VALUE ENGINEERING STUDY

US Army Corps of Engineers

Los Angeles District

Tres Rios
Phoenix, AZ

Final Report

September 2000

rsr "the value solutions team"

Robinson, Stafford & Rude, Inc.

VALUE ENGINEERING STUDY

DOD SERVICE: Army
VALUE ENGINEERING OFFICER: Bill Zeigler

Los Angeles District

Tres Rios

Phoenix, AZ

August 14-18, 2000

VALUE ENGINEERING FIRM NAME: Robinson. Stafford. & Rude. Inc.
Address: 3100 South Crenshaw Road
Independence, MO 64057
Phone: (816) 220-1105
Fax: (816) 220-3050

VE TEAM LEADER: John L. Robinson, PE, CVS
Phone: (816) 220-1105
Fax: (816) 220-3050
Email: john@rsrsolutions.com

VALUE ENGINEERING TEAM MEMBERS

Name	Discipline
Ralph Hanson	Cost Estimator
George Johnson, P.E.	Civil and Hydraulic Engineering
Robert Prager, P.E.	Geotechnical and River Engineering
Munsell McPhillips, Ph.D.	Bioengineering
Keith O'Hara	Civil Engineer
Andy Richardson	Civil Engineer
Bill Zeigler	VEO/Civil Engineer

TABLE OF CONTENTS

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1

EXECUTIVE SUMMARY

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

EXECUTIVE SUMMARY

This report presents the results of a VE study conducted to review the design of the Tres Rios project for the U.S. Army Corps of Engineers, Los Angeles District (District).

The project is being designed for the City of Phoenix (the City).

The project is being designed by the District's in-house staff.

The project was reviewed at the completion of the Feasibility Report. The VE process used to review this project is an organized, multidisciplinary process designed to find alternative ways to achieve the project's necessary and desired functions at the lowest life cycle cost. The VE team (team) identified the important project functions and possible alternative ways to achieve them, then selected the best alternatives and developed them into workable recommendations for project improvement and cost savings.

The VE workshop (workshop) was conducted in Phoenix, AZ by Moffatt & Nichol Engineers (MNE) in association with Robinson, Stafford, & Rude, Inc. (RSR).

PROJECT DESCRIPTION

The Tres Rios project was conceived to provide flood control in combination with environmental restoration. The project consists of:

- A 300-million gallon per day (mgd) pump station that will allow the 91st Avenue Wastewater Treatment Plant to operate during the 100-year flood event. This pump station will also feed the plant's effluent water to the regulating wetlands.
- A 184-acre regulating wetland to even out the diurnal flows from the WWTP pump station before discharging the water through a series of constructed wetlands.
- 128 acres of constructed wetlands on the river side of a new north bank levee system. The flows through these wetlands are then conveyed by a 36-inch diameter pipe to the west end of the project to irrigate a new riparian corridor.
- Cottonwood/willow riparian corridors along both sides of the river.

- A water conveyance system to transport water by a pipeline from the WWTP's dewatering wells to a gravel pit lake within the riverbed. From the gravel pit the water flows through an open channel to feed a new open water/marsh are on the south side of the river.

- Open water/marshes along the south side of the river on the east end of the project and along the north side of the river on the west end. These open water/marsh areas have been located where there are currently dense populations of slat cedar, which this project is trying to eradicate.

This project is largely predicated on increasing the flood capacity through the permanent removal of salt cedar, which local residents believe has contributed to the reduced flood conveyance capacity of the Gila River in this reach. This project is using the open water/marsh areas to prevent the growth of salt cedar in these areas. In other areas, riparian corridors are being established with a cottonwood and willow complex that under the design conditions are expected to out compete the salt cedar. The wetland areas and the open/water marsh areas maintain a virtually clear river cross-section for the flows. The structure of the cottonwood/willow corridors will increase the conveyance capacity over the salt cedar and will prevent the re-growth of this undesirable tree. In addition, the open water/marsh, the wetlands, and the riparian corridors all contribute to the establishment of a habitat that is more conducive to desirable plants, birds, and animals.

VALUE ENGINEERING PROCEDURE

The 40-hour workshop took place from August 14-18, 2000. This study followed the format of the six step Value Engineering Job Plan. The process is consistent with the SAVE International and U.S. Army Corps of Engineers standard value methodology. Each step is designed to achieve results and assure savings to the District and the City.

WORKSHOP RESULTS

The workshop focused on the optimization of capital and O&M costs. A structured approach was used to identify high cost areas of the project and to determine the functional requirements. Portions of the project that were not functionally required or that contained major portions of project costs became focus areas. From this, the team generated 261 ideas for alternatives to the current design. Based on the team members' judgment and input from the District and the City representatives, 12 of these ideas were developed as VE recommendations.

An oral presentation of the workshop results was made to the District and the City on August 18, 2000.

VE Recommendations

Section 3 – Summary of Recommendations, includes a complete list of all the recommendations developed. This table shows the number and title of the idea as well as a summary of the cost savings associated with each recommendation. The cost savings shown are the capital or first cost savings and the life cycle cost savings. Life cycle cost savings includes the capital cost savings plus any operations and maintenance cost savings over the economic life of the project.

Some recommendations presented in this report are variations of a common concept and others are alternatives to a specific aspect of the design. Thus, not necessarily all recommendations in this report can be implemented, because, selection of some will preclude or limit the use of others.

Optimum Potential Cost Savings

After developing all of the recommendations, the VE team reviewed the composite list to identify the optimum combination of these recommendations. The VE team's opinion of this optimum combination is shown in Table 1-2.

This combination results in the following potential cost savings:

Capital Cost Savings	$16,937,600
Present Worth of Operations and Maintenance (O&M) Cost Savings	$1,875,100
Life Cycle Cost Savings	$18,812,700

These potential savings do not reflect any costs for redesign, which must be considered. Moreover, the full benefit and impact of many of the recommendations goes beyond the cost savings to include improved project performance of required functions.

It should also be noted that these are recommendations only. Final responsibility for acceptance and design rests with the District and the City.

Design Suggestions

In addition to the VE recommendations, the team made 17 design suggestions. These are suggestions for changes or clarifications to the project documents which do not have an identifiable or quantifiable cost impact, within the scope of the workshop.

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

TABLE 1-1

Summary of Implementation Decisions

Idea No.	Idea Description	First Cost Savings	Life Cycle Cost Savings	Decision
F-15	Reduce excavation of the open water marshes	$3,863,200	$3,863,200	
F-16	Flatten levees and eliminate riprap	$3,589,200	$3,589,200	
F-42	Locate interior drains to support habitat development	$(175,500)	$(175,500)	
F-70	Use an irrigation ditch along the north side and eliminate pipe	$3,225,500	$3,225,500	
F-75	Construct levees in a natural landform	$3,887,800	$3,887,800	
H-02	Eliminate riprap and armor levee with live materials	$3,839,200	$3,839,200	
H-25	Simplify the dewatering pipe route	$1,001,000	$1,001,000	
H-27	Increase the height of the levee and reduce scheduled maintenance	$(115,400)	$318,600	
H-28	Locate all openwater marshes to avoid lining	$3,330,900	$3,330,900	
H-30	Plant northwest area in cottonwood/willows and eliminate stringers	$6,995,700	$7,231,700	
H-58	Develop plant nurseries within the project area	$720,600	$720,600	
OM-33	Use hydraulically designed system that eliminates mechanical controls	$(423,100)	$782,000	

A-Accepted *AM-Accepted with Modifications* *F-Further Study Required* *O-Open or Undecided* *R-Rejected*

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

TABLE 1-2

VE Team's Optimum Combination

Idea No.	Idea Description	First Cost Savings	O&M Cost Savings	Life Cycle Cost Savings
F-15	Reduce excavation of the open water marshes	$3,863,200	-	$3,863,200
F-42	Locate interior drains to support habitat development	$(175,500)	-	$(175,500)
F-70[2]	Use an irrigation ditch along the north side and eliminate pipe	$3,225,500	-	$3,225,500
H-02	Eliminate riprap and armor levee with live materials	$3,839,200	-	$3,839,200
H-27	Increase the height of the levee and reduce scheduled maintenance	$(115,400)	$434,000	$318,600
H-28	Locate all openwater marshes to avoid lining	$3,330,900	-	$3,330,900
H-30[1]	Plant northwest area in cottonwood/willows and eliminate stringers	$2,672,201	$236,000	$2,908,201
H-58	Develop plant nurseries within the project area	$720,600	-	$720,600
OM-33	Use hydraulically designed system that eliminates mechanical controls	$(423,100)	$1,205,100	$782,000
	TOTAL SAVINGS	$16,937,601	$1,875,100	$18,812,701

Notes: 1. Savings reduced by $3,258,100 x 1.327 to account for the overlap with VE Recommendation F-70.

2. Channel is not necessary with VE Recommendation H-30; however, channel cost was included for use in VE Recommendation F-42.

SECTION 2

PROJECT DESCRIPTION

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

Project Description

GENERAL OVERVIEW

The Tres Rios area consists of that portion of the Salt River and Gila River extending from 83rd Avenue to a downstream point at the Agua Fria River. The study area is located in Maricopa County, Arizona. The study area is approximately 9.2 miles long and one mile wide, and encompasses approximately 5,600 acres. The Salt River flows into the Gila River just upstream of the 115th Avenue crossing. The Agua Fria River flows into the Gila River near the downstream end of the study area.

The natural riparian ecosystem has been degraded within the study area. Several factors have contributed to the degradation of the system including: drastic reductions of natural flood events; population encroachment and subsequent unauthorized and unregulated use; severe reduction in base flows; diurnal variations in the effluent-dominated surface waters; and dominance of exotic species such as salt cedar (*Tamarix chinensis*). The opportunity exists to restore riparian habitat within the study area, as well as to address flooding problems and the recreation needs of the study area.

A number of habitat restoration alternatives with some flood control components were developed in cooperation with the non-Federal sponsor and evaluated relative to their effectiveness, acceptability, completeness, and incremental economic efficiency. From the array of alternatives, a plan has been selected that is technically feasible, economically efficient, and environmentally sound according to Federal water resources planning criteria. The selected plan is characterized by:

- a regulating wetland to even out diurnal variations in treatment plant discharge
- constructed wetlands arranged linearly along the north bank of the river
- a pipeline from the overbank wetland leading to riparian corridors west of El Mirage Road
- open water/marsh areas within the channel west of El Mirage Road
- distribution of dewatering well water from the treatment plant to large open water/marsh creation areas along the south side of the river
- flood control levees

The non-Federal sponsor has also expressed a desire to increase the passive recreation opportunities incidental to the restoration effort within the study area. The riparian habitat created by the selected restoration plan would be unlike any other resource in the metropolitan area.

FLOOD PROTECTION

Holly Acres Subdivision occupies a low-lying area within the 100-year floodplain. In 1992, residents of the subdivision filed suit against the water department charging that the department's practice of discharging treated effluent to the Salt River had fostered extensive salt cedar establishment. The residents alleged that the presence of salt cedar had reduced the channel conveyance during high flow events and consequently exposed the residents to a flood threat. As part of the settlement agreement, the department agreed to develop a plan to protect the residents by 2002.

The proposed project design includes flood protection at a 100-year level for the residents of Holly Acres and surrounding agricultural interests. The necessity of preventing flooding on Gila River Irrigation Company-owned (GRIC) land was also recognized in project planning.

Levee

A flood control levee (100-year) would be constructed just north of the proposed features along the entire length of the reach between the regulating wetland and approximately Dysart Road. The levee would extend as close to the north bank of the river as possible, and would take advantage of any existing protection levees along the bank. The levee height will range from 4 feet to 10 feet high. The river side will have a 15-inch thick riprap armor with two-foot horizontal on one foot vertical (2:1) slopes. The levee design would include a toe-down of 15 feet in areas adjacent to the active channel, and 7 feet in areas set back from the river.

The real estate plan includes an analysis that concludes mitigation is not required as a result of the flood control improvements. The proposed project includes a North Bank levee for the purposes of flood protection. A hydrologic analysis of the potential for induced flooding to the south side of the river was completed to determine the depth, duration, and extent of water surface elevation changes to south side properties. The 100-year flood would be only minimally raised at certain locations on the south side due to the proposed project. The largest change during a 100-year flood event would result in an approximate water surface elevation increase of one foot, with an 8-hour duration. Much of the land potentially affected is presently hardstand and river bottom parking areas associated with Phoenix International Raceway.

HABITAT RESTORATION

The habitat value of the project reach is seriously compromised by the dominance of invasive salt cedar. Other factors limiting the habitat quality and diversity are the minimal base flow and absence of extensive, stable riparian forest structure. Salt cedar has established in areas that would normally support a cottonwood/willow complex. Historically, extensive mesquite thickets also populated the riparian corridor. By the turn of the 20^{th} century, much of the native riparian vegetation was lost. Salt cedar is especially problematic because of its much longer germination period and far higher tolerance for saline conditions.

Existing riparian vegetation which includes all representative height classes is at a premium in Arizona. Riparian habitat that has one or more components (i.e. understory or overstory) impacted, can still be restored. These types of riparian areas should be protected from further degradation.

Low elevation riparian habitat has been lost and modified as a result of urban, suburban and agricultural conversion. Habitat modification from water diversion and impoundment, channelization, excessive livestock grazing, and other changes has resulted in the disruption of natural water flow regimes and reduced or no seedling regeneration. Human disturbance from recreational uses has also impacted habitat. Habitat fragmentation can affect the colonization potential of certain species such as the yellow-billed cuckoo which requires stretches of habitat approximately 0.5 miles in length. Similarly, low population numbers can affect the reproduction potential of species as demonstrated by the recent efforts with the California condor. Poor water quality may also affect species dependent on aquatic resources such as the black hawk.

Several species of concern are present in the Tres Rios study area, including the southwestern willow flycatcher and the Yuma clapper rail. Loss of habitat is one of the main reasons for a decline in the southwestern willow flycatcher population. Nests are usually located in the fork of a shrub or a tree 4-25 feet above the ground. With the loss of preferred habitat throughout the southwest, southwestern willow flycatchers have been observed utilizing salt cedar thickets for nesting. However, salt cedar may not provide the thermal cover necessary for successful nesting in many areas. Restoration of preferred habitat for this species was a major feature of the design.

Pump Station and Diurnal Wetland

A pump station facility having an approximate capacity of 2,900 gpm would be constructed to convey effluent from the 91st Avenue Wastewater Treatment Plant to the regulating, or diurnal wetland. The diurnal wetland, approximately 184 acres and averaging 5 feet deep, would be constructed between 91st and 99th Avenue, and would buffer diurnal flow rate fluctuations from the wastewater plant. This will allow the fluctuations to take place within the regulating wetland so that a more constant flow can be discharged from the regulating wetland into the river and the overbank wetlands. The basins would be graded so that approximately 0.5 feet of depth fluctuation would occur during any 24-hour period.

Cross-slope grading would minimize ponding outside of the low-flow conveyance area. Vegetation would be planted appropriate to the hydrologic regimes within the wetland, which would range from no inundation along the upper banks to approximately four to six hours of inundation each day along the lower portion of the banks. Further, there would be a combination of shallow emergent areas along the bottom, and deep, open water segments within the low-flow area. Finally, approximately five species of aquatic macrophytes are currently being considered.

Regulated Wetlands

Overbank Wetlands

The linear, overbank wetland, approximately 128 acres and averaging 4-5 feet deep, would receive flow discharged from the diurnal wetland and would be constructed between 99th and 113th Avenues. The basins would be planted with various species of bulrush, cattails, water lilies and other aquatic and terrestrial plants to create a riparian habitat attractive to wildlife of the area.

Open Water/Marshes

Discharge from the wetlands would be conveyed in a 36-inch diameter steel pipe that leads to eight riparian corridors west of El Mirage Road, totaling approximately 38 acres. The cottonwood/willow stringers are riparian corridors that consist of a 20-foot wide, 4-foot deep low flow channel with a 75-foot wide, 3-foot deep bench. They will be planted with predominantly Fremont cottonwood and Gooding willow trees to provide riparian habitat. Water that flows through the riparian area would continue down slope into four open water/marsh areas, totaling approximately 134 acres, between El Mirage Road and the Agua Fria. The open water/marsh areas along the river's north side would thereby receive water from (1) water continuing through the riparian corridors, (2) the natural flow in the river, and (3) groundwater in the area. Each open water/marsh consists of a 300 feet to 500 feet wide, 5-foot deep pond. Ponds will be clay lined to prevent loss of water caused by infiltration. Ponds will be connected in series by riprap lined connecting riffles. Control gates at the pond outlet will be used to control the flow to each pond. A 100-foot wide, 2-foot deep bench will be constructed at the bank of each pond. The bench will be planted with marsh habitat type plants while the deeper section of the pond will be left as open water habitat. Nesting islands for waterfowl will be constructed in the center of the ponds. In addition, the channel would be graded to convey surface water to supply two cottonwood-willow corridors between 111th Avenue and El Mirage Road that total approximately 69 acres.

Cottonwood/Willow Corridors

Groundwater from existing dewatering wells within the treatment plant would be pumped in a 5,200 foot-long pipe into an existing impoundment of water just east of 83rd Avenue. This water would then outlet into the main channel into a secondary distribution system of pipes and canals in order to create cottonwood-willow riparian corridors (approximately 16 acres) and open water/marsh areas (approximately 206 acres). The salt cedar that primarily occupies this area, between 91st and 115th Avenues, would be cleared and replanted as appropriate.

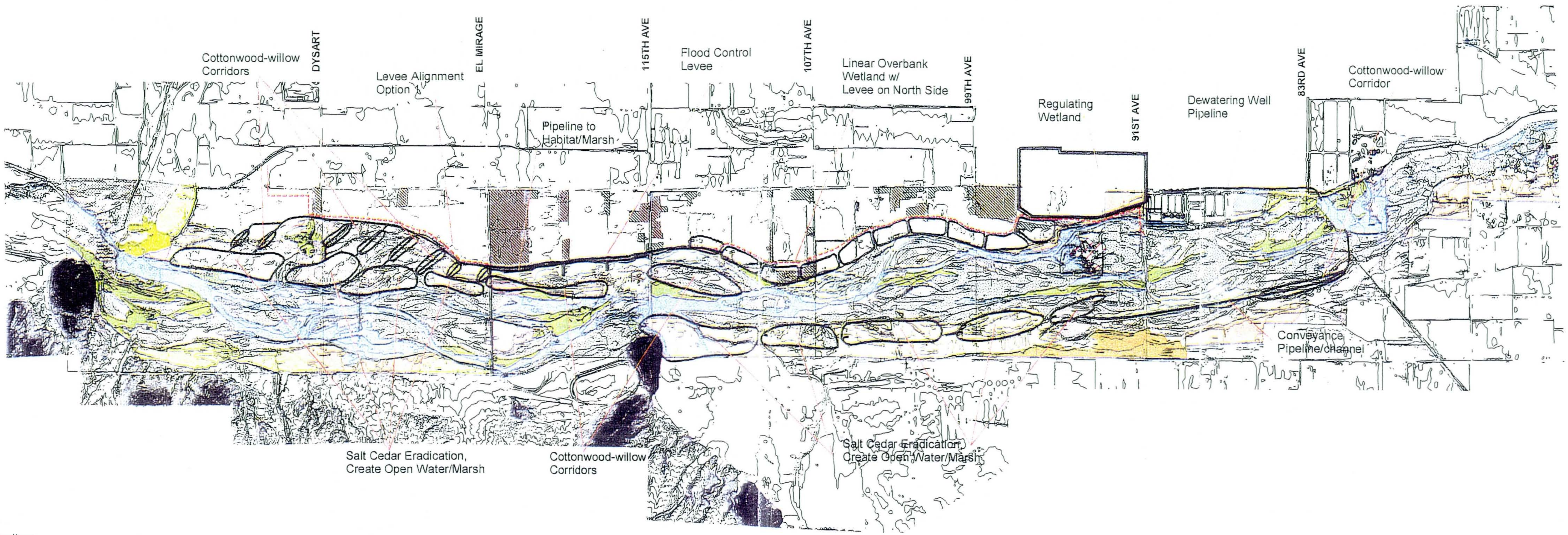
The cottonwood/willow riparian corridors would be dominated by Fremont cottonwood (*Populus fremontii*) and Goodding willow (*Salix gooddingii*) and planted primarily at densities of 50 plants/acre. The understory would consist of desert broom (*Baccharis sarothroides*), elderberry and other native understory plants.

Cottonwood/willow riparian vegetation will be planted along the riparian corridors and along the edge of open water marshes. After the initial five years, these habitats are expected to become self-vegetating, provided the water distribution system described above is maintained. Following major flood events, some of the restored cottonwood/willow vegetation may be removed by flood waters.

Restored habitats are expected to support native wildlife. The high quality wetland marsh and cottonwood/willow habitats are expected to support the diverse assemblage of wildlife that is associated with these habitat-types. The project design includes monitoring of wildlife abundance and diversity to determine whether habitats actually attract and support significant populations of a wide variety of native wildlife.

SECTION 3

SUMMARY OF RECOMMENDATIONS



HABITAT
- Agriculture
- Cobble
- Cottonwood-Willow II
- Desert
- Desert Wash
- Dike
- Gravel Mine
- Hayfield Wetlands
- Honey Mesquite IV
- Honey Mesquite V
- Marsh
- Mix: Cottonwood-Willow/Salt Cedar II
- Mix: Cottonwood-Willow/Salt Cedar III
- Mix: Cottonwood-Willow/Salt Cedar III B
- Mix: Cottonwood-Willow/Salt Cedar IV
- Quailbush-Saltbush
- Quailbush-Saltbush/Salt Cedar
- Residential
- Road
- Salt Cedar
- Salt Cedar II
- Salt Cedar III
- Salt Cedar IV
- Salt Cedar IV B
- Salt Cedar V
- Water

Source: TETRA TECH, INC., Infrastructure Southwest Group

rsr "the value solutions team" Robinson, Stafford, & Rude, Inc. 3100 S. Crenshaw Road Independence, MO 64057	US Army Corps of Engineers – Los Angeles District *Tres Rios Project – Environmental Restoration Project* *Phoenix, Arizona* Project Overview & Site Plan	Figure 2-1

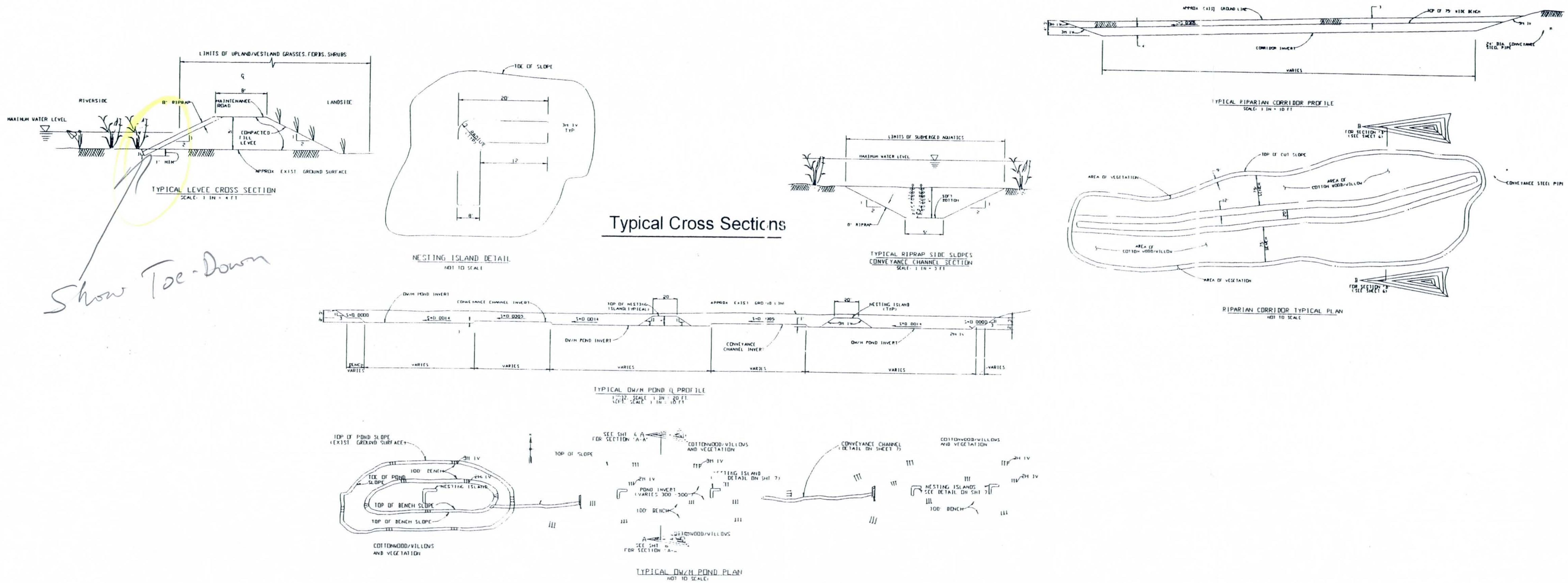
VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

SUMMARY OF RECOMMENDATIONS

Idea No.	Idea Description	First Cost Savings	O&M Cost Savings	Life Cycle Cost Savings
F-15	Reduce excavation of the open water marshes	$3,863,200	-	$3,863,200
F-16	Flatten levees and eliminate riprap	$3,589,200	-	$3,589,200
F-42	Locate interior drains to support habitat development	$(175,500)	-	$(175,500)
F-70	Use an irrigation ditch along the north side and eliminate pipe	$3,225,500	-	$3,225,500
F-75	Construct levees in a natural landform	$3,887,800	-	$3,887,800
H-02	Eliminate riprap and armor levee with live materials	$3,839,200	-	$3,839,200
H-25	Simplify the dewatering pipe route	$1,001,000	-	$1,001,000
H-27	Increase the height of the levee and reduce scheduled maintenance	$(115,400)	$434,000	$318,600
H-28	Locate all openwater marshes to avoid lining	$3,330,900	-	$3,330,900
H-30	Plant northwest area in cottonwood.willows and eliminate stringers	$6,995,700	$236,000	$7,231,700
H-58	Develop plant nurseries within the project area	$720,600	-	$720,600
OM-33	Use hydraulically designed system that eliminates mechanical controls	$(423,100)	$1,205,100	$782,000



Source: TETRA TECH, INC., Infrastructure Southwest Group

rsr "the value solutions team" Robinson, Stafford, & Rude, Inc. 3100 S. Crenshaw Road Independence, MO 64057	**US Army Corps of Engineers – Los Angeles District** *Tres Rios Project – Environmental Restoration Project* *Phoenix, Arizona* Typical Cross Sections	Figure 2-2

SECTION 4

VE RECOMMENDATIONS

FLOOD PROTECTION

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: F-15

PAGE NO.: 1 of 8

DESCRIPTION: Reduce excavation of the open water marshes

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

In the original concept, the open water marsh is excavated three feet deep in the vegetation area and an additional two feet deep in the open water area.

PROPOSED CONCEPT:

The proposed concept is that the open water marsh is excavated two feet deep in the vegetation area and an additional two feet deep in the open water area.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$19,315,800	-	$19,315,800
PROPOSED CONCEPT	$15,452,600	-	$15,452,600
SAVINGS	$3,863,200	-	$3,863,200

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Flow channel does not change
- Habitat value may not change
- Decreases amount of excavation

DISADVANTAGES:

- May not reach groundwater level for some open water marshes
- May allow more rapid growth of less desirable vegetation such as cattails

JUSTIFICATION:

Slight changes in depth over large areas can significantly decrease the amount of excavation. The depths should be selected based on the threshold for aquatic habitat.

DISCUSSION

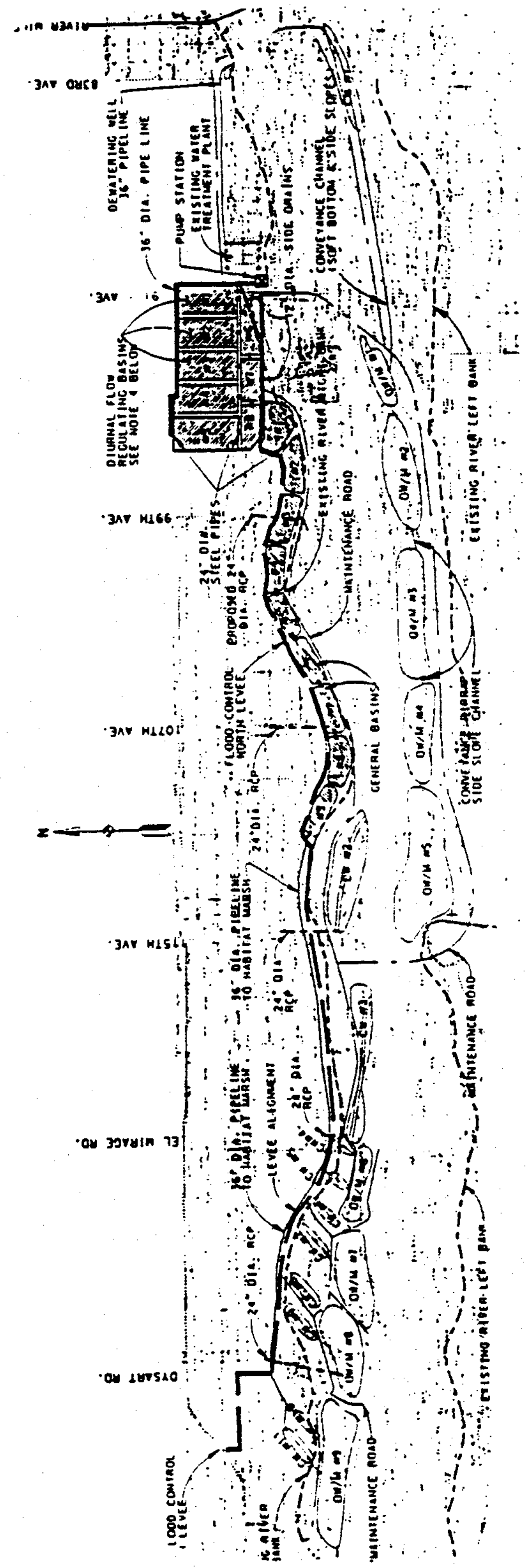
The main objective of this recommendation is to explore the impact of minor changes in elevation over large areas.

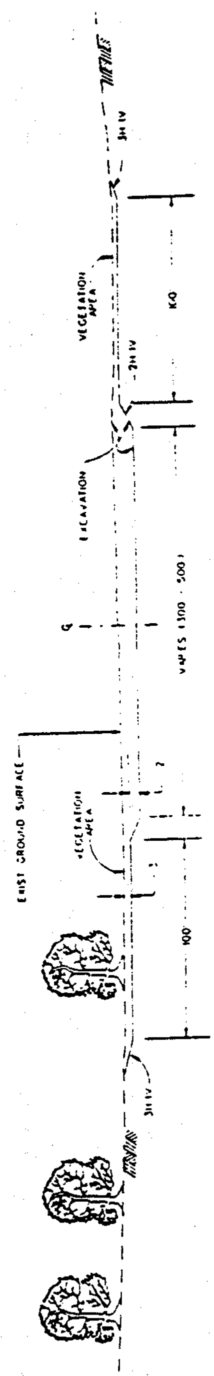
The depths are currently set at three feet for the shelves with an additional two feet at the pools. The depths should be set based on the desired aquatic habitat. The depths should be varied throughout the open water marsh with deeper holes and habitat in the pools and on the shelves. The effect of shading by the cottonwood/willow should be incorporated into the design. The required habitat conditions can be developed with a sloping, pitted bottom.

While the one foot reduction is arbitrary, so is the proposed depth in the original concept. The point of this recommendation is to illustrate that a relatively minor adjustment in the depth of these pools results in significant cost savings. Rather than set an arbitrary depth, the value team recommends that serious consideration be given to the depth necessary to support the habitat that is desirable to this project.

From an O&M perspective, the value team does not believe a one-foot change in pool depth will have a noticeable change to the required O&M effort. To account for sediment load, the pools would have to be significantly deeper. This is not practical or cost effective.

