Volume 1 of 2

Draft Feasibility Report and Environmental Impact Statement

Rio Salado Oeste

Salt River-Phoenix, Arizona

Prepared by:

US Army Corps of Engineers

Los Angeles District

South Pacific Division

City of Phoenix

March 2006

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT CORPS OF ENGINEERS
P.O. BOX 532711
LOS ANGELES, CALIFORNIA 90053-2325

April 28, 2006

REPLY TO
ATTENTION OF

Planning Division
Plan Formulation Branch

TO INTERESTED PARTIES:

Enclosed for your review and comment is a copy of the Draft Environmental Impact Statement (EIS) for the Rio Salado Oeste Feasibility Study Report, Salt River, Phoenix Arizona. The general study area for the Rio Salado Oeste Feasibility Study is located within the City of Phoenix, an urbanized portion of the Sonoran Desert. Its boundaries lie within the 100-year floodplain of the Salt River and its area is defined by Lower Buckeye Road on the north, Baseline Road on the south, 19th Avenue on the east, and 83rd Avenue on the west.

The primary purpose of the restoration project is to improve the overall ecological health of the river and reestablish a more stable, less degraded, and sustainable condition along an approximately eight-mile segment of the Salt River by restoring the natural ecosystem functions and processes. Secondary benefits of the project are recreational opportunities and general improvements in aesthetic quality. The project design incorporates earth moving, planting of vegetation and irrigation installation to facilitate restoration of 1,466 acres of riparian habitats along the Salt River.

The Draft EIS evaluates the alternatives carried forward for detailed environmental analysis. In general, the primary difference among Alternatives 2, 4, 5, 5A, and 5B is the number and location of acres of planted native vegetation. The difference in native vegetation acreage is created by varying measures within the alternatives, such as adding effluent as a water source and by restoring open gravel pits to either lakes, wetlands or both. The environmental consequences related to the preferred alternative (Alternative 5A) and other alternatives are addressed in Chapter 4. A description of future maintenance and the related impacts are also included in the Draft EIS.

The U.S. Army Corps of Engineers is the lead Federal agency responsible for complying with the National Environmental Policy Act (NEPA). The City of Phoenix is the local sponsor and proponent responsible for complying with the Arizona Environmental Quality Act (AEQA), as appropriate. The City of Phoenix will be responsible for maintenance of the project features once construction activities are complete. This environmental document is written in compliance with NEPA, AEQA and other applicable environmental laws and regulations.

The comment period begins on or about May 5, 2006 with publication of the Notice of Availability in the *Federal Register*, and extends 45 calendar days from that date. Please address your written comments to:

U.S. Army Corps of Engineers
Los Angeles District
Arizona/Nevada Area Office
Attn: Mr. Michael Fink
3636 North Central Avenue, Suite 900
Phoenix, Arizona 85012-1936

A public hearing is currently scheduled for May 18, 2006, at 6:30 p.m. located in Room 169 of the Travis L. Williams Family Services Center, 4732 South Central Avenue, Phoenix, Arizona. Notice will also be given in local media and mailings.

Please direct your phone or fax comments to Mr. Scott Estergard or Mr. Michael Fink of my staff at (602) 640-2003 or fax (602) 640-5382. Ms. Karen Williams is the point of contact for the City of Phoenix and can be reached at (602) 262-4717. Thank you for your review of this document.

Sincerely,

Daniel E. Sulzer
Acting Chief, Planning Division

Enclosure

US Army Corps
of Engineers

Los Angeles District
South Pacific Division

Draft Feasibility Report

Rio Salado Oeste

Salt River-Phoenix, Arizona

March 2006

EXECUTIVE SUMMARY

This report summarizes technical and feasibility study planning efforts undertaken to date to establish existing, future without-project, and future with-project conditions within the Rio Salado Oeste, Salt River study area in Phoenix, Arizona, to examine the measures and alternatives developed, and to present a recommended plan. This Feasibility Report serves to document plan formulation efforts in the development of potential alternatives for ecosystem restoration. These efforts will culminate in a complete feasibility report that identifies and recommends an implementable solution to improve the overall ecological health of the river and reestablish a more stable, less degraded, and sustainable condition.

The primary problem and focus of much of the efforts discussed in the report relates to the severe degradation and loss of riparian habitat along the Salt River. Historically, the study area supported significant biological resources including extensive riparian and marsh habitats. Urban development, diversion of water to support agriculture, and domestic livestock grazing have eliminated or altered most of the natural vegetation communities that occupied the study area leaving only scattered remnants of the original vegetation communities. Modifications of the river system, such as damming and flow diversion, currently do not allow flows through the study area except during flood events. In addition, sand and gravel mining operations have induced additional changes to the river channel and hydrology. As diversions of water increased, the perennial flows in the river ceased, causing the groundwater table to drop. These changes in hydrological conditions caused the natural riparian ecosystem to decline resulting in only small, isolated fragments of this former habitat remain. Today, the study area consists of a highly disturbed riverbed with minimal extant native vegetation.

This Feasibility Report includes identification of problems, opportunities, constraints, and planning objectives. A wide range of technical issues were analyzed with the goal of developing an accurate description of historic, existing, and future without-project conditions within the study area. This baseline assessment serves to identify, confirm, and refine problems, opportunities, and planning objectives and to guide the formulation of solutions. The major technical areas of focus for the study include hydrology and hydraulics, vegetation and wildlife habitat, cultural resources, projections on growth and development, and water availability and extent, particularly in reference to its effect on the riparian zone. Chapter 4 of this report details all of the areas of evaluation that comprise the without-project conditions. Detailed documentation of technical studies is included in the study's Technical Appendices, under separate cover. This report also develops and discusses potential solutions as a guide to potential Federal and non-Federal involvement in a restoration project and as a resource to assist in the decision-making. It provides a description and discussion of the likely array of alternative plans, including their benefits, costs, and environmental effects, and outputs. Chapter 5 of this report presents the results of the plan formulation process used in the development of alternatives. Assessments of the impacts of each alternative are also presented in Chapter 5. Chapter 6 identifies and describes the coordinated implement able solution (tentatively recommended plan) that best meets the planning objectives of a comprehensive ecosystem restoration through the study area.

This study effort is a joint partnership of the City of Phoenix and the Corps of Engineers, Los Angeles District. A wide variety of management measures were identified for use in developing full-scale alternatives.

Based on the cost-effectiveness and incremental cost evaluation, together with the analysis of impacts in the system of accounts and associated evaluation criteria, Alternative 5A is the plan that reasonably maximizes net ecosystem restoration benefits by having the maximum amount of restoration benefits compared to costs. Therefore, Alternative 5A is identified as the NER Plan and is presented as the recommended plan to be considered for implementation.

The total first cost of the project is currently estimated at $163,581,307 ($151,254,899 for ecosystem restoration and $12,326,408 for recreation). Based on the requirements of WRDA 1986, cost-sharing for ecosystem restoration features including all lands, easements, rights-of-way, relocations, and disposal areas (LERRDs) would be 65 percent Federal and 35 percent non-Federal. Cost sharing for the recreation plan would be 50 percent Federal and 50 percent non-Federal, or 0 percent Federal and 100 percent non-Federal, depending upon the features. USACE guidance (ER 1105-2-100, Appendix E) specifies that the level of financial participation by the Corps in recreation development may not increase the Federal cost of the project by more than 10 percent. Thus, the Federal share is currently estimated at $104,478,888 ($ 98,315,684 for ecosystem restoration and $6,163,204 for recreation). The cost for all operations and maintenance would be the responsibility of the non-Federal sponsor. Annual operation and maintenance for the ecosystem restoration project and recreation is currently estimated at $2,080,000 and $2,055,000 respectively. In addition, all water rights and costs associated with providing water to the project shall be borne by the non-Federal sponsors. The value of this water has been estimated at $817,000 annually.

The recommended plan provides a net habitat value of 847 AAFCU's, or an increase in 267 AAFCU's over without-project conditions. This is a 46 percent increase with project implementation.

The analysis presented in this report shows that the tentatively recommended plan is feasible and would provide environmental restoration benefits that serve the public interest. Therefore, it is recommended that the tentatively recommended plan described herein for ecosystem restoration be authorized for implementation as a Federal project, with such modifications as in the discretion of the Chief of Engineers that may be advisable, and subject to cost sharing and financial arrangements satisfactory to the President and Congress.

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LIST OF ACRONYMS

AAFCU	Average Annual Functional Capacity Units
ac-ft	acre-feet
ADMP	Area Drainage Master Plan
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game & Fish Department
AGR	Annual Growth Rate
AMA	Active Management Area
APE	Area of Potential Effects
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CERCLIS	Comprehensive Environmental Response, Compensation, and Information System
CE	Cost Effectiveness
City	City of Phoenix
c.y.	cubic yards
DDT	dichlorodiphenyltrichloroethane
DRCC	Durango Regional Conveyance Channel
EAD	Equivalent Annual Damages
EDC	Engineering During Construction
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EQ	Environmental Quality
ER	Engineering Regulation

ERDC	Engineering Research and Development Center
ERNS	Emergency Response and Notification System
ESA	Environmental Site Assessment
FAA	Federal Aviation Administration
FCD	Flood Control District
FCI	Functional Capacity Index
FCSA	Feasibility Cost Sharing Agreement
FCU	Functional Capacity Unit
FCDMC	Flood Control District of Maricopa County
FEMA	Federal Emergency Management Agency
ft	Feet
ft/ft	Feet vertical drop per lineal feet
HGM	Hydrogeomorphic Modeling
HR	House Resolution
HTRW	Hazardous, Toxic, and Radioactive Wastes
IDC	Interest During Construction
ICA	Incremental Cost Analysis
LERRD	Lands, Easements, Rights-of-way, Relocations, and Disposal Areas
LPP	Locally Preferred Plan
LUST	Leaking Underground Storage Tank
MAG	Maricopa County Association of Governments
mgd	million gallons per day
MNA	Museum of Northern Arizona
NED	National Economic Development
NER	National Ecosystem Restoration

NPDES	National Pollution Discharge Elimination System
NPL	
NRPA	National Recreation & Parks Association
O&M	Operations and Maintenance
OMRR&R	Operation, Maintenance, Repair, Replacement, and Rehabilitation
OHV	off-road vehicle
OSE	Other Social Effects
P&G	Planning and Guidance
PCA	Project Cooperation Agreement
PED	Pre-Construction Engineering and Design
PWAA	Partial Wetland Assessment Area
RBA	Risk-based Analysis
RCRA	Resource Conservation and Recovery Act
RED	Regional Economic Development
RM	River Mile
S&A	Supervision and Administration
SHPO	State Historic Preservation Office
SR101	State Route 101, Pima Freeway
SROG	Multi-City Sub-regional Operating Group
SRP	Salt River Project
SWPPP	Storm water Pollution Prevention Plan
TDS	total dissolved solids
TIN	Triangular Irregular Network
UAU	Upper Alluvial Unit
URS	URS Corporation

USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WRDA	Water Resources Development Act
WWTP	Wastewater Treatment Plant
yr	Year

CHAPTER I
STUDY AUTHORITY

This report was prepared as an interim response to the following authorities provided by Congress. It presents the findings of a feasibility study of the Rio Salado Oeste, Salt River, Arizona. The Salt River is a significant tributary to the Gila River in the State of Arizona (Figure I-1).

- The first authority is given by Section 6 of Public Law 761, dated June 28, 1938, known as the Flood Control Act of 1938, which reads in part as follows:

  "the Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys...at the following localities: ...Gila River and tributaries, Arizona."

- The second and most recent authority is provided by a Resolution of the Committee on Public Works and Transportation, U.S. House of Representatives, adopted May 17, 1994 (Docket 2425) (Figure I-2) which states:

  "*...the Secretary of the Army is requested to review the reports of the Chief of Engineers on the State of Arizona...in the interest of flood damage reduction, environmental protection and restoration, and related purposes.*"

The Energy and Water Appropriations Act, 2000, Public Law 106-60 appropriated funds for investigations of civil works project prior to construction. A reconnaissance level review of the Salt River (Rio Salado Oeste) was conducted under that authorization. The results and conclusions of the reconnaissance phase were presented in the *Rio Salado Oeste, Salt River, Phoenix Arizona Section 905(b) Report September 2000.* The recommendation of this report was that there was a Federal interest in proceeding to a second, feasibility phase of the General Investigation. The Corps of Engineers Headquarters certified the reconnaissance report on November 8, 2000, giving the Los Angeles District authority to move into the feasibility phase.

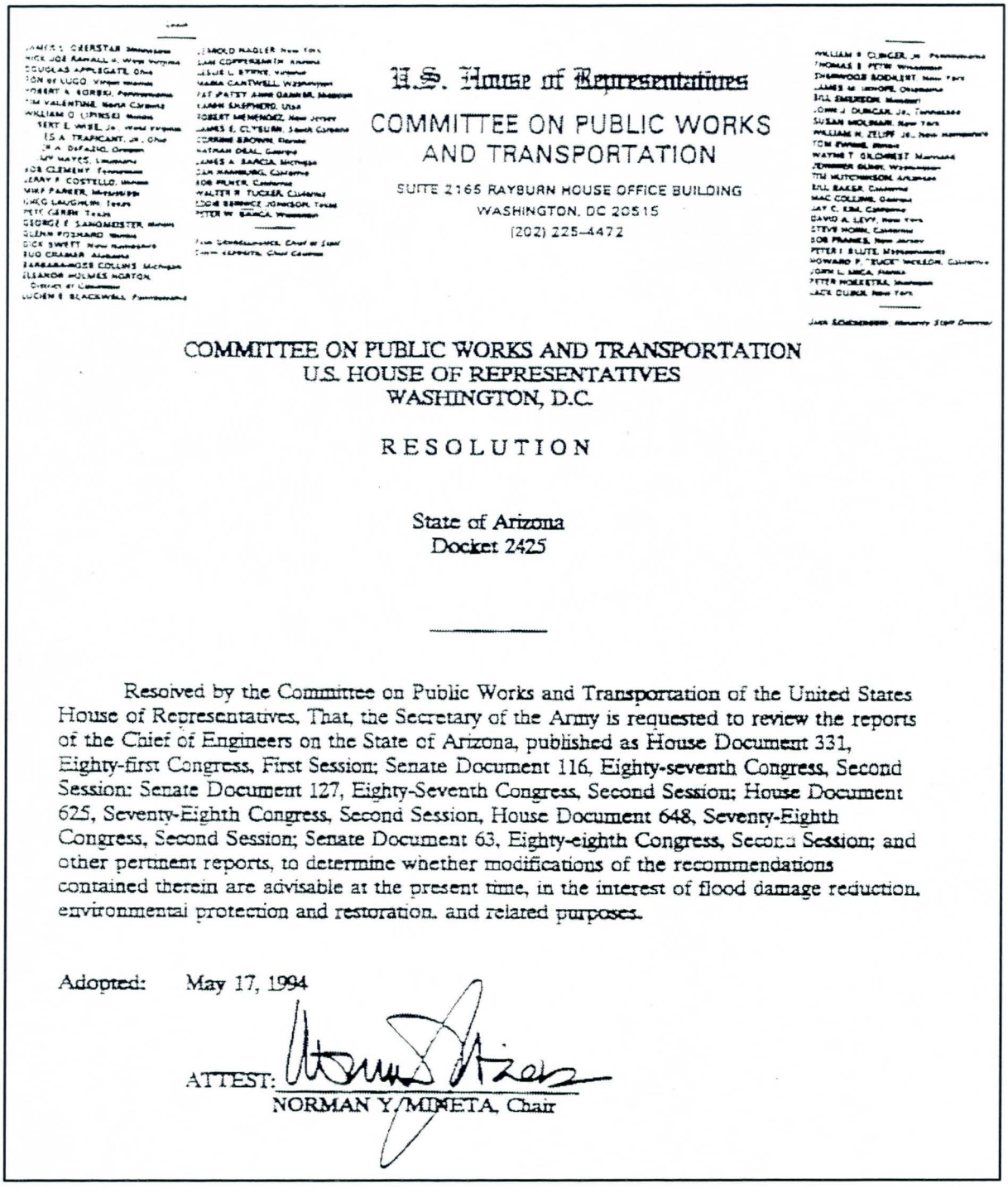
VICINITY MAP

Figure I-1

Rio Salado Oeste

US Army Corps of Engineers

Figure I-2: HR 2425



U.S. House of Representatives

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

SUITE 2165 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-4472

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C.

