1,000	$400,000
		subtotal					$3,855,060
		mobilization (5%)					$192,753
		subtotal					$4,047,813
		unlisted items (10%)					$404,781
		subtotal					$4,452,594
		contingencies (25%)					$1,113,149
		grandtotal					$5,566,000

QUANTITIES		PRICES	
BY	**APPROVED**	**BY**	**CHECKED**
DATE PREPARED	**DATE**	**DATE**	**PRICE LEVEL**

FEATURE: **PROPOSAL 2**

San Acacia Pipe/Valvel/Lock Passage

PROJECT San Acacia Fish Passage - Value Engineering Study

DIVISION

UNIT

filename: G:\VALUE_EN\San Acacia Dam Fish Passage\San Acacia Fish\[Fish Lift Hiebert.xls

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		12" PVC drain pipe		200	lf	$10	$2,000
		5' diameter pipe (rcp C-76 class 4)		240	lf	$152	$36,480
		1 elbow		1	ea	$3,500	$3,500
		5' sluice gate-cast iron, installed		1	ea	$28,300	$28,300
		12" butterfly valves		3	ea	$1,300	$3,900
		structural steel		200	lf	$65	$13,000
		fabricate/install trashracks, 5/8" x 3"		75	sf	$31	$2,325
		fabricate/install grating		36	sf	$31	$1,116
		furnish/install automation system		1	ea		$60,000
		excavate for fish inlet pipe		1,200	cy	$6	$7,200
		compacted backfill		1,000	cy	$10	$10,000
		dewatering			ls		$175,000
		subtotal					$342,821
		mobilization (5%)					$17,179
		subtotal					$360,000
		unlisted items (10%)					$36,000
		subtotal					$396,000
		contingencies (25%)					$99,000
		total construction cost					$495,000
		Behaviour research					
		2 - 30 day experiments					
		test pipe model, pressure tank					$15,000
		technician time		60	sd	$563	$33,780
		biologist time		60	sd	$756	$45,360
		incendental fish holding, setup evaluation labor		10	sd	$563	$5,630
		analysis write-up, both experiments		12	sd	$756	$9,072
		subtotal					$108,842
		grandtotal					$600,000

QUANTITIES		PRICES	
BY	**APPROVED**	**BY**	**CHECKED**
DATE PREPARED	**DATE**	**DATE**	**PRICE LEVEL**