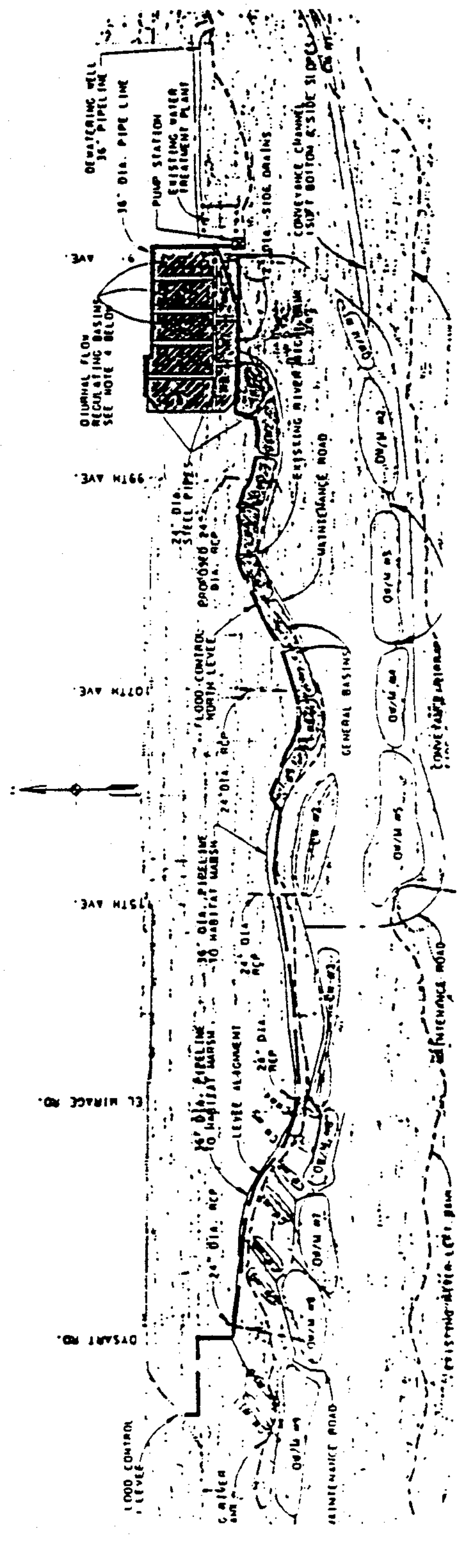
ORIGINAL CONCEPT — SKETCH

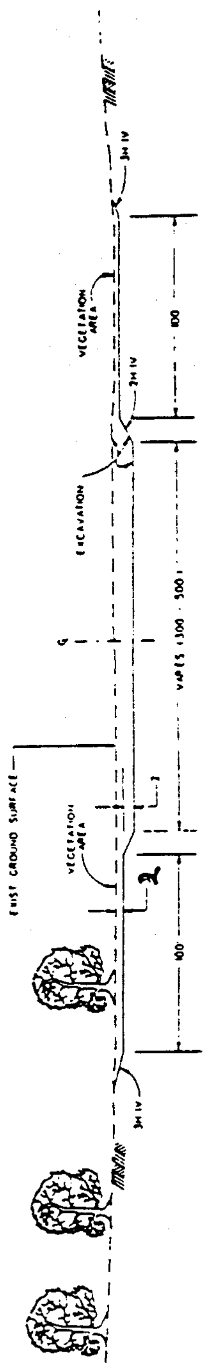




SECTION "A-A"
OPEN-WATER/MARSH POND CROSS SECTION FOR ALT 3 & 4
NOT TO SCALE

PROPOSED CONCEPT — SKETCH





SECTION "A-A"
OPEN-WATER/MARSH POND CROSS SECTION FOR ALT 3 & 4
NOT TO SCALE

ORIGINAL CONCEPT — CALCULATIONS

Excavation

Independent open water marsh	1,120,000 cy
Dependent open water marsh	1,800,000 cy
	2,920,000 cy

Grading area

Independent open water marsh	139 acre
Dependent open water marsh	223 acre
	362 acre

PROPOSED CONCEPT — CALCULATIONS

Original:		=	2,920,000 cy
Assume a decrease of 1 ft on the average:	362 acre-ft	=	584,000 cy
Proposed total:		=	2,336,000 cy

Assume 700 ft wide by 1 ft deep = 700 sf decrease in cross section

Area of cross-section for 100-yr. flow = approximately 35,000 sf

700 sf out of 35,000 sf does not increase flood rise.

COST SAVINGS ESTIMATE

			Original Concept		Proposed Concept	
Item	Unit of Measure	Unit Cost	Quantity	Total	Quantity	Total
Excavation	cy	5.00	2,920,000	14,600,000	2,336,000	11,680,00
Contingency, PED, E. S&A	%	32.3		4,715,800		3,772,640
TOTALS				19,315,800		15,452,640
NET SAVINGS						3,863,160

All costs from project MCACES Report and MCACES Database except if noted below:

1.

2.

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: F-16

DESCRIPTION: Flatten levees and eliminate riprap

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

In the original concept, the levee is lined on the riverside with 15 inches of riprap. The riprap is also toed-down from 7 ft to 15 ft as scour protection. The upstream slope is 2H:1V.

PROPOSED CONCEPT:

The proposed concept replaces the riprap and toe down with a 4H:1V with a cobble fill, which is excavated from the channel bottom. The material would be selected but not processed.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$4,481,700	-	$4,481,700
PROPOSED CONCEPT	$892,500	-	$892,500
SAVINGS	$3,589,200	-	$3,589,200

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Eliminates need for riprap
- Eliminates excavation for toe down
- Eliminates soil riprap interface that is difficult to fill and would be an area of scour
- The flatter slope decreases the tractive shear along the face of the levee

DISADVANTAGES:

- Unless planted with drought tolerant plant, slightly decreases habitat
- Very localized scour might require some maintenance

JUSTIFICATION:

Flattening the slope and replacing the riprap with cobbles is a more natural slope at this environmental restoration project. The proposed levee cross-section for seepage and stability remains the same. The cobble fill offers the scour protection required by CoE standards. The velocities for the majority of the project are less than 5 fps and scour potential is low.

DISCUSSION

EM 1110-2-1913 DESIGN AND CONSTRUCTION OF LEVEES Section 7-6 Protection of River Slopes lists a number of factors for determining the type of slope armor. These factors include:

- Duration of floodwaters
- Relative susceptibility of embankment to erosion
- Riverside protection by timber stands
- Structures riverside of the levee that could constrict flow
- Curvature and transitions of levee
- Flatness of slope
- Performance data
- Remoteness of project for inspection and maintenance

Based on the criteria stated in the EM, there is an opportunity to change the slope protection. For this project, the flood duration is short, maybe three weeks against the levees. The material is not susceptible to erosion. Estimated erosive velocities are estimated to be greater than three fps. The riverside is protected by timber stands. The levee is relatively straight except near the western end at the turn out. The slope is relatively flat. The recommended slope is 4H:1V. The Holly Acres levee is armored with cobbles and is steeper and has performed well. The project will be monitored.

Still Average?

Based on the HEC-RAS, the average channel ~~velocity is 5 fps except at the~~ extremes of the project and near the 115th Avenue Bridge. The maximum predicted velocity is 10.5 fps at the ends of the project. The habitat, especially, the willow/cottonwood complex, will slow the near bank velocities.

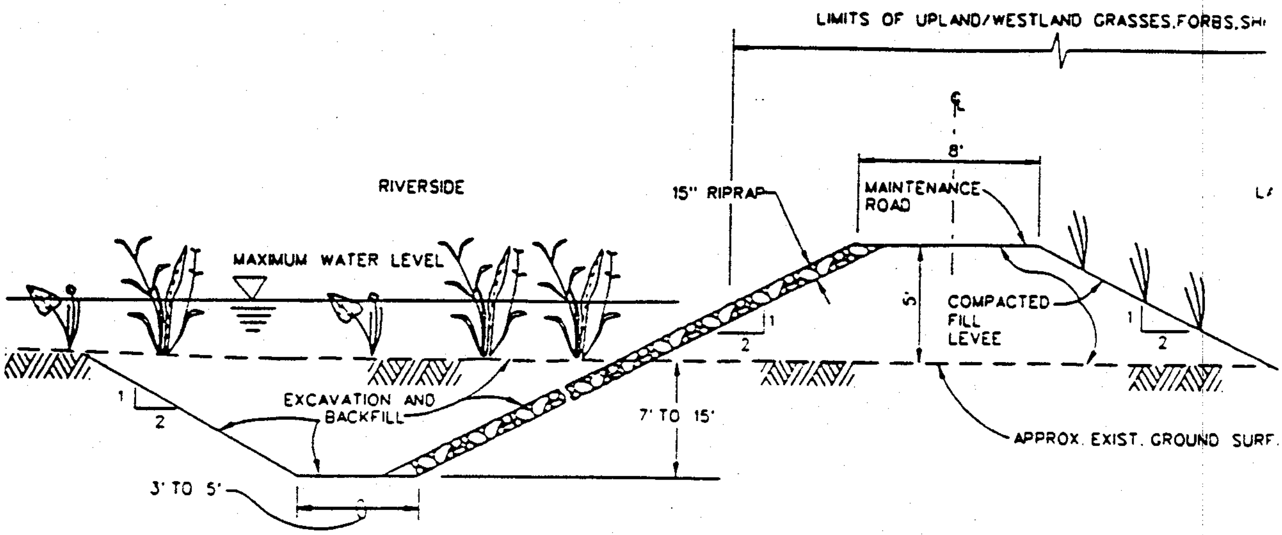
The detail as shown for the original concept requires the excavation of natural material to construct the turndown for the riprap. The excavated material is then backfilled in the trench. It is difficult to backfill against the riprap on a 2 to 1 slope. The contact of the riprap and backfill is the weakest point. If scouring is initiated, it will probably be at this location and scour down the face of the riprap removing the backfill.

The core of the levee remains the same to protect from seepage and piping.

PROPOSAL NO.: F-16

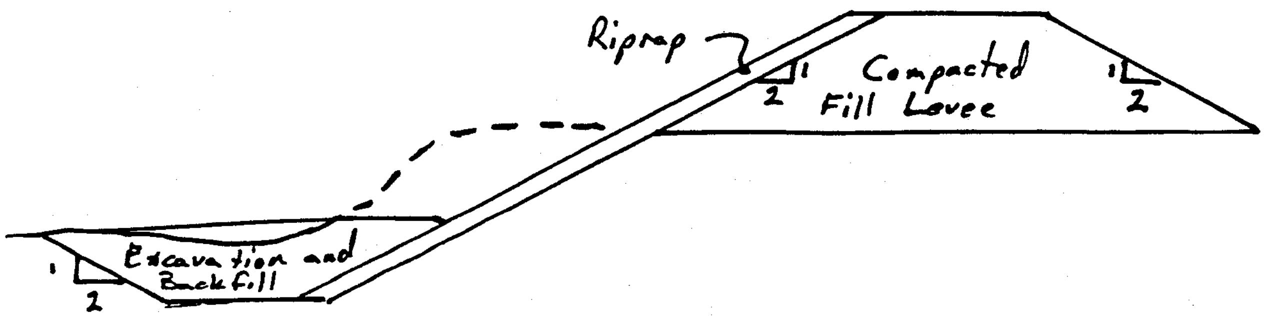
PAGE NO.: 4 of 11

ORIGINAL CONCEPT — SKETCH

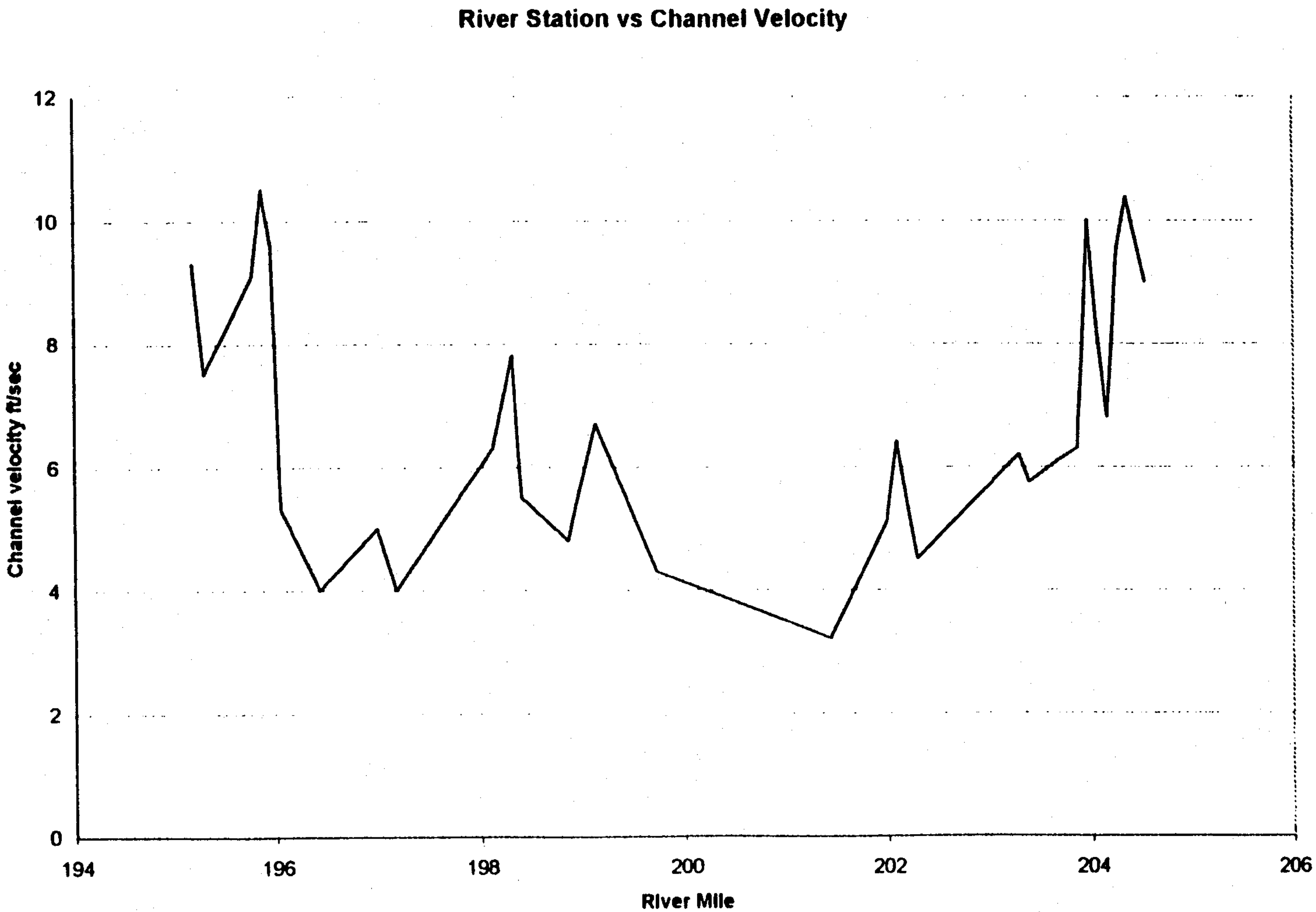


TYPICAL LEVEE SECTION
SCALE 1 IN = 4 FT

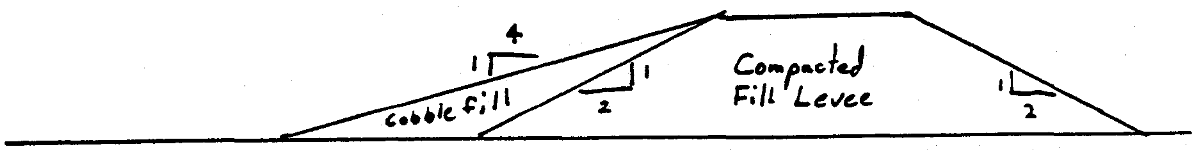
ORIGINAL CONCEPT — SKETCH



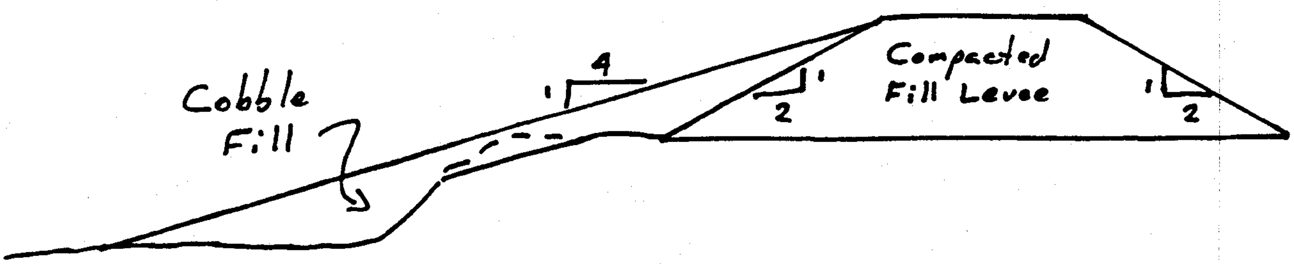
ORIGINAL CONCEPT — SKETCH



PROPOSED CONCEPT — SKETCH



PROPOSED CONCEPT — SKETCH

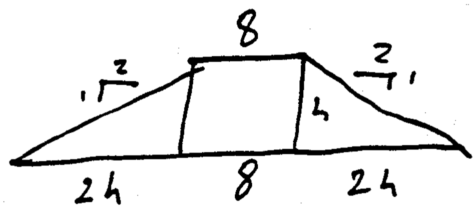


ORIGINAL CONCEPT — CALCULATIONS

Calculate average levee dimensions:

141,000 cy of fill in levee or 3,807,000 ft^3

measured length of levee is 25,000 ft with calculated area of 152 sf area is

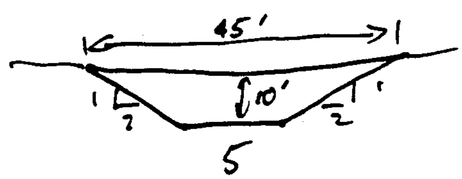


Area = $\frac{(8+8+2h+2h)}{2} \times h$ = $(8+2h) \times h$ = 152 ft

by trial and error, "h" = approximately 7 ft

Calculate habitat area:

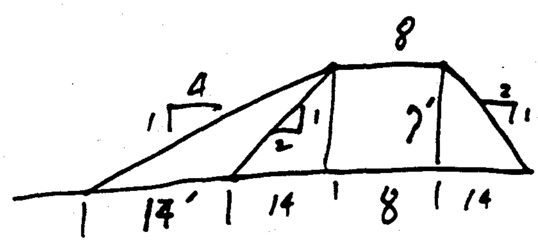
Say average trench is



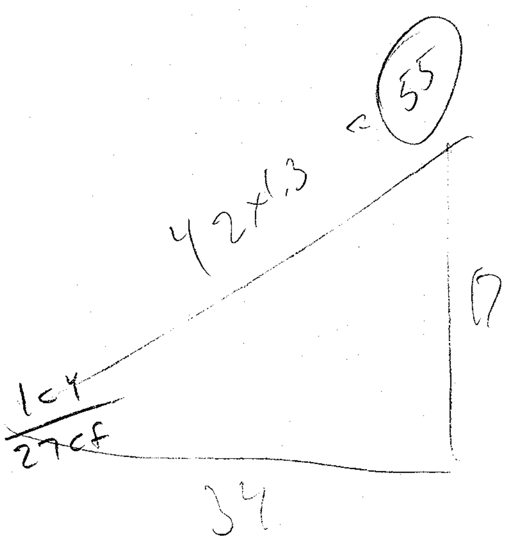
45 ft x 25,000 ft = 1,125,000 sf = 25.8 acres

PROPOSED CONCEPT — CALCULATIONS

Calculate volume of cobble fill



Area	=	½ x h x b	=	½ x 7 x 14	=	49 sf
Volume	=	Area x length				
	=	49 sf x 25,000 ft	=	$1{,}225{,}000\ ft^3$		
	=	$\frac{1{,}225{,}000\ ft^3}{27\ ft^3/cy}$	=	45,400 cy		



160

$87600\ ton \times 2000\ \frac{\#}{ton} \times \frac{1\ cf}{160\ \#}\ \frac{1\ cy}{27\ cf}$

160#/cf

VALUE ENGINEERING STUDY

PROPOSAL NO.: F-16

COST SAVINGS ESTIMATE

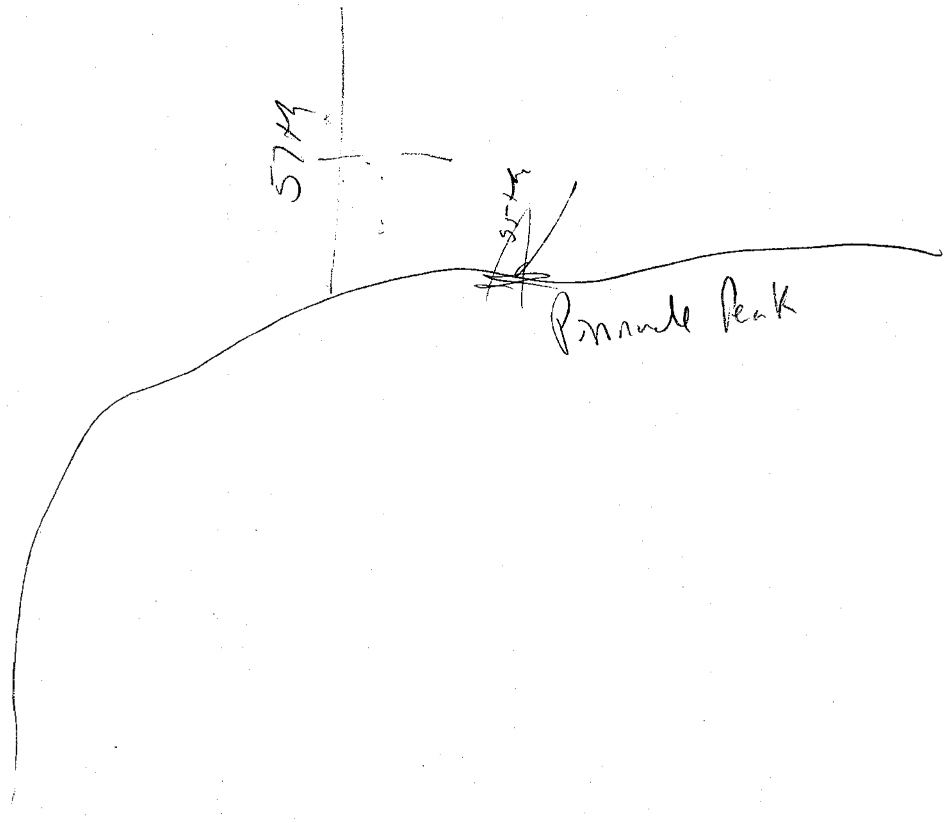
87000 x 2000 / 160 x 27

Item	Unit of Measure	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Toe excavation and backfill	cy	5.00	358,000	1,790,000	0	-
Riprap slope protection	tons	12.00	95,000 cy 87,600	1,051,200	0	-
Compacted levee fill	cy	3.00	141,000	423,000	141,000	423,000
Cobble fill	cy	5.00	-	-	45,400	227,000
					40,300 ton	
Subtotal				3,264,200		650,000
Contingency, PED, E, S&A	%	37.3		1,217,500		242,500
TOTALS				4,481,700		892,500
NET SAVINGS						3,589,200

All costs from project MCACES Report and MCACES Database except if noted below:

1. – Quantities don't look right
2. for Rip Rap vs Cobble fill

– Are cobbles available in adequate quantities



57th
Pinnacle Peak

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: F-42

DESCRIPTION: Locate interior drains to support habitat development

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

In the original concept, the north levee will be 8 to 10 ft above existing interior land elevations. The internal runoff will require detention space to accommodate a 100-year local event. Impoundment areas and pipe connections to the rivers are proposed at five locations.

PROPOSED CONCEPT:

The proposed concept uses interior drains that will drain runoff to the river during all local rainfall events less than the 100-year event. It is proposed that the outfall drains be connected and the outlets located to drain to the riparian habitat avoiding the overbank wetlands and the impoundment basins which are being utilized as managed habitat areas.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$153,800	-	$153,800
PROPOSED CONCEPT	$329,500	-	$329,500
SAVINGS	$(175,700)	-	$(175,700)

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Delivers stormwater runoff to riparian areas
- Creates habitat in impoundment basins
- Uses the proposed 36-in pipeline for dual purpose
- Combines five impoundment basins into one

DISADVANTAGES:

- Adds 3,200 ft of 24-in connector pipe

JUSTIFICATION:

The 36-in pipeline is only needed to establish initial growth. The rainfall runoff to riparian areas provides the natural water cycle for habitat. The impoundment basin can provide additional habitat.

DISCUSSION

The existing concept uses five separate impoundment basins and five pipe outlets with two of the outlets draining to the overbank wetlands basins. The storm water drainage may have picked up contaminants that could be harmful to the overbank wetlands.

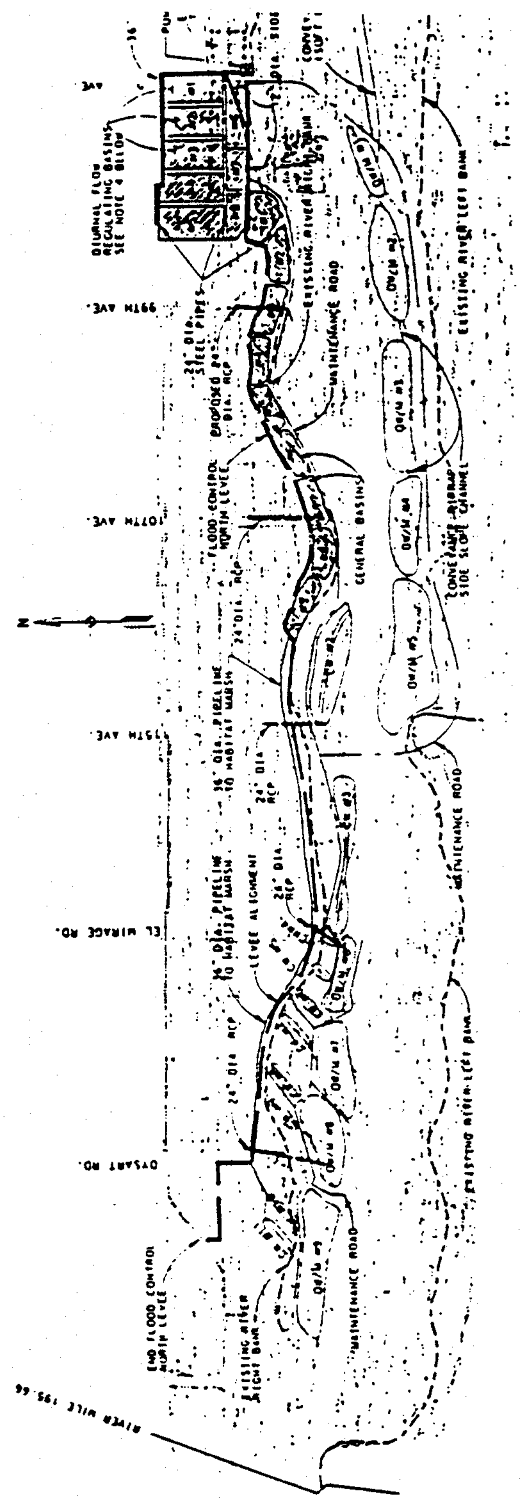
It is proposed that the two easterly outlets be connected by pipe and conveyed west to connect to the other three proposed outlets. These three outlet locations will be located to drain to the constructed riparian habitat areas. Additional outlets will be added to match the number of riparian corridors to be constructed. It is proposed that the 36-in pipeline from the west end of the overbank wetland basins be used to connect the storm drain outlets. Under this concept, the five separate detention basins (impoundment areas) could be combined at one location. The selected impoundment area or areas can be developed into a habitat area during dry weather using the pipeline connection to the wetland basin. The plant selection and operation must be designed to meet the flood control requirements for storage capacity. The interconnected pipe system must be designed to provide control gates that will prevent backflow into the interior land area during high flow events. The combining of impoundment basins into one location should simplify land acquisition. The basin size can be more cost effective because some of the separate basins had more capacity than required because of minimum size criteria.

VALUE ENGINEERING STUDY

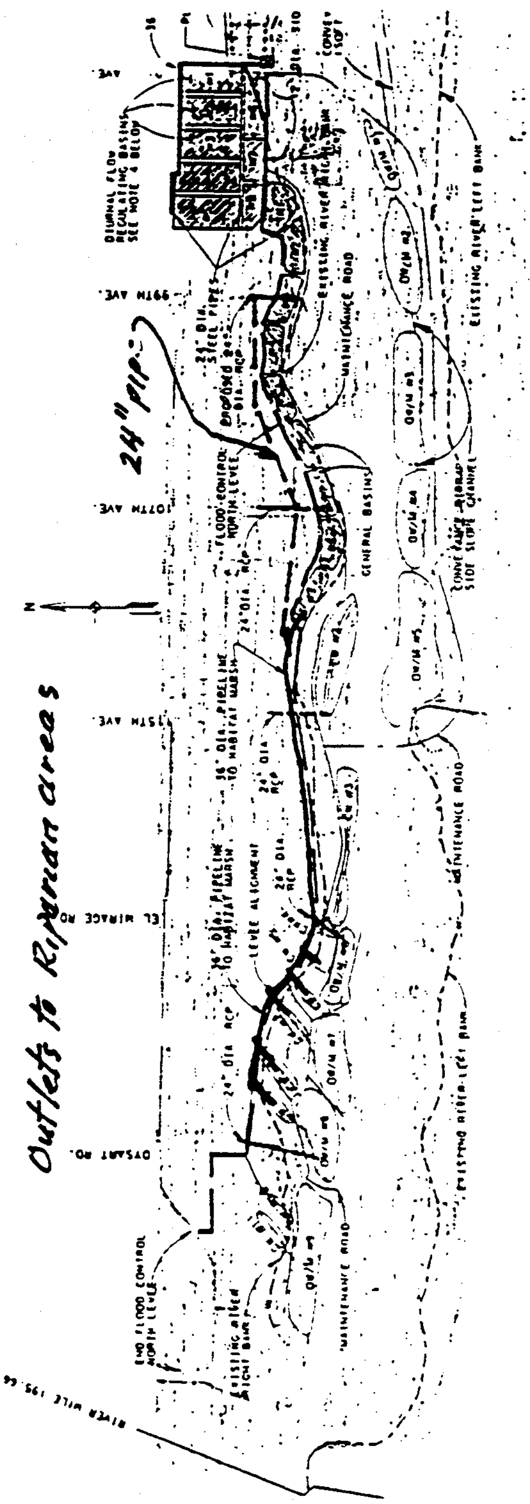
PROPOSAL NO.: F-42

PAGE NO.: 4 of 7

ORIGINAL CONCEPT — SKETCH



PROPOSED CONCEPT — SKETCH



ORIGINAL & PROPOSED CONCEPT — CALCULATIONS

Interior Drainage: Hydrologic Estimates for Tres Rios Levees. NNA/14July1999

	Location				
	99th Ave.	107th Ave.	115th Ave.	El Mirage Rd.	Dysart Road
Drainage Area - sq. mi.	1.5	1	0.25	0.35	0.25
100-yr Peak Discharge cfs	1000	700	200	280	200
100-yr Volume acre-feet	100	60	15	20	15

Notes: data (peak and volume estimates) based on Figures 3-1 and 3-3 from Appendix A, Rio Salado Feasibility Report, April 1998.

Suggestion: to size detention basin/impoundment area, consider reducing the 100-yr volume by the capacity of the selected drain in cfs, e.g. the impoundment area for the interior drainage to 99th Avenue could be 50 acre-feet if a 50 cfs pipe were selected. As the pipe capacity approaches the peak flow rate, less impounded area would be necessary, of course. However, this total will be a non-zero number in order to provide sufficient head to drive the water. For the above data, the tailwater is considered to be non-existent or negligible.

VALUE ENGINEERING STUDY

PROPOSAL NO.: F-42

COST SAVINGS ESTIMATE

			Original Concept		Proposed Concept	
Item	Unit of Measure	Unit Cost	Quantity	Total	Quantity	Total
Interior drainage 24-in RCP	lf	40.00	1,550	62,000	1,550	62,000
Inlet structures	ea	5,000	5	25,000	5	25,000
Outlet weir structures	ea	5,000	5	25,000	5	25,000
Connector pipe 24-in RCP	lf	40.00	-	-	3,200	128,000
Subtotal				112,000		240,000
Contingency, PED, E, S&A	%	37.3		41,775		89,520
TOTALS				153,800		329,500
NET SAVINGS						(175,700)

All costs from project MCACES Report and MCACES Database except if noted below:

1.

2.

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: F-70

DESCRIPTION: Use an irrigation ditch along the north side and eliminate pipe

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

The original concept includes 36-in gravity pipeline conveying water along the north levee from the overbank wetlands to the riparian corridor, a distance of 14,000 ft.

PROPOSED CONCEPT:

The proposed concept would replace 12,300 ft. of the above pipe with an open irrigation ditch.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$4,309,100	-	$4,309,100
PROPOSED CONCEPT	$1,083,600	-	$1,083,600
SAVINGS	$3,225,500	-	$3,225,500

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Potential water feature
- Potential habitat development
- Reduces construction time
- Lower capital cost

DISADVANTAGES:

- Post-flood maintenance required
- Reduced access to levee

JUSTIFICATION:

There is a dramatic capital cost savings potential for this proposal. Habitat and recreational features may be added to the stream banks.

DISCUSSION

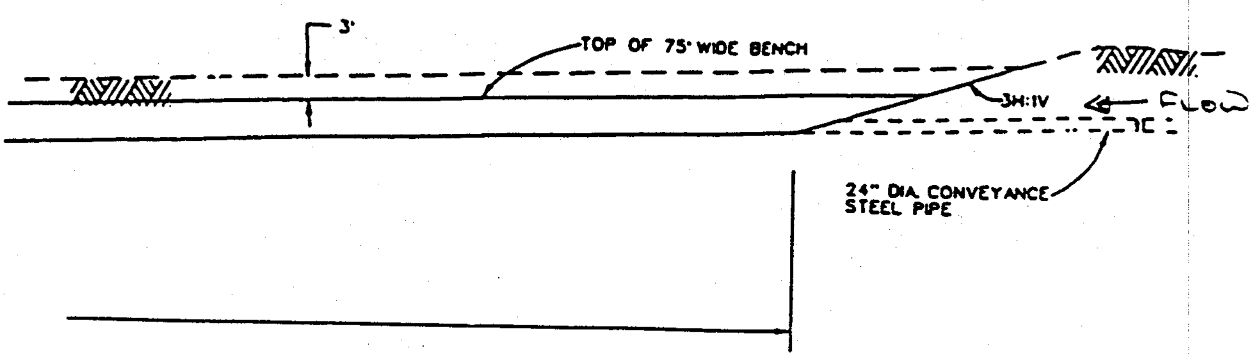
The original design includes 14,000 ft. of 36-in steel pipe to convey water from linear overbank (general) wetlands to the riparian corridors. This gravity pipeline is primarily located north of the proposed levee alignment and passes beneath the Holly Acres development.