RESOLUTION

State of Arizona
Docket 2425

Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That, the Secretary of the Army is requested to review the reports of the Chief of Engineers on the State of Arizona, published as House Document 331, Eighty-first Congress, First Session; Senate Document 116, Eighty-seventh Congress, Second Session; Senate Document 127, Eighty-Seventh Congress, Second Session; House Document 625, Seventy-Eighth Congress, Second Session, House Document 648, Seventy-Eighth Congress, Second Session; Senate Document 63, Eighty-eighth Congress, Second Session; and other pertinent reports, to determine whether modifications of the recommendations contained therein are advisable at the present time, in the interest of flood damage reduction, environmental protection and restoration, and related purposes.

Adopted: May 17, 1994

ATTEST:

NORMAN Y. MINETA, Chair

CHAPTER II
STUDY INFORMATION

2.1 STUDY PURPOSE AND STUDY SCOPE

The Rio Salado Oeste Study is being conducted by the U.S. Army Corps of Engineers (USACE), Los Angeles District and the City of Phoenix, with the cooperation of the Flood Control District of Maricopa County (FCDMC). The purpose of this study is to identify whether there is a Federal interest in implementing a project along the Salt River from 19th to 83rd Avenues in Phoenix. This study is to identify feasible flood damage reduction and ecosystem restoration alternatives that are technically feasible, economically practicable, sound with respect to environmental considerations, and publicly acceptable. The City of Phoenix, as the non-Federal sponsor, supports the proposed project purpose to provide flood damage reduction, ecosystem restoration, passive recreation, and other related outputs.

This report describes the existing conditions in the project area, the future without-project condition, and the future with-project condition. Conditions that exist at the time of the study are collectively called the existing condition. The without-project condition is the same as the "no action" alternative, and describes what is expected to happen in the absence of Federal action. The future with-project condition describes, for each alternative, what is expected to happen if that alternative plan is implemented. The significant natural, economic, and social resources described in the existing and future without-project condition are compared to the future with-project condition in order to identify differences between alternatives.

Alternative plans are being developed and evaluated to meet the objectives stated above. This report is intended to ultimately be a complete decision document that presents the results of the feasibility phase of the General Investigation effort. Specifically, this feasibility report will:

- Provide a complete presentation of study results and findings, so that readers can reach independent conclusions regarding the reasonableness of recommendations
- Assure compliance with applicable statutes, Executive orders, and policies, in accordance with budgetary priorities

- Provide a sound and documented basis for decision-makers at all levels to judge the need and justification for the recommended solution(s)

2.2 NEED FOR THE PROJECT/PROPOSED ACTION

The City of Phoenix and the Corps of Engineers together are conducting the feasibility study to identify and define environmental degradation, flooding, and related land and water resource problems, and to develop solutions to restore the environment.

The primary problem is the severe degradation and loss of riparian habitat along the Salt River since the early 20th century. The Salt River once flowed perennially and supported substantial growth of cottonwoods, willows, and mesquites. The river channel carried abundant water that supported early irrigation projects. Increasing appropriation of surface and groundwater to support expansion of agriculture and growing urban populations resulted in the transformation of the Salt River to a dry river that flows only ephemerally in response to storm runoff and effluent discharge.

As a result of this change, stands of native riparian habitat are rare in the study area. Loss of riparian habitat is extremely significant in the arid southwest. Historically comprising a mere three percent of the landscape, over 95 percent has already been lost in Arizona. This type of river-connected riparian and fringe habitat is of an extremely high value due to its rarity. The Nature Conservancy lists desert riparian woodland as a very rare although significantly important cover type and describes restoration of riparian systems in the Sonoran Desert as critical. (Marshall et al 2000).

It has been estimated that 75 to 90 percent of all wildlife in the arid southwest is riparian dependent during some part of its life cycle. As a direct consequence of the extent of the lost or degraded riparian habitat, the area has experienced a major reduction in species diversity and in the populations of remaining species. In addition, destruction of native riparian habitat facilitates an increase in invasive plant species that are more tolerant of disturbed conditions. Such plants consume more water than do native vegetation because of their ability to occupy a greater areal extent on the landscape, placing additional strains on limited water supply.

Presently, there is land available for restoration. As long as these conditions remain unchanged, there is opportunity to accomplish significant restoration in the study area. Restoration options have the potential to increase riparian habitat acreage and quality thereby expanding wildlife diversity and quantity, controlling invasive plant species, and providing an ecological resource that is significant and valuable to the region. In addition to restoration there are opportunities to reduce future flood damages and improve recreation opportunities associated with the restored floodplain.

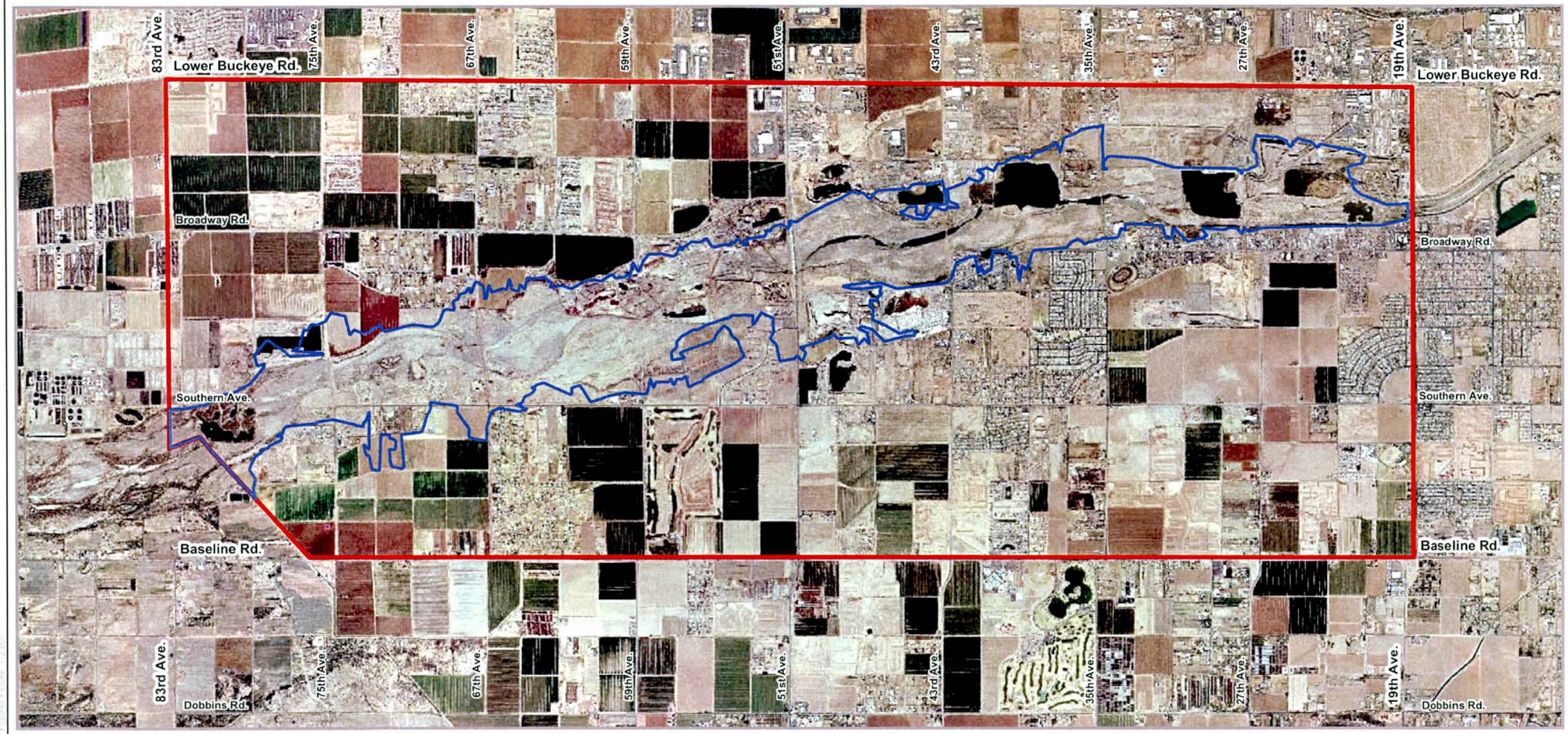
2.3 STUDY AREA

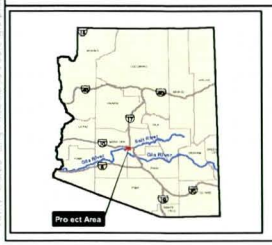
The study area is geographically located in Maricopa County, Arizona, and is entirely within the City of Phoenix (see Figure I-1). The study area is approximately 8 miles long extending from 19th Avenue on the east to 83rd Avenue on the west, and from Lower Buckeye Road on the north to approximately Baseline Road on the south. While this is a large study area extending beyond the riverbanks, any implementation of project features would be associated with the river floodplain. The project implementation area extends from 19th Avenue on the east and 83rd Avenue on the west, and is the area within the 100-year floodplain of the Salt River. The study area is approximately 4 miles wide and consists of approximately 20,480 acres. The project implementation area is, on average, approximately 1 mile wide and consists of approximately 3,315 acres. Figure II-1 displays the study area and project implementation areas.

The Rio Salado Oeste Project is one of four ecosystem restoration projects that are in various stages of progress, from the planning phase to construction. The projects are being conducted by the Corps and various local sponsors along the Salt River, downstream of Granite Reef Dam. Figure III-1 depicts the locations of these projects with respect to the Rio Salado Oeste Project. Additional description of those projects will follow in Chapter III.

2.4 HISTORY OF THE INVESTIGATION

In response to the study authority, the reconnaissance phase of the study was completed in 2000. This reconnaissance phase resulted in the finding that there was a Federal interest in continuing to a feasibility phase. The Feasibility Cost Share Agreement (FCSA) with the City of Phoenix was signed in June 2001 and the feasibility phase was initiated.





Legend

- Project Study Area
- Project Implementation Area

March 2006

PROJECT STUDY AREA AND PROJECT IMPLEMENTATION AREA

Rio Salado Oeste

N
W E
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0 5,000 10,000
Feet

Figure II-1

US Army Corps of Engineers

2.5 PLANNING PROCESS AND REPORT ORGANIZATION

The Corps planning process consists of six steps defined in the Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies established in 1983. The process identifies and responds to problems and opportunities associated with the study objectives and specific Federal, State, and local concerns. The planning process culminates in the selection of a recommended plan. The process involves a systematic approach to making determinations at each step so that the interested public and decision-makers are fully aware of the basic assumptions employed. The data and information analyzed, the areas of risk and uncertainty, the reasons and rationales used, and the significant implications of each alternative plan are all exposed through this process. The six steps listed below are addressed in this report and are contained in the chapters shown. These steps are further described in Chapter V, Plan Formulation.

1. Specify water and related land resources problems and opportunities (Chapter V)
2. Inventory, forecast, and analyze water and related land resources conditions within the study area (Chapter IV)
3. Formulate alternative plans (Chapter V)
4. Evaluate the effects of the alternative plans (Chapter V)
5. Compare the alternative plans (Chapter V)
6. Select the recommended plan based upon the comparison of the alternative plans (Chapter V and VI)

The final product of this feasibility study is a Feasibility Report and Environmental Impact Statement (EIS) that will serve as the basis for obtaining Congressional authorization of the plan components determined to be feasible and cost-effective.

The requirements identified in this report may change as project features are further refined during the Pre-construction Engineering and Design (PED) Phase of the project. The project features including actual lands required, and estates to be acquired in those lands may change after approval of the feasibility report. As project features are further refined in subsequent

implementation efforts, the Corps will review the siting determination for the various project features set out in the report in accordance with established policies. This review may result in changes in design or land requirements for specific project features, while maintaining the overall benefit levels presented in the recommended plan. If there are substantive changes in the recommended plan and/or the requirements of this project based on more detailed analysis, then the Los Angeles District will prepare necessary documentation.

2.5.1 Environmental Operating Principles

The Corps of Engineers has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles" applicable to all its decision-making and programs. These principles foster unity of purpose on environmental issues, reflect a new tone and direction for dialogue on environmental matters, and ensure that employees consider conservation, environmental preservation, and restoration in all Corps activities. By implementing these principles, the Corps will continue its efforts to develop the scientific, economic, and sociological measures to judge the effects of its projects on the environment and to seek better ways of achieving environmentally sustainable solutions. The principles are described in Engineering Circular 1105-2-404, "Planning Civil Work Projects under the Environmental Operating Principles," 1 May 2003.

- Achieve Environmental Sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
- Consider Environmental Consequences. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.
- Seek Balance and Synergy. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
- Accept Responsibility. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that affect human health and welfare and the continued viability of natural systems.

- Mitigate Effects. Seek ways and means to assess and mitigate cumulative effects to the environment; bring systems approaches to the full life cycle of our processes and work.
- Understand the Environment. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and effects of our work.
- Respect Other Views. Respect views of individuals and groups interested in Corps activities; actively listen, and learn from their perspective in the search to find innovative win-win solutions to the nation's problems, solutions that also protect and enhance the environment.

CHAPTER III
PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

The Resolution of the Committee on Public Works and Transportation adopted May 17, 1994 (Figure I-2) requested review of reports of the Chief of Engineers on the State of Arizona "in the interest of flood damage reduction, environmental protection and restoration, and related purposes." Although six specific reports are listed none are relevant to this study area, those include:

- House Document 331, 81st Congress. Gila River and Tributaries Below Gillespie Dam, Ariz.
- Senate Document 116, 87th Congress. Gila River and Tributaries in the Vicinity of Tucson, Arizona.
- Senate Document 127, 87th Congress. Gila River, Arizona, Camelback Reservoir
- House Document 625, 78th Congress. Bill Williams River and Tributaries, Arizona
- House Document 648, 78th Congress. Little Colorado River, Arizona and New Mexico.
- Senate Document 63, 88th Congress. Little Colorado River, Winslow, Arizona.

Other pertinent reports, however, are described below. Prior to the beginning of this feasibility study, many efforts had been conducted to identify, quantify, and seek funding to implement solutions to help alleviate flooding and improve environmental quality in the Salt River ecosystem. This chapter discusses these studies and reports that have been prepared on issues relating to the Salt River study area, and identifies existing projects and structures located within the area.

3.1 PRIOR STUDIES AND REPORTS

The Salt River has been extensively utilized for irrigation since prehistoric times. In the 1800s, settlers reestablished many historical irrigation canals. Since then, the Phoenix metropolitan area has established itself around the river. The Salt River has presented many opportunities and challenges, and has been studied extensively.