The proposed change replaces most of the pipeline with a soft-bottom trapezoidal channel (irrigation ditch) with a depth of approximately 2-3 ft below finished grade. The channel follows the inside (south) bank of the north levee. The construction requires excavation, shaping and selective backfill. The channel could be formed to resemble a natural stream bed. A pipe is still required beneath the Holly Acres development due to a lack of space between the development and the levee that exists in this reach.

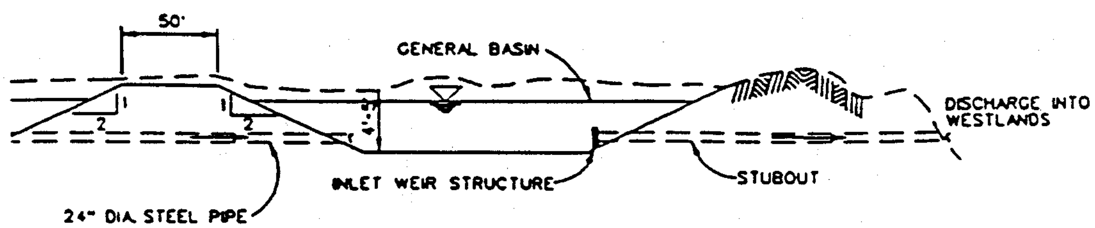
The necessity of piping beneath Holly Acres should be evaluated during design.

Increased maintenance of the channel was not considered a relevant issue. The channel to the west end of the project is only needed under the original concept to establish the riparian corridors. If the channel should fail within five years, the irrigation company's water would short circuit to the river. This would simply provide the opportunity for new riparian corridors. The value team does not consider this a failure of the system. The irrigation company would still get their water and the cottonwood/willow corridors would be into groundwater. Thus, the channel should require little to no maintenance to accomplish the required function.

ORIGINAL CONCEPT — SKETCH

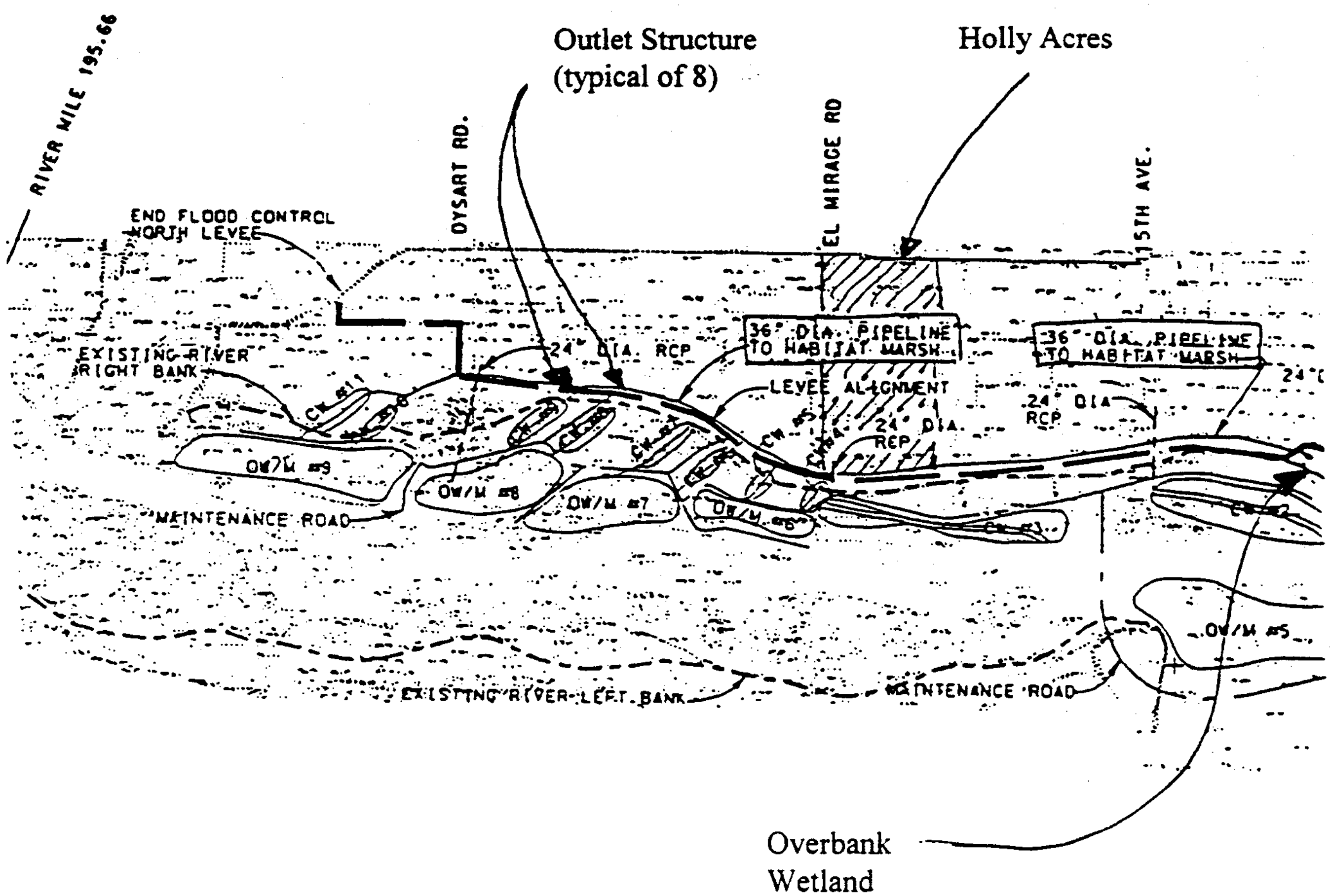


Riparian Corridor – Partial Profile
N.T.S.



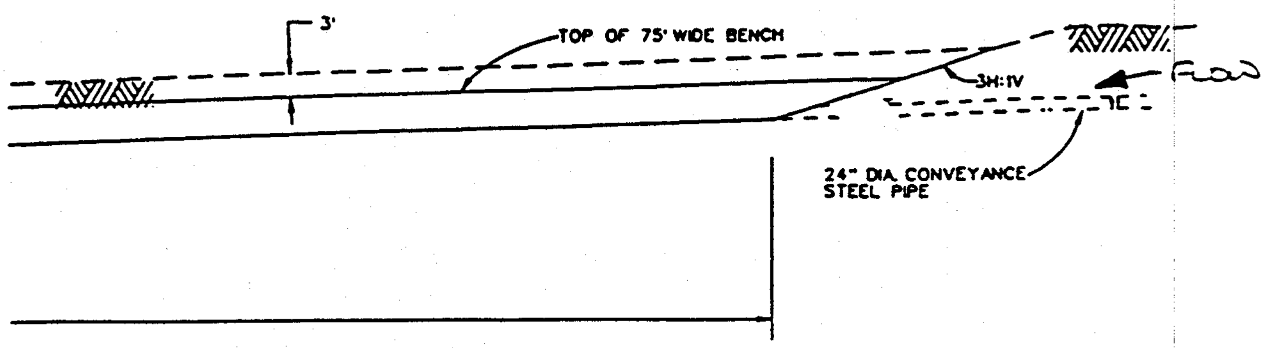
General (Linear Overbank) Wetland – Partial Profile
N.T.S.

ORIGINAL CONCEPT — SKETCH

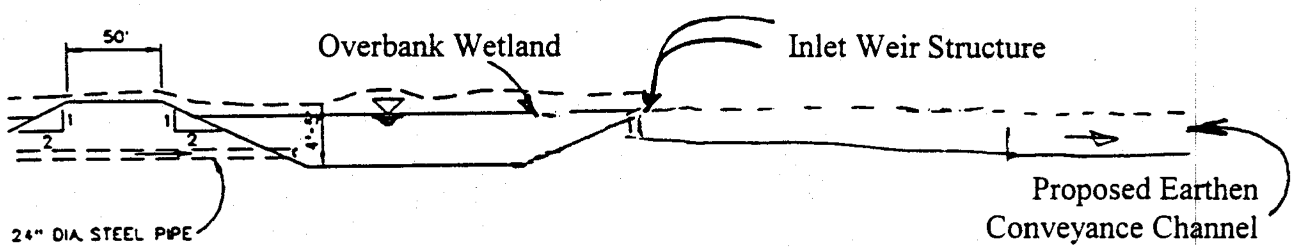


West Plan – Tres Rios

PROPOSED CONCEPT — SKETCH

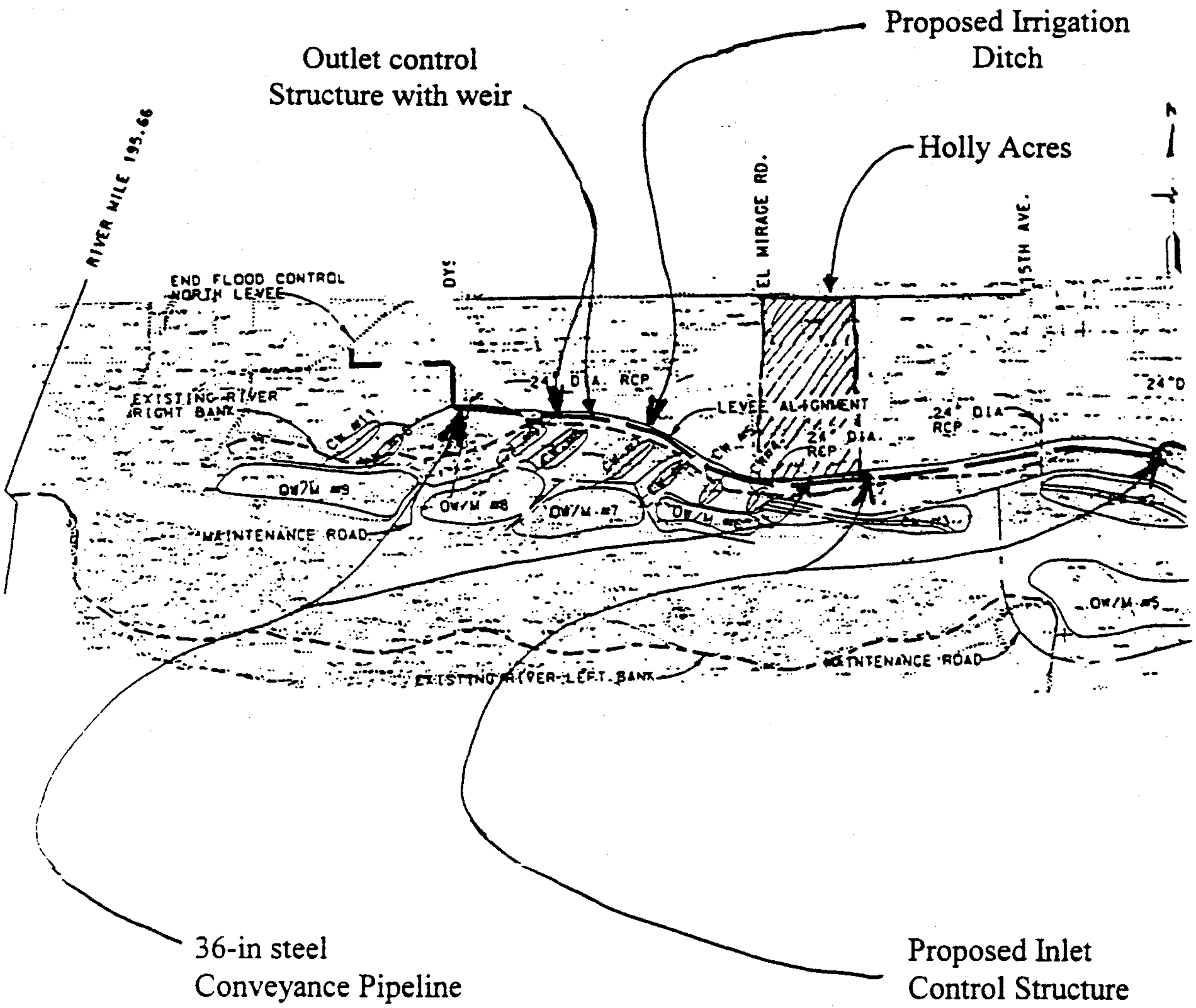


Riparian Corridor – Partial Profile
N.T.S.



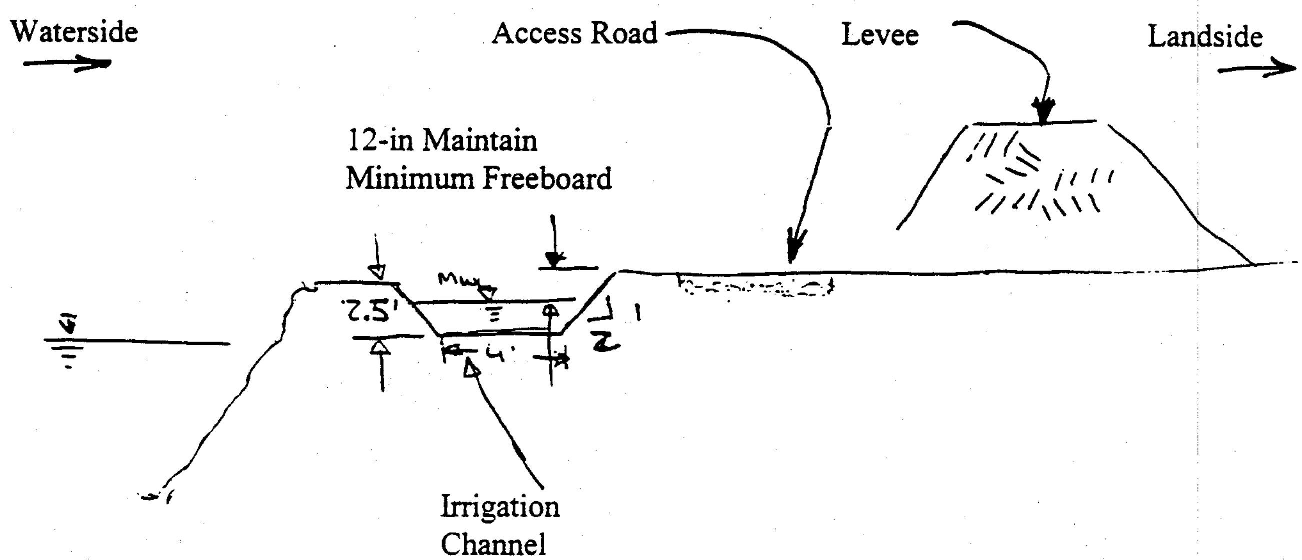
General (Linear Overbank) Wetland – Partial Profile
N.T.S.

PROPOSED CONCEPT – SKETCH



West Plan – Tres Rios

PROPOSED CONCEPT — SKETCH



Typical Profile of Levee & Channel
N.T.S.

ORIGINAL CONCEPT — CALCULATIONS

Assumptions:

Per item 4a, Appendix D, Tres Rios Feasibility Study

$$\frac{49{,}200 \text{ cy backfill}}{14{,}000 \text{ lf pipe}} = \frac{3.5 \text{ cy backfill}}{\text{lf pipe}}$$

$$\frac{52{,}900 \text{ cy excavation}}{14{,}000 \text{ lf pipe}} = \frac{3.8 \text{ cy excavation}}{\text{lf pipe}}$$

PROPOSED CONCEPT — CALCULATIONS

Assumptions:

1. Ditch is soft-bottomed trapezoidal channel
2. Use costs identified in Appendix D, Tres Rios Feasibility Study
3. From alternative 3.5 plan, length of pipe beneath Holly Acres equals approximately 1,700 ft.

Quantities:

	Original length		Holly Acres	
Channel length:	14,000 lf	–	(1,700)	
=	12,300 ft			
Channel excavation:	12,300 ft x 3.8 cy/lf	=	46,740 cy	
Channel backfill: shaping	Assume 0 cy; but increase cost of excavation to $8 to allow for			
Pipe excavation:	1,700 lf x 3.8 cy/lf	=	6,460 cy	
Pipe backfill:	1,700 lf x 3.5 cy/lf	=	5,950 cy	
Total excavation:	46,740 cy + 6,460 cy	=	53,200 cy	

COST SAVINGS ESTIMATE

			Original Concept		Proposed Concept	
Item	Unit of Measure	Unit Cost	Quantity	Total	Quantity	Total
36-in steel pipe	lf	200	14,000	2,800,000	1,700	340,000
Pipe excavation	cy	5.00	52,900	264,500	6,460	32,300
Pipe backfill	cy	3.00	49,200	147,600	5,950	17,850
Channel excavation & form	lf	8.00	-	-	46,740	373,920
Inlet structure with weir	ls	5.000	1	5,00	2	10,000
Outlet structure	ls	5,000	8	40,000	9	45,000
Subtotal				3.257,100		819,070
Contingency, PED. E. S&A	%	32.3		1,052,040		264,560
TOTALS				4,309,100		1,083,600
NET SAVINGS						3,225,500

All costs from project MCACES Report and MCACES Database except if noted below:

1.

2.

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: F-75

DESCRIPTION: Construct levees in a natural landform

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

In the original concept, the north and perhaps the south levees will be constructed with 8 ft top widths and 1 ft on 2 ft side slopes. The riverside of the levees will have 15-in riprap armor and a toe down of 7 ft to 15 ft.

PROPOSED CONCEPT:

The proposed concept would construct the levees with a varying total width of 1 ft on 4 ft and 1 ft on 5 ft slopes and a top width of 12 ft with no riprap or riprap toe down.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$34,780,000	-	$34,780,000
PROPOSED CONCEPT	$30,892,200	-	$30,892,200
SAVINGS	$3,887,800	-	$3,887,800

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- The levees will still provide 100-yr flood control protection.
- This proposal will use some of the excess material which would be stock piled from the excavation.
- With the low flow velocities at the levees and the repositioning of cottonwood/willows, the riprap and toe down riprap is not required.

DISADVANTAGES:

- None apparent. However, more hydraulic analysis is needed to make sure the proposal works.

JUSTIFICATION:

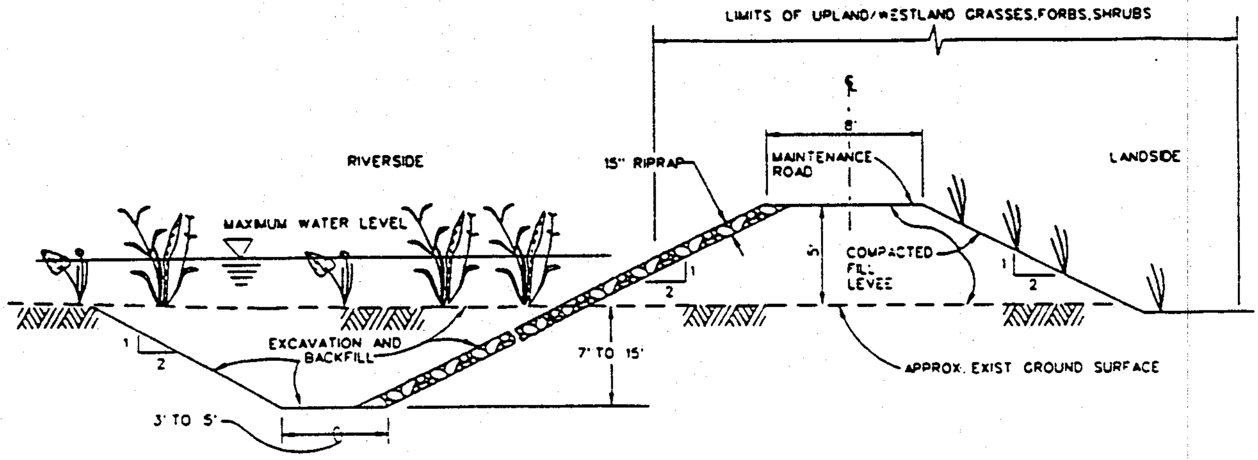
The intent of this recommendation is to provide a beneficial use of some of the excess excavation by putting additional material on the north side levee. This would be done in such a manner to make the levee look more like a natural landform.

DISCUSSION

The value team feels that the levee flood protection would be more appealing to the local residents if they were constructed to a more natural appearance. This recommendation would use more of the excavated material from the project, thus requiring less stock piling. With a broader levee, the riprap and riprap toe down would not be required. The cottonwood/willow riparian corridor planted at the toe of the levee would provide protection during the high flows when the levees would be in use.

This proposal assumes that real estate is not a concern, and that an expanded levee toe toward the river would be covered with existing real estate.

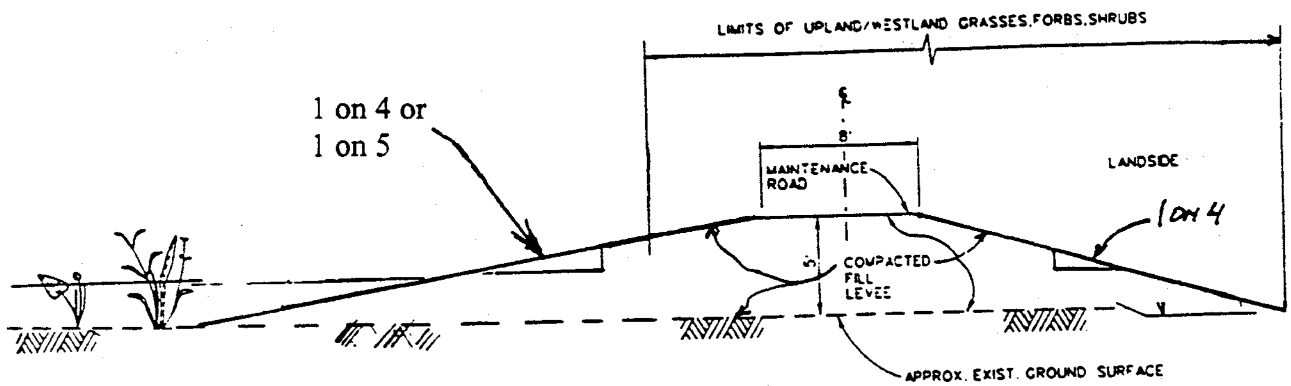
ORIGINAL CONCEPT — SKETCH



Typical Levee Section
Scale: 1 in = 4 ft

PROPOSED CONCEPT — SKETCH

sketch



*The toe would vary based on the 1 on 4 or 1 on 5 slopes.

Typical Levee Section
Scale: 1 in = 4 ft

ORIGINAL CONCEPT — CALCULATIONS

From MCACES Quantities and Estimate

Clearing and grubbing	$50,000
Compacted fill levee	141,000 cy
Toe excavation and backfill	358,000 cy
Riprap slope protection	87,600 tons
Interior drainage (24-in RCP)	1,550 lf
Inlet structures	5 ea
Outlet weir structures	5 ea
Excavation and stock pile	4,572,500 cy

(added quantities from MCACES estimate for Alternate 3.5)

PROPOSED CONCEPT — CALCULATIONS

Based on MCACES Quantities and Estimates

Clearing and grubbing – assume 50% increase	$75,000
Compacted fill levee – assume 50% increase	211,500 cy
Toe excavation and backfill	0 cy
Riprap slope protection	0 tons
Interior drainage (24-in RCP) assume 30% increase	2,015 lf
Inlet structures	5 ea
Outlet weir structures	5 ea
Reduced excavation and stock pile (E & S)	211,500 cy – 141,000 cy = 70,500 cy
Reduced excavation & stock pile	4,572,500 cy – 70,500 cy = 4,502,000 cy

COST SAVINGS ESTIMATE

Item	Unit of Measure	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Clearing and grubbing	ls		1	50,000	1	75,000
Compacted fill levee	cy	3.00	141,000	423,000	211,500	634,500
Toe excavation and backfill	cy	5.00	358,000	1,790,000	0	-
Riprap slope protection	tons	12.00	87,600	1,051,200	0	-
Interior drainage	lf	40.00	1,550	62,000	2,015	80,600
Inlet structures	ls	5,000	5	25,000	5	25,000
Outlet structures	ls	5,000	5	25,000	5	25,000
Excavation	cy	5.00	4,572,500	22,862,500	4,502,000	22,510,000
Subtotal				26,288,700		23,350,100
Contingency, PED, E, S&A	%	32.3		8,491,300		7,542,100
TOTALS				34,780,000		30,892,200
NET SAVINGS						3,887,800

All costs from project MCACES Report and MCACES Database except if noted below:

1. Levee contingency at 15% in lieu of 20%
2. Excludes real estate costs

HABITAT DEVELOPMENT

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: H-02

DESCRIPTION: Eliminate riprap and armor levee with live materials

CRITERIA CHALLENGE: Yes CRITERIA NO.:

ORIGINAL CONCEPT:

The original concept would armor the levee with riprap to protect from scouring flows.

PROPOSED CONCEPT:

The proposed concept would eliminate riprap including toe excavation and backfill and protect from scour using soil bioengineering methods and avoiding root exclusion zones.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$3,901,000	-	$3,901,000
PROPOSED CONCEPT	$61,8000	-	$61,8000
SAVINGS	$3,839,200	-	$3,839,200

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Adds new habitat element (upper riparian)
- Self maintaining once established
- Aesthetically appealing

DISADVANTAGES:

- Requires temporary irrigation to establish vigorous vegetation

JUSTIFICATION:

The proposed concept achieves the project objectives by adding valuable new habitat while protecting property and infrastructure.

DISCUSSION

The conditions at this site are amenable to using soil bioengineering methods to protect the levee. Channel velocities are generally low (<8 fps) in the project reach. The velocities at the bank are substantially lower. There are dozens of bioengineering methods that are used in similar applications. All share the following characteristics:

- Soil strengthening through root reinforcement. Well developed root systems can increase soil shear resistance by a factor of two.[1]
- Soil strengthening through mechanical buttressing.
- Hydraulic roughness to lower flow velocity at bank and direct scouring flows to the center of the channel.

Bioengineering methods range from purely vegetative: live fascines, brush layering, live staking and simply dense planting to hybrid structures including engineering materials such as geogrid, riprap or geoweb.

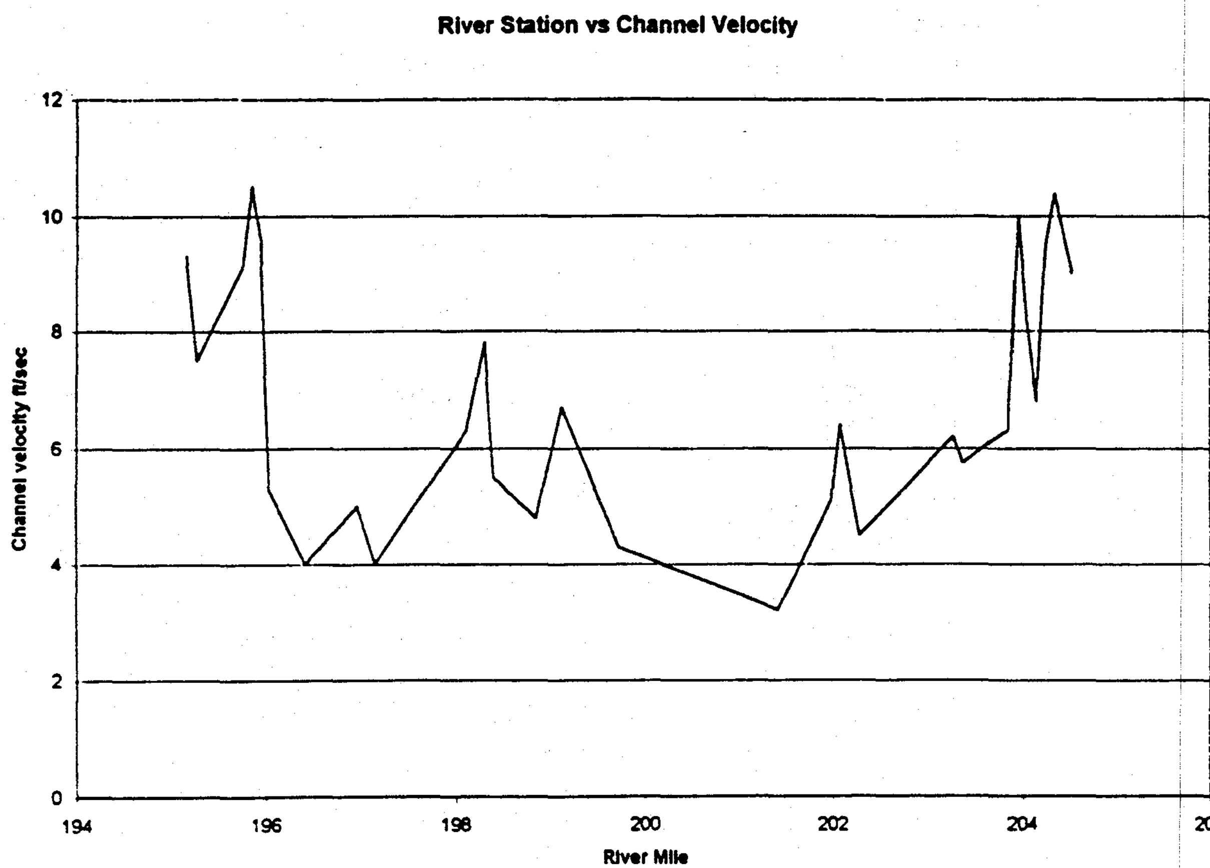
In this project, a purely vegetative approach would provide adequate slope protection while adding considerable upper riparian habitat. Mesquite, quailbush, and rabbitbush vegetation would work well. The practice is to plant young rooted stock on the slope and supply drip irrigation until established. Vegetated slopes are generally self maintaining and are replanted only on areas where plant loss causes a large gap in cover.

This recommendation is consistent with CoE guidance for vegetative approaches to riverside slope protection as described in EM 1110-2-1913.

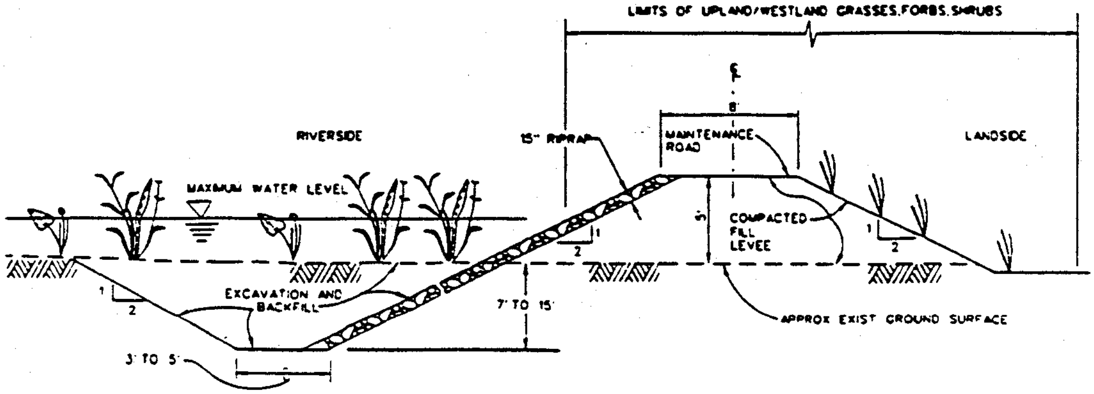
As an alternate, the levee slope could be covered with landscape fabric to prevent penetration, more soil added to flatten the slope and then planted.

1 Gray & Sotir, Biotechnical and Soil Bioengineering for Slope Stabilization, Wiley & Sons, New York, 1996, pp. 64-94.

ORIGINAL CONCEPT — SKETCH



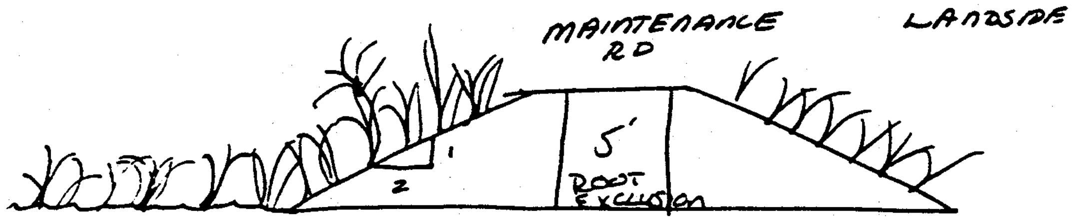
ORIGINAL CONCEPT — SKETCH



Typical Levee Section
Scale: 1 in – 4 ft

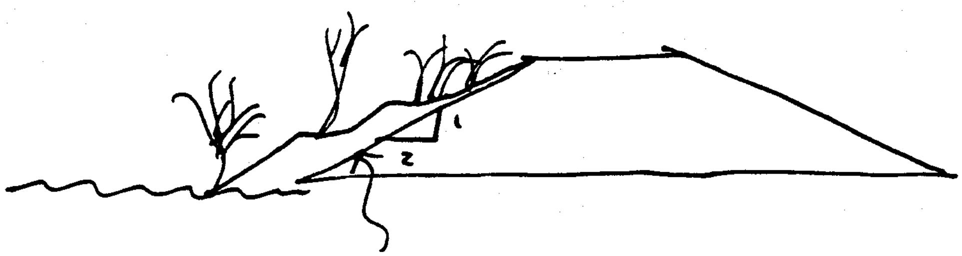
PROPOSED CONCEPT — SKETCH

Preferred



PROPOSED CONCEPT — SKETCH

Alternate



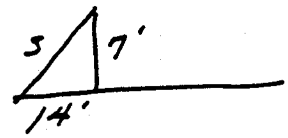
Landscape
Fabric

Quail and rabbitbush near the top of the slope and mixed mesquite/shrub lower.

PROPOSED CONCEPT — CALCULATIONS

Levee surface area

- Length = 25,000 ft
- Average height = 7 ft
- Designed slope 2:1



- Slope length

$$S = \sqrt{7^2 + 14^2} = 15.6 \text{ ft}$$

- Levee surface area

$$A = 25{,}000 \text{ ft} \times 15.6 \text{ ft} = 391{,}312 \text{ ft}^2 \text{ (approximately 9 acres)}$$

VALUE ENGINEERING STUDY

PROPOSAL NO.: H-02

COST SAVINGS ESTIMATE

Item	Unit of Measure	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Mid high levee						
Toe excavation and backfilling	cy	5.00	358,000	1,790,000	0	-
Riprap slope protection	cy	12.00	87,600	1,051,200	0	-
Upland plantings	acre	5,000*	0	0	9	45,000
Subtotal				2.841,200		45,000
Contingency, PED, E, S&A	%	37.3		1,059,800		16,800
TOTALS				3,901,000		61,800
NET SAVINGS						3,839,200

All costs from project MCACES Report and MCACES Database except if noted below:

1. *Unit costs based on recent local experience
2.

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: H-25

PAGE NO.: 1 of 8

DESCRIPTION: Simplify the dewatering pipe route

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

The original concept would convey the dewatering well water one mile up the gradient in a 36-in steel pipe to the gravel pit lake, then divert the flow from the lake in a 36-in concrete pipe 1,200 ft long to a 3,000-ft long cottonwood/willow corridor. The flow from the cottonwood/willow corridor is in 6,000 ft of trapezoidal channel to an open water marsh system.

PROPOSED CONCEPT:

The proposed concept is to convey the dewatering well water to the river bank in 1,000 ft of 36-in steel pipe, then convey the water in 3,000 ft of 36-in concrete pipe from the bank to a trapezoidal channel. The water would then be transported in 1,000 ft of trapezoidal channel which is to be relocated to the cottonwood/willow corridor then on to the open water marsh system.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$1,909,100	-	$1,909,100
PROPOSED CONCEPT	$908,100	-	$908,100
SAVINGS	$1,001,000	-	$1,001,000

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Reduces construction effort
- Achieves goal of delivering flow to south open water marsh
- Maintains habitat units
- Still allows for blending of Salt River Project (SRP) tailwater from the southwest
- Simplifies the south side water delivery system

DISADVANTAGES:

- Decreases water exchange in the gravel pit lake

JUSTIFICATION:

The proposed change reduces the length of the dewatering well water conveyance system by 50 percent and thus reduces total construction. The changes do not delete any habitat areas and maintains the habitat unit goal. The changes accomplish the goals proposed for the Tres Rios south side features.

DISCUSSION

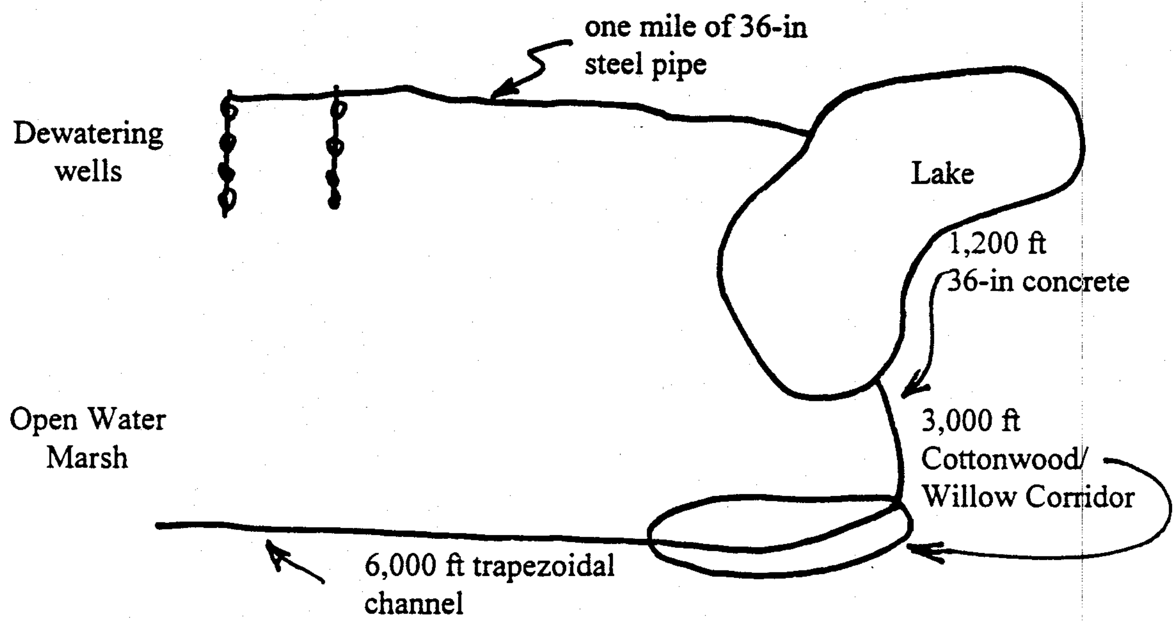
The purpose of the dewatering well delivery system is to collect the water from the dewatering wells at the 91st Avenue wastewater treatment plant and to provide a delivery system to the Tres Rios habitat features located on the south side of the Gila River. The dewatering well delivery system allows the dewatering well water to be put to beneficial use in Tres Rios.

The original concept involved pumping the water up the gradient to an existing gravel pit and then using a gravity flow system to the south side habitat features. The original concept included 5,280 ft of 36-in steel pipe, 1,200 ft of 36-in concrete pipe, and 6,000 ft of trapezoidal channel. This is a total of 12,480 ft of conveyance system. The original concept also provided for blending of the dewatering well flow with the irrigation spillway discharge that enters the Tres Rios area from the southeast. The flows would be co-mingled in the trapezoidal channel prior to entering the first open water marsh feature on the south side.

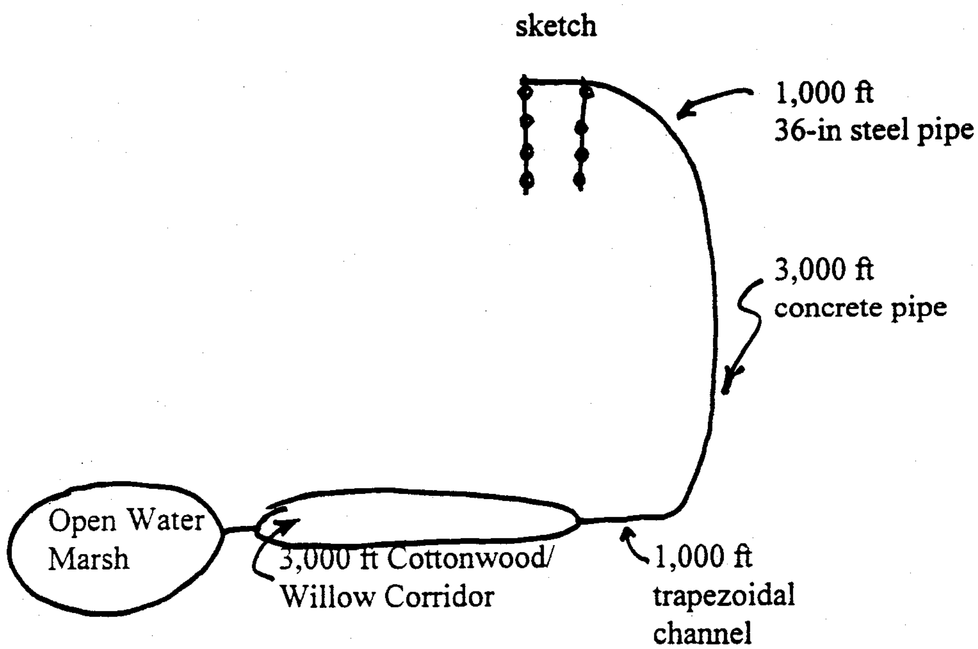
The proposed changes accomplish most of the goals of the original concept. However, the proposed changes result in a shorter delivery system. The proposed changes alter the delivery system to include 1,000 ft of 36-in steel pipe, 4,000 ft of 36-in concrete pipe and 4,000 ft of trapezoidal channel. This is a total of 6,000 ft of conveyance system and reduces the overall length by 50 percent. This results in less construction and construction time. The proposed changes relocates the cottonwood willow corridor to the west from the original location and places it closer to the first open water marsh in the south side system. This maintains the habitat features and associated habitat units.

The proposed changes do not provide for the exchange of water in the gravel pit lake. Water from the proposed upstream projects could be directed into the gravel pit lake in the future and would provide water exchange in the lake.

ORIGINAL CONCEPT — SKETCH



PROPOSED CONCEPT — SKETCH



ORIGINAL CONCEPT — CALCULATIONS

Dewatering well system 36-in steel pipe

36-in pipe	=	5,280 ft		
Trench	=	3.71 cy/ft	=>	19,600 cy
Backfill	=	3.47 cy/ft	=>	18,300 cy

Dewatering well system 36 inch concrete pipe

36-in pipe	=	1,200 ft		
Trench	=	3.75 cy/ft	=>	4,500 cy
Backfill	=	3.5 cy/ft	=>	4,200 cy

Trapezoidal channel soft side

Clearing and grubbing	=	one lump sum
Grading and shaping	=	3.0 acres
Excavation and stockpile	=	11,600 cy
Vegetation planting	=	1.0 acres

PROPOSED CONCEPT — CALCULATIONS

Dewatering well system 36-in steel pipe

36-in pipe	=	1,000 ft				
Trench	=	3.71 cy/ft	=>	3,800 cy		
Backfill	=	3.47 cy/ft	=>	3,500 cy		

Dewatering well system 36 inch concrete pipe

36-in pipe	=	4,000 ft				
Trench	=	3.75 cy/ft	=>	15,000 cy		
Backfill	=	3.5 cy/ft	=>	14,000 cy		

Trapezoidal channel soft side 1/6 original concept

Clearing and grubbing	=	one lump sum	=	50,000/6	=	8,300
Grading and shaping	=	0.5 acres		3/6	=	0.5
Excavation and stockpile	=	270 cy	=	11,600/6	=	1,930
Vegetation planting	=	0.2 acres		1/6	=	0.2

VALUE ENGINEERING STUDY

PROPOSAL NO.: H-25

COST SAVINGS ESTIMATE

Item	Unit of Measure	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
36-in steel pipe	ft	200.00	5,200	1,040,000	1,000	200,000
Trench	cy	5.00	19,600	98,000	3,800	19,000
Backfill	cy	3.00	18,300	54,900	3,500	10,500
36-in concrete pipe	ft	80.00	1,200	96,000	4,000	320,000
Trench	cy	5.00	4,500	22,500	15,000	75,000
Backfill	cy	3.00	4,200	12,600	14,000	42,000
Trapezoidal channel soft						
Clearing and grubbing	ls	50,000	1	50,000	1/6	8,300
Grading and shaping	acre	2,500	3	7,500	0.5	1,250
Excavation and stock pile	cy	5.00	11,600	58,000	1,930	9,650
Vegetation planting	acre	3,500	1	3,500	0.2	700
Subtotal				1,443,000		686,400
Contingency, PED, E, S&A	%	32.3		466,100		221,700
TOTALS				1,909,100		908,100
NET SAVINGS						1,001,000

All costs from project MCACES Report and MCACES Database except if noted below:

1.

2.

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: H-27

DESCRIPTION: Increase the height of the levee and reduce scheduled maintenance

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

One of the project functions is flood protection of riverside land and development including the Holly Acres development. The original project concept to effect this is a levee from the existing Flood Control District (FCD) levee at El Mirage Road to a terminus near Dysart Road. The planned levee height is to provide 100-yr protection with freeboard as required by FEMA standard.

PROPOSED CONCEPT:

The proposed concept is a higher levee that provides more freeboard. The extra freeboard results in significant benefits. For cost estimating purposes, one foot is assumed as added height.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$589,000	$869,000	$1,458,000
PROPOSED CONCEPT	$704,400	$435,000	$1,139,400
SAVINGS	$(115,400)	$434,000	$318,600

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Provides more protection to river side of the property
- Increases sediment depth allowed prior to maintenance being needed
- Provides useful place for surplus excavation material
- Provides factor of safety for highly unknown/variable/difficult to predict sediment parameter

DISADVANTAGES:

- Increased construction cost for levees (increased earthwork volume)
- Possible trouble with CoE approval – approval is for 100-yr elevation

JUSTIFICATION:

The increased benefits of the proposed concept outweigh the added construction cost. The added construction cost will be relatively small. On a life cycle basis, savings in operation and maintenance costs will be significantly more than the construction cost increase. The levee maintenance costs in the feasibility report are too low.

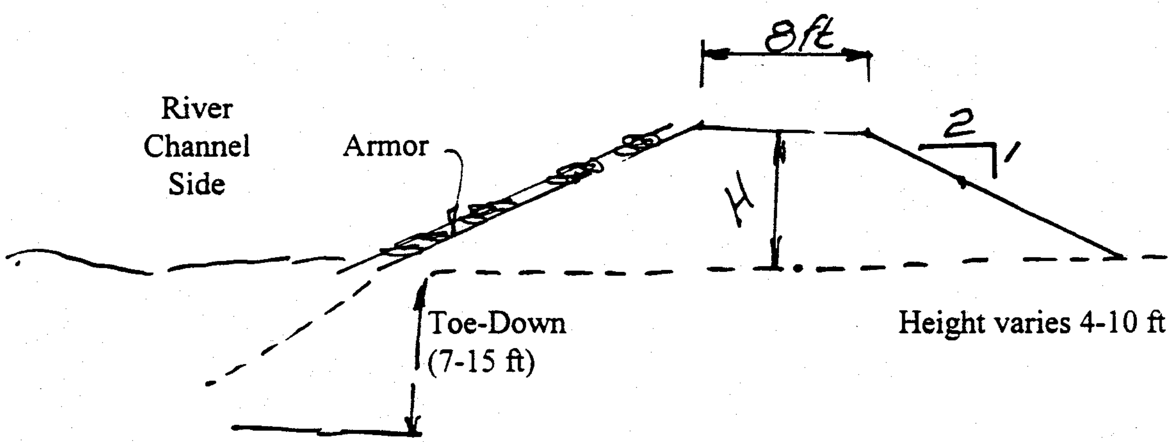
DISCUSSION

It appeared unclear to the value team how the proposed change would result in a lower maintenance cost. One team member suggested that increasing the time period between maintenance activity would be a burden to the maintenance agency – FCD. He suggested FCD would try to plan annual maintenance efforts at a frequency close to annually would be most cost effective. FCD disagrees. By raising levee height, freeboard is added to the levee. All added freeboard can be used to contain sediment that washes into the river during flood events. FCD has made the point that sediment transport is an important parameter in the project. First, it has not been analyzed. Further, it will be very difficult to analyze and predict accurately as there are three rivers involved in the analysis.

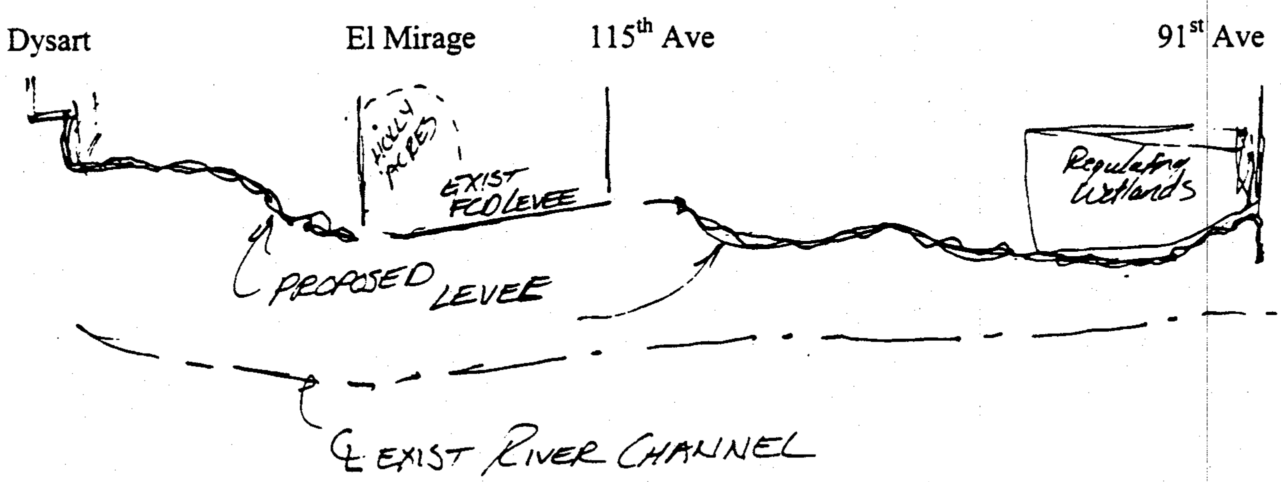
Considering the difficulty in predicting depth of sediment, more freeboard is warranted. What if sediment depth is far greater than anticipated? The project could lose 100-yr frequency protection on the levee shortly after construction, requiring a big maintenance effort to restore it. It is prudent to build the project with a safety factor to prevent this scenario. In this case, this safety factor is not costly. Currently, the project shows a great surplus of excavated soil. Rather than wasting it, the soil can be put to beneficial use in the levee. There is essentially no hauling to bring it to the levee because it is on site.

As for annual, periodic trips to the river for maintenance, it is to be avoided. The point of the project is river management – not maintenance. By staying out of the river, maintenance costs are reduced. The feasibility report greatly under-estimates maintenance. Mobilization and labor are the biggest components. More trips to the river increase these costs. The proposed change lowers life cycle costs.

ORIGINAL CONCEPT — SKETCH

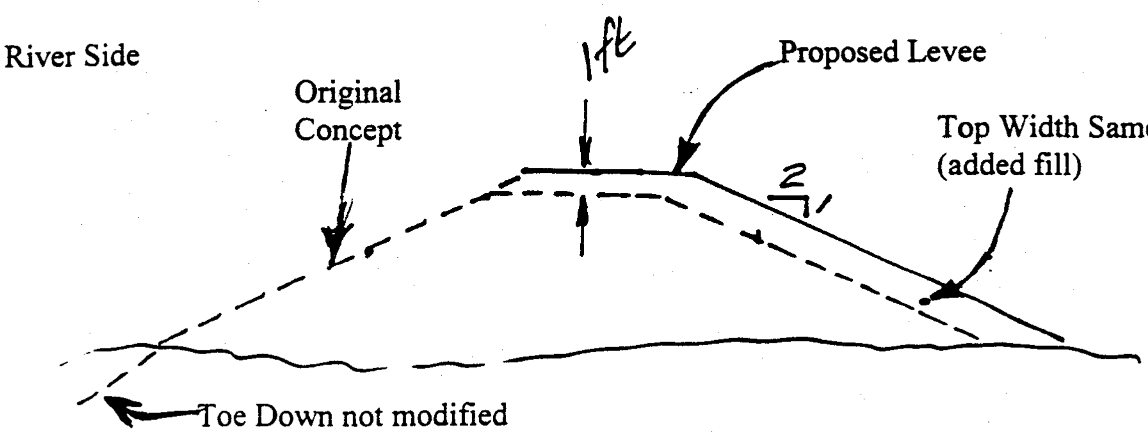


Levee Cross Section

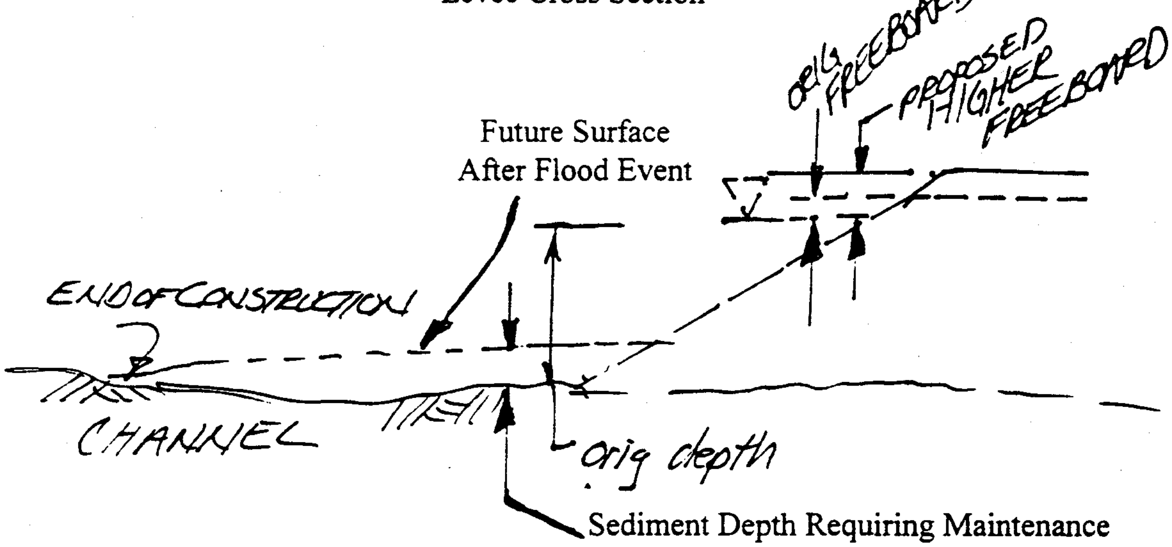


Reference: Feasibility Report, Figure 5.6, and "Flood Control Levee, p. VI-6.

PROPOSED CONCEPT — SKETCH



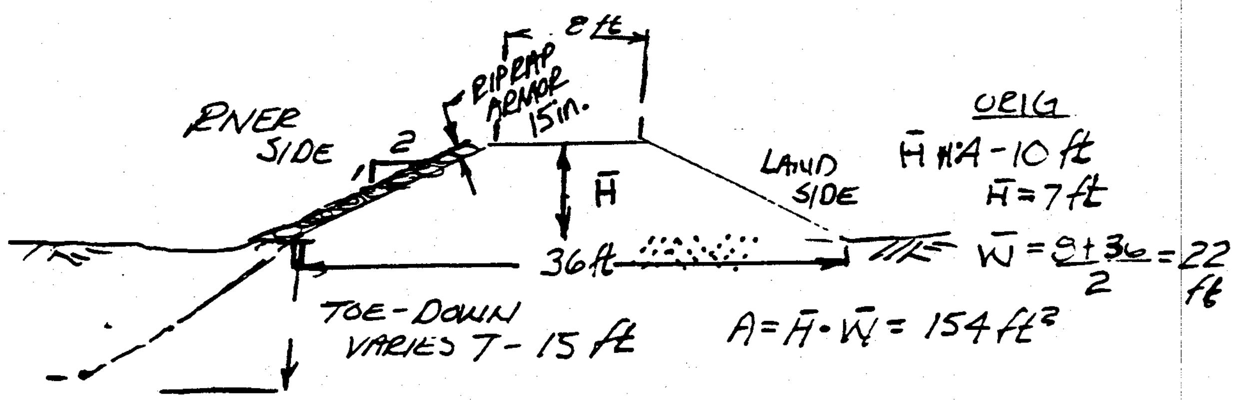
Levee Cross Section



Sediment Depth Reduces Freeboard

Higher freeboard increases this depth, decreasing periodic maintenance

ORIGINAL CONCEPT — CALCULATIONS



LEVEE CONFIGURATION (FIG 5.6)	LENGTH (ft)	VOL A·L (ft³)	(yd³)
~~OPT 1~~	~~5,106~~	~~785,460~~	~~29,500~~
~~OPT 2~~	~~61,545~~	~~1,008,000~~	~~37,500~~
	25,000	3.8×10^6	143,000

Reference: Feasibility Report, Figure 5.6, and "Flood Control Levee, p. VI-6.

ORIGINAL CONCEPT — CALCULATIONS

The following table shows the annual costs incurred by the Flood Control District for the Holly Acres levee over the past four years.

Maintenance Costs for Salt / Gila Control Works

Holly Acres

Fiscal Year	FCD Hours	FCD Labor Costs	CSC Hours	CSC Costs	Total Labor Hours	Total Labor Costs	Equipment Costs	Material Costs	Total Costs	Fiscal Year
1996-1997	257.00	$3.729.63	36.00	$32.13	$293.00	$3,761.76	$1,331.02	$3,728.16	$8,820.94	1996-1997
1997-1998	281.25	$4.476.19	479.50	$359.63	$760.75	$4,835.82	$1,079.07	$2,567.21	$8,482.10	1997-1998
1998-1999	528 00	$8.503.02	530.00	$397.50	$1,058.00	$8,900.52	$3,244.21	$8,630.17	$20,774.90	1998-1999
1999-2000	288.00	$4.713.39	135.50	$101.63	$423.50	$4,815.02	$869.72	$4,378.62	$10,063.86	1999-2000

4 Year Averages			
Average FCD Hours	338 56	Average CSC Hours	295.25
Average FCD Costs	$5.355 56	Average CSC Costs	$222.72
Average Equipment Costs	$1.631.01	Average Material Costs	$4.826.09

4 Year Average Labor, Equipment and Material Costs	$12.035.38

Tres Rios will require substanitally more as currently planned. Assume that annual costs will increase by a factor of five.

Annual costs = $12,000 x 5 = $60,000

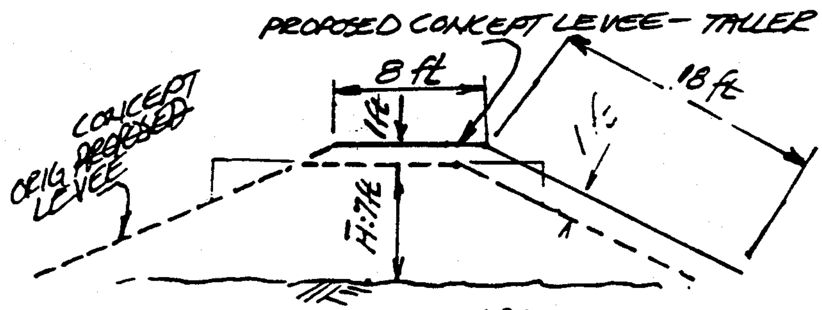
PROPOSED CONCEPT — CALCULATIONS

By raising the levee one foot, it is assumed that this will extend the required maintenance cycle by one year.

If the annual costs equal $60,000 in the original concept, then the bi-annual costs would equal $60,000 in the proposed concept.

$$\text{Annualized} = \frac{\$60,000}{2} = \$30,000$$

PROPOSED CONCEPT — CALCULATIONS



ADDED AREA:
8 + 18 = 26 ft²

PROPOSED VOLUME:
ORIG. VOL + ADDED AREA × L

ADDED VOL = AREA • LENGTH

LEVEE CONFIGURATION	LENGTH (ft)	ADDED VOL (ft³)	ORIG CONCEPT VOL (ft³)	PROPOSED VOL (CY)
~~OPT 1~~ ~~OPT 2~~ FIG 5.6	25,000 ~~5,100~~ ~~6,545~~	~~132,600~~ ~~170,170~~	~~785,400~~ ~~1,008,000~~ N/A	~~34,000~~ ~~44,000~~
EXIST FCD LEVEE	5,818	151,270		6,000
FIG 5.6	25,000	650,000 (24,100 cuyd)	~~[illegible]~~ 3.8×10⁶	165,000
				171,000 CY

ASSUME EXISTING LEVEE MUST ALSO BE RAISED

VALUE ENGINEERING STUDY

PROPOSAL NO.: H-27

PAGE NO.: 10 of 11

COST SAVINGS ESTIMATE

			Original Concept		Proposed Concept	
Item	Unit of Measure	Unit Cost	Quantity	Total	Quantity	Total
Levee embankment fill	cy	3.00	143,000	429,000	171,000	513,000
Subtotal				429,000		513,000
Contingency, PED. E, S&A	%	37.3		160,000		191,400
TOTALS				589,000		704,400
NET SAVINGS						(115,400)

All costs from project MCACES Report and MCACES Database except if noted below:

1. Estimate has 141,000 cy fill
2.

LIFE CYCLE COST ANALYSIS

LIFE CYCLE PERIOD 50 YEARS

ANNUAL PERCENTAGE RATE = 6.625%

INITIAL COSTS	PRESENT DESIGN (PRESENT WORTH)	PROPOSED DESIGN (PRESENT WORTH)
Base Cost		
SUB-TOTAL		

SINGLE EXPENDITURE	YEAR	PRESENT WORTH FACTOR	PRESENT DESIGN		PROPOSED DESIGN	
			ESTIMATE	PRESENT WORTH	ESTIMATE	PRESENT WORTH
Salvage						
SUB-TOTAL						

ANNUAL EXPENDITURE	YEARS	PRESENT WORTH FACTOR	PRESENT DESIGN		PROPOSED DESIGN	
			ESTIMATE	PRESENT WORTH	ESTIMATE	PRESENT WORTH
O&M	50	14.484	60,000	869,000	30,000	435,000
Energy						
SUB-TOTAL				869,000		435,000
TOTAL PRESENT WORTH						
LIFE CYCLE SAVINGS						434,000

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: H-28

DESCRIPTION: Locate all open water marshes to avoid lining

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

As described in the Feasibility Report, the original concept has all open water marshes lined with clay or soil. The location of open water marshes is determined primarily to eradicate salt cedar.

PROPOSED CONCEPT:

The proposed concept locates open water marsh areas along the highest ground water to allow co-mingling; thereby, avoiding the need for soil/clay lining.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$3,330,900	-	$3,330,900
PROPOSED CONCEPT	$0	-	$0
SAVINGS	$3,330,900	-	$3,330,900

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Locates open water areas along probable thalweg, improving conveyance and sediment transport
- More nearly mimics natural system
- Eliminates conveyance pipeline
- Provides for mixing of dewatering well and Salt River Project (SRP) irrigation water
- Meets Gila River Irrigation Company desire for both open water and cottonwood/willow on their bank
- Groundwater-fed pools are cooler, improving fish and other aquatic life survivability

DISADVANTAGES:

- Will have seasonal (not diurnal) variations in depth

JUSTIFICATION:

The proposed change provides improved conveyance and sediment transport while achieving a more natural flow and habitat configuration.

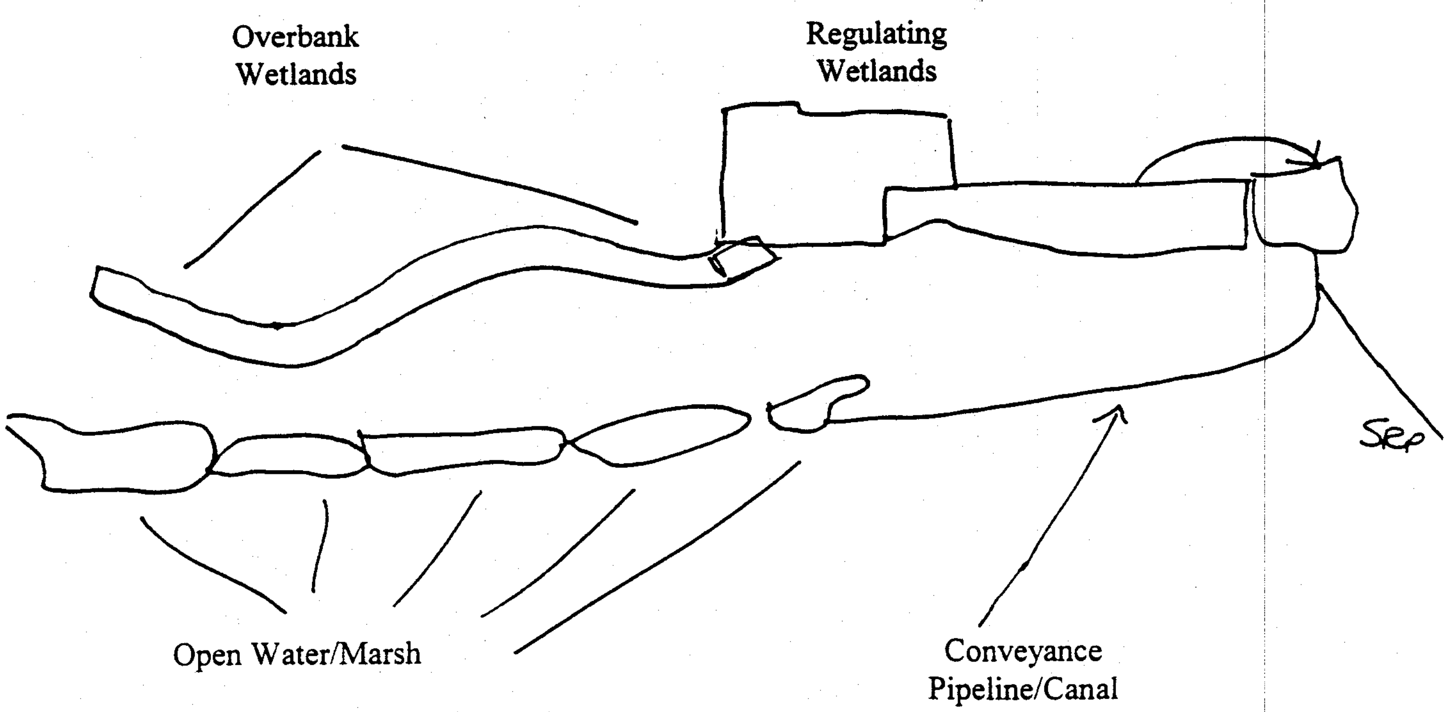
DISCUSSION

In this recommendation, the two eastern most open water marshes on the south bank are relocated to the north west. A cottonwood/willow corridor is established in their place. The location of the other open watei marsh features is essentially unchanged. The recommended configuration places open water marshes at near-surface groundwater and in an alignment in general accordance with William Graf's[1] probable location of the thalweg. The likelihood of maintaining open channels to convey flows is improved. Aligning open water marshes with the thalweg also improves sediment transport capacity.