Various agencies and engineering consulting firms have conducted or published over 50 studies and reports on the Salt River since 1980. The topics of the reports or studies include water resources, flood control, recreation and urban development, and environmental assessment. A sample of the prior studies and reports is presented by topic below, and in effect provide a history of water resources studies in the area. The findings in these reports and the chronology of change within the Salt River corridor are important and essential in describing the changes over time and in outlining the importance of this project.

3.1.1 Water Resources Studies or Reports

The Maricopa Association of Governments (MAG) completed an overall conceptual plan for a Salt River redevelopment in 1974. The plan outlined water use and implementation recommendations and called for specific plans for two demonstration projects.

In 1978, the Corps of Engineers conducted a study that extended along the Salt River from the Gila River confluence to Granite Reef Dam. The study evaluated problems and alternative possibilities related to flood control, wastewater, floodwater conservation, and fish and wildlife recreation. The study focused especially on the 16-mile reach between 27th Avenue in Phoenix and Country Club Drive in Mesa.

In 1981, the Corps of Engineers investigated water and related land resources issues in the Phoenix Metropolitan area, including issues of water quality, flood control, water conservation, and fish and wildlife enhancement. At that time, none of the projects proposed by local agencies were found to warrant Federal interest, with the exception of flood control along the Salt and Gila Rivers.

The Rio Salado Development District was created in the late 1970s and early 1980s. Their function was to investigate and implement a regional redevelopment of the Salt River. Maricopa County voters defeated the resolution to create a tax authority for the District. However, the District did conduct several studies. A published memorandum in 1982 provides a basis for the determination of a source of water for the redevelopment project. The memo identifies potential sources, gives general background on these sources, and provides a preliminary analysis of each.

In 1982, Water Resources Associates, a private engineering consulting firm, conducted a study that evaluated the potential water sources and flood control options for a regional redevelopment of the Salt River. Sources for domestic water include obtaining Central Arizona Project (CAP) allotment, and obtaining water rights from surface and groundwater from lands within the district. The source identified for aesthetic and recreational water was poor-quality groundwater. Flood management plans were based on an existing condition scenario and on an upstream flood control design condition.

Carr, Lynch Associates, a private engineering consulting firm, also conducted a study in 1982, which evaluated the potential water sources and flood control options for a regional project within the Salt River. This study included discussion on the physical structure of the project and its surroundings, the social structure, the economic situation, and water supply and flood control.

In 1992, the Corps of Engineers completed the *Central Maricopa County Reconnaissance Study*. This study describes and analyzes flooding problems and water resource opportunities within the Phoenix metropolitan area to develop a wide range of alternatives that would reduce the severity of, or totally eliminate, these problems. Twenty-three flooding problems were identified within Central Maricopa County. Two areas determined to be of Federal interest were a flood control project on the Dysart Drain near Luke Air Force Base, and a water quality and environmental restoration project on the Salt River near 91st Avenue. That project (Tres Rios) was not recommended to proceed at that time.

In 1993, the U.S. Bureau of Reclamation (USBR) completed the Conceptual Design for the Tres Rios Demonstration Wetlands. The design was completed in cooperation with the City of Phoenix, Arizona Game and Fish Department (AGFD), Arizona Department of Environmental Quality, Maricopa County Parks and Recreation, FCDMC, and the U.S. Environmental Protection Agency (EPA). The study evaluates methods for reclaiming water from sewage effluent from the 91st Avenue Regional Wastewater Treatment Plant (WWTP) and develops plans for using the reclaimed water directly or through exchange mechanisms. The report presents a conceptual design for a constructed wetland demonstration project designed to improve the quality of treated effluent currently being discharged to the Salt River.

In 1994, Arizona State University completed a geomorphic assessment of the Salt River for the Corps. The assessment supports a reconnaissance-level geomorphologic evaluation of the Lower Salt River and a portion of the Gila River. The study discusses environmental history, hydrologic system, geomorphic system, and engineering features of the Salt River.

The City of Phoenix completed a report in 1994 that summarizes resulting problems and issues that are part of the setting of the present river as it passes through the city. The report includes resources and activities that will be the basis of the area's restoration.

In 1995, the Corps completed the reconnaissance phase of the Rio Salado, Salt River, Arizona Project. The report included an assessment of the problems and opportunities and an evaluation of alternatives for a 33-mile portion of the Salt River. A preliminary environmental assessment and a detailed habitat evaluation of the study reach were included.

In April 1998, the Corps completed the feasibility report and EIS for the Rio Salado, Salt River, Arizona Project. The report identified plans that would provide environmental restoration benefits and serve the public interest. The project is currently in the final phase of construction with anticipated completion in 2006/2007.

In April 2000, the Corps completed a feasibility report and EIS for the Tres Rios, Arizona Project. The study examined a portion of the Salt River and Gila River from 83rd Avenue downstream to the Agua Fria River, and selected a plan that includes environmental restoration and flood control components. The project is currently in the design phase.

3.1.2 Flood Control Studies or Reports

In 1981, the Corps prepared a document as a result of severe flooding along the Salt and Gila Rivers. The flood damage reduction measures presented include discussion on flood proofing, relocation, floodplain regulations, preparedness planning, channel excavation, and evaluation of hydraulic structures.

In 1989, Simons, Li & Associates, Inc., a private engineering consulting firm, prepared a report on the channelization of the Salt River through Tempe, Arizona. The study addresses issues related to channel design, determines appropriate hydraulic design criteria, and presents several alternative design concepts. The engineering analysis includes the evaluation of alternative river

sections, alignments, and profiles. In addition, the study identifies potential impacts due to the proposed changes.

The Corps of Engineers completed the Salt-Gila Reconnaissance Report in 1989. The study focuses on the flooding problems and associated solutions downstream from the confluence of the Verde and Salt Rivers to Gillispie Dam. It was determined that no analyzed solution was economically justified; therefore, the study did not proceed to the feasibility phase.

In 1994, the Corps completed a bank-stabilization study on the Salt River. The study focused on that portion of the Salt River located entirely within the Salt River Pima-Maricopa Indian Community, east of Scottsdale and within Maricopa County. Flood events in 1992 and 1993 caused erosion of landfill material into the Salt River. Several flood protection measures and alternatives were considered. The study concluded there was no Federal interest in participating in installation of bank stabilization at this location. With Federal Emergency Management Agency (FEMA) funding, the Salt River Pima-Maricopa Indian Community initiated construction of bank stabilization of two of the landfill sites, which were studied.

The FCDMC completed a land use and structures inventory in 1994. The inventory was published in a report that listed the various structures, utilities, and land use conditions along the Salt and Gila Rivers from Granite Reef Dam to Gillespie Dam.

In 1996, the Corps, in cooperation with the USBR, completed an analysis of various release plans for the operation of the modified Roosevelt Dam. As a result of this effort, new hydrology for the lower Salt and Gila Rivers was developed, which showed significant reductions in discharges downstream.

The FCDMC has teamed up with the Cities of Phoenix, Tolleson, and Avondale to prepare an area drainage master plan (ADMP) for the southwest valley area of Maricopa County. The Durango ADMP quantifies the extent of flooding problems and develops a solution. The plan addresses much of the land to the north of the project area and the potential for flooding problems due to interior drainage (http://www.fcd.maricopa.gov/Projects/DurangoADMP/).

The FCDMC has also completed the Laveen ADMP. The study area is in the southwestern portion of the metropolitan Phoenix area within Maricopa County, Arizona, and comprises 39

square miles in the city of Phoenix and unincorporated Maricopa County. The focus area for this portion of the ADMP is the 16 square miles west of 43rd Avenue. The entire area bounded by the Salt River on the north, 7th Avenue on the east, South Mountain Park on the south, and the Gila River Indian Community boundary on the west is the contributing area for the hydrology. The project has been completed and components of it are in planning and pre-design. (http://www.laveenadmp.com/)

3.1.3 Recreation and Urban Development Studies or Reports

In 1983, the Rio Salado Development District completed an economic analysis of the impacts that a redeveloped Salt River would have on the economy of metropolitan Phoenix. The study quantifies, on an annual basis, new public dollar revenues derived from increased property and sales tax revenues and income generated by a redevelopment project from the sale and/or lease of publicly owned land in the project area. Conclusions from this study indicated that over a fifty-year period, redevelopment of the Salt River corridor would provide $7.6 billion in public revenues and $2.4 billion in private benefits to the metropolitan region and the State of Arizona.

In 1985, Carr, Lynch Associates completed a master plan for a regional redevelopment of the Salt River corridor. The master plan involves a major reclamation of nearly 10,000 acres of land, including transformation of the present riverbed into a regional park, development of its banks, and cultural and educational uses. This master plan was never implemented.

In 1989, the City of Phoenix completed the South Village Redevelopment Plan. The plan established that redevelopment activities in this area of Phoenix must begin with rehabilitation and redevelopment of the Salt River as it passes through Phoenix.

In 1991, the City of Phoenix Planning Department completed an estimate of what the City would be like in the year 2015. The estimate included discussion of the future role of the Salt River.

In 1994, the City of Phoenix conducted an economic analysis that included a listing of development activities necessary to initiate and sustain economic development within the Salt River area of Phoenix. The analysis determined that the key to redevelopment outside of the river corridor was redevelopment of the river itself.

As required by State law, Maricopa County prepared a comprehensive plan "to conserve the natural resources of the County, to ensure efficient expenditure of public funds, and to promote the health, safety, convenience, and general welfare of the public" (Maricopa County, 1997). The plan provides a guide for decisions made by the planning and zoning commission and the board of supervisors concerning growth and development. The Salt River itself is identified as "Proposed Open Space" on the land use map. This designation recognizes that natural resources and open spaces are important to the quality of life in the county and, if acquired, are intended to be planned and managed to protect, maintain, and enhance their intrinsic value for recreational, aesthetic, and biological purposes.

The Rio Salado Beyond the Banks Area Plan was completed by the City of Phoenix and became effective December 17, 2003. The plan is a policy document for future investment in and revitalization of the area. The plan boundaries are Interstate 17/Interstate 10 (I-17/I-10) freeways on the north, Broadway Road on the south, 19th Avenue on the west, and 32nd Street on the east. The area is being revitalized to realize its full potential from its proximity to Rio Salado, Downtown Phoenix, Sky Harbor International Airport, other job centers, and regional transportation linkages. It connects to the restored Rio Salado as an attractive recreational and environmental amenity; provides an attractive mix of land uses abutting the Rio Salado; builds on existing neighborhoods, area history, and cultural identity; provides infill housing to support seven city employment centers; employs a growing and increasingly skilled workforce; and creates a vibrant place that attracts area residents and visitors to a wide variety of recreational, environmental, and commercial activities

The Estrella Planning Area land use plan (Maricopa County, 1992a) regulates planning and development activities within its jurisdiction of unincorporated Maricopa County. Within the study area, this includes the land uses extending north from and including the Salt River. There are also islands of land incorporated within the city throughout portions of the Estrella Planning Area. The Estrella Planning Area is currently very rural in character and is an island of farming activity surrounded by more urban-type development. The area along the north of the Salt River is occupied by agricultural, agribusiness, gravel mining, and vacant land uses, with isolated industrial and residential development.

The Laveen Planning Area land use plan (Maricopa County, 1992b) regulates planning and development activities for approximately 30 square miles of unincorporated Maricopa County south of the banks of the Salt River. The area is generally characterized by rural ranchettes, cultivated farmland, and dairy farms, with a small urban area within the city in the northeastern portion of the planning area. The area, along the south banks of the Salt River, is currently vacant, with a minor amount of developed land and agricultural land uses nearby. Currently, industrial development and a considerable number of auto-wrecking and salvage operations are located in the northeast quadrant closest to the City boundaries (primarily along Broadway) and have had an influence on development in the area. The properties in the area are zoned for Rural Residential, Industrial, and Special Use.

The City of Phoenix General Plan (City of Phoenix, 2001) regulates planning and development activities within incorporated areas of the city in the vicinity of the study area. Additionally, the General Plan considers areas currently outside the jurisdictional political boundaries (unincorporated county lands) for potential future annexation. Through goals, policies and recommendations, the General Plan provides a short- (within the next 10 years) and long-range (10 to 20 years) comprehensive direction for the growth, conservation, and redevelopment of all physical aspects of the city.

As part of the strategic growth concepts adopted by the City of Phoenix, the Estrella and Laveen areas are two of the major target growth areas identified in the General Plan, and are within the study area. The Rio Montana Plan (2000), prepared for the eastern portion of Laveen, identifies "encouraging development and redevelopment along the Rio Salado that will be compatible with the Rio Salado Habitat Restoration Project" as one of the major issues that is unique to the area. Additionally, the Estrella Plan (1999) identifies "encouraging development along the Rio Salado that will be compatible with the new residential character village" as one of the major issues that is unique within the area (City of Phoenix, 2001).

The City of Phoenix recently completed the Rio Salado Pathway feasibility study evaluating the linkage between 28th Street in Phoenix and Priest Drive in Tempe. The pathway is an accessible, shared-use path on the south bank of the river along the 4-mile stretch adjacent to Phoenix Sky Harbor Airport. The long-term vision is of an established linear park that would provide connectivity between various projects on the river corridor.

3.1.4 Environmental Assessment Studies or Reports

In 1987, Dames & Moore, a private engineering consulting firm, completed an investigation of the waste sites within the Salt River bed. The study was performed for the Rio Salado Development District. The study area extended completely through the Phoenix metropolitan area. The study recommends a plan for the complete investigation and remediation of waste sites and provides an order-of-magnitude cost estimate for the implementation of the plan. Sixty-three landfills or dumpsites were identified. The projected costs for investigation and remediation of waste sites range from $49,500,000 to $90,800,000.

In 1994, as a part of the Rio Salado Reconnaissance Study, the Corps of Engineers completed an environmental evaluation. The evaluation presents a brief synthesis of present conditions, active and passive location of landfill sites, potential mitigation of upper aquifer contamination, preservation and/or reconstruction of ecological habitats, and potential opportunities for water resources recreation based on demand and economic feasibility. The study area covered 33 miles of the Salt River through the metropolitan Phoenix area. Included in the evaluation was a field reconnaissance conducted to determine the present habitat values of the vegetation within the Salt River. A total of 29 sites were assessed during the field study.

In 1998, the Corps of Engineers completed an EIS for the Rio Salado Environmental Restoration Project. The EIS and feasibility report were prepared for an ongoing project on the Salt River immediately upstream from the study area.

In 2000, the Corps of Engineers prepared an EIS for the Tres Rios Feasibility Study, another ongoing project on the Salt River. The EIS evaluated the effects of a proposed environmental restoration and flood control project immediately downstream on the Salt River.

In 1997, CH2MHILL prepared the "Salt-Gila River Baseline Ecological Characterization" for the City of Phoenix in their effort to implement a full-scale constructed treatment wetland system at the 91st Avenue WWTP. The characterization includes information for the Salt River area between 75th Avenue to the east and Buckeye Diversion Dam to the west.

3.1.5 Studies/Projects Currently Underway

3.1.5.1 South Mountain Corridor Study

The Arizona Department of Transportation (ADOT) is currently conducting the South Mountain Corridor Study (http://www.dot.state.az.us/ROADS/SouthMtn). The South Mountain Freeway was included in the Regional Freeway System Plan that was approved by Maricopa County voters in 1985. The EIS will first consider whether there is a purpose and need for a project, and if so, will examine the potential social, economic, and environmental impacts of each reasonable alternative, along with ways to lessen those impacts. Currently, several alternatives have been advanced for further study. Several remaining alternatives include crossing the river and project area somewhere between 59th and 91st Avenues. It is assumed that there is potential for a future freeway to cross the project area at some point in the future but that crossing should not adversely affect the Rio Salado Oeste Project. Construction funding for the project is included in the Regional Transportation Plan for 2009-2015.