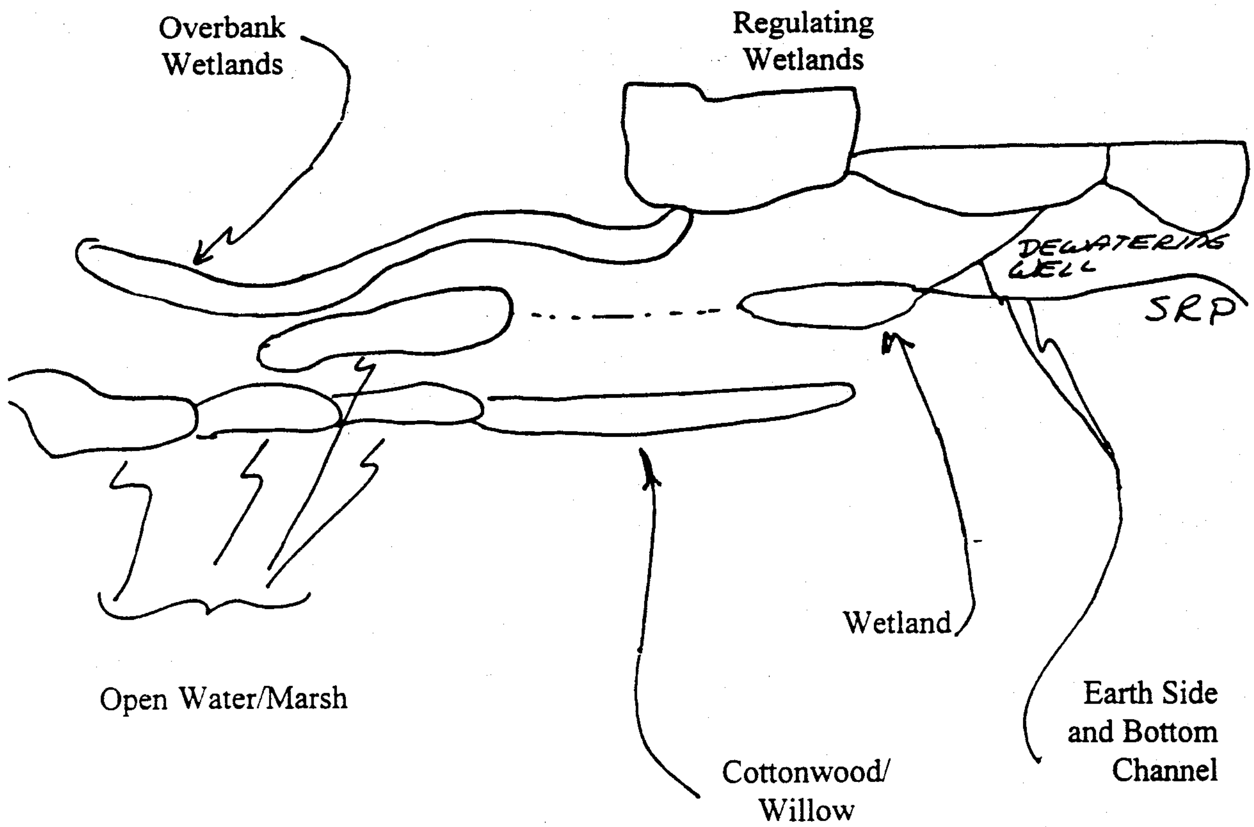
Placement over near-surface groundwater eliminates the need to line the open water marsh. The cottonwood/willow complex along the south bank protects it from erosion and directs scouring flows to the center of the channel. This recommended configuration also includes shortening of the dewatering pipeline. The SRP flow and water from the dewatering well mix in a small additional wetland area.

[1] = William L. Graf, Patricia J. Beyer, and Thad A Waskiewicz, Geomorphic Assessment of the Lower Salt River, Central Arizona, Department of Geography, Arizona State University, Tempe, Arizona, October 1994.

ORIGINAL CONCEPT — SKETCH



PROPOSED CONCEPT — SKETCH



VALUE ENGINEERING STUDY

PROPOSAL NO.: H-28

PAGE NO.: 6 of 6

COST SAVINGS ESTIMATE

Item	Unit of Measure	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Dewatering well						
36-in steel pipe	lf	200	5,200	1,040,000		
Pipe and trench excavation	cy	5.00	19,600	98,000		
Pipe trench backfill	cy	3.00	18,300	54,900		
36-in pipe from gravel pit lake						
36-in concrete pipe	lf	80.00	1,200	96,000		
Pipe trench excavation	cy	5.00	4,500	22,500		
Pipe trench backfill	cy	3.00	4,200	12,600		
Open water marsh topsoil lining	cy	10.00	60,100	601,000		
Open water march north	cy	10.00	57,000	570,000		
Subtotal				2,495,000		
Contingency, PED, E, S&A	%	32.3		805,900		
TOTALS				3,300,900		
NET SAVINGS						3,300,900

All costs from project MCACES Report and MCACES Database except if noted below:

1.

2.

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: H-30

PAGE NO.: 1 of 8

DESCRIPTION: Plant northwest area in cottonwood/willows and eliminate stringers

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

The original concept includes a 36-in steel pipe that conveys water from the overbank wetlands to cottonwood/willow corridors on the west end of the project.

PROPOSED CONCEPT:

The proposed concept would eliminate the pipe and discharge water directly to the river from the overbank wetlands. The downstream north bank has areas of seepage. Planting moist areas with cottonwood/willows as planned would achieve habitat. If drier areas are encountered farther uphill, mesquite bosques would be planted.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$8,434,200	$236,000	$8,670,200
PROPOSED CONCEPT	$1,438,500	$0	$1,438,500
SAVINGS	$6,995,700	$236,000	$7,231,700

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Addresses potential vector problem by concentrating plantings (particularly willows) on damp areas, thereby allowing surface drying
- Takes advantage of existing bank/channel morphology

DISADVANTAGES:

- None apparent

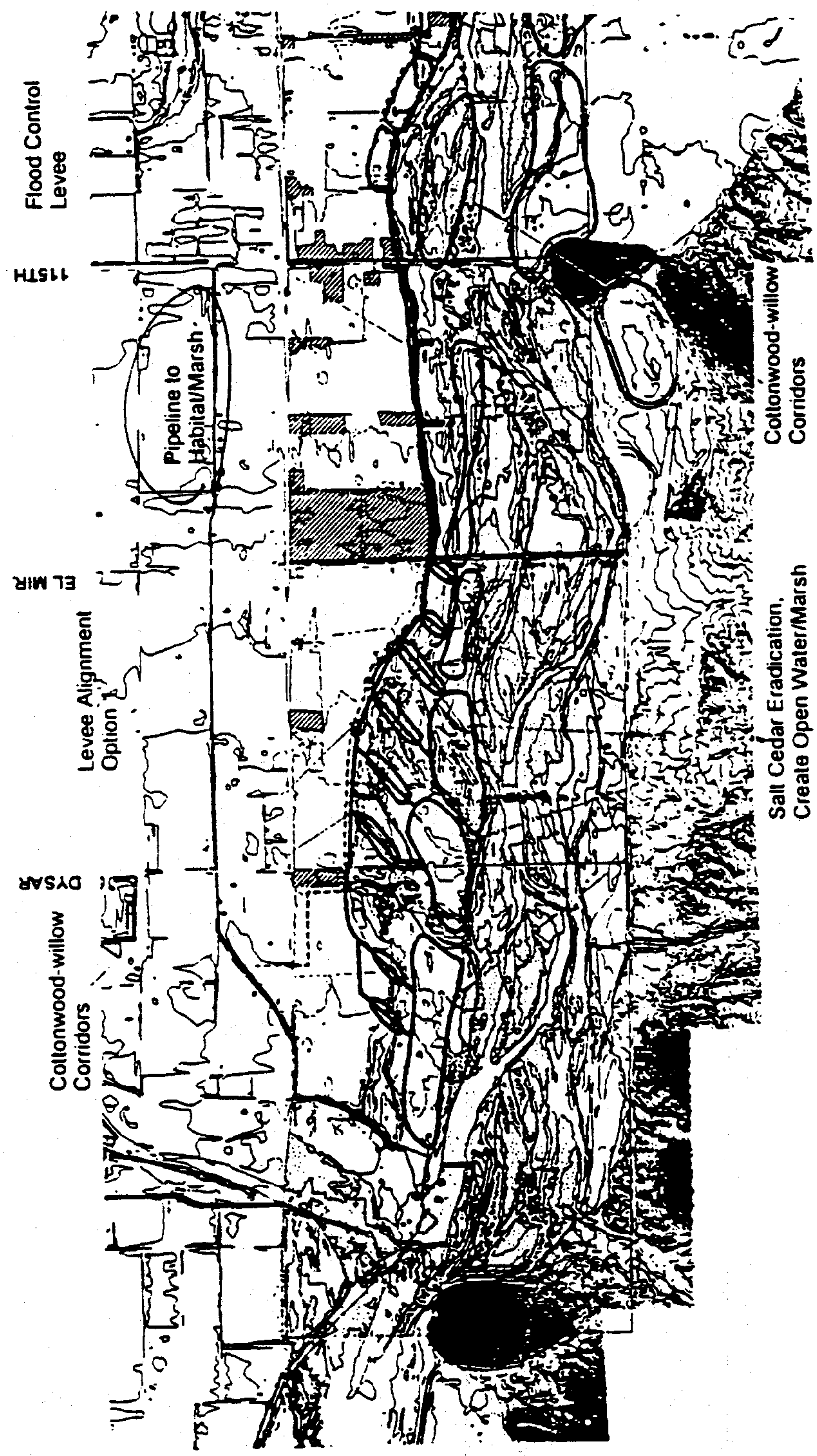
JUSTIFICATION:

The proposed change achieves project objectives while simplifying configuration.

DISCUSSION

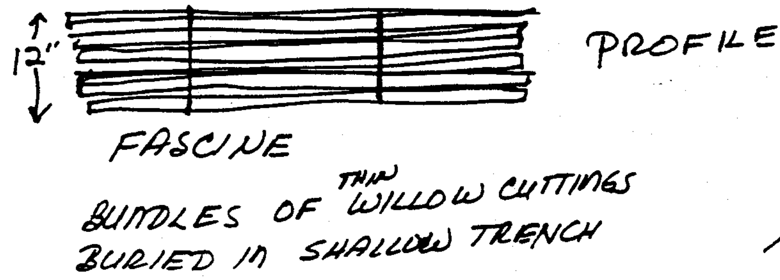
In this recommendation, the cottonwood/willow habitat is established without permanent supplemental water from the overbank wetlands. In the original concept, the water was delivered to the cottonwood/willow stringers to eliminate perched surface water and encourage drainage; thereby eliminating an existing vector problem. In the proposed concept, surface drainage is accomplished by dense willow plantings or fascines. The rapid growth of willows and their fine shallow roots provide surface drying without interfering with the deep buttressing root architecture of the cottonwood. If very seepy areas are encountered, the willow fascines can be arranged in pole drain configuration. This approach maintains the desired riparian habitat while simplifying the design. This results in a more robust self adjusting system.

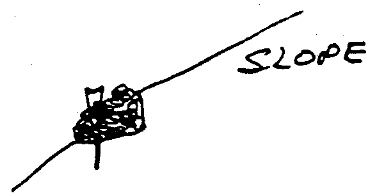
ORIGINAL CONCEPT — SKETCH

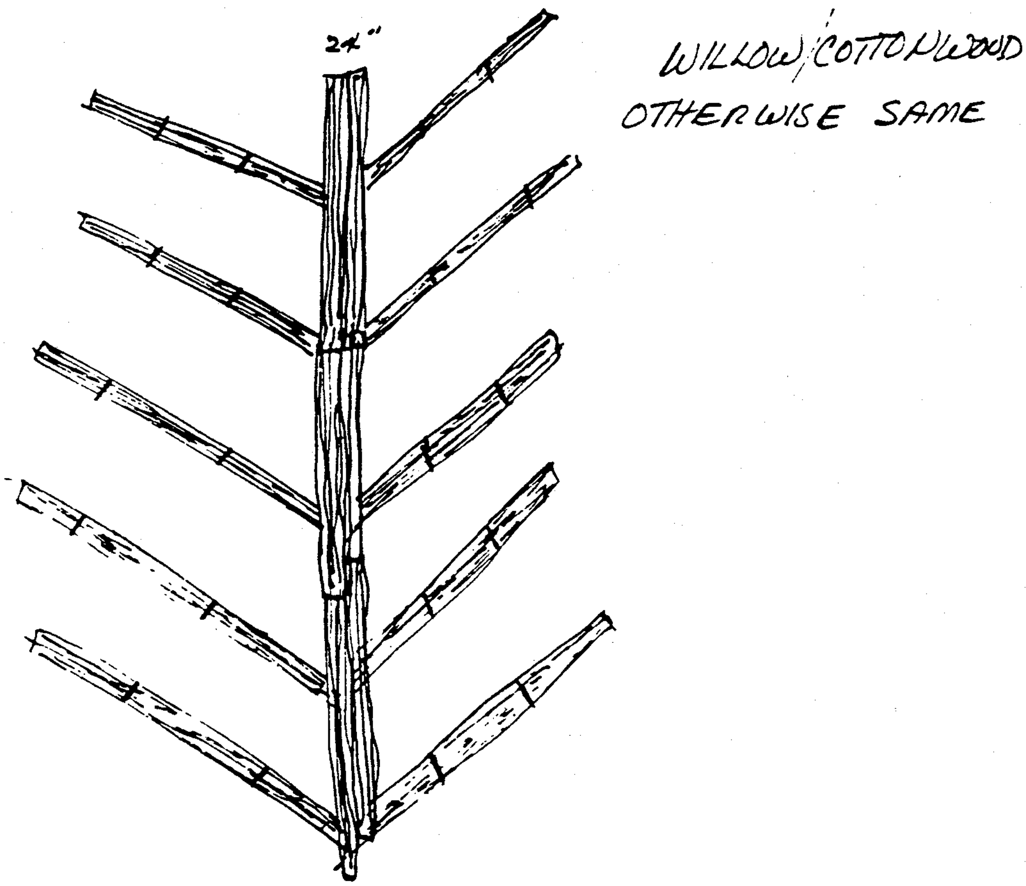


PROPOSED CONCEPT — SKETCH

Habitat same as original concept sketch







Pole Drain

PROPOSED CONCEPT — CALCULATIONS

Willow fascine pole drains

Assume drain area of approximately 8,000 sf

Place central drains 200 ft apart

Approximately 40 drain systems

Central drain 100 ft long, lateral drains 8 ft apart and 20 ft long

Each drain system will have 24 laterals/central drain, 580 ft of fascine/system x 40 = 23,200 lf

Approximately $9/lf

$5,220/fascine, assuming locally harvested willow.

Excavation quantity for installation of willow pole drains

For each pole drain, main stem – trenching

100 ft long x 2 ft diameter x 1 ft deep			=	20 ft^3/side stem
24 side stems/pole drain			=	480 ft^3

To trench in one pole drain system

00 ft^3 + 480 ft^3			=	880 ft^3
40 pole drain systems	=	35,200 ft^3	=	1304 cy

VALUE ENGINEERING STUDY

PROPOSAL NO.: H-30

COST SAVINGS ESTIMATE

Item	Unit of Measure	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Pipeline from wetlands to corridor	ls			3,258,100		0
Dependent riparian corridors						
C & G, grading, vegetation and revegetation				872,000		872,000
Excavation and stock pile	cy	5.00	342,600	1,713,000	1305	6525
Topsoil lining	cy	10.00	53,200	532,000	-	0
Willow fascine pole drains	lf	9.00	-	0	23,200	208,800
Subtotal				6,375,100		1,087,325
Contingency, PED, E, S&A	%	37.3		2,059,100		351,200
TOTALS				8,434,200		1,438,500
NET SAVINGS						6,995,700

All costs from project MCACES Report and MCACES Database except if noted below:

1.

2.

LIFE CYCLE COST ANALYSIS

LIFE CYCLE PERIOD 50 YEARS

ANNUAL PERCENTAGE RATE = 6.625%

INITIAL COSTS	PRESENT DESIGN (PRESENT WORTH)	PROPOSED DESIGN (PRESENT WORTH)
Base Cost		
SUB-TOTAL		

SINGLE EXPENDITURE	YEAR	PRESENT WORTH FACTOR	PRESENT DESIGN		PROPOSED DESIGN	
			ESTI-MATE	PRESENT WORTH	ESTI-MATE	PRESENT WORTH
Salvage						
SUB-TOTAL						

ANNUAL EXPENDITURE	YEARS	PRESENT WORTH FACTOR	PRESENT DESIGN		PROPOSED DESIGN	
			ESTI-MATE	PRESENT WORTH	ESTI-MATE	PRESENT WORTH
O&M (generalized at ½%/year of capital cost of pipeline)	50	14.484	16,291	236,000	0	0
SUB-TOTAL				236,000		0
TOTAL PRESENT WORTH				236,000		0
LIFE CYCLE SAVINGS						236,000

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: H-58

DESCRIPTION: Develop plant nurseries within the project area

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

The original concept was not specified. It is assumed that purchasing local plant stock for initial construction of vegetated areas would be required to avoid salt cedar invasion into cleared areas.

PROPOSED CONCEPT:

The proposed concept would be to develop a plant nursery to propagate both wetland and riparian desired species for project construction and operation and maintenance needs in the future. Surplus would be available to other local projects and would create a revenue source to offset continued operation and maintenance costs.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$793,800	-	$793,800
PROPOSED CONCEPT	$73,200	-	$73,200
SAVINGS	$720,600	-	$720,600

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Supply project needs for wetland and riparian plants
- Supply other projects (internal and external) as needed
- Experiment with different native species in a controlled manner
- Create revenue source to offset capital and O&M costs
- Gives project staff ability to manage genetic sources of stock
- Response time would be improved after O&M events
- Recovery time would be increased to flood event plant disturbance
- Ability to experiment with different species in a controlled manner to determine phyto-accumulation benefits for water treatment and eco-indicators for water quality

DISADVANTAGES:

- Additional O&M cost (revenue to offset)
- More management needed to oversee nursery operation

JUSTIFICATION:

The advantages appear to outweigh disadvantages. Irrespective of cost of the project, quality benefits make this a suitable option for implementation or inclusion in the project plan.

DISCUSSION

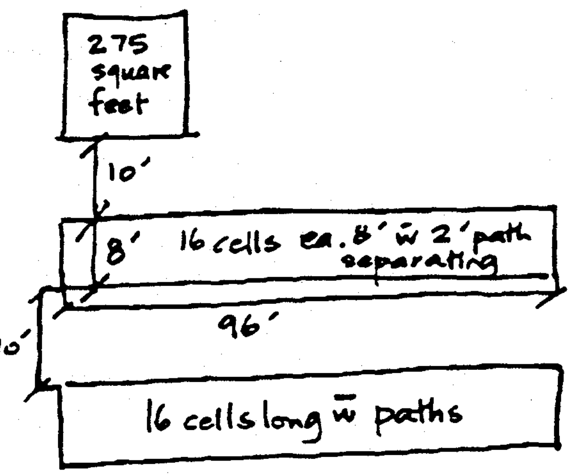
The value team believes that the creation of a wetland and riparian plant nursery for the Tres Rios project and other associated projects would be very cost effective. The species of vegetation to be used can be controlled and the quality assured. Replacement vegetation that has died or is experiencing stress can be quickly replaced. Other City of Phoenix riparian habitat projects as well as city parks and other governmental agencies can benefit. Not only will the initial vegetation costs be saved, but also the annual O&M costs can be saved.

Additionally, the value team believes that this nursery may provide a revenue source in the range of $28,000 to $60,000 per year depending on demand.

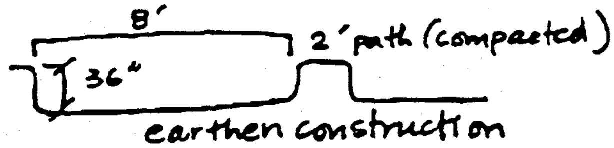
PROPOSED CONCEPT — SKETCH

Wetland Nursery

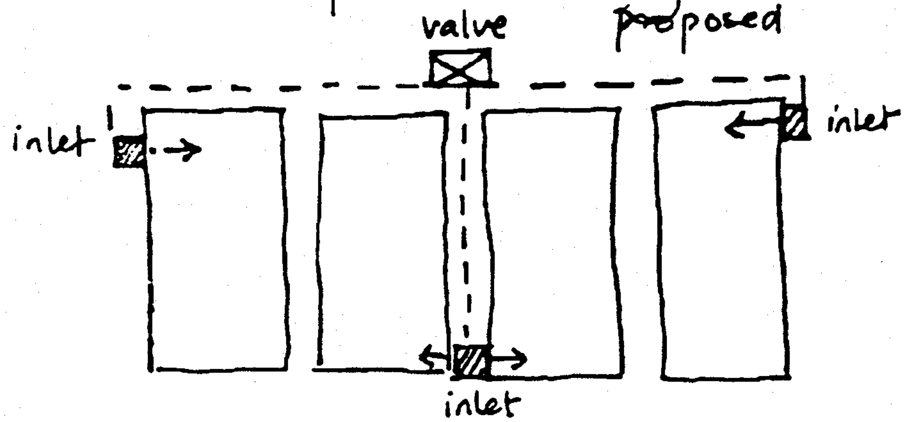
1. plan View



2. section View



3. detail plan view - irrigation proposed



Location needs to be close to the Visitor's Center

Riparian Species Concept

located in multiple areas suitable for cuttings and flood irrigation

(Outside of levee, but within project boundaries)

One of these locations should be as close as possible to the Visitor's Center

Typical for each set of four cells

Cells to be flood irrigated with species appropriate substrate

ORIGINAL CONCEPT — CALCULATIONS

$1.8 million budgeted for planting

1:2 ratio anticipated between plant cost and labor cost

therefore, $600,000 value on plant cost

PROPOSED CONCEPT — CALCULATIONS

275 sf greenhouse construction (with some automated features): $25,000

(1) staff person Water Services $50,000 (with support from both Park Recreation and Library Department (PRLD) staff as well as other Water Services staff

VALUE ENGINEERING STUDY

PROPOSAL NO.: H-58

COST SAVINGS ESTIMATE

			Original Concept		Proposed Concept	
Item	Unit of Measure	Unit Cost	Quantity	Total	Quantity	Total
Earthwork	cy	5.00			1,100	5,500
2-in irrigation valves	ea	115.00			8	920
2-in irrigation inlets	ea	100.00			24	2,400
PVC pipe	lf	15.00			1,260	18,900
Shade cloth	sf	1.10			2,600	2,860
Greenhouse	sf	90.00			275	24,750
Subtotal			estimated	600,000		55,330
Contingency, PED, E, S&A	%	32.3		193,800		17,871
TOTALS				793,800		73,200
NET SAVINGS						720,600

All costs from project MCACES Report and MCACES Database except if noted below:

1.

2.

OPERATIONS & MAINTENANCE

VALUE ENGINEERING STUDY

PROJECT TITLE: Tres Rios

PROJECT LOCATION: Phoenix, AZ

PROPOSAL NO.: OM-33

DESCRIPTION: Use hydraulically designed system that eliminates mechanical controls.

CRITERIA CHALLENGE: No CRITERIA NO.:

ORIGINAL CONCEPT:

The original concept includes regulating basins, overbank wetlands and open water marsh, and utilizes gates/valves at the inlet and outlet of each basin. The overbank wetlands also include drain valves to facilitate basin maintenance.

PROPOSED CONCEPT:

The proposed concept use hydraulic features (overflow weirs, headwalls) to eliminate valves and gates wherever practical. In all remaining cases, activation is reduced and replaced by automation where practical. Additionally, consideration needs to be given to a bypass for overbank basins.

SUMMARY OF COST SAVINGS

	FIRST COST	PRESENT WORTH OF O&M COSTS	LIFE CYCLE COSTS
ORIGINAL CONCEPT	$119,100	$1,205,100	$1,324,200
PROPOSED CONCEPT	$542,200	$0	$542,200
SAVINGS	$(423,100)	$1,205,100	$782,000

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Reduced capital cost potential
- Reduced system complexity
- Fewer maintenance points
- (For overbank bypass) Allows service of single basin
- Fewer valves means reduced calibration effort

DISADVANTAGES:

- (For overbank bypass) Adds some capital cost for channel
- (For overbank bypass) Adds to land requirement in river
- Reduced field adjustment capability
- Beaver may be attracted to weirs

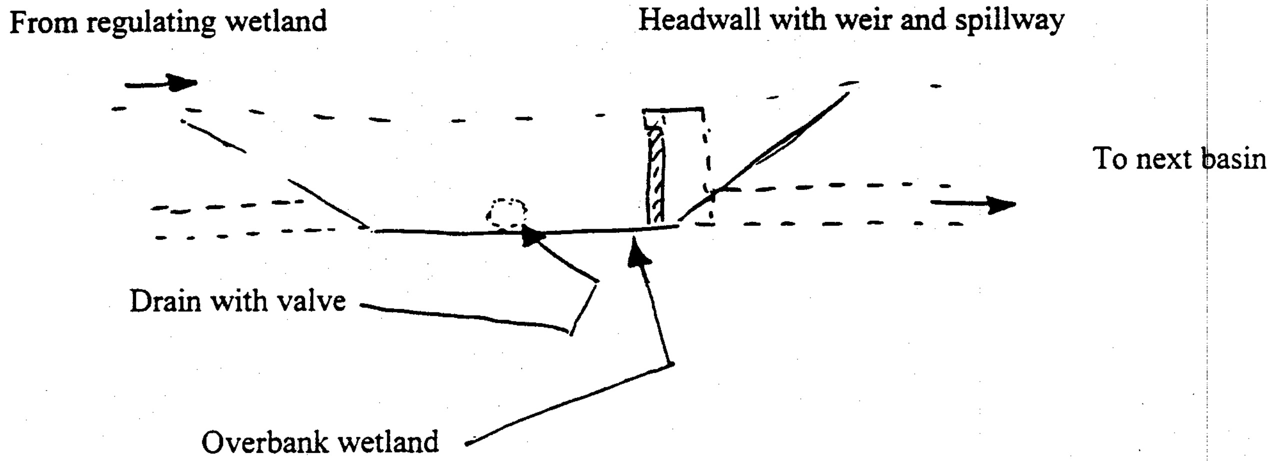
JUSTIFICATION:

Reducing the number of values will lower capital and O&M costs. Without the overbank bypass, all of the basins must be offline to service just one.

DISCUSSION

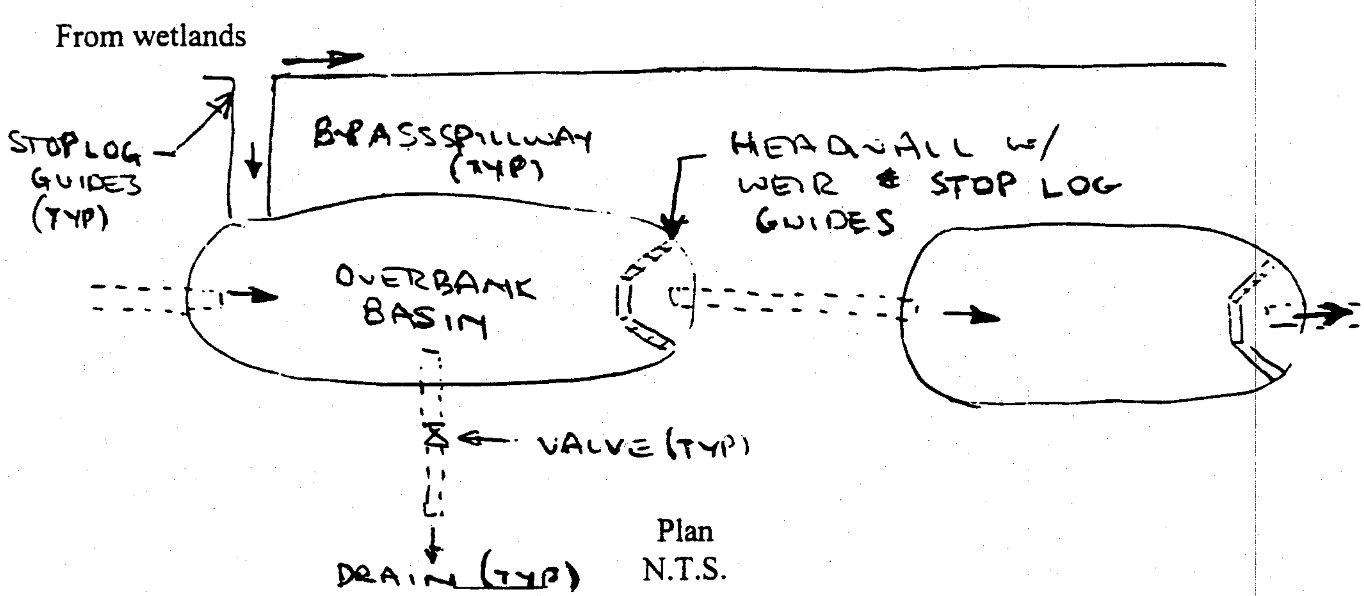
For the overbank basins, a single control gate at the regulating basin would be installed to modulate flow to these basins. Drain valves on basins are still required but pinch or eccentric plug valves may prove better than gate valves due to solids handling and reduced sticking potential. The flow from basin to basin would be via a static headwall with overflow weir to a pipe. A bypass channel would permit bypassing of any or all basins. Stop log guides in each weir would also facilitate single-basin maintenance. Spilling over headwall could add dissolved oxygen to water and waterfall sounds.

PROPOSED CONCEPT — SKETCH



Profile
N.T.S.

Earthen Bypass Channel



Plan
N.T.S.

COST SAVINGS ESTIMATE

Item	Unit of Measure	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Gates	ea	5,000	18	90,000		
Concrete headwall with weir	ea	5,000			9	45,000
Earthen channel	cy	8.00			45,600	364,800
Subtotal				90,000		409,800
Contingency, PED, E. S&A	%	32.3		29,100		132,400
TOTALS				119,100		542,200
NET SAVINGS						(423,100)

All costs from project MCACES Report and MCACES Database except if noted below:

1.

2.

LIFE CYCLE COST ANALYSIS

LIFE CYCLE PERIOD 50 YEARS | ANNUAL PERCENTAGE RATE = 6.625%

INITIAL COSTS	PRESENT DESIGN (PRESENT WORTH)	PROPOSED DESIGN (PRESENT WORTH)
Base Cost		
SUB-TOTAL		

SINGLE EXPENDITURE	YEAR	PRESENT WORTH FACTOR	PRESENT DESIGN		PROPOSED DESIGN	
			ESTI-MATE	PRESENT WORTH	ESTI-MATE	PRESENT WORTH
Salvage						
SUB-TOTAL						

ANNUAL EXPENDITURE	YEARS	PRESENT WORTH FACTOR	PRESENT DESIGN		PROPOSED DESIGN	
			ESTI-MATE	PRESENT WORTH	ESTI-MATE	PRESENT WORTH
O&M (1 man year)	50	14.484	83,200	1,205,100		-
Energy						
SUB-TOTAL				1,205,000		0
TOTAL PRESENT WORTH				1,205,000		0
LIFE CYCLE SAVINGS						1,205,100

SECTION 5

DESIGN SUGGESTIONS

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

DESIGN SUGGESTIONS

In addition to the recommendations in the previous section, the team identified several issues as design suggestions. These are presented to bring attention to areas of the design which, in the opinion of the team, should be changed for reasons other than cost, such as:

- improved operation
- ease of maintenance
- easier construction
- reduced risk of construction claims
- clarification of construction documents
- or safer working conditions.

It is recommended that these issues be reviewed for their potential benefit to the project and possible cost savings.

F-36 Consider future flows

The value team feels that the design team needs to consider the effect of future water flows (small), which will enter the Tres Rios project reach from the east and the Gila River to the southeast. It appears that some of the analysis of the sources of water for the project (other than the treatment plant) is based on data for historic flows. In the continuing design effort, the design team should consider the small flows that will be contributed by the Rio Salado Oeste Project and future flows related to the Gila River to the southeast. This will make sure that the Tres Rios Project's water sources aren't oversized or undersized.

F-81 Geomorphology considerations

Professor William L. Graf, et. al. prepared a study, *Geomorphic Assessment of the Lower Salt River, Central Arizona*, dated October 1994. The information in the report should be used to inform design. Applied geomorphology, bioengineering and river engineering concepts should be more fully incorporated in the design.

Information in Sections 1.4.3 and 2.1 summarizes the environmental significance and the riparian ecology.

On page 72 of the report, the authors discuss the probable location of the thalweg. This information should be used to determine the main thread of the river. Probability maps are presented in Appendix 8.15. On page 47, they discuss sinuosity and gradient and the effects on the thalweg location. They also discuss the effect of gradient on sediment transport and bed materials. Sediment transport, degradation and deposition are also discussed on pages 33, 42 and 79.

In general, the Salt River at the project location is transporting sediment through the system by scouring at flows between 15,000 to 40,000 cubic feet per second (page 72) and depositing at lower flows or during falling flood levels. Careful location of river structures can be used to influence sediment transport and the location of deposited material. For example, the plantings near the banks of the river increase the hydraulic roughness. This dissipates energy, slows the water and sediment drops out. The roughness on the bank forces the high velocity flows toward the thalweg and transports sediment through that part of the system. This phenomenon will have important implications in maintaining the desired depths of the open water areas.

The effects of the vegetation are similar to wing dams or rock vanes. In fact, live vanes can be planted. Important design considerations for live woody guide vanes include the following:

- Woody vegetation should be planted in groves. The interaction of the roots and woody structure absorbs and distributes the flow energy. The groves should be of sufficient width for this interaction. The upstream trees may be damaged but not destroyed by flood waters.

- The grove should exhibit a diverse forest structure with both understory and canopy species.

- The effects of the falling flood waters should be considered. Rising flood water will generally be parallel to the channel. Falling flood waters will have a component toward the thalweg.

- Gaps in the forest structure result in a hydraulic loss due to expansion. This can result in eddying or deposition. Forest structure should be reviewed for hydraulic impacts.

- Moving water flows perpendicular to a submerged or gapped structure. Live vanes can be oriented slightly upstream to direct flow away from the banks. Spacing of the vanes should be determined from hydraulics. The width of the vane influences the effectiveness of the redirection. For example, thin vanes turn the flow sharply and with greater turbulence while wider vanes are useful in circumstances requiring more oblique flow lines and greater energy dissipation over the vane surface. Similarly to rock vanes, asymmetrical vegetated vanes can be used to direct flow.

- Vanes composed of shorter vegetation can be used as sills to manage sediment or incision and direct flow.

F-82 Evaluate the need for a pump station

The water supply for the wetlands and the habitat features on the north side of the Salt and Gila Rivers is effluent from the 91^{st} Avenue Wastewater Treatment Plant (WWTP). The original concept for Tres Rios includes a pumping station to lift the water to the regulating wetlands, which provides a constant rate water supply to the Tres Rios habitat features. The regulating wetlands buffer the diurnal flow effects that occur as a result of influent to the WWTP. The original concept for Tres Rios includes a 300 million gallon per day (mgd) pump station, 3,900 feet of 84-inch transmission main and the 184 acre regulating wetlands.

During the creative idea phase of the value engineering workshop, several topics were developed to address:

- the need for a 300 mgd pump station
- the potential to use a gravity system to transmit the effluent to the regulating wetlands
- the sizing of the pump station
- how the pump station, regulating wetlands and overbank wetlands would function during flood stages

These topics were raised because the needs and operation of the pump station were not clearly defined. The purpose of this discussion is to summarize the need for the pump station, the operation of the pump station and the justification for the capacity.

The purposes of the 300 mgd pump stations are to provide the water supply for Tres Rios and to protect the 91^{st} Avenue Wastewater Treatment Plant (WWTP) during floods.

The pump station will be operated to transport the flow to the regulating wetlands in the 84-inch pipeline. During non-flood periods, when the effluent entering the pump station exceeds the needs of the regulating wetlands, the surplus effluent will be discharged to the Salt River through a port in the pump station. During flood periods, the port in the pump station will be closed and the pump station will be operated to pump all of the effluent over the flood protection levee and into the Salt River. The pump station will not be used to pump effluent to the regulating wetlands because the habitat features supplied by the regulating wetlands will be submerged and the effluent water supply will not be needed.

The 300 mgd capacity was based on several factors. The first factor was the projection of monthly and daily influent to the WWTP in 2025 accounting for peaking factors. This defined the 300 mgd flow rate. The second factor was the assumption that the Arizona Nuclear Power Project will not be diverting any effluent for cooling water. This would mean that the influent flow would be equal to the effluent flow.

The 300 mgd capacity is required to accommodate the total effluent quantity during flood periods. If the 300 mgd pump station is not incorporated into Tres Rios, the 91^{st} Avenue WWTP operation could be impacted by flooding. This is not to say that floodwater would enter the plant but rather that the effluent could not be discharged into the river via the effluent channel and the resulting effluent backwater throughout the plant could impact WWTP operation. The function of the pump station is really to protect the water supply for Tres Rios. If the WWTP is not protected it would not be feasible to guarantee the water supply would be available for Tres Rios and this guarantee is a requirement of the project sponsor.

F-83 Use the gravel pit operators for construction and maintenance

The original concept for Tres Rios requires the excavation of riverbed materials to construct the open water/marsh habitat features, to construct the water distribution channels and to modify the morphology of the riverbed by removing the higher elevation portions within the thalweg channel. The riverbed materials are primarily sand, gravel and cobbles. A portion of the excavated materials will be used to construct Tres Rios habitat and flood control features and a portion will require stockpiling. After Tres Rios is constructed, periodic maintenance will be required. A part of the maintenance program will be to remove sediments transported into Tres Rios by floods.

A proposed concept evaluated as a part of the value engineering workshop was to allow sand and gravel pit operators to mine the materials. In the future, it will become more difficult for sand and gravel pit operators to secure permits to develop new pits in the river channel. However, as the Phoenix area continues to grow the demands for aggregate materials will increase. The value of a material source will also increase. Tres Rios could help meet a part of the demand for materials.

This concept presents the opportunity to reduce the construction costs and maintenance costs. During the construction, sand and gravel pit operators could be solicited to provide no cost excavation services and receive the material in exchange. The pit operators could sell the materials. The pit operators would have to operate within specific corridors defined as a part of the project design and conduct the excavation to achieve project design goals. During maintenance, the pit operators would be directed to remove materials from specific areas following defined access corridors.

The advantages associated with this concept are a potential reduction in excavation and stockpiling costs during construction and a potential reduction in maintenance costs. The disadvantage could be the time associated with a pit operator to excavate and remove materials.

A maintenance opportunity associated with the pit operator participation is the control of salt cedar. The design team needs to evaluate if sand and gravel mining could be incorporated into a salt cedar eradication and maintenance program. Mature vegetation could be removed as a part of the construction phases and the young vegetation would be removed as a part of maintenance.

The Tres Rios design team should contact local sand and gravel pit operators to assess the feasibility of implementing this proposal. The design team should verify the amount of materials that the pit operators could anticipate using, the rate at which the materials could be excavated and removed and the projected value to the project of allowing the pit operators to provide this service.

H-34 Modify cottonwood/willow complex to minimize cowbird nest parasitism

Neotropical migration birds including the southwestern willow flycatcher are among the critical species for this project. These species are also vulnerable to nest parasitism by the brown-headed cowbird. Neotropicals are adapted to nesting in dense forest and have no mechanism for identifying and ejecting cowbird eggs. The adjacent open land, particularly the agricultural land, is very good cowbird habitat. The degree to which the low number of willow flycatchers is attributable to nest parasitism as opposed to other factors is unclear; however, the design of this project should minimize the threat to nesting success by constructing willow/cottonwood habitat in large dense blocks of greater than 25 hectare blocks. Thin strands of riparian forest provide virtually no protection. Further, a monitoring program such as that developed at Roosevelt Dam should be instituted and breeding success tracked to the extent practical should become a permanent element of the management program.

Finally, we strongly encourage cooperative agreements with local/adjacent property owners to develop cowbird unfriendly habitat. This, as well as a trapping program, could and should be part of the community participation.

H-47 Use increased areas of overbank wetlands storage to encourage preferred species germination and discourage nondesirable species.

Salt cedar and cottonwood/willow have very different germination windows; however, they both need similar conditions for seedling propagation. If the overbank wetlands were increased in size to allow enough storage to mimic the flood conditions conducive to cottonwood/willow germination, this would help to control salt cedar invasion. This would need to be done by storing flood flows for periods long enough to fully saturate the soil column. Ideally, this would be done in early February. Prior to this, some maintenance to clear bare soil would improve germination conditions as well.

Cottonwood will begin to set seed through February and willow should follow through late February into early March. The recently flooded bare soil should remain undisturbed during the germination period and any flood flows from overbank wetlands should be restricted during May through October during the salt cedar germination period. Any discharges exceeding the low water level should be followed with a maintenance program during this period to remove salt cedar seedlings.

H-50 Plan for beavers

Beavers are drawn to many types of water features such as narrow channels, pipe outlets, isolated moving water as well as cottonwood and willow trees. One of the problems with beavers is that their dams can completely block water bodies causing stagnant flow. This will lead to vector problems.

Since beaver will be present, sacrificial areas that they like should be created including thick groves of cottonwood and willow and slow moving streams. This way their activities can be controlled.

To keep them out of other areas of the project, the design should include wide channels that have a higher velocity and are relatively deep. The use of step pools or short, steep channels will also discourage beaver from moving to important areas of the project.

H-80 Periodically flush to remove salinity

Salinity buildup in any natural system is a critical issue. Therefore, it is important to provide a way to get enough water to drier areas of the project to flush salt through the soil column.

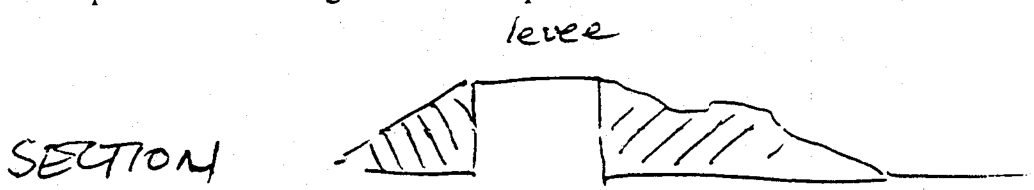
One way to encourage this is through grading the basins in a step terrace to cause water to move through the system, but pond enough to force water through the soil column. This could be used to direct interior and exterior storm flows to drier areas of the project to encourage flushing of the system.

It would also be important to provide provisions for temporary pumping of water from the wetland or open water areas to drier areas to add more water to the system to encourage flushing. This could be done with gas-powered pumps and plastic hose.

H-87 Vary the soil type from the top to the bottom of levee slope

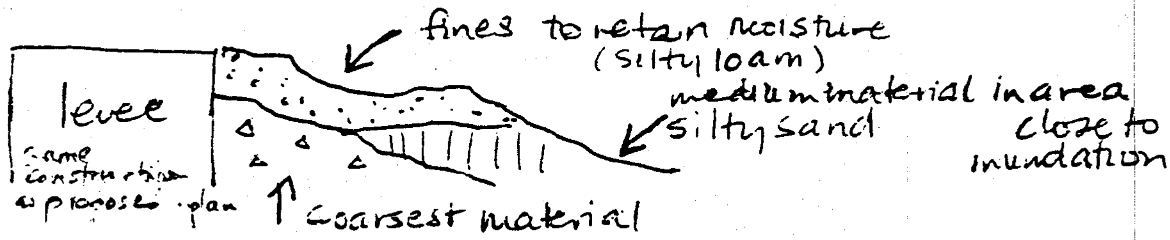
Because of the gradient of the levee, there will be a problem of water not being absorbed by trees and shrubs closest to the top. Some suggestions to minimize this problem are:

- Vary the slope and reduce the gradient where possible.



This will decrease the tendency for irrigation water or other flows to flow over the surface and not percolate to root zones.

- Soil texture should be modified to minimize this problem where possible.



To mimic silty loam or more moisture retentive soils, organics could be mixed in appropriate proportion with sand.

H-107 Use topsoil excavated from salt cedar areas for levee core material to contain the salt.
Soil excavated from the open water marsh areas will have a high salt concentration. It is likely that leaving this material on site would be detrimental to the project because of its effect on plant survival. The value team recommends considering incorporating the soil within the levee core. While this recommendation addresses the issue of soil disposal, it raises the question of how the soil can be safely incorporated into the levee; specifically, whether the high organic content material would jeopardize levee integrity. Nevertheless, the value team suggests that methods for properly compacting and incorporating the material be investigated.

Other issues to investigate are as follows:

- Salinity tolerance of target species
- Salinity of the soil
- Whether incorporating the excavated soil would necessitate a change in the geometry of the levee

If this design suggestion proves feasible, the advantages would be reduced hauling costs and potentially higher habitat quality.

H-109 Distribute water into cells to leach salt from system
Salinity accumulates in areas that do not receive flooding or flood irrigation. Cottonwood and willow species (particularly willow) are very sensitive to salinity. Cottonwood's and willow's long term survival in the project area, outside of the frequent inundation zone, will depend on some design consideration which will allow flooding.

This is particularly essential to plant success in those areas in which cottonwood/willow are planted where ground-water depth exceeds four feet. This is relevant as salinity levels in the water feeding the cottonwood/willow growing areas are at their salinity tolerance level currently.

Some suggestions:

1. During detailed design allocate cottonwood/willow communities to those areas with groundwater depth no greater than eight feet.

2. In those areas where cottonwood/willow are shown exceeding four-foot depth to ground water, berm an area at least 8-12 ft to allow flooding to leach salts out of the bulk of the root zone further down the soil profile. This is a good idea for all cottonwood/willow areas, but should be a priority in areas with deeper ground water.

3. Continuous monitoring of dissolved solids through salt or conductivity tests on irrigation water will be critical to ensuring cottonwood/willow salt tolerances are not exceeded.

OM-04	Team with other agencies for environmental education and O&M
OM-05	Develop ongoing and comprehensive training program for staff and volunteers
OM-34	Design the monitoring program to meet system requirements based on science not on a daily schedule

Operation and Maintenance

One of the greatest tools to minimize costs will be a comprehensive operational management plan that is science based and takes advantage of partnerships for monitoring, management and interpretation.

Ongoing monitoring is the best way to ensure that the system is healthy and avoids unexpected costs. The key to a successful monitoring plan will be to take a science based approach. Different elements of the system, such as the cottonwood/willow habitat versus the open water marsh habitat, will require specific monitoring plans. Monitoring schedules and techniques should be adapted based on the system type, and should themselves be evaluated regularly to adapt to seasonal changes, or changes that result from system growth and maturity.

Monitoring plans should include identification of discreet meaningful measures of project performance. Details of these measurements should be determined by experienced habitat and river professionals. For illustrative purposes, the following measures should be considered:

- water quality parameters
- soil salinity
- populations and breeding success of targeted fauna
- rate of critical habitat establishment survival of introduced cottonwood/willow
- indicators of salt cedar reestablishment from cleared areas.

Partnership Opportunities

Monitoring is one aspect of the project that can be taken on by volunteers from partnerships with interest groups or area schools and universities. Because the restored system is within a normally dry area, there will be interest from the general public, area businesses, and groups such as the Audubon Society that will be eager to participate by planting trees, monitoring tree growth, maintaining trails, or serving as docents.

Perhaps the most critical element of the O&M plan will be a comprehensive training program for both staff and volunteers. The program needs to stay current with service and technology, incorporating new techniques and technologies into the O&M plan.

All staff and volunteers should be trained to recognize early indicators of system stress. Further training should include distinctions between routine interventions to improve system performance and when professionals should be called in.

Costs

- Arizona State University (ASU) research could be contracted at approximately half of the cost of private industry research or less.
- Arizona Game and Fish Department (AZGF) recruitment for cooperative monitoring for wildlife use will decrease private biological wildlife monitor by a half as well. (The alternative would be private biological consultants or additional staff hires.)
- Maricopa Audubon would be a great partner to offset AZGF staff efforts.

OM-42 Develop a disposal plan for operation and management efforts

Some of major operation and maintenance efforts are related to the removal of waste material from the project features. The type of material to be removed includes vegetation, either dead or excess, flood related material such as cobble, sand and fine sediment as well as decayed vegetation which is part of the dredged material.

The removal process used will include backhoes, hand-work dredging and large equipment removal processes. Each of these removal methods will require different disposal methods. Some of the disposal methods which can be used include: landfill disposal, material reuse, vegetation reuse, composting and incineration.

Landfill disposal would be used for non-organic material such as plastics, material dumped on site, waste building material and some types of contaminated soils. Currently, most waste material is landfilled including landscaping/vegetation maintenance waste material. There are ways around sending everything to a landfill.

There is a lot of material that could be collected during dredging operations. This material may be reused. Some of the material could be used to replace material that has been washed away in other areas of the project along basin banks. Some of the material may be suitable for topsoil in the nursery cells. Some of the cobble of ABC type material could be sold or given to sand and gravel operations. Some of the material with a higher organic content could be used as part of a compost operation.

When vegetation needs to be removed from a portion of the site, the material should be evaluated to determine if it is healthy or if there is a need in another area where it can be relocated and reused. This material could be placed in the nursery wetlands until it is needed. It could be transferred to other projects, including city projects.

Any plant material that is either dead or unhealthy should be composted with tree trimmings, grass clippings and other organic material or soil. This compost/mulch material could be used to augment soil in the project areas or in the nursery cells. It could also be transferred to other city projects for landscape or planting projects.

It is important that material related to salt cedar removal (including top soil) needs to be removed off-site and probably disposed of in a landfill. This will keep any seeds from re-germinating and remove any residual salt from the system.

Another disposal method that could be used to remove wetland vegetation is incineration or controlled burn. This will clear the basin of vegetation while returning organic carbon to the soil strata. Controlled burning operations have been found to be very effective in wetland systems. A burn permit from Maricopa County would be required and the fire department would control the procedure so proper controls are maintained.

OM-45 Use self regulating flow system

The Feasibility Study indicates the water flow from basin to basin will be conveyed through pipes or open channels with gates for flow regulation. While this project is still in the preliminary stage and types of gates have not been specified, the value team felt it was important to recommend that the water flow control devices between basins be as simple as possible and self regulating. Precise water surface elevations are not critical to the basins' operations. The flow connection between basins could be a fixed drop structure. Simple mechanical gates actuated by floats of weights can be used to reduce the need for manual operation or adjustment. Weirs designed hydraulically to avoid using stop logs for changes in water surface elevation can be used.

The main purpose of using self regulating flow controls is to reduce O&M and monitoring time.

V-9 Incorporate permanent features to apply larvacide
V-14 Design all water areas to encourage water movement

The value team suggests the following vector control approaches, in addition to ongoing mosquito monitoring:

- Design all open water features to encourage water movement: first through gravitational flow and, if necessary, install pumps instead of aeration systems to circulate water. Current studies at the Tres Rios Wetland Demonstration Project support research that water movement prevents mosquito breeding.

- Promote habitat elements that attract and sustain natural predators. Minor improvements to the habitat include constructing bat boxes (an excellent grant-funded volunteer project); encouraging an aquatic environment that can sustain mosquito fish; providing areas attractive to swallows.

- Incorporate permanent vector control features into the project design. It is likely that some chemical controls will be used at the project occasionally. The value team recommends installing a permanent system that can inject larvacides into the wetlands. This provides application flexibility and would eliminate the need for expensive truck-mounted equipment or labor-intensive manual application methods.

- Tailor mosquito management approaches to specific conditions, a one-size-fits-all approach is inappropriate.

- Evaluate all vector control techniques regularly, based on monitoring results adapted to seasonal and global changes.

V-19 Develop an environmental management zone to reduce development and thus reduce human exposure

An environmental management zone (EMZ) surrounding the project limits (not including existing development) would have several project benefits. The EMZ could manage adjacent land uses to minimize conflicts such as excluding high density residential, which may be sensitive to mosquitoes associated with wetland habitat area. Some associated agriculture uses which may increase cowbird parasitism on the project could also be excluded.

The EMZ would be applied and approved by a detailed planning process where coordination would be essential between the City of Phoenix planners and the Gila River Indian community, Avondale planners and Maricopa County planners. This would need council approval by each project partner entity responsible for adjacent lands to the project. This could enable regulation of any other land uses found to have a potential negative impact on the project. The model for the EMZ would be the Skunk Creek Water Course Master Plan EMZ which was created through detailed environmental and planning analysis.

APPENDIX – PARTICIPANTS

VE STUDY PARTICIPANTS

Name	Organization	Phone	VE Workshop	Design Presentation	Mid-Point Review	VE Presentation
John Robinson	Robinson, Stafford, & Rude, Inc.	816-220-1105	X	X	X	X
Dale Bulick	Corps of Engineers, Los Angeles Dist.	213-452-4010		X		X
Aimee Conroy	City of Phoenix WWED	602-534-2976	X	X	X	X
Kevin Conway	Greeley and Hansen	602-275-5595		X		X
Van Crisostomo	Corps of Engineers, Los Angeles Dist.	213-452-3558		X		
Ralph Hanson	Moffatt and Nichol Engineers	562-426-9551	X		X	X
Ruthanne Henry	City of Phoenix PRLD	602-261-8799	X	X	X	X
Ted Ingersoll	Corps of Engineers, Los Angeles Dist.	213-452-3586		X		
George Johnson	Moffatt & Nichol	562-426-9551	X	X	X	X
Gregory Jones	FCDMC	602-506-5537		X		X
Paul Kinshella	City of Phoenix WWED	602-495-3754		X		X
Tom Luzano	Corps of Engineers, Los Angeles Dist.	213-452-3651		X		
Glenn Mashburn	Corps of Engineers, Los Angeles Dist.	213-452-3549		X		
Munsell McPhillips	Intuition & Logic	314-963-9581	X	X	X	X
Scott Newhouse	FCD	602-506-2929	X		X	X
Keith P. O'Hara	Greeley and Hansen	602-275-5595	X	X	X	X
Dick Perreault	FCDMC	602-506-4774		X		X
David Pham	Corps of Engineers, Los Angeles Dist.	213-452-3648		X		
Robert Prager	Intuition & Logic	314-963-9581	X	X	X	X
Tom Renckly	FCDMC	602-506-8610		X		X
Andy Richardson	Greeley and Hansen	602-275-5595	X	X		X
Mike Ternak	Corps of Engineers, Los Angeles Dist.	602-640-2003		X	X	X
Frank Turek	Greeley and Hansen	602-275-5595		X	X	X
Roland Wass	PBS&J	602-943-1103		X		
Bill Werner	Arizona Game and Fish Department	602-789-3607		X	X	X
Karen Winters	City of Phoenix PRLD	602-495-5720	X	X		X
William Zeigler	Corps of Engineers, Los Angeles Dist.	213-452-3747	X	X	X	X

APPENDIX – COST INFORMATION

Tres Rios

Capital Cost Model #1

	Pump Station		Regulating Wetlands		Overbank Wetlands		Pipe Wetlands to Riparian		Dependent Riparian		Indep. OW/M North		Indep. OW/M North	
	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total
Excavation & Stockpile		0.0%	$ 5,840,000	6.8%	$ 4,833,000	5.6%		0 0%	$ 1,713,000	2.0%	$ 5,600,000	6.5%	$ 1,705,000	2.0%
Facility & Pumps	$ 8,000,000	9.3%		0.0%		0.0%		0 0%		0.0%		0.0%		0.0%
36" Steel Pipe Installed		0 0%		0.0%		0.0%	$ 3,212,100	3.7%		0.0%		0.0%		0.0%
Vegatation Planting		0.0%	$ 262,500	0.3%	$ 262,500	0.3%		0.0%	$ 525,000	0.6%	$ 300,000	0.3%	$ 450,000	0.5%
Topsoil Lining		0 0%		0.0%		0.0%		0 0%	$ 532,000	0.6%	$ 570,000	0.7%	$ 568,000	0.7%
84" Steel Pipe Installed	$ 2,092,400	2.4%		0.0%		0 0%		0 0%		0.0%		0.0%		0.0%
Toe Excavation & Backfill		0 0%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%
Grading		0 0%	$ 300,000	0.3%	$ 300,000	0.3%		0.0%	$ 132,000	0.2%	$ 278,000	0.3%	$ 140,000	0.2%
Riprap		0 0%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%
Vegetation Removal		0.0%		0.0%		0.0%		0.0%	$ 165,000	0.2%	$ 237,500	0.3%	$ 87,500	0.1%
24" Steel Pipe Installed		0.0%	$ 253,000	0.3%	$ 236,800	0.3%		0.0%		0.0%		0.0%		0.0%
Clearing & Grubbing		0 0%	$ 50,000	0.1%	$ 50,000	0.1%		0.0%	$ 50,000	0.1%	$ 50,000	0.1%	$ 50,000	0.1%
Compacted Levee Fill		0.0%		0.0%		0.0%		0.0%		0.0%		0 0%		0.0%
Monitoring & Controls	$ 200,000	0 2%	$ 60,800	0.1%		0.0%		0.0%		0.0%		0.0%		0.0%
36" Concrete Pipe Installed		0 0%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%
Outlet Weir Structure & Gate		0 0%	$ 35,000	0.0%	$ 15,000	0.0%	$ 20,000	0 0%		0.0%		0.0%		0.0%
Inlet Structure w/Gate	$ 5,000	0 0%	$ 50,000	0.1%		0.0%	$ 5,000	0 0%		0.0%		0.0%		0.0%
Interior Drainage		0 0%		0.0%		0.0%		0 0%		0.0%		0.0%		0.0%
12" Concrete Pipe Installed		0 0%		0.0%		0.0%	$ 21,000	0.0%		0.0%		0.0%		0.0%
Deep Well Pump System		0.0%		0.0%		0.0%		0 0%		0.0%		0.0%		0.0%
Subtotal	$ 10,297,400	12.0%	$ 6,851,300	8.0%	$ 5,697,300	6.6%	$ 3,258,100	3.8%	$ 3,117,000	3.6%	$ 7,035,500	8.2%	$ 3,000,500	3.5%
Contingencies	$ 1,544,610		$ 1,027,695		$ 854,595		$ 488,715		$ 467,550		$ 1,055,325		$ 450,075	
PE & D	$ 1,029,740		$ 685,130		$ 569,730		$ 325,810		$ 311,700		$ 703,550		$ 300,050	
Engineering during Constructio	$ 102,974		$ 68,513		$ 56,973		$ 32,581		$ 31,170		$ 70,355		$ 30,005	
Supervision & Administration	$ 648,736		$ 431,632		$ 358,930		$ 205,260		$ 196,371		$ 443,237		$ 189,032	
Real Estate	$ 3,220,000	3.7%		0.0%	$ 2,093,000	2.4%	$ 103,500	0 1%	$ 690,000	0.8%	$ 1,150,000	1 3%	$ 1,955,000	2 3%
Total	$ 16,843,460	19 6%	$ 9,064,270	10.5%	$ 9,630,528	11.2%	$ 4,413,966	5 1%	$ 4,813,791	5.6%	$ 10,457,967	12 2%	$ 5,924,662	6.9%

Tres Rios

Capital Cost Model #1

	Dewatering Well Collection System		Pipe from Lake to Riparian Cor.		Conveyance Channel		Dep. OW/M South		Levee		Total	
	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total
Excavation & Stockpile		0 0%		0.0%	$ 69,500	0.1%	$ 9,000,000	10.5%		0.0%	$ 28,760,500	33.4%
Facility & Pumps		0.0%		0.0%		0.0%		0.0%		0.0%	$ 8,000,000	9.3%
36" Steel Pipe Installed	$ 1,192,900	1.4%		0.0%		0.0%		0.0%		0.0%	$ 4,405,000	5.1%
Vegatation Planting		0 0%		0.0%	$ 4,725	0.0%	$ 555,000	0.6%		0.0%	$ 2,359,725	2.7%
Topsoil Lining		0 0%		0.0%		0.0%	$ 601,000	0 7%		0.0%	$ 2,271,000	2.6%
84" Steel Pipe Installed		0 0%		0.0%		0.0%		0.0%		0.0%	$ 2,092,400	2.4%
Toe Excavation & Backfill		0.0%		0.0%		0.0%		0.0%	$ 1,790,000	2.1%	$ 1,790,000	2.1%
Grading		0 0%		0.0%	$ 9,125	0.0%	$ 446,000	0.5%		0.0%	$ 1,605,125	1.9%
Riprap		0 0%		0.0%	$ 17,500	0.0%		0.0%	$ 1,051,200	1.2%	$ 1,068,700	1.2%
Vegetation Removal		0 0%		0.0%		0.0%	$ 280,000	0.3%		0.0%	$ 770,000	0.9%
24" Steel Pipe Installed		0 0%		0.0%		0.0%		0.0%		0.0%	$ 489,800	0.6%
Clearing & Grubbing		0 0%		0.0%	$ 100,000	0.1%	$ 50,000	0.1%	$ 50,000	0.1%	$ 450,000	0.5%
Compacted Levee Fill		0 0%		0.0%		0.0%		0 0%	$ 423,000	0.5%	$ 423,000	0.5%
Monitoring & Controls		0 0%		0.0%		0.0%		0 0%		0.0%	$ 260,800	0.3%
36" Concrete Pipe Installed		0 0%	$ 131,100	0.2%		0.0%		0 0%		0.0%	$ 131,100	0.2%
Outlet Weir Structure & Gate		0 0%		0.0%		0 0%		0 0%	$ 25,000	0.0%	$ 95,000	0.1%
Inlet Structure w/Gate		0.0%		0.0%		0.0%		0.0%	$ 25,000	0.0%	$ 85,000	0 1%
Interior Drainage		0 0%		0.0%		0.0%		0.0%	$ 62,000	0.1%	$ 62,000	0 1%
12" Concrete Pipe Installed		0 0%		0.0%		0.0%		0.0%		0.0%	$ 21,000	0.0%
Deep Well Pump System	$ 9,200	0 0%		0.0%		0.0%		0 0%		0.0%	$ 9,200	0.0%
Subtotal	$ 1,202,100	1 4%	$ 131,100	0.2%	$ 200,850	0.2%	$ 10,932,000	12.7%	$ 3,426,200	4.0%	$ 55,149,350	64.1%
Contingencies	$ 180,315		$ 19,665		$ 30,128		$ 1,639,800		$ 685,240		$ 8,443,713	
PE & D	$ 120,210		$ 13,110		$ 20,085		$ 1,093,200		$ 342,620		$ 5,514,935	
Engineering during Constructio	$ 12,021		$ 1,311		$ 2,009		$ 109,320		$ 34,262		$ 551,494	
Supervision & Administration	$ 75,732		$ 8,259		$ 12,654		$ 688,716		$ 215,851		$ 3,474,409	
Real Estate	$ 1,035,000	1 2%	$ 345,000	0 4%	$ 1,610,000	1 9%		0 0%	$ 676,000	0.8%	$ 12,877,500	15.0%
Total	$ 2,625,378	3 1%	$ 518,445	0 6%	$ 1,875,725	2 2%	$ 14,463,036	16 8%	$ 5,380,173	6.3%	$ 86,011,400	100.0%

Tres Rios

Capital Cost Model #2

	Pump Station		Regulating Wetlands		Overbank Wetlands		Riparian Corridors		Open Water Marsh (North)		Conveyance Channel		Open Water Marsh (South)		Levee		Total	
	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total
Excavation & Stockpile		0.0%	$ 5,840,000	6.8%	$ 4,833,000	5.6%	$ 1,713,000	2.0%	$ 7,305,000	8.5%	$ 69,500	0.1%	$ 9,000,000	10.5%		0.0%	$ 28,760,500	33.4%
Facility & Pumps	$ 8,000,000	9.3%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%	$ 8,000,000	9.3%
Pipe Installed	$ 2,092,400	2.4%	$ 253,000	0.3%	$ 236,800	0.3%	$ 3,364,100	3.9%		0.0%		0.0%	$ 1,192,900	1.4%		0.0%	$ 7,139,200	8.3%
Vegatation Planting		0.0%	$ 262,500	0.3%	$ 262,500	0.3%	$ 525,000	0.6%	$ 750,000	0.9%	$ 4,725	0.0%	$ 555,000	0.6%		0.0%	$ 2,359,725	2.7%
Topsoil Lining		0.0%		0.0%		0.0%	$ 532,000	0.6%	$ 1,138,000	1.3%		0.0%	$ 601,000	0.7%		0.0%	$ 2,271,000	2.6%
Toe Excavation & Backfill		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%	$ 1,790,000	2.1%	$ 1,790,000	2.1%
Grading		0.0%	$ 300,000	0.3%	$ 300,000	0.3%	$ 132,000	0.2%	$ 418,000	0.5%	$ 9,125	0.0%	$ 446,000	0.5%		0.0%	$ 1,605,125	1.9%
Riprap		0.0%		0.0%		0.0%		0.0%		0.0%	$ 17,500	0.0%		0.0%	$ 1,051,200	1.2%	$ 1,068,700	1.2%
Vegetation Removal		0.0%		0.0%		0.0%	$ 165,000	0.2%	$ 325,000	0.4%		0.0%	$ 280,000	0.3%		0.0%	$ 770,000	0.9%
Clearing & Grubbing		0.0%	$ 50,000	0.1%	$ 50,000	0.1%	$ 50,000	0.1%	$ 100,000	0.1%	$ 100,000	0.1%	$ 50,000	0.1%	$ 50,000	0.1%	$ 450,000	0.5%
Compacted Levee Fill		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%	$ 423,000	0.5%	$ 423,000	0.5%
Monitoring & Controls	$ 200,000	0.2%	$ 60,800	0.1%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%	$ 260,800	0.3%
Outlet Weir Structure & Gate		0.0%	$ 35,000	0.0%	$ 15,000	0.0%	$ 20,000	0.0%		0.0%		0.0%		0.0%	$ 25,000	0.0%	$ 95,000	0.1%
Inlet Structure w/Gate	$ 5,000	0.0%	$ 50,000	0.1%		0.0%	$ 5,000	0.0%		0.0%		0.0%		0.0%	$ 25,000	0.0%	$ 85,000	0.1%
Interior Drainage		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%	$ 62,000	0.1%	$ 62,000	0.1%
Deep Well Pump System		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%	$ 9,200	0.0%		0.0%	$ 9,200	0.0%
Subtotal	$ 10,297,400	12.0%	$ 6,851,300	8.0%	$ 5,697,300	6.6%	$ 6,506,100	7.6%	$ 10,036,000	11.7%	$ 200,850	0.2%	$ 12,134,100	14.1%	$ 3,426,200	4.0%	$ 55,149,250	64.1%
Contingencies	$ 1,544,610		$ 1,027,695		$ 854,595		$ 975,915		$ 1,505,400		$ 30,128		$ 1,820,115		$ 685,240		$ 8,443,698	
PE & D	$ 1,029,740		$ 685,130		$ 569,730		$ 650,610		$ 1,003,600		$ 20,085		$ 1,213,410		$ 342,620		$ 5,514,925	
Engineering during Constructi	$ 102,974		$ 68,513		$ 56,973		$ 65,061		$ 100,360		$ 2,009		$ 121,341		$ 34,262		$ 551,493	
Supervision & Administration	$ 648,736		$ 431,632		$ 358,930		$ 409,884		$ 632,268		$ 12,654		$ 764,448		$ 215,851		$ 3,474,403	
Real Estate	$ 3,220,000	3.7%		0.0%	$ 2,093,000	2.4%	$ 1,138,500	1.3%	$ 3,105,000	3.6%	$ 1,610,000	1.9%	$ 1,035,000	1.2%	$ 676,000	0.8%	$ 12,877,500	15.0%
Total	$ 16,843,460	19.6%	$ 9,064,270	10.5%	$ 9,630,528	11.2%	$ 9,746,070	11.3%	$ 16,382,628	19.0%	$ 1,875,725	2.2%	$ 17,088,414	19.9%	$ 5,380,173	6.3%	$ 86,011,268	100.0%