3.1.5.2 Va Shly'ay Akimel Salt River Feasibility Study

USACE is currently partnering with the Salt River Maricopa Indian Community and City of Mesa in a feasibility study upstream on the Salt River. The study area encompasses a 14-mile reach of the Salt River extending from immediately downstream of the Granite Reef Dam to the Pima Freeway State Route 101 (SR101). The study efforts are directed toward improving and increasing fish and wildlife habitat values and diversity for threatened and endangered species with potential incidental benefits associated with flood damage reduction, recreation, and water quality and supply. The feasibility study was completed in late 2004 and the Chief's Report was submitted in January 2005. A design agreement and plan are being developed and design on the project is expected to begin in 2006.

3.1.5.3 35th Avenue Bridge Improvements

The City of Phoenix has designed and is planning improvements to the 35th Avenue Bridge crossing the Salt River within the study area. The purpose is to improve the safety and operation of traffic along 35th Avenue between Broadway Road and Lower Buckeye Road and to provide an all-weather crossing over the Salt River. The existing 35th Avenue Bridge across the Salt

River was built in 1983 as an emergency repair project to replace a bridge that was washed out by flooding. It was built as a half-bridge and designed to accommodate the 35-year flow event, and was planned to be widened and lengthened in the future.

Currently a design for widening is in progress. The proposed work includes construction of a new 5-lane, 8-pier, 9-span precast concrete I-girder bridge with cast-in-place concrete deck slab to replace the existing two-lane bridge. The bridge will be constructed upstream of the current bridge, which will be demolished after traffic is rerouted onto the new bridge. Old fill material on the north and south sides of the river will be excavated and replaced by the new bridge abutments. Rock protection will be placed at the bridge abutments to protect the new bridge. Additional fill will be removed from the river bed to allow the new bridge to convey the 100-year discharge.

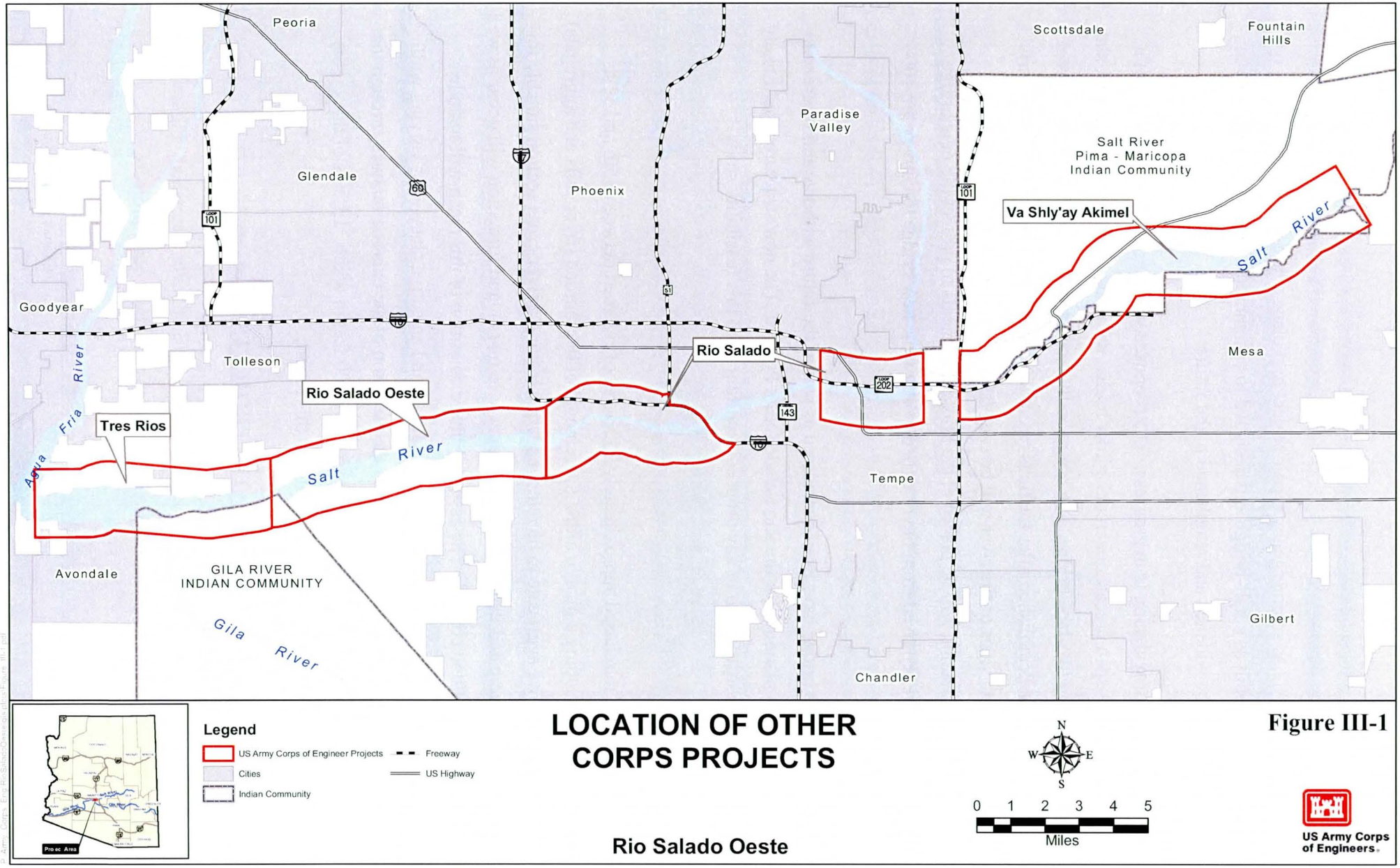
Modifications to this bridge have been considered as part of the future without- and future with-project conditions in planning for the Rio Salado Oeste Project. The new structure would likely be in place prior to construction of any proposal resulting from this feasibility study.

3.1.5.4 Rio Salado Marsh

The City of Phoenix purchased approximately 250 acres of riverbed between 35th and 51st Avenues and is developing a plan to allow the removal of overburden (river soils and aggregate) in a manner that allows aggregate to be removed while leaving a river cross section suitable for restoration. It is anticipated that conditions conducive to marsh land formation will occur as well as improvements to flood control. The assumed future condition of this reach will include removal of approximately 5.03 million tons of material and an active channel of varying width from 300 to 600 feet. The channel will match the elevation of the existing thalweg through the reach, and will be bordered by terraces approximately 500 feet in width. Effects of this on the water surface elevations will be discussed later in this report.

3.2 EXISTING AND ONGOING WATER PROJECTS

The following projects and structures are located within the Salt River watershed. Figure III-1 shows the location of the Rio Salado Oeste Project relative to these other projects.



LOCATION OF OTHER CORPS PROJECTS

Figure III-1

Rio Salado Oeste

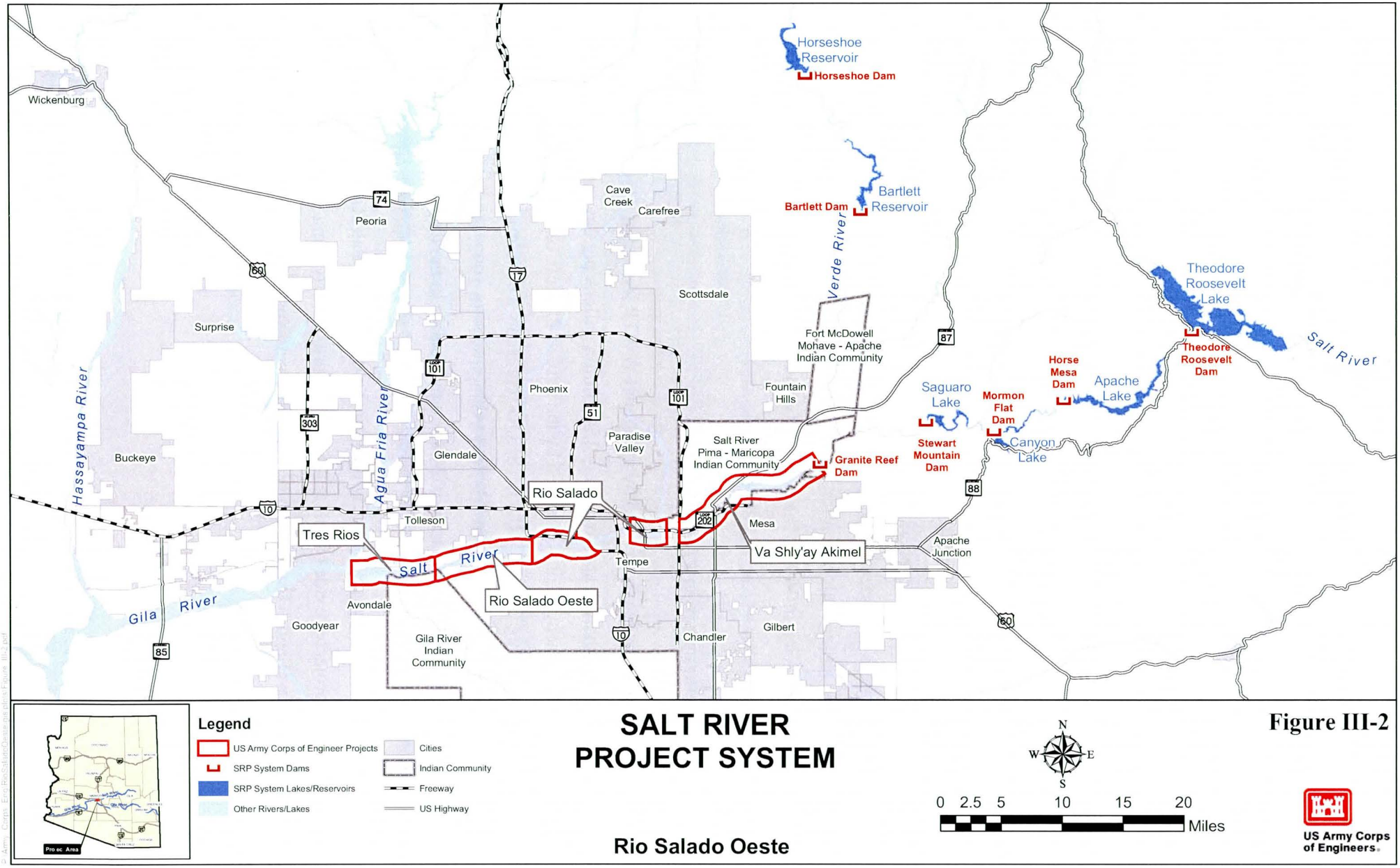
3.2.1 Salt River Project System

Flows in the Salt River are controlled by a series of upstream dams built by USBR and operated by the Salt River Project (SRP) (Figure III-2). The SRP system comprises six reservoirs and seven dams on the Salt and Verde Rivers. The dams include Roosevelt Dam, Horse Mesa Dam, Mormon Flat Dam, Stewart Mountain Dam, and Granite Reef Dam on the Salt River. On the Verde River, the dams are Horseshoe Dam and Bartlett Dam. The reservoirs receive runoff from a combined watershed of more than 12,600 square miles.

Roosevelt Dam is the oldest and largest in the SRP system. Congress originally authorized it in 1903 for water supply and power generation. The construction of the dam was completed in 1911. In 1978, Congress authorized the modification of Roosevelt Dam. The modifications were to include a new storage allocation for flood control. The modifications to the dam began in 1989 and were completed in 1996. The dam has been operated under a new Water Control Manual since 1997.

3.2.2 Tres Rios Demonstration Project

The Phoenix Metropolitan area is serviced by a regional WWTP located at 91st Avenue and the Salt River. The plant discharges approximately 154 million gallons per day (mgd) of effluent to the Salt River. The treatment plant is operated by the City of Phoenix on behalf of the Multi-City Sub-regional Operating Group (SROG). SROG represents a consortium of cities including Phoenix, Mesa, Glendale, Tempe, Scottsdale, and Youngtown. In 1992, USBR was authorized by Sections 1605 and 1608 of Public Law 102-575 to participate in the development of a demonstrations wetlands project at the 91st Avenue plant. In 1995, the SROG and the USBR built the Tres Rios Demonstration Project within the floodway of the Salt River below the 91st Avenue plant. The project provides final treatment of approximately 2 mgd of effluent within 10 acres of constructed wetlands. This project is immediately downstream of the Rio Oeste study area.


Horseshoe Reservoir
Horseshoe Dam
Wickenburg
Bartlett Dam
Bartlett Reservoir
Cave Creek
Carefree
Peoria
Verde River
Scottsdale
Theodore Roosevelt Lake
Theodore Roosevelt Dam
Salt River
Surprise
Fort McDowell Mohave - Apache Indian Community
Horse Mesa Dam
Apache Lake
Saguaro Lake
Mormon Flat Dam
Fountain Hills
Phoenix
Hassayampa River
Agua Fria River
Stewart Mountain Dam
Canyon Lake
Paradise Valley
Salt River Pima - Maricopa Indian Community
Granite Reef Dam
Buckeye
Glendale
Rio Salado
Tolleson
Mesa
Tres Rios
Va Shly'ay Akimel
Apache Junction
Salt River
Tempe
Gila River
Rio Salado Oeste
Avondale
Goodyear
Gila River Indian Community
Chandler
Gilbert
Legend
US Army Corps of Engineer Projects
SRP System Dams
SRP System Lakes/Reservoirs
Other Rivers/Lakes
Cities
Indian Community
Freeway
US Highway
Project Area
SALT RIVER PROJECT SYSTEM
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Miles
US Army Corps of Engineers.

Figure III-2

3.2.3 Salt River Channelization

In 1996, ADOT and the FCDMC completed channelization of the Salt River from 48th Street to Price Road, a distance of approximately 7.5 miles. The channelization included soil cement and gabion bank protection with grade control and drop structures. The channelization is designed to convey floodwaters and eliminate erosion and channel migration. The design capacity is 250,000 cubic feet per second (cfs) with one foot of freeboard at Rural (Scottsdale) Road Bridge. The construction also included a construction of a defined confluence with Indian Bend Wash.

3.2.4 Tempe Town Lake

The City of Tempe, together with private developers, constructed Tempe Town Lake on the Salt River. The project includes two inflatable dams within the Salt River bed. The dams are located approximately 2 miles apart at the Center Parkway alignment and just upstream of the confluence with Indian Bend Wash. The lake contains approximately 3,500 acre-feet (ac-ft) of water. The project features also include an extensive seepage control system, which consists of multiple groundwater pumps. As the lake infiltrates into the riverbed, the pumps recover the water and place it back into the lake.

3.2.5 Rio Salado Project

Upstream of the Rio Salado Oeste Project on the Salt River is the Rio Salado Project. It is a Corps and City of Phoenix project currently under construction. The project area is broken into two reaches, Tempe and Phoenix. The Tempe reach includes a section of Indian Bend Wash and the confluence with the Salt River and restoration of approximately 150 acres of various habitat types. The Phoenix Reach extends from 28th Street west to the 19th Avenue Bridge, which is the upstream extend of the Rio Salado Oeste study area. The Phoenix reach includes restoration of approximately 550 acres. It includes construction of a low-flow channel in the river bottom, and establishment of open water, wetland marsh, cottonwood/willow, open edges, and mesquite habitat on the river bottom and over banks. The recreational elements associated with this project include trails, scenic overlooks, interpretive centers, gathering areas, parking, restrooms, and shade structures. At the time of writing this document most of the Phoenix reach is completed with the last phase of construction anticipated in 2006/2007.

3.2.6 Tres Rios Project

Immediately downstream of the study area is another Corps and City of Phoenix ecosystem restoration and flood damage reduction project. The project extends approximately 9 miles from the 91st Avenue WWTP to the confluence of the Gila and Agua Fria Rivers. This project is currently in design with the levee under construction.

The tentatively recommended 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

3.2.7 Laveen Area Drain Conveyance Corridor

The Laveen Area Drain Conveyance Corridor is part of the Laveen Area Drainage Master Plan and enters the project area at approximately 83rd Avenue. This is a joint project between the FCDMC, City of Phoenix, Maricopa County Department of Transportation, and SRP.

The project includes the design and construction of a conveyance channel capable of containing a 100-year flood event in the vicinity of the existing Maricopa Drain, which runs from 43rd Avenue to the Salt River for a length of approximately 5.8 miles. A flood detention basin at 43rd Avenue and Southern Avenue will mitigate peak flood flows getting to the conveyance channel. The peak discharge at the outfall of the channel for the 100-year storm event is estimated to be 2800 cfs.

Based on previous evaluations of flood hazards within this area, significant floodwater from large storm events ponds along the existing Maricopa Drain. This project will eliminate the potential flood hazard and reduce and/or eliminate potential flood damages. This project consists of channel excavation, road crossings, grade-control structures, tiling and filling in portions of the existing Maricopa Drain, and construction of an earthen low-flow channel. The channel and

basin will be grass-lined to reduce and/or eliminate erosion and sediment transport and to provide landscaping and aesthetics for multiple uses. The project is in construction and is expected to be completed in 2006.

3.2.8 43rd Avenue/Southern Avenue Basin

The 43rd Avenue and Southern Avenue Detention Basin was originally included as part of the South Phoenix Drainage Improvement Project. The detention basin has been designed by the FCDMC. The detention basin site has been acquired by the FCDMC, and is located at the southeast corner of 43rd Avenue and Southern Avenue. The basin includes an inlet structure, an inlet spillway, an outlet spillway, and an outlet structure, which will carry flood water to the existing 43rd Avenue storm drain, which outfalls to the Salt River. The basin was constructed as part of the Laveen Area Conveyance Channel Project. Construction was cost-shared between the FCDMC, City of Phoenix, and Maricopa County Department of Transportation.

The basin has 5:1 side slopes and is surfaced with grass for erosion control and aesthetic purposes. The City of Phoenix plans to use the basin as a park facility. The city will own, operate, and maintain the basin upon completion of construction. This project is scheduled to complete construction in the summer of 2006.

3.2.9 Durango Regional Conveyance Channel and 75th Avenue Storm Drain

The Durango Regional Conveyance Channel (DRCC) and 75th Avenue Storm Drain Project includes the construction of a storm drain along 75th Avenue from Interstate 10 to the Salt River, construction of a detention basin, construction of approximately 1 mile of channel, and construction of a first flush basin. The DRCC was identified in the Durango ADMP. The City of Phoenix and the FCDMC combined two projects, allowing downsizing of the DRCC project features. The City is the lead for design of the project. The City will be the lead for construction of the storm drain and the FCDMC will be the lead for construction of the DRCC. The storm drain is being designed to convey the 10-year flood, and the DRCC is being designed for the 100-year flood. The combined project will reduce flooding along 75th Avenue and in the area north of the railroad. The detention basin will also serve as a City park. Portions of this project are in construction with others scheduled to begin construction in the Spring of 2006.

CHAPTER IV
EXISTING CONDITIONS

In conducting this feasibility study, a wide range of technical issues were analyzed with the goal of developing an accurate description of historic, existing, and future without-project conditions in the Rio Salado Oeste study area. The future without-project condition is defined as that condition expected to exist in the absence of any action taken (by the Federal Government) to solve the stated problems and is also described as the No Action Alternative. The future without-project condition forecast provides a description of anticipated actions external to the project and the anticipated consequences of these actions.

Available information was initially collected about existing studies and projects that could assist in the preparation of the inventory of historic and existing conditions and the forecasting of future without-project conditions for the study area. Without a good understanding of the existing condition, one cannot understand what constitutes an improvement from a degraded condition. The information presented under without-project conditions is considered in order to formulate alternative measures that address the watershed problems and opportunities discussed in Chapter V, Plan Formulation. Major technical areas of focus for the study include hydrologic and hydraulic studies, environmental studies related to biological resources, cultural resource and recreation studies, and economic analysis.

4.1 HISTORIC CONDITIONS

Historically, gallery forests of cottonwoods and willows covered hundreds of miles along the lower reaches of rivers like the Salt River in the desert southwest. Optimal conditions for these forests were found along the Lower Salt River prior to 1900. Cottonwood and willow forests are found in depositional environments where fine-grained alluvial soils are located on floodplains. These forests commonly occur with other riparian assemblages because fluvial processes (floodplain aggradation and channel meandering) create environmental gradients and mosaics (e.g., water table depth, inundation frequency), which favor diverse riparian species assemblages.

The Lower Salt River was originally a perennial stream fed by snowmelt from the mountains to the east and the highlands to the northeast. Its clear, streaming waters contrasted greatly with the muddy, sluggish Gila River to the south and west. Flows in the river had a distinct seasonal

pattern, with highest flows occurring in December and January and lowest flows in October. The river had many channel meanders, sand bars, and backwater areas that were conducive to riparian growth.

Prior to dam construction in the early 1900s, the Salt River riparian vegetation was dominated by cottonwood, willow, and the various species of mesquite. This suite of vegetation is considered to be representative of the natural "climax community" of species that would be found in an undisturbed riparian corridor along the Salt River. Mesquites occurred along the outer bank of the river, at the extreme edge of the natural riparian vegetation. The willow and cottonwoods were located inward of the mesquites, adjacent to the low-flow channel and closer to where there was a more continuous flow of water. Some channel areas were barren, while others had vegetation in strips along the low-flow channels and abandoned high-flow channels.

The bottomlands of the Salt River supported a variety of vegetation, including trees, shrubs, marsh plants, and some grasses. Large cottonwood, willow, walnut, and alder trees grew along the margins of the river exhibiting the highest percent of annual recruitment in the secondary channel, and mesquite, creosote bush, Palo verde, and bursage covered the low terraces. Dense mesquite and other shrubs made crossing the bottomland impossible in places, while in other locations the vegetation was more scattered. There were several species of fish in the waters, similar to those found in the Gila River.

Large, dense mesquite forests or bosques are found adjacent to natural and created water retention basins, lake edges, and river floodplains in southern Arizona. Mesquite bosques were once the most abundant riparian type in the Southwest. Most modern mesquite bosques are large (typically 1 mile long and 600 feet wide), but these are small compared to pre-development bosques, which extended for miles. Mesquite bosques usually are found in the drier habitat areas within the riparian continuum. The locations for this setting are floodplains or low terraces several yards above the streambed, and up to 45 feet above the water table.

Beginning in the early 1900s, the historical conditions of the Salt River were altered by manmade activities, including two significant Federal water projects. First, USBR constructed the SRP system, a series of dams in the Salt and Verde River watersheds. The water supply and hydropower benefits that the dams provided led to the economic development of the Phoenix

metropolitan area. Metropolitan Phoenix has grown from a settlement that supplied food and animal feed to the U.S. Army outposts and mines in the area to its current population of 3.2 million people. Though the SRP project has contributed to the economic success of the Phoenix metro area, the extent of the resulting environmental impacts to the Salt River Basin has only recently begun to be studied and understood, leading to the corrective efforts of this and similar restoration studies and projects.

Due to dams and diversions, perennial flows on the Salt River have ceased. This has caused detrimental environmental impacts to natural wildlife habitat and riparian communities along the Salt River. The elimination of natural base flows reduced Salt River flows to summer or fall rainfall-related flood events. The groundwater table beneath the river dropped. The soil moisture in the riverbed was virtually eliminated, significantly reducing or eliminating microbial and biochemical processes and nutrient cycling, which directly contributed to the rapid decline and loss of the native cottonwoods, willows, and riparian ecosystem of the Salt River Basin. Most areas of the Salt River are barren today and have been significantly impacted by sand and gravel extraction operations. The vegetation observed in the Salt River corridor today is mostly limited to salt cedar, an invasive non-native species with little habitat value, and fragments of poor-quality native riparian vegetation.

4.2 EXISTING/CONDITIONS

Existing conditions are defined as those conditions that exist within the study area at the time of the study. The future without-project condition, which is the same as the "no action" alternative, is a projection of how these conditions are expected to change over time and forms the basis against which alternative plans are developed, evaluated, and compared. The term baseline is also used to refer to the existing conditions at the time of a measurement, observation or calculation and will be used occasionally throughout this report.

4.2.1 Geology, Topography, and Geomorphology

Within the study area, the Salt River flows through a major valley with a relatively flat floor of deep alluvium. Soils in the vicinity of the channel are of the hyperthermic torrifluvents association, a group of soils that are well drained to excessively well drained on nearly level or

gently sloping surfaces. They are often sandy to gravelly, but may include lenses of finer particles. These soils are often redistributed by water flows associated with nearby active channels.

Metropolitan Phoenix is geomorphically located within the Gila Lowland Section of the Sonoran Desert Subprovince, a part of the Southern Basin and Range Physiographic Province. This province is characterized by broad, gently sloping, connected alluvial valleys (basins) bounded by moderately high, rugged, northwest- to southeast-trending mountains (ranges). From the end of the Pliocene until recent (Holocene) time, the basins, including the Salt River Valley, filled with unconsolidated and occasional semiconsolidated sediment eroded from the ranges. The thickest accumulations of Valley alluvium formed during the early to middle Quaternary period.

The alluvium of the Salt River Valley is in the final stages of development, as evidenced by the numerous low-lying isolated hills (inselbergs) that project above the valley surfaces. These hills represent peaks of former mountain ranges that are now almost completely buried by alluvial material.

The mountain ranges that border the project area consist mostly of Tertiary-age sedimentary and volcanic rocks that lie unconformably upon an ancient Precambrian igneous and metamorphic basement complex. The complex is composed predominantly of igneous granite and diorite, metamorphosed schist, gneiss, and volcanic rock. The Tertiary rocks are made up of volcanic basalt, andesite, rhyolite, sedimentary sandstone, siltstone, and conglomerate.

The Phoenix basin consists of Quaternary sediments that constitute the valley fill. These consist mostly of poorly to well-consolidated (cemented) and unconsolidated gravel, sand, silt, and clay, representing several environments and ages of deposition. The total thickness of the alluvial material ranges from near 0 feet along the mountain fronts to nearly 10,000 feet under the valley interior. The valley fill materials tend to be of a coarser consistency near the mountain fronts and finer in the interior of the valley. Near the Salt River, the valley fills have been eroded as the river formed terraces during its evolution.

The predominant surface materials within the project area consist of Quaternary-age river sediment deposited as alluvium and terraces and, to a lesser extent, sheetwash-deposited

alluvium and slope-deposited colluvium. Thick layers of alluvium and terrace have accumulated within the major streams, tributaries, and floodplains of the Salt River. Streambed alluvium and terraces are flanked, covered, and underlain by thinner layers of wind- and sheetwash-deposited alluvium and bedrock colluvium.

Salt River Valley terrace deposits lie exposed above the Salt River channel in locations throughout the project area. The terraces consist of thick, well-cemented to non-cemented sand and gravel and are considered older than the alluvium within the confines of the Salt River. However, contacts between the two types of deposits are gradational at depth, which means they are undifferentiated and both remain of Quaternary age. The terrace and alluvial deposits in turn overlie thick Tertiary sedimentary and volcanic rocks beneath the basin and interface with Tertiary rocks along mountain ranges and inselbergs. The very thick Precambrian basement complex underlies basin terrace and alluvium at maximum depths of greater than 3,300 feet.

Two major soil associations are found within the project study area. Within and immediately adjacent to the river is the Carrizo-Brios Association, with the Gilman-Estrella-Avondale Association to the south. The Carrizo-Brios Association is characterized by deep, excessively drained soils and nearly level to gently sloping, gravelly sandy loams and sandy loams in stream channels on low-stream terraces. The Gilman-Estrella-Avondale Association is characterized by deep, well-drained soils and nearly level loams and clay loams on valley plains and low stream terraces (Maricopa County, 1992).

Flood flows are probably the most important events in the transportation of sediment along the Salt River. Sediment transported in a scour and fill setting by flood flows tends to move in waves or pulses, rather than at a constant rate through time. In essence there are slugs of sediment moving downstream periodically during flow events. Prior to damming of the river, smaller flow events moved sediment (fine sands, silts, and clays) by incising downward into the larger slugs of sediment found in the channel. However, incision and movement of sediment by these smaller events do not compare to the order of material moved during a flood event.

The Salt River through this reach has been relatively stable but still the riverbanks have moved laterally by as much as one-half mile in some locations during the 130-year record. Much of the lands along the south side of the river have been recovered from the active braided channel

system during the period of historical photos. The meander belt varies from approximately 2 miles in width at 19th Avenue to approximately 4 miles in width at 91st Avenue. Lateral migration would not be expected to exceed these limits.

The river is constrained upstream from 19th Avenue by levees constructed as part of earlier projects. The soil cement levees end just downstream from the 19th Avenue Bridge and the river is unconstrained by levees until just above the 91st Avenue WWTP. River alignment is fixed to some extent by bridges located at 35th Avenue, 51st Avenue and additional proposed bridges for a future freeway crossing in the middle section of this reach. The 35th Avenue Bridge is very small and provides a significant constriction to flows. The other bridges have much larger openings and provide less flow constriction. The recent historical evidence examined here indicates that the project reach is in quasi-equilibrium, although adjustments to bank and thalweg lines within the historical meander belt are possible.

Results of a sediment transport analysis show that sediment dynamics are more significant in the proximity of mining operations. The study also revealed that downstream of 35th Avenue the reach experienced mainly erosion while upstream of 35th Avenue the main process was deposition.

For additional information concerning geology of the study reach, please refer to Appendix A, Hydrology and Hydraulics, and Appendix E, Geotechnical Evaluation.

4.2.2 Hydrology

4.2.2.1 ***Surface Water Hydrology***

The Salt River drains 14,500 square miles of mountainous desert terrain in central and eastern Arizona and is the largest tributary to the Gila River. The river rises in the White Mountains of eastern Arizona and flows generally westward to its junction with the Verde River, a northern tributary that drains the edge of the Colorado Plateau near Flagstaff, Arizona. From this junction near the City of Mesa, the Salt River flows westward across the broad Salt River Valley to its confluence with the Gila River, about 14 miles west of the Phoenix Sky Harbor Airport. The Phoenix metropolitan area is near the center of the Gila River basin and lies within the lower Salt

River Valley. After the junction with the Salt River, the Gila River continues westward and joins the Colorado River near Yuma, Arizona.

Annual average rainfall in the lower Salt River Valley is approximately 8 inches; rainfall at the highest elevations of the watershed ranges up to 14 inches annually (U.S. Geological Survey [USGS], 1991). Rainfall is less than the evapotranspiration rate in all months of the year. Precipitation is derived primarily from two types of weather systems: summer thunderstorms and regional storms. Summer thunderstorms in July and August develop from the flow of subtropical air masses from the Gulf of Mexico. These two months are responsible for the majority of the total annual rainfall. Regional storms from the Pacific Ocean generate gentle, widespread showers during the fall and winter months. Summers are hot, with daily temperatures exceeding 100°F from mid-June through August. Mean daily temperatures in the summer range from 65°F to 104°F. The relative humidity is low, ranging from approximately 20 percent to 50 percent. Winters are mild, with mean daily temperatures ranging from 35°F to 70°F.