Tres Rios

Capital Cost Model #3

	Water Delivery		Overbank Wetlands		Riparian Corridors		Open Water Marsh		Levee		Total	
	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total
Excavation & Stockpile	$ 5,909,500	6.9%	$ 4,833,000	5.6%	$ 1,713,000	2.0%	$ 16,305,000	19.0%		0.0%	$ 28,760,500	33.4%
Facility & Pumps	$ 8,000,000	9.3%		0.0%		0.0%		0.0%		0.0%	$ 8,000,000	9.3%
Pipe Installed	$ 2,345,400	2.7%	$ 236,800	0.3%	$ 3,364,100	3.9%	$ 1,192,900	1.4%		0.0%	$ 7,139,200	8.3%
Vegatation Planting	$ 267,225	0.3%	$ 262,500	0.3%	$ 525,000	0.6%	$ 1,305,000	1.5%		0.0%	$ 2,359,725	2.7%
Topsoil Lining		0.0%		0.0%	$ 532,000	0.6%	$ 1,739,000	2.0%		0.0%	$ 2,271,000	2.6%
Toe Excavation & Backfill		0.0%		0.0%		0.0%		0.0%	$ 1,790,000	2.1%	$ 1,790,000	2.1%
Grading	$ 309,125	0.4%	$ 300,000	0.3%	$ 132,000	0.2%	$ 864,000	1.0%		0.0%	$ 1,605,125	1.9%
Riprap	$ 17,500	0.0%		0.0%		0.0%		0.0%	$ 1,051,200	1.2%	$ 1,068,700	1.2%
Vegetation Removal		0.0%		0.0%	$ 165,000	0.2%	$ 605,000	0.7%		0.0%	$ 770,000	0.9%
Clearing & Grubbing	$ 150,000	0.2%	$ 50,000	0.1%	$ 50,000	0.1%	$ 150,000	0.2%	$ 50,000	0.1%	$ 450,000	0.5%
Compacted Levee Fill		0.0%		0.0%		0.0%		0.0%	$ 423,000	0.5%	$ 423,000	0.5%
Monitoring & Controls	$ 260,800	0.3%		0.0%		0.0%		0.0%		0.0%	$ 260,800	0.3%
Outlet Weir Structure & Gate	$ 35,000	0.0%	$ 15,000	0.0%	$ 20,000	0.0%		0.0%	$ 25,000	0.0%	$ 95,000	0.1%
Inlet Structure w/Gate	$ 55,000	0.1%		0.0%	$ 5,000	0.0%		0.0%	$ 25,000	0.0%	$ 85,000	0.1%
Interior Drainage		0.0%		0.0%		0.0%		0.0%	$ 62,000	0.1%	$ 62,000	0.1%
Deep Well Pump System		0.0%		0.0%		0.0%	$ 9,200	0.0%		0.0%	$ 9,200	0.0%
Subtotal	$ 17,349,550	20.2%	$ 5,697,300	6.6%	$ 6,506,100	7.6%	$ 22,170,100	25.8%	$ 3,426,200	4.0%	$ 55,149,250	64.1%
Contingencies	$ 2,602,433		$ 854,595		$ 975,915		$ 3,325,515		$ 685,240		$ 8,443,698	
PE & D	$ 1,734,955		$ 569,730		$ 650,610		$ 2,217,010		$ 342,620		$ 5,514,925	
Engineering during Constructio	$ 173,496		$ 56,973		$ 65,061		$ 221,701		$ 34,262		$ 551,493	
Supervision & Administration	$ 1,093,022		$ 358,930		$ 409,884		$ 1,396,716		$ 215,851		$ 3,474,403	
Real Estate	$ 4,830,000	5.6%	$ 2,093,000	2.4%	$ 1,138,500	1.3%	$ 4,140,000	4.8%	$ 676,000	0.8%	$ 12,877,500	15.0%
Total	$ 27,783,455	32.3%	$ 9,630,528	11.2%	$ 9,746,070	11.3%	$ 33,471,042	38.9%	$ 5,380,173	6.3%	$ 86,011,268	100.0%

6.625% COMPOUND INTEREST

N	SINGLE PAYMENT		UNIFORM SERIES			
	Compound Amount Factor (CAF)	Present Worth Factor (PWF)	Sinking Fund Factor (SFF)	Capital Recovery Factor (CRF)	Compound Amount Factor (CAF)	Present Worth Factor (PWF)
	Given P to Find S	Given S to Find P	Given S to Find R	Given P to Find R	Given R to Find S	Given R to Find P
1	1.066	.9379	1.00000	1.06625	1.000	.938
2	1.137	.8796	.48397	.55022	2.066	1.817
3	1.212	.8249	.31219	.37844	3.203	2.642
4	1.293	.7737	.22648	.29273	4.415	3.416
5	1.378	.7256	.17520	.24145	5.708	4.142
6	1.469	.6805	.14112	.20737	7.086	4.822
7	1.567	.6382	.11688	.18313	8.555	5.460
8	1.671	.5986	.09879	.16504	10.122	6.059
9	1.781	.5614	.08480	.15105	11.793	6.620
10	1.899	.5265	.07367	.13992	13.574	7.147
11	2.025	.4938	.06463	.13088	15.473	7.641
12	2.159	.4631	.05715	.12340	17.499	8.104
13	2.302	.4343	.05087	.11712	19.658	8.538
14	2.455	.4074	.04554	.11179	21.960	8.946
15	2.617	.3820	.04096	.10721	24.415	9.328
16	2.791	.3583	.03699	.10324	27.032	9.686
17	2.976	.3360	.03353	.09978	29.823	10.022
18	3.173	.3152	.03049	.09674	32.799	10.337
19	3.383	.2956	.02780	.09405	35.972	10.633
20	3.607	.2772	.02541	.09166	39.355	10.910
21	3.846	.2600	.02328	.08953	42.963	11.170
22	4.101	.2438	.02136	.08761	46.809	11.414
23	4.373	.2287	.01964	.08589	50.910	11.642
24	4.662	.2145	.01809	.08434	55.283	11.857
25	4.971	.2012	.01668	.08293	59.945	12.058

6.625% COMPOUND INTEREST

N	SINGLE PAYMENT		UNIFORM SERIES			
	Compound Amount Factor (CAF)	Present Worth Factor (PWF)	Sinking Fund Factor (SFF)	Capital Recovery Factor (CRF)	Compound Amount Factor (CAF)	Present Worth Factor (PWF)
	Given P to Find S	Given S to Find P	Given S to Find R	Given P to Find R	Given R to Find S	Given R to Find P
26	5.301	.1887	.01540	.08165	64.917	12.247
27	5.652	.1769	.01424	.08049	70.217	12.424
28	6.026	.1659	.01318	.07943	75.869	12.590
29	6.426	.1556	.01221	.07846	81.896	12.745
30	6.851	.1460	.01132	.07757	88.321	12.891
31	7.305	.1369	.01051	.07676	95.172	13.028
32	7.789	.1284	.00976	.07601	102.478	13.156
33	8.305	.1204	.00907	.07532	110.267	13.277
34	8.855	.1129	.00843	.07468	118.572	13.390
35	9.442	.1059	.00785	.07410	127.427	13.496
36	10.068	.0993	.00731	.07356	136.869	13.595
37	10.735	.0932	.00681	.07306	146.937	13.688
38	11.446	.0874	.00634	.07259	157.671	13.776
39	12.204	.0819	.00591	.07216	169.117	13.858
40	13.013	.0768	.00552	.07177	181.321	13.934
45	17.933	.0558	.00391	.07016	255.595	14.253
50	24.715	.0405	.00279	.06904	357.955	14.484
55	34.060	.0294	.00200	.06825	499.022	14.651
60	46.940	.0213	.00144	.06769	693.433	14.773
65	64.690	.0155	.00104	.06729	961.360	14.861
70	89.152	.0112	.00075	.06700	1330.602	14.925
75	122.865	.0081	.00054	.06679	1839.472	14.971
80	169.326	.0059	.00039	.06664	2540.769	15.005
85	233.356	.0043	.00029	.06654	3507.259	15.030
90	321.598	.0031	.00021	.06646	4839.222	15.047
95	443.210	.0023	.00015	.06640	6674.862	15.060
100	610.808	.0016	.00011	.06636	9204.643	15.070

Cost Summary and MCACES Cost Estimate

FEASIBILITY STUDY OF TRES RIOS PHOENIX, ARIZONA

COST SUMMARY FOR ALTERNATIVE 3.5

Prepared by: Don D Nguyen

Revised: 29-Feb-00

	Estimated Cost
A. ENVIRONMENTAL RESTORATION	
- Item No 1: PUMP STATION AND PIPES TO DIURNAL WETLANDS:	$16,843,460.00
- Item No. 2: REGULATING WETLANDS	$9,064,270.00
- Item No. 3: OVERBANK WETLANDS	$9,630,528.00
- Item No. 4: PIPELINE TO CONVEY WATER FROM WETLANDS TO RIPARIAN CORRIDORS	$4,413,966.00
- Item No. 5: DEPENDENT RIPARIAN CORRIDORS FROM 36" DIA. PIPELINE	$4,813,791.00
- Item No. 6: INDEPENDENT OPEN WATER MARSH (OW/M) NORTH SIDE OF RIVER	$10,457,967.00
- Item No. 7: INDEPENDENT RIPARIAN CORRIDORS IN RIVER	$5,924,662.00
- Item No. 8: DEWATERING WELL COLLECTION SYSTEM AND ITS PIPELINE	$2,625,378.00
- Item No. 9: 36" DIA. PIPE FROM THE EXISTING LAKE TO RIPARIAN CORRIDOR AT 83rd AVE.	$518,445.00
- Item No 10: CONVEYANCE TRAPEZOIDAL CHANNEL	$1,875,726.00
- Item No. 11: DEPENDANT OPEN WATER MARSH (OW/M) SOUTHSIDE OF RIVER	$14,463,038.00
- Item No. 12: MONITORING	$806,312.00
- Item No. 13: ADAPTIVE MANAGEMENT	$806,312.00
- Item No 14: CULTURAL RESOURCES MITIGATION	$500,000.00 OR 1,000,000
Total for Environmental Restoration	**$82,743,853.00**
B. FLOOD CONTROL	
- Item 12a1: LOW LEVEE (50 year)	$4,890,835.00
- Item 12a2: MID-HIGH LEVEE (100 year)	$5,380,173.00
- Item 12a3: HIGH LEVEE (500 year)	$6,109,648.00
Recommended Total for Flood Control (mid levee)	**$5,380,173.00**
C. REC IMPROVEMENTS & ENVR EDUCATION FACILITIES	
- Item No 1: RECREATIONAL IMPROVEMENTS	$2,360,000.00
- Item No. 2: ENVIRONMENTAL EDUCATION FACILITIES	$2,500,000.00
Total for Rec Improvements & Envr Education Facilities	**$4,860,000.00**

		FEASIBILITY STUDY OF TRES RIOS AT PHOENIX, ARIZONA **COST COMPONENTS FOR ALTERNATIVE 3.5**			Prepared by: Revised:	Don D. Nguyen 29-Feb-00
Item No.		Description	Estimated Quantity	UOM	Unit Cost	Estimated Cost
A		ENVIRONMENTAL RESTORATION				
1		PUMP STATION AND PIPES TO DIURNAL WETLANDS:				
	a	Pump Stations:				
		a1 -Capacity 300 MGD	1	LS	$8,000,000.00	$8,000,000.00
		a2 -Electrical Control Panels and SCADA	1	LS	$200,000.00	$200,000.00
	b.	Pipe Line fron Pump Station to Diurnal Wetlands:				
		b1 -Pipe (84" Dia. Steel Pipe)	3,900	LF	$492.00	$1,918,800.00
		b2 -Pipe Trench Excavation	22,300	CY	$5.00	$111,500.00
		b3 -Pipe Trench Backfill	20,700	CY	$3.00	$62,100.00
		b4 -Inlet Structure W/Gate	1	EA	$5,000.00	$5,000.00
		Subtotal				$10,297,400.00
		Contingencies			15.00%	$1,544,610.00
		Planning, Survey, Engineering and Design			10.00%	$1,029,740.00
		Engineering During Construction			1.00%	$102,974.00
		Supervision and Administration			6.30%	$648,736.00
		Real Estate				$3,220,000.00
		Subtotal Item No. 1				$16,843,460.00
2		REGULATING WETLANDS				
	a	Regulating Basins				
		a1 -Clear and Grubbing	1	LS	$50,000.00	$50,000.00
		a2 -Excavation and Stockpile	1,168,000	CY	$5.00	$5,840,000.00
		a3 -Grading	150	AC	$2,000.00	$300,000.00
		a4 -Vegetation Planting	75	AC	$3,500.00	$262,500.00
	b	Pipe line between Basins to Basins including Side Drains				
		b1 -Pipe (24" Dia. Steel Pipe)	1,600	LF	$130.00	$208,000.00
		b2 -Pipe Trench Excavation	5,700	CY	$5.00	$28,500.00
		b3 -Pipe Trench Backfill	5,500	CY	$3.00	$16,500.00
		b4 -Level Sensor	8	EA	$600.00	$4,800.00
		b5 -Meter	8	EA	$7,000.00	$56,000.00

Item No.		Description	Estimated Quantity	UOM	Unit Cost	Estimated Cost
		FEASIBILITY STUDY OF TRES RIOS AT PHOENIX, ARIZONA			Prepared by:	Don D. Nguyen
		COST COMPONENTS FOR ALTERNATIVE 3.5			Revised:	29-Feb-00
		b6 -Inlet Structure with Gate	10	EA	$5,000.00	$50,000.00
		b7 -Outlet Weir Structure w/Gate	7	EA	$5,000.00	$35,000.00
		Subtotal				$6,851,300.00
		Contingencies			15.00%	$1,027,695.00
		Planning, Survey, Engineering and Design			10.00%	$685,130.00
		Engineering During Construction			1.00%	$68,513.00
		Supervision and Administration			6.30%	$431,632.00
		Real Estate				(incl in Diurnal Wt)
		Subtotal Item No. 2				$9,064,270.00
3		OVERBANK WETLANDS				
	a	General Basins				
		a1 -Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
		a2 -Excavation and Stockpile	966,600	CY	$5.00	$4,833,000.00
		a3 -Grading	150	AC	$2,000.00	$300,000.00
		a4 -Vegetation Planting	75	AC	$3,500.00	$262,500.00
	b	Pipe Connecting between Basins including Side Drains				
		b1 -Pipe (24" Dia. Steel)	1,500	LF	$130.00	$195,000.00
		b2 -Pipe Trench Excavation	5,300	CY	$5.00	$26,500.00
		b3 -Pipe Trench Backfill	5,100	CY	$3.00	$15,300.00
		b4 -Outlet Weirstructure w/Gate	3	EA	$5,000.00	$15,000.00
		Subtotal				$5,697,300.00
		Contingencies			15.00%	$854,595.00
		Planning, Survey, Engineering and Design			10.00%	$569,730.00
		Engineering During Construction			1.00%	$56,973.00
		Supervision and Administration			6.30%	$358,930.00
		Real Estate				$2,093,000.00
		Subtotal Item No. 3				$9,630,528.00

Item No		Description	Estimated Quantity	UOM	Unit Cost	Estimated Cost
		FEASIBILITY STUDY OF TRES RIOS AT PHOENIX, ARIZONA			Prepared by:	Don D. Nguyen
		COST COMPONENTS FOR ALTERNATIVE 3.5			Revised:	29-Feb-00
4		**PIPELINE TO CONVEY WATER FROM WETLANDS TO RIPARIAN CORRIDORS**				
	a	36" Dia. Steel Pipe				
		a1 -Pipe (36" Dia. Steel)	14,000	LF	$200.00	$2,800,000.00
		a2 -Pipe Trench Excavation	52,900	CY	$5.00	$264,500.00
		a3 -Pipe Trench backfill	49,200	CY	$3.00	$147,600.00
		a4 -Inlet Structure w/Gate	1	EA	$5,000.00	$5,000.00
		a5 -Outlet Structure w/Gate	4	EA	$5,000.00	$20,000.00
	b	12" dia. Concrete Pipe				
		b1 -Pipe	400	LF	$40.00	$16,000.00
		b2 -Pipe trench excavation	700	CY	$5.00	$3,500.00
		b3 -Pipe Trench Backfill	500	CY	$3.00	$1,500.00
		Subtotal				$3,258,100.00
		Contingencies			15.00%	$488,715.00
		Planning, Survey, Engineering and Design			10.00%	$325,810.00
		Engineering During Construction			1.00%	$32,581.00
		Supervision and Administration			6.30%	$205,260.00
						4,310,466
		Real Estate				$103,500.00
		Subtotal Item No. 4				$4,413,966.00
5		**DEPENDENT RIPARIAN CORRIDORS FROM 36" DIA. PIPELINE**				
		-Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
		-Exacavtion and Stockpile	342,600	CY	$5.00	$1,713,000.00
		-Grading	66	AC	$2,000.00	$132,000.00
		-Topsoil Lining	53,200	CY	$10.00	$532,000.00
		-Vegetation Removal (Salt Sedar)	66	AC	$2,500.00	$165,000.00
		-Revegetation of Natives	35	AC	$15,000.00	$525,000.00
		Subtotal				$3,117,000.00
		Contingencies			15.00%	$467,550.00
		Planning, Survey, Engineering and Design			10.00%	$311,700.00

	FEASIBILITY STUDY OF TRES RIOS AT PHOENIX, ARIZONA COST COMPONENTS FOR ALTERNATIVE 3.5			Prepared by: Revised:	Don D. Nguyen 29-Feb-00
Item No.	Description	Estimated Quantity	UOM	Unit Cost	Estimated Cost
	Engineering During Construction			1.00%	$31,170.00
	Supervision and Administration			6.30%	$196,371.00
	Real Estate				$690,000.00
	Subtotal Item No. 5				$4,813,791.00
6	INDEPENDENT OPEN WATER MARSH (OW/M) NORTH SIDE OF RIVER				
	-Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
	-Exacavtion and Stockpile	1,120,000	CY	$5.00	$5,600,000 00
	-Grading	139	AC	$2,000.00	$278,000.00
	-Topsoil Lining	57,000	CY	$10.00	$570,000 00
	-Vegetation Removal (Salt Sedar)	95	AC	$2,500.00	$237,500.00
	-Revegetation of Natives	20	AC	$15,000.00	$300,000 00
	Subtotal				$7,035,500 00
	Contingencies			15 00%	$1,055,325.00
	Planning, Survey, Engineering and Design			10.00%	$703,550.00
	Engineering During Construction			1.00%	$70,355.00
	Supervision and Administration			6.30%	$443,237.00
	Real Estate				$1,150,000.00
	Subtotal Item No. 6				$10,467,967.00
7	INDEPENDENT RIPARIAN CORRIDORS IN RIVER				
	-Clearing and Grubbing	1	LS	$50,000 00	$50,000 00
	-Exacavtion and Stockpile	341,000	CY	$5 00	$1,705,000 00
	-Grading	70	AC	$2,000 00	$140,000 00
	-Topsoil Lining	56,800	CY	$10 00	$568,000 00
	-Vegetation Removal (Salt Sedar)	35	AC	$2,500 00	$87,500 00
	-Revegetation of Natives	30	AC	$15,000 00	$450,000 00
	Subtotal				$3,000,500 00
	Contingencies			15 00%	$450,075 00

Item No.		Description	Estimated Quantity	UOM	Unit Cost	Estimated Cost
		FEASIBILITY STUDY OF TRES RIOS AT PHOENIX, ARIZONA			Prepared by:	Don D. Nguyen
		COST COMPONENTS FOR ALTERNATIVE 3.5			Revised:	29-Feb-00
		Planning, Survey, Engineering and Design			10.00%	$300,050.00
		Engineering During Construction			1.00%	$30,005.00
		Supervision and Administration			6.30%	$189,032.00
		Real Estate				$1,955,000.00
		Subtotal Item No. 7				$5,924,662.00
8		DEWATERING WELL COLLECTION SYSTEM AND ITS PIPELINE				
	a	Dewatering Well System				
		a1 -Deep Well Submersible Pumps	2	EA	$1,600.00	$3,200.00
		a2 -Water T-Valves	2	EA	$500.00	$1,000.00
		a3 -Inlet Diffusers	2	EA	$500.00	$1,000.00
		a4 -Pump Metering	2	EA	$2,000.00	$4,000.00
	b	Pipeline from well to the Existing Lake at 83rd Ave.				
		b1 -36" Dia. Steel pipe	5,200	LF	$200.00	$1,040,000.00
		b2 -Pipe Trench Excavation	19,600	CY	$5.00	$98,000.00
		b3 -Pipe Trench Backfill	18,300	CY	$3.00	$54,900.00
		Subtotal				$1,202,100.00
		Contingencies			15.00%	$180,315.00
		Planning, Survey, Engineering and Design			10.00%	$120,210.00
		Engineering During Construction			1.00%	$12,021.00
		Supervision and Administration			6.30%	$75,732.00
		Real Estate				$1,035,000.00
		Subtotal Item No. 8				$2,625,378.00
9		36" DIA. PIPE FROM THE EXISTING LAKE TO RIPARIAN CORRIDOR AT 83rd AVE.				
		-36" Dia. Concrete Pipe	1,200	LF	$80.00	$96,000.00
		-Pipe Trench Excavation	4,500	CY	$5.00	$22,500.00
		-Pipe Trench Backfill	4,200	CY	$3.00	$12,600.00

Item No.		FEASIBILITY STUDY OF TRES RIOS AT PHOENIX, ARIZONA COST COMPONENTS FOR ALTERNATIVE 3.5 Description	Estimated Quantity	UOM	Prepared by: Revised: Unit Cost	Don D. Nguyen 29-Feb-00 Estimated Cost
		Subtotal				$131,100.00
		Contingencies			15.00%	$19,665.00
		Planning, Survey, Engineering and Design			10.00%	$13,110.00
		Engineering During Construction			1.00%	$1,311.00
		Supervision and Administration			6.30%	$8,259.00
		Real Estate				$345,000.00
		Subtotal Item No. 9				$518,445.00
10		CONVEYANCE TRAPEZOIDAL CHANNEL				
	a	Riprap Side-Slope Soft Bottom Trapezoidal Channel				
		a1 -Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
		a2 -Grading and Shaping	0.65	AC	$2,500.00	$1,625.00
		a3 -Excavation and Stockpile	2,300	CY	$5.00	$11,500.00
		a4 -Riprap Side Slopes	500	TONS	$35.00	$17,500.00
		a5 -Vegetation Planting	0.35	AC	$3,500.00	$1,225.00
	b	Earth Side Slope Soft Bottom Trapezoidal Channel				
		b1 -Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
		b2 -Grading and Shaping	3	AC	$2,500.00	$7,500.00
		b3 -Excavation and Stockpile	11,600	CY	$5.00	$58,000.00
		b4 -Vegetation Planting	1	AC	$3,500.00	$3,500.00
		Subtotal				$200,850.00
		Contingencies			15.00%	$30,128.00
		Planning, Survey, Engineering and Design			10.00%	$20,085.00
		Engineering During Construction			1.00%	$2,009.00
		Supervision and Administration			6.30%	$12,654.00
		Real Estate				$1,610,000.00
		Subtotal Item No. 10				$1,875,726.00
11		DEPENDANT OPEN WATER MARSH (OW/M) SOUTHSIDE OF RIVER				

	FEASIBILITY STUDY OF TRES RIOS AT PHOENIX, ARIZONA			Prepared by:	Don D. Nguyen	
	COST COMPONENTS FOR ALTERNATIVE 3.5			Revised:	29-Feb-00	
Item No.	Description	Estimated Quantity	UOM	Unit Cost	Estimated Cost	
	-Clearing and Grubbing	1	LS	$50,000 00	$50,000.00	
	-Excavation and Stockpile	1,800,000	CY	$5.00	$9,000,000.00	
	-Grading	223	AC	$2,000 00	$446,000.00	
	-Topsoil Lining	60,100	CY	$10.00	$601,000.00	
	-Vegetation Removal (Salt Sedar)	112	AC	$2,500.00	$280,000.00	
	-Revegetation of Natives	37	AC	$15,000.00	$555,000.00	
	Subtotal				$10,932,000.00	
	Contingencies			15.00%	$1,639,800.00	
	Planning, Survey, Engineering and Design			10.00%	$1,093,200.00	
	Engineering During Construction			1.00%	$109,320.00	
	Supervision and Administration			6.30%	$688,716.00	
	Real Estate				(Incl in Trap Chan)	
	Subtotal Item No. 11				$14,463,036.00	
12	MONITORING (1% of ecosystem restoration)	1	LS	$806,312.00	$806,312.00	
	Subtotal Item No. 12				$806,312.00	
13	ADAPTIVE MANAGEMENT (1% of ecosystem restoration)	1	LS	$806,312.00	$806,312.00	
	Subtotal Item No. 13				$806,312.00	
14	CULTURAL RESOURCES MITIGATION	1	LS	$1,000,000.00	$1,000,000 00	
	Subtotal Item No. 14				$1,000,000.00	
B	FLOOD CONTROL					
1	NORTH LEVEE					
	a1 - For Low Levee:					
	-Clearing and Grubbing	1	LS	$50,000 00	$50,000.00	
	-Compacted Fill Levee	83,000	CY	$3.00	$249,000 00	

Item No.		Description	Estimated Quantity	UOM	Unit Cost	Estimated Cost
		FEASIBILITY STUDY OF TRES RIOS AT PHOENIX, ARIZONA			Prepared by:	Don D. Nguyen
		COST COMPONENTS FOR ALTERNATIVE 3.5			Revised:	29-Feb-00
		-Toe Excavation and Backfill	358,000	CY	$5.00	$1,790,000.00
		-Riprap Slope Protection	72,400	TONS	$12.00	$868,800.00
		-Interior Drainage (24" Dia. RCP)	1,550	LF	$40.00	$62,000.00
		-Inlet Structures	5	EA	$5,000.00	$25,000.00
		-Outlet Weir Structures	5	EA	$5,000.00	$25,000.00
		Subtotal				$3,069,800.00
		Contingencies			20.00%	$613,960.00
		Planning, Survey, Engineering and Design			10.00%	$306,980.00
		Engineering During Construction			1.00%	$30,698.00
		Supervision and Administration			6.30%	$193,397.00
		Real Estate				$676,000.00
		Subtotal Item 1a1				$4,890,835.00
		a2 - For Mid-high Levee:				
		-Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
		-Compacted Fill Levee	141,000	CY	$3.00	$423,000.00
		-Toe Excavation and Backfill	358,000	CY	$5.00	$1,790,000.00
		-Riprap Slope Protection	87,600	TONS	$12.00	$1,051,200.00
		-Interior Drainage (24" Dia. RCP)	1,550	LF	$40.00	$62,000.00
		-Inlet Structures	5	EA	$5,000.00	$25,000.00
		-Outlet Weir Structures	5	EA	$5,000.00	$25,000.00
		Subtotal				$3,426,200.00
		Contingencies			20.00%	$685,240.00
		Planning, Survey, Engineering and Design			10.00%	$342,620.00
		Engineering During Construction			1.00%	$34,262.00
		Supervision and Administration			6.30%	$215,851.00
		Real Estate				$676,000.00
		Subtotal Item 1a2				$5,380,173.00
		a3 - For High Levee:				
		-Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
		-Compacted Fill Levee	175,000	CY	$3.00	$525,000.00
		-Toe Excavation and Backfill	358,000	CY	$5.00	$1,790,000.00
		-Riprap Slope Protection	98,700	TONS	$15.00	$1,480,500.00
		-Interior Drainage (24" Dia. RCP)	1,550	LF	$40.00	$62,000.00
		-Inlet Structures	5	EA	$5,000.00	$25,000.00

		-Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
		-Excavation and Stockpile	1,800,000	CY	$5.00	$9,000,000.00
		-Grading	223	AC	$2,000.00	$446,000.00
		-Topsoil Lining	60,100	CY	$10.00	$601,000.00
		-Vegetation Removal (Salt Sedar)	112	AC	$2,500.00	$280,000.00
		-Revegetation of Natives	37	AC	$15,000.00	$555,000.00
		Subtotal				$10,932,000.00
		Contingencies			15.00%	$1,639,800.00
		Planning, Survey, Engineering and Design			10.00%	$1,093,200.00
		Engineering During Construction			1.00%	$109,320.00
		Supervision and Administration			6.30%	$688,716.00
		Real Estate				(Incl in Trap Chan)
		Subtotal Item No. 11				$14,463,036.00
12		MONITORING (1% of ecosystem restoration)	1	LS	$806,312.00	$806,312.00
		Subtotal Item No. 12				$806,312.00
13		ADAPTIVE MANAGEMENT (1% of ecosystem restoration)	1	LS	$806,312.00	$806,312.00
		Subtotal Item No. 13				$806,312.00
14		CULTURAL RESOURCES MITIGATION	1	LS	$1,000,000.00	$1,000,000.00
		Subtotal Item No. 14				$1,000,000.00
B		FLOOD CONTROL				
1		NORTH LEVEE				
		a1 - For Low Levee:				
		-Clearing and Grubbing	1	LS	$50,000.00	$50,000.00
		-Compacted Fill Levee	83,000	CY	$3.00	$249,000.00

		-Clearing and Grubbing	1	LS	$50,000 00	$50,000 00
		-Compacted Fill Levee	175,000	CY	$3 00	$525,000 00
		-Toe Excavation and Backfill	358,000	CY	$5 00	$1,790,000 00
		-Riprap Slope Protection	98,700	TONS	$15 00	$1,480,500 00
		-Interior Drainage (24" Dia. RCP)	1,550	LF	$40 00	$62,000 00
		-Inlet Structures	5	EA	$5,000 00	$25,000 00

Tres Rios

Capital Cost Model #3

	Water Delivery		Overbank Wetlands		Riparian Corridors		Open Water Marsh		Levee		Total	
	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total
Excavation & Stockpile	$ 5,909,500	6.9%	$ 4,833,000	5.6%	$ 1,713,000	2.0%	$16,305,000	19.0%		0.0%	$28,760,500	33.4%
Facility & Pumps	$ 8,000,000	9.3%		0.0%		0.0%		0.0%		0.0%	$ 8,000,000	9.3%
Pipe Installed	$ 2,345,400	2.7%	$ 236,800	0.3%	$ 3,364,100	3.9%	$ 1,192,900	1.4%		0.0%	$ 7,139,200	8.3%
Vegatation Planting	$ 267,225	0.3%	$ 262,500	0.3%	$ 525,000	0.6%	$ 1,305,000	1.5%		0.0%	$ 2,359,725	2.7%
Topsoil Lining		0.0%		0.0%	$ 532,000	0.6%	$ 1,739,000	2.0%		0.0%	$ 2,271,000	2.6%
Toe Excavation & Backfill		0.0%		0.0%		0.0%		0.0%	$ 1,790,000	2.1%	$ 1,790,000	2.1%
Grading	$ 309,125	0.4%	$ 300,000	0.3%	$ 132,000	0.2%	$ 864,000	1.0%		0.0%	$ 1,605,125	1.9%
Riprap	$ 17,500	0.0%		0.0%		0.0%		0.0%	$ 1,051,200	1.2%	$ 1,068,700	1.2%
Vegetation Removal		0.0%		0.0%	$ 165,000	0.2%	$ 605,000	0.7%		0.0%	$ 770,000	0.9%
Clearing & Grubbing	$ 150,000	0.2%	$ 50,000	0.1%	$ 50,000	0.1%	$ 150,000	0.2%	$ 50,000	0.1%	$ 450,000	0.5%
Compacted Levee Fill		0.0%		0.0%		0.0%		0.0%	$ 423,000	0.5%	$ 423,000	0.5%
Monitoring & Controls	$ 260,800	0.3%		0.0%		0.0%		0.0%		0.0%	$ 260,800	0.3%
Outlet Weir Structure & Gate	$ 35,000	0.0%	$ 15,000	0.0%	$ 20,000	0.0%		0.0%	$ 25,000	0.0%	$ 95,000	0.1%
Inlet Structure w/Gate	$ 55,000	0.1%		0.0%	$ 5,000	0.0%		0.0%	$ 25,000	0.0%	$ 85,000	0.1%
Interior Drainage		0.0%		0.0%		0.0%		0.0%	$ 62,000	0.1%	$ 62,000	0.1%
Deep Well Pump System		0.0%		0.0%		0.0%	$ 9,200	0.0%		0.0%	$ 9,200	0.0%
Subtotal	$17,349,550	20.2%	$ 5,697,300	6.6%	$ 6,506,100	7.6%	$22,170,100	25.8%	$ 3,426,200	4.0%	$55,149,250	64.1%
Contingencies	$ 2,602,433		$ 854,595		$ 975,915		$ 3,325,515		$ 685,240		$ 8,443,698	
PE & D	$ 1,734,955		$ 569,730		$ 650,610		$ 2,217,010		$ 342,620		$ 5,514,925	
Engineering during Constructi	$ 173,496		$ 56,973		$ 65,061		$ 221,701		$ 34,262		$ 551,493	
Supervision & Administration	$ 1,093,022		$ 358,930		$ 409,884		$ 1,396,716		$ 215,851		$ 3,474,403	
Real Estate	$ 4,830,000	5.6%	$ 2,093,000	2.4%	$ 1,138,500	1.3%	$ 4,140,000	4.8%	$ 676,000	0.8%	$12,877,500	15.0%
Total	$27,783,455	32.3%	$ 9,630,528	11.2%	$ 9,746,070	11.3%	$33,471,042	38.9%	$ 5,380,173	6.3%	$86,011,268	100.0%