Little data exist to document the pre-development, seasonal flow fluctuations in the Salt River. In the pre-settlement era prior to 1900, the river was one of the few perennially watered riparian areas of the Sonoran desert, with highly productive cottonwood, willow, and mesquite habitats. Analyses of pre-development conditions indicate that Salt River stream flow infiltrated and recharged groundwater upstream of Indian Bend Wash near Scottsdale. Groundwater discharged to the channel to provide perennial base flow in downstream sections of the channel (USGS, 1991). Under natural conditions, flows peaked in late winter (February and March), supplied by storms and snowmelt. Flows were lowest in June, averaging only 6 percent of the mean high flows in February. Data for 1965 through 1993 show flows occurring most frequently during March and April and least frequently during July and August, much like the natural flow pattern. The system of dams upstream of the study area effectively delays the flows by one month. This delay becomes insignificant, however, in light of the length of periods without flow in a river that is perennial under natural conditions.

Dam System

During the 20th century, the Phoenix area changed from an agricultural to an urban region, resulting in significant changes in the physical characteristics of the rivers in the area. Agricultural and urban activities have given rise to an intricate network of structures associated with the river used for irrigation, drainage, erosion protection, and flood control. Numerous upstream dams on the Salt and Gila Rivers have radically altered the natural hydrologic regime of the rivers. The SRP operates seven dams and storage reservoirs within the Salt River watershed. Stored water is allocated for hydropower, municipal and industrial supply, and agriculture. Modifications to the Theodore Roosevelt Dam also include an allocation for flood control. The total space for water-supply storage behind these dams is approximately 1.9 million ac-ft, with an additional 560,000 ac-ft for flood control. Modified Theodore Roosevelt Dam is the largest facility and receives drainage from approximately 5,800 square miles. The Verde River is the principal tributary and watershed of the Salt River (6,700 square miles). Its flows are partially controlled by Horseshoe Dam (located furthest upstream) and Bartlett Dam (approximately 25 miles upstream of the confluence with the Salt River), which provide an additional 310,000 ac-ft of storage. New Waddell Dam is located on the Agua Fria River northwest of Phoenix and downstream of the project study area.

Table IV-1: Major Dams and Reservoirs in the Gila River Basin

Dam	River	Reservoir	Date of Origin	Storage (ac-ft)
Waddell	Agua Fria	Lake Pleasant	1927	165,000
Bartlett	Verde	Bartlett Lake	1939	182,000
Horseshoe	Verde	Horseshoe Lake	1949	141,000
Stewart Mountain	Salt	Saguaro Lake	1930	71,000
Mormon Flat	Salt	Canyon Lake	1938	59,000
Horse Mesa	Salt	Apache Lake	1927	248,000
Roosevelt	Salt	Roosevelt Lake	1911	1,600,000[b]
Coolidge	Gila	San Carlos Lake	1928	1,222,000
Painted Rock	Gila	Painted Rock Lake	1959	2,500,000

The dams have significantly altered the natural hydrologic regime of the lower Salt River and have changed both the magnitude and timing of flows. The SRP releases water only for flood-

control purposes to lower reservoir levels, either prior to winter rains or when the reservoirs are unexpectedly full. The system of dams has eliminated perennial flow and steady, high winter flows. Since Bartlett Dam began operating on the Verde River in 1938, the lower Salt River has contained water only as a result of controlled or uncontrolled releases from Granite Reef Diversion Dam. Granite Reef Diversion Dam is located about 3 miles downstream of the Salt-Verde confluence, and is the most downstream SRP dam. The purpose of this facility is to divert upstream reservoir releases into the Arizona Canal (for the area north of the Salt River), and the South Canal (for the area south of the Salt River). The canals crisscross the Phoenix metropolitan area for water delivery to agricultural, municipal, and industrial uses. There are no releases during climatically drier years, such as the period between 1942 and 1964, and the Salt River is dry during those times except for storm water runoff, groundwater emergence, and effluent.

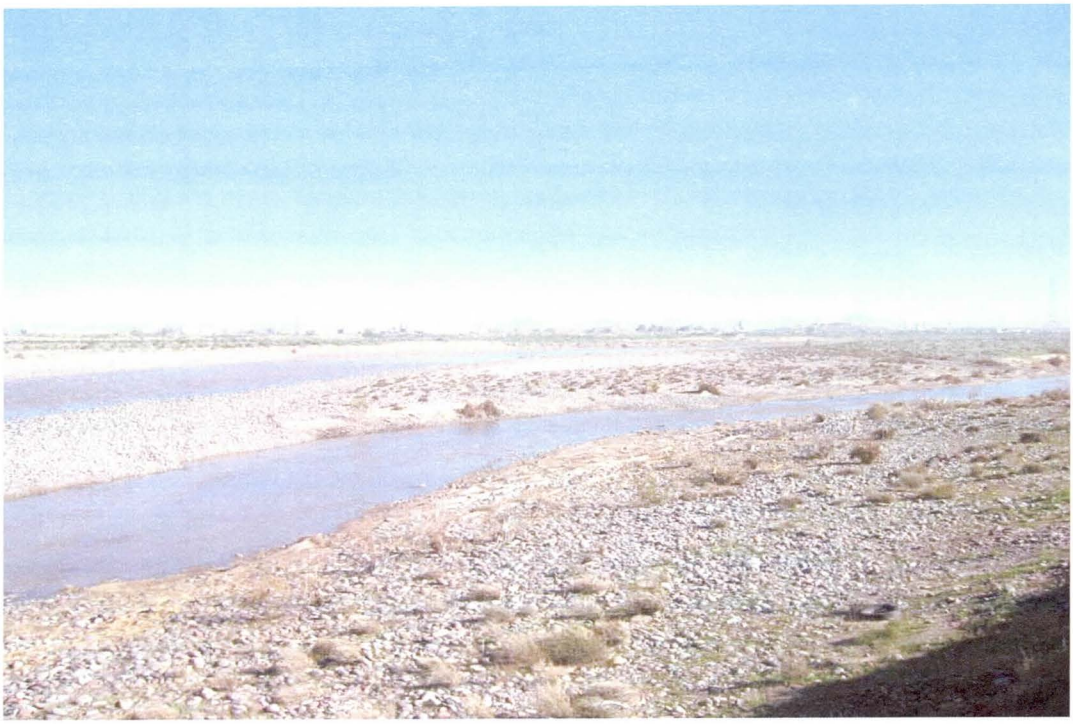


Figure IV-1: Flows in the Salt River on January 19, 2005 (as seen looking NE from an area adjacent to the 51st Avenue Bridge.)

Discharge

Before 1938, an average of 413,000 ac-ft of water flowed through the channel (USACE, 1998). The estimated pre-development, average annual watershed yield was about 1,250,000 ac-ft (USGS, 1991). Since 1965, the channel has carried an average of only 293,000 ac-ft of water per year, with less than 10,000 ac-ft in almost three-fifths of the years (USACE, 1998).

Hydrologic modeling used to develop a water-control plan for Modified Theodore Roosevelt Dam indicates that water would have spilled over Granite Reef Diversion Dam in only 34 of 105 years under the current configuration of dam operations (USACE, 2000). The resulting frequency of spills is approximately once every 3 years. When water is spilled over Granite Reef Diversion Dam, the flow is typically sustained for several days or more, and of significant magnitude. Since 1965, there have been about two releases per year, and they have lasted an average of 22.5 days, with a peak mean daily flow of 13,960 cfs.

Beginning on New Years Eve 2004, SRP began releasing water from Bartlett Dam to accommodate storage for rainfall and snowmelt from the Verde River watershed. The highest recent discharge occurred on February 13, 2005, of approximately 35,000 cfs as recorded by the USGS gauge at 51st Avenue (http://waterdata.usgs.gov/az/nwis/rt).

Storm Water

Storm water enters the Salt River at numerous locations in the study area and has the potential to degrade the surface quality of water in the system. The quality of water from storm drains varies depending on the length of time between storm events, the amount of flow, and the source of storm water runoff. Runoff often contains a significant amount of sediment that is washed from undeveloped land and other sources, as well as chemical contaminants or pollutants. The types of chemical pollutants will vary depending on the land uses within the particular drainage area. Potential water quality impacts associated with runoff from industrial sites are projected to be minimal because the compliance requirements of storm water Arizona Pollutant Discharge Elimination System (AZPDES) permits require each industrial site to have Storm water Pollution Prevention Plan (SWPPP). Runoff from turf areas has the potential to contain pesticide and

fertilizer residuals. Runoff from paved areas can contain hydrocarbon products, metals, and anything spilled on the pavement.

*4.2.2.2 **Surface Water Quality***

Contaminants in the surface waters and groundwater of Arizona fall into seven categories: volatile organic compounds (VOCs), pesticides, metals, nutrients, ions, microorganisms, and radiological substances. Similar quality issues exist for all water sources in the lower Salt River, namely contamination by VOCs and various metals, ions, nutrients, and herbicides.

Surface water naturally provides the main source of recharge for groundwater. Shallow groundwater in other reaches of the river often emerges in the channel, creating surface flows. Effluent from WWTPs and other industries contributes to both surface and subsurface flows. Thus, contaminants do not remain in one part of the system and may affect all water sources. Refer to Table IV-2 for a list of contaminant categories and specific contaminants expected at the Oeste location.

Salt River flows maintain high amounts of mineral content and total dissolved solids (TDS). When flood flows do occur, they commonly violate quality standards for fecal coliform bacteria. The Salt River water contains a sodium chloride character both above and below the SRP system dams due to salt springs upstream of the lakes. Verde River water has a lower amount of TDS than found in the Salt River water. The Verde water tends to lower the overall TDS content in flows downstream of their confluence. The quality of water would be sufficient to support native fish species; however, elimination of the base flows does not allow it.

Table IV-2: Types of Water Contaminants in the Lower Salt River

Contaminant Category	Principal Contaminants	Typical Sources	Potential Health Impacts
Volatile organic compounds (VOCs)	Organic solvents Trichloroethene (TCE) Tetrachloroethylene (PCE) 1,1,1 Trichloroethane (TCA) Chloroform 1,1 Dichloroethane (DCE) 1,1 Dichloroethane (DCA) Benzene	Landfills Underground storage tanks Airports High technology industry	Carcinogen
Pesticides	Dibromochloropropane (DBCP) Ethylene dibromide (EDB)	Agriculture (soil fumigants) Urban runoff	Toxics Carcinogen
Metals	Arsenic Barium Boron Chromium Copper Iron Lead Manganese Selenium Zinc	Landfills Mines Metal finishing Natural origin	Toxics Carcinogen
Nutrients	Nitrate	Agriculture (fertilizers) Wastewater treatment Septic tanks Industrial manufacturing	Methemoglobinemia (blue-baby disease)
Ions	Total dissolved solids (TDS) Sulfate Chloride Fluoride	Mines Agriculture Natural origin	Taste, hardness Laxative effect Toxics
Micro-Organisms	Fecal coliform	Septic tanks Wastewater treatment Agriculture	Infectious disease
Radiological		Mines Natural origin	Carcinogen

Source: Graf et al., 1994

Additional discussion of surface water quality can be found in Appendix D, Groundwater Quality and Hydrogeology Report, and Appendix F, Modified Phase I Environmental Site Assessment (ESA).

*4.2.2.3 **Groundwater Hydrology***

Prior to development of the Phoenix metropolitan area and construction of upstream reservoirs, the Salt River was a perennial stream. The river was a significant source of groundwater recharge in some areas and a recipient of groundwater discharge in other areas. (See Table IV-3

for estimated predeveloped groundwater hydrology budgets for Salt River Valley. As the area began to be settled, irrigation to support crops was obtained by diverting the stream flow into canals. By the 1900s, much of the Salt River Valley was waterlogged due to recharge from canal seepage and deep percolation combined with a lack of groundwater pumping. Beginning in the 1920s, substantial groundwater pumping began for irrigation and to control shallow groundwater levels. Following World War II, advances in drilling and pump technology allowed extensive pumping from deep aquifers to occur. The result of the groundwater pumping practices was extensive overdraft.

Table IV-3: Estimated Pre-Development Groundwater Budget for Salt River Valley

Source of Inflow	Volume (ac-ft/yr)
Stream channel recharge	100,000
Groundwater inflow	30,000
Mountain front recharge	10,000
Total inflow	140,000
Groundwater discharge to stream channel	60,000
Evapotranspiration	76,000
Total outflow	140,000

The groundwater supply beneath the study area is regulated by the Arizona Department of Water Resources (ADWR). To aid in monitoring, ADWR differentiates between groundwater basins. The subsurface geologic conditions in the study reach are within the Phoenix Active Management Area (AMA) of ADWR.

URS Corporation (URS), a private Architectural/Engineering firm conducted a groundwater quality and hydrogeology study for the Rio Salado Oeste Project (April 2002). The current groundwater condition in the study area was presented in the URS study report. According to the report, groundwater generally occurs under unconfined conditions within the Upper Alluvial Unit (UAU). Groundwater flow in the eastern third of the study area (east of 39th Avenue) is generally from the south to north-northwest toward the Roosevelt Irrigation District well field located along or north of Lower Buckeye Road between 19th and 35th Avenues. The groundwater gradient is steepest to the north with values as high as 0.008 ft/ft in the vicinity of 35th Avenue and Lower Buckeye Road. The groundwater-flow direction in the western two thirds of the study area (West of 39th Avenue) ranges from northwest to west. The groundwater gradient flattens to the west with values as low as 0.002 ft/ft. Static water level is relatively

shallow, ranging from 20 to 50 feet below ground surface within the Salt River channel to 60 to 80 feet below ground surface north and south of the river.

Fluctuations in static water level can be as much as 20 to 30 feet on an annual basis due to agriculture pumping demands, and have declined as much as 25 feet in the last five years (Dames & Moore, 1991; Parsons Engineering Science, 2001). Hydrographs of selected wells show this decline is most pronounced in the eastern portion of the site near the Roosevelt Irrigation District well field. The selected wells provided static water levels from both ends of the study area that have the most complete water level records. Contributing factors that may cause the fluctuations are water discharge from the 35th Avenue water treatment plant outfall during winter months that produces groundwater mounding, and related radial flow during periods of discharge and basin-wide groundwater pumping and storm water runoff into the Salt River.