Tres Rios

Capital Cost Model #3

	Water Delivery		Overbank Wetlands		Riparian Corridors		Open Water Marsh		Levee		Total	
	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total	Cost	% of Total
Excavation & Stockpile	$ 5,909,500	6.9%	$ 4,833,000	5.6%	$ 1,713,000	2.0%	$16,305,000	19.0%		0.0%	$28,760,500	33.4%
Facility & Pumps	$ 8,000,000	9.3%		0.0%		0.0%		0.0%		0.0%	$ 8,000,000	9.3%
Pipe Installed	$ 2,345,400	2.7%	$ 236,800	0.3%	$ 3,364,100	3.9%	$ 1,192,900	1.4%		0.0%	$ 7,139,200	8.3%
Vegetation Planting	$ 267,225	0.3%	$ 262,500	0.3%	$ 525,000	0.6%	$ 1,305,000	1.5%		0.0%	$ 2,359,725	2.7%
Topsoil Lining		0.0%		0.0%	$ 532,000	0.6%	$ 1,739,000	2.0%		0.0%	$ 2,271,000	2.6%
Toe Excavation & Backfill		0.0%		0.0%		0.0%		0.0%	$ 1,790,000	2.1%	$ 1,790,000	2.1%
Grading	$ 309,125	0.4%	$ 300,000	0.3%	$ 132,000	0.2%	$ 864,000	1.0%		0.0%	$ 1,605,125	1.9%
Riprap	$ 17,500	0.0%		0.0%		0.0%		0.0%	$ 1,051,200	1.2%	$ 1,068,700	1.2%
Vegetation Removal		0.0%		0.0%	$ 165,000	0.2%	$ 605,000	0.7%		0.0%	$ 770,000	0.9%
Clearing & Grubbing	$ 150,000	0.2%	$ 50,000	0.1%	$ 50,000	0.1%	$ 150,000	0.2%	$ 50,000	0.1%	$ 450,000	0.5%
Compacted Levee Fill		0.0%		0.0%		0.0%		0.0%	$ 423,000	0.5%	$ 423,000	0.5%
Monitoring & Controls	$ 260,800	0.3%		0.0%		0.0%		0.0%		0.0%	$ 260,800	0.3%
Outlet Weir Structure & Gate	$ 35,000	0.0%	$ 15,000	0.0%	$ 20,000	0.0%		0.0%	$ 25,000	0.0%	$ 95,000	0.1%
Inlet Structure w/Gate	$ 55,000	0.1%		0.0%	$ 5,000	0.0%		0.0%	$ 25,000	0.0%	$ 85,000	0.1%
Interior Drainage		0.0%		0.0%		0.0%		0.0%	$ 62,000	0.1%	$ 62,000	0.1%
Deep Well Pump System		0.0%		0.0%		0.0%	$ 9,200	0.0%		0.0%	$ 9,200	0.0%
Subtotal	$17,349,550	20.2%	$ 5,697,300	6.6%	$ 6,506,100	7.6%	$22,170,100	25.8%	$ 3,426,200	4.0%	$55,149,250	64.1%
Contingencies	$ 2,602,433		$ 854,595		$ 975,915		$ 3,325,515		$ 685,240		$ 8,443,698	
PE & D	$ 1,734,955		$ 569,730		$ 650,610		$ 2,217,010		$ 342,620		$ 5,514,925	
Engineering during Constructi	$ 173,496		$ 56,973		$ 65,061		$ 221,701		$ 34,262		$ 551,493	
Supervision & Administration	$ 1,093,022		$ 358,930		$ 409,884		$ 1,396,716		$ 215,851		$ 3,474,403	
Real Estate	$ 4,830,000	5.6%	$ 2,093,000	2.4%	$ 1,138,500	1.3%	$ 4,140,000	4.8%	$ 676,000	0.8%	$12,877,500	15.0%
Total	$27,783,455	32.3%	$ 9,630,528	11.2%	$ 9,746,070	11.3%	$33,471,042	38.9%	$ 5,380,173	6.3%	$86,011,268	100.0%

[redacted]

MCACES
COST EST

MEANS '99

ST'L PIPE

	84"	492	585	[illegible]	PG 85
Wetlands to Riparian & Corridors	36"	200	205	1/2" W	
	24"	130	129	3/8" W	

*	12" CONC	40	18.15	PG 102

Levee

24" RCP	40	39.50
36"		76.–

MEANS '99

MCACES
COST EST

ST. PIPE

	84"	492	585	[illegible]	pg 85
Wetlands to Riparian & Corridors	36"	200	205	1/2" W	
	24"	130	129	3/8" W	

*	12" Conc.	40	18.15	pg 102

Levee

24" RCP	40	39.50	↓
36"		76.–	↓

026 650 | Water Systems

		CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1999 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
660 1020	12" diameter	B-35A	195	.287	L.F.	10.80	7.40	5.20	23.40	29
1030	18" diameter		175	.320		16.55	8.25	5.80	30.60	37.50
1040	5/16" wall thickness, 12" diameter		195	.287		13.95	7.40	5.20	26.55	32.50
1050	18" diameter		59.20	.946		24.50	24.50	17.10	66.10	83.50
1060	36" diameter		28.96	1.934		48.50	50	35	133.50	169
1070	3/8" wall thickness, 18" diameter		43.20	1.296		24.50	33.50	23.50	81.50	[illegible]
1080	24" diameter		36	1.556		32.50	40	28	100.50	129
1090	30" diameter		30.40	1.842		43	47.50	33.50	124	158
1100	1/2" wall thickness, 36" diameter		26.08	2.147		69.50	55.50	39	164	205
1110	48" diameter		21.68	2.583		103	66.50	46.50	216	269
1120	60" diameter		16	3.500		135	90	63	288	360
1130	72" diameter		10.16	5.512		154	142	99.50	395.50	500
1135	7/16" wall thickness, 48" diameter		20.80	2.692		90.50	69.50	48.50	208.50	260
1140	5/8" wall thickness, 48" diameter		21.68	2.583		129	66.50	46.50	242	297
1150	60" diameter		16	3.500		161	90	63	314	385
1170	84" diameter		10	5.600		227	144	101	472	585
1180	96" diameter		9.84	5.691		259	147	103	509	625
1190	3/4" wall thickness, 60" diameter		16	3.500		193	90	63	346	420
1200	72" diameter		10.16	5.512		232	142	99.50	473.50	585
1210	84" diameter		10	5.600		271	144	101	516	630
1220	96" diameter		8.64	6.481		310	167	117	594	730
1230	108" diameter		8.48	6.604		350	170	119	639	780
1240	120" diameter		8	7		390	180	126	696	850
1250	7/8" wall thickness, 72" diameter		10	5.600		271	144	101	516	630
1260	84" diameter		9.84	5.691		310	147	103	560	680
1270	96" diameter		8	7		360	180	126	666	820
1290	120" diameter		7.20	7.778		455	200	141	796	965
1300	1" wall thickness, 84" diameter		10	5.600		365	144	101	610	735
1310	96" diameter		8	7		415	180	126	721	880
1320	132" diameter		7.20	7.778		590	200	141	931	1,100
1330	144" diameter		6.80	8.235		645	212	149	1,006	1,200
1340	1-1/8" wall thickness, 108"		6	9.333		540	241	169	950	1,150
1350	120" diameter		5.76	9.722		600	251	176	1,027	1,250
1360	1-1/4" wall thickness, 132" diameter		5.60	10		775	258	181	1,214	1,450
1370	144" diameter	▼	5.20	10.769	▼	775	278	195	1,248	1,500
662 [illegible]	**PIPING, WATER DISTRIBUTION, COPPER**									
[illegible]	Not including excavation or backfill									
[illegible]	Tubing, type K, 20' joints, 3/4" diameter	Q-1	150	.107	L.F.	1.82	3.13		4.95	6.75
[illegible]	1" diameter	1 Plum	136	.059		2.32	1.92		4.24	5.45
[illegible]	1-1/2" diameter	Q-1	120	.133		3.73	3.91		7.64	10.05
[illegible]	2" diameter		105	.152		5.95	4.47		10.42	13.35
[illegible]	2-1/2" diameter		145	.110		8.60	3.22		11.82	14.35
[illegible]	3" diameter		134	.119		11.90	3.50		15.40	18.40
[illegible]	4" diameter		105	.152		18.55	4.47		23.02	27.50
[illegible]	5" diameter	▼	19	.842		47.50	24.50		72	90
[illegible]	6" diameter	Q-2	24	1	▼	55	30.50		85.50	107
[illegible]	Tubing, type L									
[illegible]	2" diameter	1 Plum	106	.075	L.F.	6.40	2.46		8.86	10.80
[illegible]	3" diameter	Q-1	140	.114		12.40	3.35		15.75	18.75
[illegible]	4" diameter		105	.152		19.60	4.47		24.07	28.50
[illegible]	6" diameter	Q-2	24	1	▼	48	30.50		78.50	98.50
[illegible]	Fittings, brass, corporation stops, 3/4" diameter	1 Plum	19	.421	Ea.	16	13.75		29.75	38.50
[illegible]	1" diameter		16	.500		24	16.30		40.30	51
[illegible]	1-1/2" diameter		13	.615		65	20		85	102
[illegible]	2" diameter	▼	11	.727	▼	115	23.50		138.50	163

SITE WORK 2

027 150 | Sewage Systems

			Crew	Daily Output	Labor-Hours	Unit	1999 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P
156	2280	20" diameter pipe	B-20	4.60	5.217	Ea.	350	127		477	[illegible]
	2290	24" diameter pipe		4	6		600	146		746	[illegible]
	2320	For 12" long, add to 9"					15%	25%			
	2330	For 18" long, add to 9"					70%	55%			
	8000	For internal cleaning and inspection, see Div. 026-108									
	8100	For pipe testing, see Div. 151-220									
162	0010	**PIPING, DRAINAGE & SEWAGE, CONCRETE** R027-110									
	0020	Not including excavation or backfill									
	0050	Box culvert, cast in place, 6' x 6'	C-15	16	4.500	L.F.	85	115		200	276
	0060	8' x 8'		14	5.143		125	132		257	345
	0070	12' x 12'		10	7.200		245	185		430	560
	0100	Box culvert, precast, base price, 8' long, 6' x 3'	B-69	140	.343		180	8.05	7.85	195.90	219
	0150	6' x 7'		125	.384		250	9.05	8.80	267.85	299
	0200	8' x 3'		133	.361		210	8.50	8.25	226.75	253
	0250	8' x 8'		100	.480		310	11.30	11	332.30	370
	0300	10' x 3'		110	.436		250	10.25	10	270.25	300
	0350	10' x 8'		80	.600		335	14.10	13.75	362.85	405
	0400	12' x 3'		100	.480		315	11.30	11	337.30	375
	0401	Piping, precast concrete, box culvert, 8' long, 12' x 3'		100	.480			11.30	11	22.30	29.50
	0450	12' x 8'		67	.716		420	16.85	16.40	453.25	505
	0500	Set up charge at plant, add to base price				Job	2,500			2,500	2,750
	0510	Inserts and keyway, add				Ea.	220			220	242
	0520	Sloped or skewed end, add					350			350	385
	1000	Non-reinforced pipe, extra strength, B&S or T&G joints									
	1010	6" diameter	B-14	265.04	.181	L.F.	3.47	4.12	.83	8.42	11.15
	1020	8" diameter		224	.214		3.81	4.87	.98	9.66	12.85
	1030	10" diameter		216	.222		4.23	5.05	1.01	10.29	13.65
	1040	12" diameter		200	.240		5.20	5.45	1.09	11.74	15.45
	1050	15" diameter		180	.267		6.05	6.05	1.22	13.32	17.50
	1060	18" diameter		144	.333		7.45	7.60	1.52	16.57	21.50
	1070	21" diameter		112	.429		9.20	9.75	1.95	20.90	27.50
	1080	24" diameter		100	.480		11.25	10.90	2.19	24.34	32
	1560	Reinforced culvert, class 2, no gaskets									
	1590	27" diameter	B-21	88	.318	L.F.	15.25	7.95	1.54	24.74	31
	1592	30" diameter	B-13	80	.700		17	16.25	6.85	40.10	52
	1594	36" diameter		72	.778		25	18.10	7.65	50.75	64
	2000	Reinforced culvert, class 3, no gaskets									
	2010	12" diameter	B-14	210	.229	L.F.	8.10	5.20	1.04	14.34	18.15
	2020	15" diameter		175	.274		9.90	6.25	1.25	17.40	22
	2030	18" diameter		130	.369		11.55	8.40	1.68	21.63	27.50
	2035	21" diameter		120	.400		14.80	9.10	1.82	25.72	32.50
	2040	24" diameter		100	.480		18.35	10.90	2.19	31.44	39.50
	2045	27" diameter	B-13	92	.609		22	14.15	5.95	42.10	53
	2050	30" diameter		88	.636		26.50	14.80	6.25	47.55	59
	2060	36" diameter		72	.778		36	18.10	7.65	61.75	76
	2070	42" diameter	B-13B	72	.778		44	18.10	11	73.10	88.50
	2080	48" diameter		64	.875		57.50	20.50	12.40	90.40	108
	2090	60" diameter		48	1.167		61.50	27	16.50	105	128
	2100	72" diameter		40	1.400		95.50	32.50	19.80	147.80	178
	2120	84" diameter		32	1.750		203	40.50	25	268.50	315
	2140	96" diameter		24	2.333		243	54	33	330	390
	2200	With gaskets, class 3, 12" diameter	B-21	168	.167		7.25	4.17	.81	12.23	15.45
	2220	15" diameter		160	.175		8.70	4.38	.85	13.93	17.35
	2230	18" diameter		152	.184		10.90	4.61	.89	16.40	20
	2240	24" diameter		136	.206		16.30	5.15	1	22.45	27
	2260	30" diameter	B-13	88	.636		22	14.80	6.25	43.05	54

APPENDIX – FUNCTION ANALYSIS WORKSHEETS

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

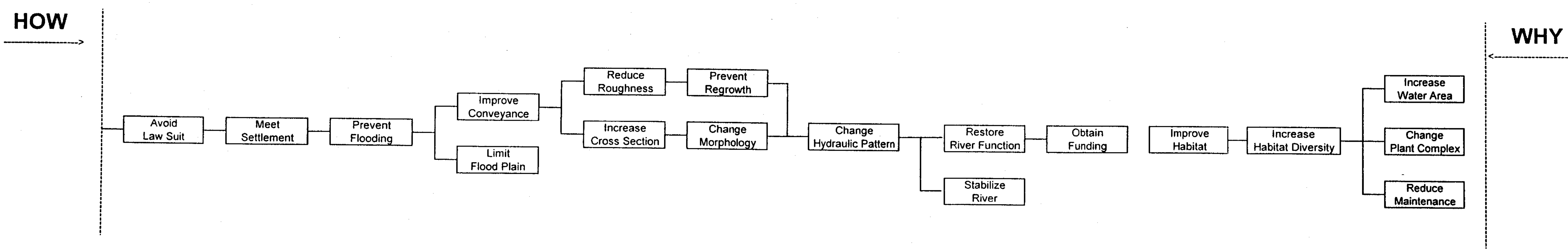
PROJECT LOCATION: *Phoenix, AZ*

FUNCTION ANALYSIS WORKSHEET

COMPONENT	FUNCTION VERB	FUNCTION NOUN	KIND	COST	WORTH	% OF TOTAL
Pump Station	Prevent	Flooding				
	Deliver	Water				
Regulating Wetlands	Regulate	Flow				
Overbank Wetlands	Increase	Cross-section				
	Protect	Investment				
	Increase	Habitat Diversity				
	Enhance	Water Quality				
	Obtain	Topsoil				
Riparian Corridors	Improve	Habitat				
	Reduce	Vectors				
	Improve	Conveyance				
Open Water/Marsh	Increase	Habitat Diversity				
	Improve	Conveyance				
	Prevent	Re-growth				

Kind B = Basic S = Secondary RS = Required Secondary

Function Analysis System Technique Diagram



Tres Rios
Phoenix, AZ

APPENDIX – CREATIVE IDEAS AND EVALUATION

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

CREATIVE IDEA LISTING & EVALUATION

Idea No.	Description	Votes
	Flood Protection	
F-01	Build a north and south levee	5
F-02	No levees and more people out of the floodplain	0
F-03	Build check dams to inundate and flood out salt cedar	3
F-04	Excavate basins to inundate and keep out salt cedar	0
F-05	Use jet pumping to facilitate removal of salt cedar and build shallower OW/M	0
F-06	Use guide vanes (line) to induce scour or train river	3
F-07	Construct a conveyance channel for entire flow	0
F-08	Have county remove the landfill	2
F-09	Thin salt cedar rather than complete removal	0
F-10	Use strip clearing for salt cedar	1
F-11	Provide upstream flood storage	0
F-12	Flood the entire reach (Lake Tempe)	0
F-13	Flood proof the structures	0
F-14	Remove salt cedar from Gila	0
F-15	Reduce excavation of the open water marshes	5
F-16	Flatten levees and eliminate riprap	5
F-17	Steepen u/s levee, use live crib wall, and eliminate riprap	5
F-18	Go to zero discharge at the plant	0

VALUE ENGINEERING STUDY

PROJECT LOCATION: *Phoenix, AZ*

Idea No.	Description	Votes
F-19	Build a bypass channel from the plant	1
F-20	Make sure north bank levee doesn't cause south flooding	4
F-21	Remove all hydraulic impedance hard points	1
F-22	Make the Aqua Fria more efficient	0
F-23	Introduce a transgenic organism that targets salt cedar	0
F-24	Do nothing and face the lawsuit	0
F-25	Set back levees to provide conveyance with existing conditions	0
F-26	Get a flood easement for overbank storage	0
F-27	Create a forebay on the landside for flood storage and drain back	2
F-28	Use a forebay/tailbay in the OW/M for sediment trapping	2
F-29	Levee around existing structure clusters only	1
F-30	Use a lined concrete channel	0
F-31	Deposit excess excavation on south bank	1
F-32	Deny future real estate development	0
F-33	Replace regulating wetlands with OW/M	0
F-34	Extend overbank wetland along the entire north bank	4
F-35	Locate OW/M to maximize conveyance	3
F-36	Consider future flows	DS
F-37	Overbuild the north levee to use more of the excess excavation	4
F-38	Excavate the OW/M ponds, but don't fill	0

Idea No.	Description	Votes
F-39	Release from u/s reservoirs to scour channel	0
F-40	Start a pilot channel and release from u/s to finish scour	1
F-41	Build cottonwood/willow guide vanes to scour a channel from u/s releases	4
F-42	Locate interior drains to support habitat development	8
F-43	Install dewatering wells to lower groundwater to kill salt cedar	1
F-44	Use water from F-43 to service desirable areas	2
F-45	Use electro-osmotic method to kill salt cedar	0
F-46	Cut down salt cedar and cover with cobble	0
F-47	Introduce salt cedar blight	1
F-48	Raise the north side levee to a 500-year level	1
F-49	Use freeze-wall technology to kill salt cedar	0
F-50	Protect Holly Acres with a basin instead of a levee	0
F-51	Install u/s grade control by Holly Acres to increase velocity	1
F-52	Build a flume in front of Holly Acres	0
F-53	Build a hydraulic jump to get water past Holly Acres	0
F-54	Build a bypass channel	0
F-55	Build a 120' wide levee at the 100-year elevation	0
F-56	Build an off-line basin in the Gila with an underflow/overflow system	0
F-57	Optimize size of regulating wetlands and pumping system	7
F-58	Use old sludge drying beds for on-site detention during flooding	5

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

Idea No.	Description	Votes
F-59	Harvest the salt cedar	0
F-60	Use salt cedar for some beneficial use	2
F-61	Make the river channel wider	0
F-62	Add river training structures	0
F-63	Cut and manage re-growth of salt cedar	4
F-64	Put shade structures over salt cedar	0
F-65	Increase use of competing plant species to reduce salt cedar	4
F-66	Introduce salt cedar predators	0
F-67	Use a herbicide	0
F-68	Increase the open water areas to reduce roughness	1
F-69	Straighten channel	0
F-70	Use an irrigation ditch along the north side and eliminate pipe	6
F-71	Dig channel deeper	0
F-72	Resize the overbank wetlands based on conveyance rather than larvacide application	1
F-73	Move regulating wetlands north of plant	0
F-74	Move regulating wetlands upstream of plant	1
F-75	Construct levees in a natural landform	7
F-76	Build a deep channel and allow flooding between channel and riverbanks for retention	0
F-77	Vary the elevation of the levee	4

Idea No.	Description	Votes
F-78	Use internal drainage water for post-flood clean up sluicing	3
F-79	Revisit Manning's "n" based on restoration plan	DS
F-80	Construct grout curtain around landfill	1
F-81	Geomorphology	DS
F-82	Evaluate the need for a pump station	DS
F-83	Use the gravel pit operators for construction and maintenance	DS
	Habitat Development	
H-01	Plant the riprap with drought tolerant species	9
H-02	Eliminate riprap and armor levee with live material	5
H-03	Eliminate riprap and use vegetative retards (wing dike)	3
H-04	Plant grain for food source	DS
H-05	Make all open water features round to reduce perimeter and thus reduce vector problem	0
H-06	Make all open-water features slongated to facilitate eater fowl	1
H-07	Maximize length of open-water features to reduce perimeter	1
H-08	Maximize open-water features and ensure continuous flow	0
H-09	Use step-pool morphology to connect open water marshes	3
H-10	Steepen slopes on nesting islands to protect nestlings	DS
H-11	Increase size of open water marshes and add more islands	4
H-110	Put a wetland at the end of the SRP channel	2
H-12	Add fish structure in open water areas	0

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

Idea No.	Description	Votes
H-13	Vary size/shape nesting islands to enhance species-specific habitat	0
H-14	Provide predator habitat	1
H-15	Increase nesting opportunities	0
H-16	Protect desirable nesting areas by monitoring/trapping and predator eradication	0
H-17	Protect nesting islands from scour e.g. armor	1
H-18	Add nesting site at the overbank wetlands	3
H-19	Send diurnal flow to another protection	0
H-20	Decrease amount of overbank wetlands and invrease open water marsh	0
H-21	Expand the regulating wetlands and reduce the overbank wetlands	1
H-22	Move the riparian corridors upstream and on the riverside of the overbank wetlands	1
H-23	Replace the two open water marshes on the south and place on the north and west end	1
H-24	Eliminate all piping with unlined canals and plant cottonwood/willow	1
H-25	Simplify the dewatering pipe route	5
H-26	Simplify the geometry of the overbank wetlands to reduce maintenance roads	2
H-27	Increase the height of the levee and reduce scheduled maintenance	6
H-28	Locate all openwater marshes to avoid lining	5
H-29	Add a willow/cottonwood corridor adjacent to the plant	3
H-30	Plant northwest area in cottonwood/willows and eliminate stringers	6

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

Idea No.	Description	Votes
H-31	Make shallower OW/M with grouted bottoms	0
H-32	Use the ANP pipeline for the parrallel conveyance	0
H-33	Modify OW/M and riparian corridors to minimize cowbird nest parasitism	3
H-34	Modify the cottonwood/willow complex to minimize cowbird nest parasitism	2
H-35	Modify land (re-zone) adjacent to prime neotropical nesting areas	0
H-36	Create no pesticide or herbicide spray zones adjacent to project	0
H-37	Locate size, shape of OW/M based on thalweg locational maps and geomorphic assesment report	DS
H-38	Stabilize banks with mesquite	6
H-39	Increase the number and distribution of cottonwood/willow corridors	4
H-40	Put cottonwoo/willow corridors near Indian reservations	4
H-41	Reduce size of OW/M on south side and plant more cottonwood/willow	0
H-42	Increase the area of the overbank wetlands	0
H-43	Use the landfill area for nature center location	2
H-44	Construct overbank ponds for threatened fish	4
H-45	Evaluate areas for open space for wildlife corridors	3
H-46	Construct an OW area around landfill and plant on the landfill	1
H-47	Use increased areas of overbank wetlands storage to encourage preferred apecies germination and discourage non-desirable	2
H-48	Vary depth of OW/M to increase fish habitat	4

Idea No.	Description	Votes
H-49	Decrease depth of OW/M to a depth of 2 feet	1
H-50	Plan for beavers	DS
H-51	Evaluate habitat for desirable species	0
H-52	Work with Fish & Wildlife to develop harvesting opportunities for Gila top minnow	0
H-53	Excavate the north channel to provide more terraces	0
H-54	Don't use the historic river location to locate new OW/M	0
H-55	Provide riparian habitat in greater than 25 Ha blocks	3
H-56	Expand existing OW areas and use alternative for salt cedar	0
H-57	Evaluate salt cedar habitat value and remove according to value	1
H-58	Develop plant nurseries within the project area	6
H-59	Create xeric riparian areas on overbank	2
H-60	Create a stretch of river with flowing water by using a recirculating pump	1
H-61	Build a braided stream instead of OW/M	0
H-62	Use cottonwood/willow retards to move sediment through the system	1
H-63	Use volunteer labor to plant the project	1
H-64	Inoculate project areas with materials from demonstration project	0
H-65	Create plant stock nursury a year ahead of project construction	4
H-66	Use the U/S reach of the Salt River to start plantings for this project	1
H-67	Use water from regulating wetlands to flush sediment fron cobble areas to discourage growth of salt cedar	0

Idea No.	Description	Votes
H-68	Remove the salt cedar and put all water in the upper part of the reach and treat as a desert wash environment	0
H-69	Set up several demonstrations in nursery to evaluate best means to propagate growth	2
H-70	Incorporate nursery into a permanent habitat area and for future harvesting	3
H-71	Take dewatering water and place in river at closest location to plant (WWTP)	4
H-72	Plant trees on the levee banks (upper riparian)	2
H-73	Evaluate proper nutrients are in the soil for growth	3
H-74	Plant herbaceous material to stabilize the levee	3
H-75	Plant hydraulic rough shrubs and grasses to reduce scour and eliminate the turndown	4
H-76	Plant levees and overbank with food source plants	0
H-77	Create working gardens for Indian community	0
H-78	Create ethno-botanical gardens	2
H-79	Develop overbank wetlands on south bank using irrigation water	0
H-80	Periodically flush to remove salinity	DS
H-81	Use interior drainageways for riparian corridors	1
H-82	Use drainage trenches in areas of high groundwater to discourage growth of salt cedar	0
H-83	Lower the groundwater to kill salt cedar	0
H-84	Pump out groundwater to lower groundwater and re-introduce on the surface	1

VALUE ENGINEERING STUDY

Idea No.	Description	Votes
H-85	Replace pipe on north side with a temporary drip irrigation system	0
H-86	Replace pipe on north with open channel	3
H-87	Vary the soil type from top to bottom of the levee slope	2
H-88	Use gravel pit area for OW/M	0
H-89	Use salt water marsh grass to out compete salt cedar	0
H-90	Re-regulate flood discharge to accommodate fone sediment transport	0
H-91	Re-regulate Roosevelt dam and provide continuous flow	0
H-92	Bypass irrigation and interior drains from the farmland	1
H-93	Route all farmland runoff through wetlands	3
H-94	Route upstream runoff through bypass system	0
H-95	Require U/S property owners and adjacent owners to treat runoff	0
H-96	Install irrigation dewatering wells on north bank and incorporate into Tres Rios water supply	2
H-97	Develop partnership with farmers to provide emergency water source during drought events	4
H-98	Sell dewatering water for beneficial use on northside	0
H-99	Provide comprehensive educational habitat cells with universal access	4
H-100	Plant upland riparian areas to "hide" the racetrack	1
H-101	Eliminate P.I.R.	0
H-102	Limit human access to less sensitive areas and close some areas entirely during breeding season	4
H-103	Divert water from project to develop habitat at P.I.R.	0

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

Idea No.	Description	Votes
H-104	Select plants for P.I.R. that will help remove pollutants	0
H-105	Relocate desirable species from other areas (breeding pairs)	2
H-106	Team with PIR for joint use of parking	3
H-107	Use topsoil excavation from salt cedar areas for levee core material to contain the salt	3
H-108	Quickly remove excavated salt cedar from site	0
H-109	Distribute water int cells to leach salt for initial plant development	DS
	Operations & Maintenance	
OM-01	Use state/county in-mates as full-time maintenance, park and education staff	1
OM-02	Do OM-01 in combination with state/county staff	1
OM-03	Develop permanent O&M easements	1
OM-04	Team with other agencies for environmental education and O&M&M	3
OM-05	Develop ongoing and comprehensive training program for staff and volunteers	4
OM-06	Use low head power generators to offset pumping cost	2
OM-07	Combine O&M and recreation access routes	2
OM-08	Expand adoptive management timeframe from 5 to 10 years with agreements to allow public access	2
OM-09	Use proven standardized equipment for flow regulating and monitoring	4
OM-10	Include a system to indicate when maintenance is required	4
OM-11	Charge admission	1

Idea No.	Description	Votes
OM-12	Charge admission for infrequent or non-local users	1
OM-13	Charge admission and offset with volunteer credits	0
OM-14	Give away salt cedar	0
OM-15	Start partnering O&M and interpretive staff with other city departments	3
OM-16	Maximize automation	1
OM-17	Minimize automation	1
OM-18	Eliminate equestrian access	0
OM-19	Form River-keeper program	3
OM-20	Involve O&M staff with final design and construction	2
OM-21	Provide accurate as-built plans	4
OM-22	Use waste methane for pump power	2
OM-23	Operate nursery to allow surplus stock for revenue generation	3
OM-24	Develop institutional arrangements for O&M&M and recreational features	2
OM-25	Provided dedicate security team	1
OM-26	Include training for security team to identify environmental issues	1
OM-27	Involve well-trained community groups in monitoring habitat and reproductive success, and include monitoring of threat species	3
OM-28	Design visual lanes for security patrols	0
OM-29	Develop agreements for fire protection	2
OM-30	Develop Holly Acres volunteer crew	0

Idea No.	Description	Votes
OM-31	Use indicator plants to monitor health of wetlands	0
OM-32	Balance system flexibility versus maintenance requirements	3
OM-33	Use hydraulically designed system that eliminates mechanical controls	6
OM-34	Design the monitoring program to meet system requirements based on science not on a daily schedule	4
OM-35	Use leverage on water source to negotiate a better power rate	1
OM-36	Use solar/wind to power pumps	2
OM-37	Eliminate pumps and use gravity for entire system, and move riparian corridor to Southeast	2
OM-38	Use off-peak power and store for later use	4
OM-39	Use the overbank wetland for regulating flow and eliminate the regulating wetland	3
OM-40	Use the western quarry and not the eastern quarry to cross with the dewatering water	4
OM-41	Ensure there is adequate space on the overbank to construct facilities	2
OM-42	Develop a disposal plan for O&M efforts	2
OM-43	O&M cost is too low	2
OM-44	Design using standardized and interchangeable components	4
OM-45	Use self regulating flow system	2
OM-46	Find beneficial use of wetland muck	0
OM-47	Consider emergency service access	1
OM-48	Develop plan to redistribute city staff on an as-needed basis	3

Idea No.	Description	Votes
	Vector Control	
V-01	Design swallow and purple martin habitat	1
V-02	Drain the swamps	0
V-03	Add circulation/aeration to the OW/M	3
V-04	Design all water features with vertical walls	2
V-05	Design water feature plantings to provide fish access	3
V-06	Develop several small OW/M rather then large ones and add Gila topminnow	0
V-07	Provide bat boxes that will attract bats	1
V-08	Periodically introduce sterile insects to reduce population	3
V-09	Incorporate permanent features to apply larvacide	3
V-10	Give all the residents "OFF"	0
V-11	Do not provide non-natural means for vector control	0
V-12	Don't approach vector control with "one-size" fits all mentality. Vary approach as necessary.	3
V-13	Use an appropriate public information program and reduce effort to control vectors	0
V-14	Design all water areas to encourage water movement	4
V-15	Use some type of wind/solar system to move water	0
V-16	Eliminate standing water areas beyond project features	2
V-17	Promote local government mosquito abatement district	3
V-18	Restrict evening access	0

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Phoenix, AZ*

Idea No.	Description	Votes
V-19	Develop an environmental management zone to reduce development and thus reduce human exposure	DS
V-20	Develop pesticide-spraying program	0
V-21	Develop placebo pesticide spraying program	0
V-22	Spray as a last resort and specifically target mosquito	0
V-23	Develop means to reduce muskrat burrowing	0
V-24	Develop area to concentrate muskrat habitat	1

Appendix – List of Study Materials Furnished

VALUE ENGINEERING STUDY

PROJECT TITLE: *Tres Rios*

PROJECT LOCATION: *Pnoenix, AZ*

STUDY MATERIALS FURNISHED

"Feasibility Report and Final Environmental Impact Statement," Tres Rios, Arizona, US Army Corps of Engineers, Los Angeles District, South Pacific Division, April 2000.

"Tres Rios Hydrologic Model Development and Applications Report," Salt/Gila Groundwater Analysis Project – Project Number WS90140004-S, Water & Environmental Systems Technology, Inc., prepared for Greeley and Hansen, Phoenix, Arizona, dated June 2000.

"Technology Appendices," Feasiblity Report, US Army Corps of Engineers, Los Angeles District, South Pacific Division, April 2000.

"Tres Rios Management Plan," Report and Reocmmendations, Habitat Technology Company, March 11, 1998.

William L. Graf, Patricia J. Beyer, and Thad A Waskiewicz, Geomorphic Assessment of the Lower Salt River, Central Arizona, Department of Geography, Arizona State University, Tempe, Arizona, October 1994.