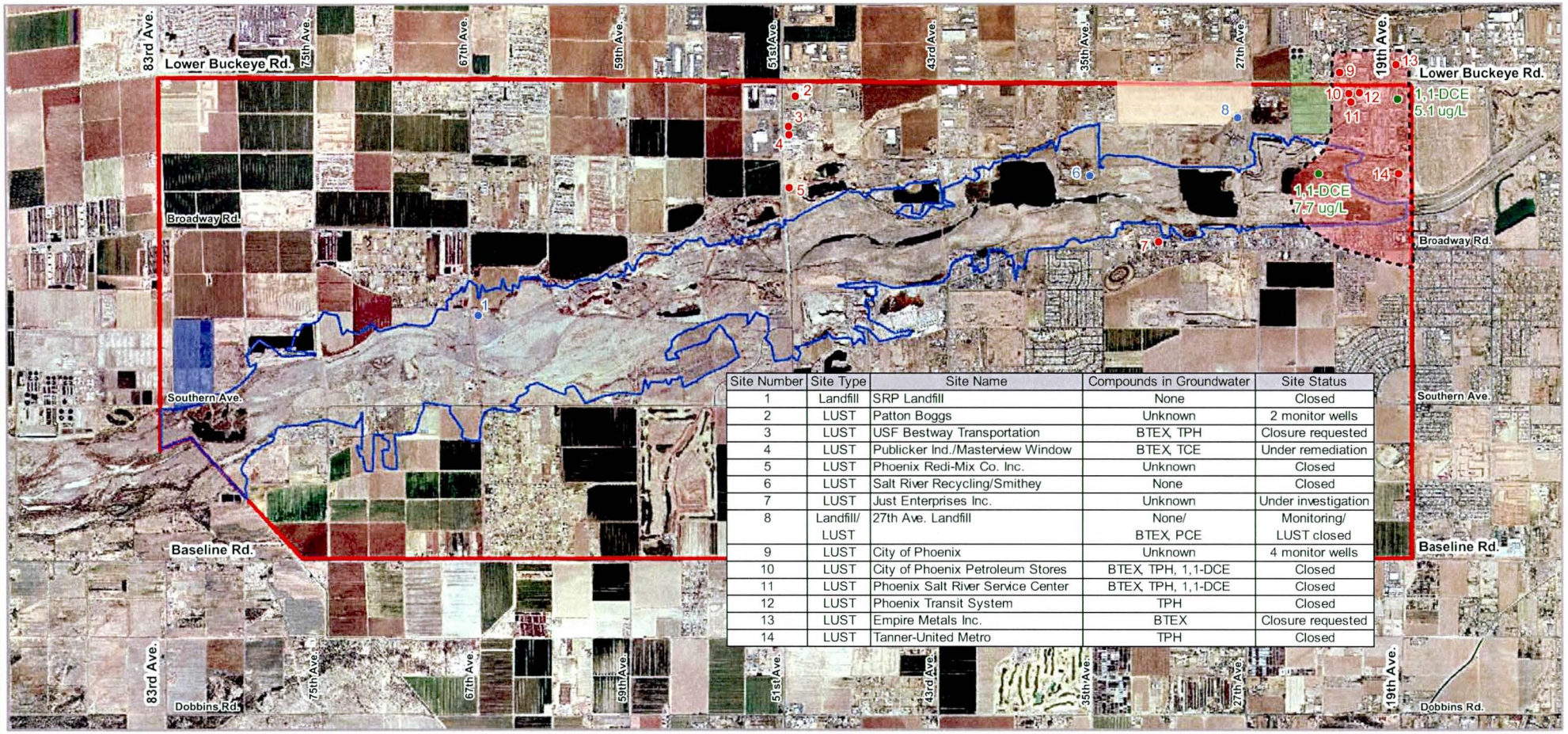
A groundwater contour map of the study area was prepared using ADWR well data from 1997 because it represented the most complete data set available. ADWR collected many water levels from both production and monitoring wells in the month of October, at the end of the pumping season. Water levels represent static values prior to significant precipitation. Some data outside of the study area were incorporated while contouring to fill data gaps. The hydrographs were prepared and reviewed to validate whether the contour map is representative of current conditions. In general the selected wells show a consistent water level decline without radical changes in gradient direction. Therefore, while the groundwater elevation has declined approximately 10 to 20 feet since 1997, the current contours are likely to be similar to the 1997 contours (URS, 2002). For additional information concerning the groundwater hydrology please refer to Appendix C, Groundwater Modeling.

4.2.2.4 ***Groundwater Quality***

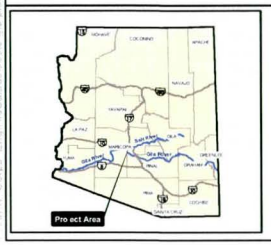
When groundwater pumping was initiated in the Phoenix metropolitan area in the 1920s, the groundwater quality, although high in minerals, was considered to be of very good quality. Today, there are a number of groundwater problems in the Salt River Valley. The problems associated with inorganic chemical constituents include high levels of chloride, TDS, nitrates, and salinity. The problems associated with trace organic constituents include the pesticide dibromochloropropane and volatile halocarbons. Most of the regional problems are currently

limited to groundwater in the UAU. Areas of groundwater quality concern are summarized in the April 2000 URS report and depicted on Figure IV-2. Those sites include landfills and Leaking Underground Storage Tank (LUST) sites. There are also two superfund sites in the study area.

Groundwater in the eastern half of the study area has lower TDS than other portions but has been impacted by petroleum releases of several Underground Storage Tanks (USTs) and may have elevated concentrations of 1,1-DCE. In the southwestern part of the study area data indicate elevated concentrations of TDS and nitrates.



Site Number	Site Type	Site Name	Compounds in Groundwater	Site Status
1	Landfill	SRP Landfill	None	Closed
2	LUST	Patton Boggs	Unknown	2 monitor wells
3	LUST	USF Bestway Transportation	BTEX, TPH	Closure requested
4	LUST	Publicker Ind./Masterview Window	BTEX, TCE	Under remediation
5	LUST	Phoenix Redi-Mix Co. Inc.	Unknown	Closed
6	LUST	Salt River Recycling/Smithey	None	Closed
7	LUST	Just Enterprises Inc.	Unknown	Under investigation
8	Landfill/ LUST	27th Ave. Landfill	None/ BTEX, PCE	Monitoring/ LUST closed
9	LUST	City of Phoenix	Unknown	4 monitor wells
10	LUST	City of Phoenix Petroleum Stores	BTEX, TPH, 1,1-DCE	Closed
11	LUST	Phoenix Salt River Service Center	BTEX, TPH, 1,1-DCE	Closed
12	LUST	Phoenix Transit System	TPH	Closed
13	LUST	Empire Metals Inc.	BTEX	Closure requested
14	LUST	Tanner-United Metro	TPH	Closed



Legend

- Project Study Area
- Project Implementation Area
- 27th Ave. Landfill
- Possible extent of 1,1-DCE plume
- 23rd Ave. Wastewater Treatment Plant
- 91st Ave. Wastewater Treatment Plant
- Wells with elevated concentrations of 1,1-DCE
- Sites with known or probable groundwater contamination
- Groundwater investigation sites with no known impacts

AREAS OF GROUNDWATER QUALITY CONCERN

Figure IV-2

March 2005

Source:
Groundwater Quality and Hydrogeology Report, (URS 2002a)

Rio Salado Oeste

N
W E
S

0 5,000 10,000
Feet

US Army Corps of Engineers

The Groundwater Quality and Hydrogeology Report and Modified Phase I Environmental Site Assessment (ESA) are included in Appendix D and Appendix F, respectively, and include much more detailed discussion of water quality.

4.2.3 Hydraulic Conditions

An existing Flood Insurance Study HEC-RAS model from the confluence with the Gila River (River Mile [RM] 199.82) to about 12th Street (RM 214.14) was provided by FCDMC. This model will be referred to as the FEMA model. The FCDMC also provided aerial photographs from 1993 and 1999, an ArcInfo coverage with contours with a 4-foot interval developed for the Salt/Gila River Master Plan (1992), an ArcInfo coverage with the cut lines of 100 of the FEMA model cross sections, and an ArcInfo Triangular Irregular Network (TIN) of the study area including raw data in point files and breakline format also created for the Salt/Gila River Master Plan (1992). The line coverage included cross sections from RM 202.09 to RM 211.12. Cross section 202.09 is located approximately 1,100 feet downstream of 91st Avenue, while cross section 211.12 is about 2,150 feet downstream of 19th Avenue.

The hydraulic model was used to generate water surface profiles and inundation boundaries for a series of frequency flood events ranging from 5- to 500-year return periods. Small flows are generally contained in the main channel, and only the large flows (100-year and 500-year) occupy significant portions of the floodplains outside the river banks.

4.2.4 Water Supply

Since the source of water that provided for the habitat that historically existed on the Salt River has been altered by upstream dams and adjacent development, alternative water sources would be necessary to implement restoration alternatives. Possible sources for that water supply include flood flows, stormwater runoff, effluent, and groundwater. Decisions pertaining to water supply extend beyond source, quality, quantity, and cost but also include existing legal agreements and water rights that apply to both surface and groundwater.

4.2.4.1 ***Effluent***

The City of Phoenix Water Services Department has identified the potential availability of an average 8 mgd of reclaimed water from the 23rd Avenue WWTP. It was recommended that the capacity to handle as much as 20 mgd to accommodate large diurnal variations in flow should be incorporated into the water supply system. Project planning should also account for "no-flow" periods of up to 12 hours. Note: 1 mgd = 1.55 cfs or 3.07 ac-ft/day.

4.2.4.2 ***Storm Water***

Although highly dependent on rainfall and not necessarily a consistent source, storm water runoff must be considered in project planning. Table IV-4 provides initial information pertaining to storm water outfalls, their locations, and sizing. While the outfalls listed in Table IV-4 are present in the study area not all of them currently reach the river channel. The Interior Drainage Report in Appendix B includes a detailed description of potential storm water runoff to the study area.

Table IV-4: Storm water Outfalls within the Study Reach

Outfall #	Site Location	Pipe Size	Comments
SR01	51st Avenue and Salt River - North Side	96 inch	
SR02	43rd Avenue and Salt River - North Side	90 inch	
SR03	35th Avenue and Salt River- North Side	75 inch	
SR04	27th Avenue and Salt River- North Side	72 inch	23rd Ave. WWTP discharges
SR05	25th Avenue and Salt River- North Side	102 inch	
SR06	22nd Avenue and Salt River- North Side	78 inch	
SR30	27th Avenue and Salt River- South Side	108 inch	FCDMC first flush sample sta.
SR47	51st Avenue and Salt River- North Side	48 inch	
SR48	45th Avenue and Salt River- South Side	48 inch	
SR49	67th Avenue and Salt River- North Side	96 inch	FCDMC first flush sample sta.
SR58	35th Avenue and Salt River- N/E Side	60 inch	
SR59	2333 W. Durango (23rd Ave. WWTP east side of 35th Avenue and Salt River) - North Side	48 inch	Part of SR05 conveyance system

Storm water may prove sufficient to support ephemeral wetlands or even riparian habitat in portions of the study area. Table IV-5 on the next page provides a summary of outfalls that provide storm water flows to the river channel and that will be considered to potentially provide source water for restoration features. The modification of storm water outfalls to capture runoff to support habitat will be discussed further later in this report.

Table IV-5: Storm water Outfalls and Estimated Average Runoff in Acre-Feet (AF)

No.	Site Location	Jan (AF)	Feb (AF)	Mar (AF)	Apr (AF)	May (AF)	Jun (AF)	Jul (AF)	Aug (AF)	Sep (AF)	Oct (AF)	Nov (AF)	Dec (AF)	Annual (AF)
SR01[1,2]	51st Avenue and Salt River - North Side	23.9	24.7	31.6	8.0	4.4	4.7	29.6	34.3	30.7	23.3	23.6	35.7	274
SR02[1,2]	43rd Avenue and Salt River - North Side	23.9	24.7	31.6	8.0	4.4	4.7	29.6	34.3	30.7	23.3	23.6	35.7	274
SR03[1,2]	35th Avenue and Salt River- North Side	19.5	20.2	25.7	6.5	3.6	3.8	24.2	28.0	25.1	19.0	19.3	29.1	224
SR04[1,2]	27th Avenue and Salt River- North Side	29.6	30.7	39.2	9.9	5.4	5.8	36.8	42.6	38.1	29.0	29.3	44.3	341
SR05[1,2]	25th Avenue and Salt River- North Side	10.9	11.3	14.4	3.6	2.0	2.1	13.5	15.6	14.0	10.6	10.8	16.3	125
SR06[1,2]	22nd Avenue and Salt River- North Side	48.8	50.5	64.5	16.3	9.0	9.5	60.6	70.1	62.8	47.7	48.2	72.9	561
SR07[1,2]	19th Avenue and Salt River- North Side	6.9	7.1	9.1	2.3	1.3	1.3	8.5	9.9	8.8	6.7	6.8	10.3	79
SR30[1,2]	27th Avenue and Salt River- South Side	17.1	17.7	22.6	5.7	3.1	3.3	21.2	24.5	22.0	16.7	16.9	25.5	196
SR31[1,2]	19th Ave, South Bank	20.1	20.8	26.6	6.7	3.7	3.9	25.0	28.9	25.9	19.6	19.9	30.0	231
SR48[1,2]	45th Avenue and Salt River- South Side	142.7	147.6	188.6	47.6	26.2	27.9	177.1	205.0	183.7	139.4	141.0	213.2	1640[3]
SR49[1,2]	67th Avenue and Salt River- North Side	48.5	50.2	64.1	16.2	8.9	9.5	60.2	69.7	62.5	47.4	48.0	72.5	558

1. Monthly storm water runoff distributions were assumed to follow the monthly pattern of rainfall.
2. Annual runoff volumes were computed from the drainage area versus average annual runoff relationships developed for the Rio Salado Study.
3. 1640-acre feet based upon drainage area; however, it is anticipated that runoff from this will decrease with modification in design/construction.

4.2.4.3 Flood Flows

The Salt River is dry most of the time due to the upstream dams that were constructed for water supply to agriculture and the Phoenix valley. Although the river is subject to flooding, flood water can only be considered a possible supplemental water supply for a restoration project. Discharge-frequency values are provided in Table IV-6 and more detailed information on flood flows can be found in Appendix A, Hydrology and Hydraulics. The 100-year floodplain is shown on Figure IV-3.

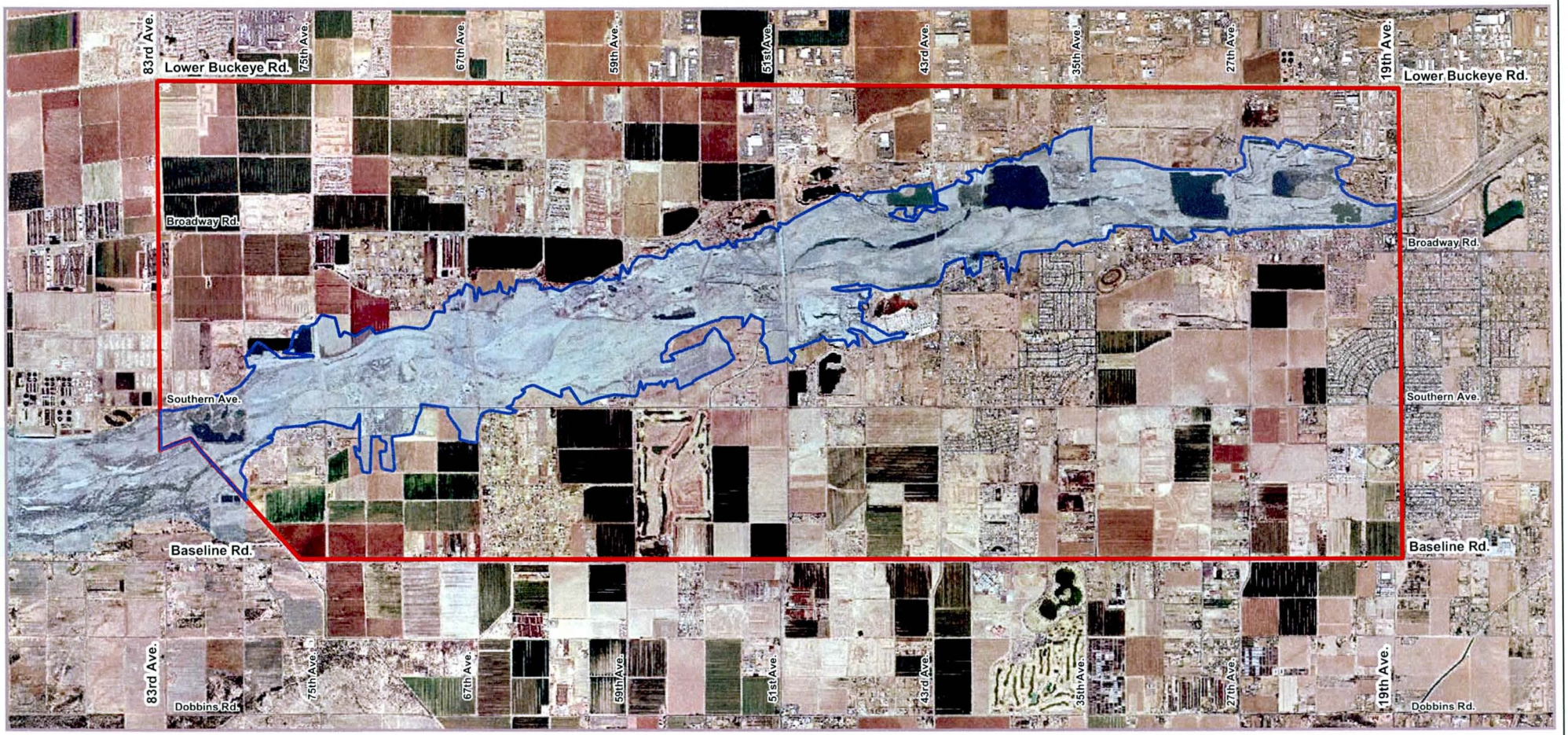
While not necessarily a preferred source for delivery of water and implementation of restoration measures, flood flows need to be considered in plan formulation. In a natural system, they provide the necessary dynamics to maintain the ecosystem and are an important factor in seed dispersal. Measures considered in the formulation of plans should account for the possible damages off loading as well as the potential advantages of flooding—flooding may provide benefits towards project sustainability.

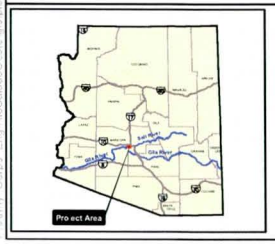
Table IV-6: Discharge-Frequency Values Used in the Existing Conditions Model

Location	Return Period					
	5-yr	10-yr	20-yr	50-yr	100-yr	500-yr
Peak Discharges (ft^3/s) in the Salt River at:						
Central Avenue	20,200	53,000	87,000	135,000	166,000	240,000
67th Avenue	20,000	51,000	84,000	132,000	164,000	237,000

4.2.4.4 Groundwater

The Salt River was once a perennial stream, and groundwater levels were shallow and provided for a significant amount of riparian and wetland habitat. Today, static water level ranges from 20 to 50 feet below ground surface within the Salt River channel to 60 to 80 feet below ground surface north and south of the river. Data indicate that over the past 25 years groundwater elevations in the study area have decreased approximately 15 to 20 feet.





Legend

- Project Study Area
- Project Implementation Area
- 100-Year Floodplain

March 2006

100-YEAR FLOODPLAIN

Rio Salado Oeste

N
W E
S

0 5,000 10,000
Feet

Figure IV-3

US Army Corps of Engineers

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Groundwater quality in the eastern half of the study area has been impacted by hydrocarbon releases and elevated concentrations of 1,1-DCE. Elevated concentrations of TDS and nitrates are of concern on the southwestern side of the project area.

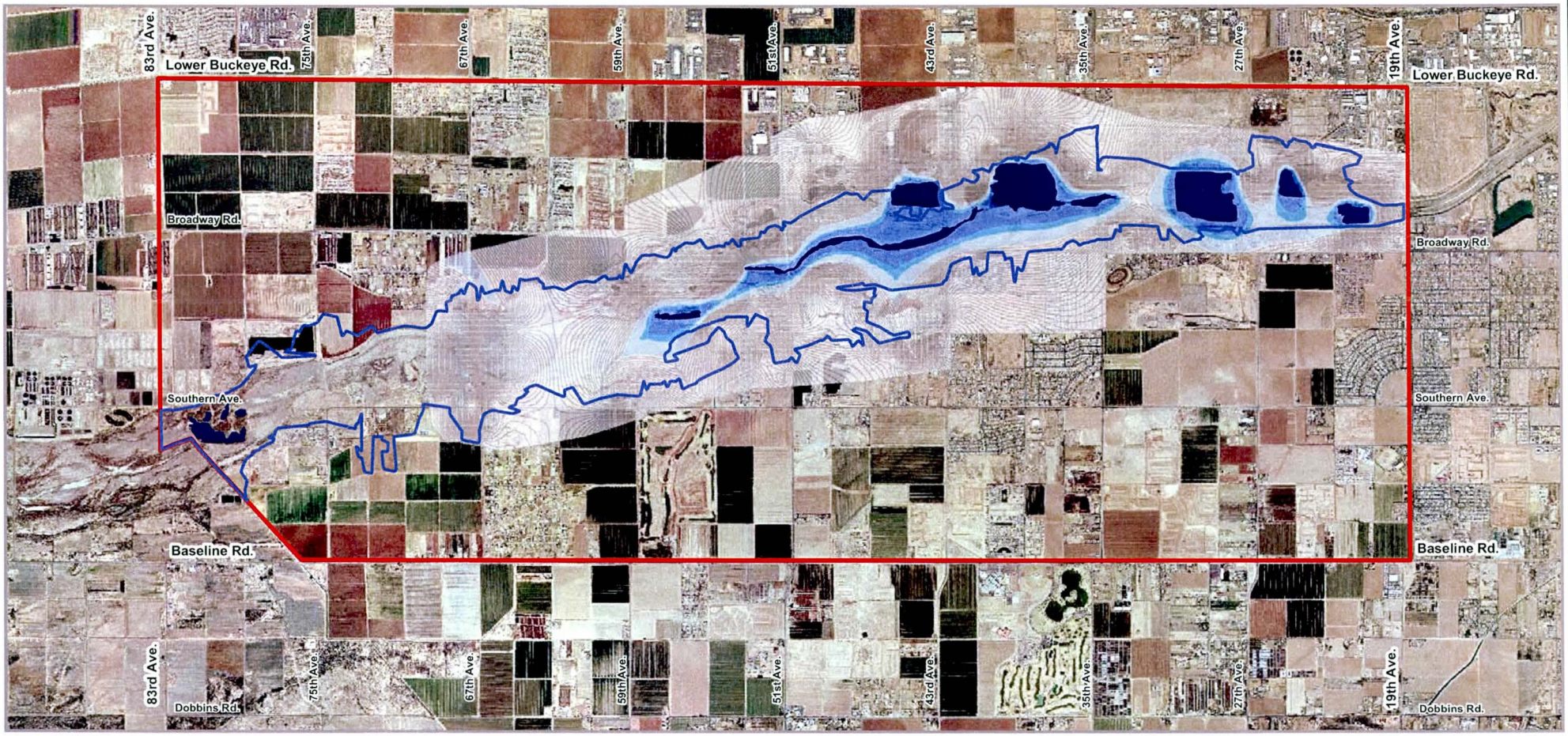
The subsurface geologic conditions in the study reach are within the Phoenix AMA and are regulated by the ADWR. The City has the rights to pumping of groundwater for their service area but would prefer to pursue other sources prior to considering groundwater as a project source. Figure IV-4 depicts an approximation of existing depth to groundwater within the study area, based upon extrapolation of 2002 ADWR well data and observed water levels in excavated gravel pits.

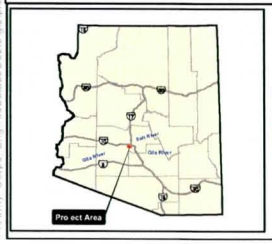
4.2.5 Land Use

The study area is located in a rapidly developing and changing area of metro Phoenix. Land uses range from industrial and commercial to residential and agriculture. Estrella Village and Laveen Village are the two primary planning areas that lie adjacent to the Salt River between 19th Avenue and 83rd Avenue. Estrella Village is characterized by an ample supply of undeveloped land, large parcels, natural and scenic amenities, and excellent transportation access. Approximately 62 percent of the Village is undeveloped, either vacant or with agricultural uses. However, there are at least 21 residential developments in various phases of approval and development.

The Laveen Village contains largely undeveloped and agricultural properties. Primary agricultural crops grown in the area include cotton, citrus, and corn. Farmers, equestrians, and those looking for solitude and mountain access have valued the area. However, development pressures have increased in this area due to its proximity (about 7 miles) to downtown.

Based upon the City of Phoenix General Plan (Revised February 2001), most of the land area on the north side of the river between 19th and 59th Avenues is zoned industrial, with some high-density residential between 43rd and 60th Avenues. From 60th to 83rd Avenues, the primary land use is low-density residential. To the south, some land between 19th and 35th Avenues is zoned as commercial otherwise, the prevailing land use is low- to medium-density residential.





Legend

- Project Study Area
- Project Implementation Area

Depth to Groundwater

- Surface Water
- 0 - 3 Feet
- 4 - 5 Feet
- 6 - 10 Feet
- 11 - 112 Feet

March 2005

DEPTH TO GROUNDWATER

Rio Salado Oeste

Figure IV-4

N W E S

0 5,000 10,000

Feet

US Army Corps of Engineers

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4.2.5.1 Future Land Use

As of July 2003 there were approximately 35,000 approved lots in the Laveen and Estrella Villages. At this rate of growth it is assumed that by 2009 the majority of the lands adjacent to the river will be developed and converted from agriculture to urban.

4.2.5.2 Aggregate Mining

As seen in Figure IV-5 below, since the construction of upstream dams began controlling the flows in the Salt River, sand and gravel mining operations moved into the riverbed and surrounding floodplain to mine the natural resource. The materials extracted from the river have been used extensively throughout the development of the Phoenix Metropolitan area and have contributed to geomorphic changes to the floodplain and adjacent over bank. Removal of sediments also removes materials that would normally be redeposited during flood events.

Figure IV-5: Aggregate mining within the project area.

There are an estimated 671 acres of sand and gravel mining operations within the 100-year floodplain of the project area. Between 19th and 35th Avenues, the river is lined with operations

and is nearly 100 percent modified. South of the river between 43rd Avenue and 51st Avenue there are mining operations that cross the river just downstream of 51st and extend on the north side to near 63rd Avenue. Two new operations are in the permitting process between 51st and 67th Avenues. It is assumed that the existing mining operations will continue operating until resources and demand dictate that they are no longer feasible in their existing locations. As can be seen to the west of 51st Avenue, new operations will begin in previously un-mined portions of the river, close to new development.

4.2.6 Vegetative Habitat

Historically, the study area supported significant biological resources including extensive riparian and wetland habitats within the floodplain. Urban development, diversion of water to support agriculture, and domestic livestock grazing have eliminated or altered most of the natural vegetation communities that occupied the project study area leaving only scattered remnants of the original vegetation communities. Modifications of the river system, such as damming and flow diversion, currently allow no natural flow through the project study area, except during flood events. The Salt River below Granite Reef Diversion Dam is essentially devoid of vegetation. Vegetation communities in the project study area have been highly modified from their original state and currently contain a mosaic of degraded natural communities and manmade artificial communities. Included in this reach of the Salt River are a large number of open water areas, mostly the results of gravel mining. Adjacent to several of these there is dense vegetation including some cottonwood and willows as well as the occasional cattail or bulrush.

4.2.6.1 Cover Types

A classification system of cover types was developed for this study and is mainly based upon vegetation cover. Cover types were mapped for the length of the study reach and 1 mile on either side of the thalweg, or center of the river channel. Scattered remnants of natural vegetation remain; those cover types include cotton-willow forest, mesquite, scrub-shrub lands, and emergent wetlands. Of those cover types, scrub-shrub lands are the most dominant in the study area, covering approximately 1,200 acres. The scarcest is cottonwood/willow forest, extant within merely 10.5 acres (not including an additional 120 acres in which salt cedar dominates Figure IV-6 below).

Figure IV-6: Landscape dominated by Salt Cedar (83rd Avenue)

Cottonwood/Willow Forest

Cottonwood/willow forest is representative of high-quality riparian habitat in Arizona. Riparian habitats are defined as habitats or ecosystems that are associated with adjacent bodies of water (rivers, lakes, or streams) or are dependent on the existence of perennial or ephemeral surface or subsurface water drainage. They are further characterized by having diverse assemblages of plant and animal species in comparison with adjacent upland areas.

Because of the modification of the Salt River system, groundwater elevations have been lowered and have contributed to the decline in cottonwood and willow species. These same conditions have also favored the establishment and dominance of salt cedar. Structural types of most stands of cottonwood/willow within the study area show evidence of disturbed and early successional conditions consistent with past histories of water diversion, infrequent severe floods, and land clearing. These plant species are also found in habitats that are narrow, linear strands of vegetation oriented in the main direction of water flow that may occur in riverine flood channels and along the banks of streams.

In terms of height, basal area, and density, Fremont's cottonwood and Gooding's willow are dominant canopy species in the cottonwood/willow associations in the study area, along with salt

cedar. The cottonwood/willow riparian habitat is patchy in the study area and much of the original stands of this habitat have been replaced by the invasive and non-native salt cedar.

Scrub-Shrub Lands

Scrub-shrub lands are common and are present within the active channel of the river occupying 12 percent of the project study area (Figure IV-7). They are dominated by various combinations of burrobush, rabbitbush, quailbush, saltbush, and occasionally by creosotebush. Many of these areas have been highly disturbed from off-highway vehicle (OHV) traffic and gravel mining activities and contain little or no vegetation cover. If the total vegetation cover was less than 10 percent, the area was mapped as unvegetated river bottom; if water was present, it was mapped as low-flow channel. Throughout drainages in the Sonoran Desert there are dense areas of scrublands which are too dense to be considered desert scrub. They usually contain the same species found in the drier desert scrub but area usually more dense and also contain distinctive riparian species including Seepwillow, desert broom, or Desert willow. While river bottom, scrub shrub and riparian scrub are often referred to interchangeably by different disciplines this report will attempt to specify the difference.

Figure IV-7: Scrub-Shrub Lands Dominated by Saltbush and Rabbitbush.

Wetlands (Low-Flow Channels)

Low-flow channels in the Salt River have been almost entirely eliminated, occurring in less than 1 percent of the project study area and mostly associated with effluent or storm water discharges (Figure IV-8). These features are characterized by either seasonal or perennial open water, and are generally unvegetated when present. Vegetation, when present, consists of scattered patches of Bermuda grass, salt heliotrope, and sedges.

Figure IV-8: Low-Flow Channel with Wetland Vegetation (immediately upstream of 51st Avenue Bridge)

Mesquite Woodlands

Mesquite woodlands historically occurred over large areas within the river floodplain and on higher terraces of the river. These communities have been nearly eliminated from the river ecosystem by changes to natural processes. Currently, only small fragmented stands of scattered mesquite woodlands remain along the Salt River. Mesquite is common throughout the region, but has been reduced to remnant patches adjacent to the project study area on the Gila River Indian Community. Although scattered mesquite occurs throughout the study reach there are no large stands that could be considered mesquite woodlands.

4.2.6.2 ***Habitat Evaluation***

Hydrogeomorphic Modeling Process

The Hydrogeomorphic Modeling (HGM) approach was chosen for habitat evaluation on the Rio Salado Oeste because of its ability to provide an analysis of the processes and conditions necessary for restoration and maintenance of riparian and wetland habitat. The HGM—developed by scientists and the Engineering Research and Development Center (ERDC)—allows existing community characteristics, composition, and function to be compared to fully functional systems. Under this assessment procedure, the focus is narrowed to (1) the functions a particular type of wetland will perform and (2) the characteristics of the ecosystem and landscape controls of those functions. The ability of a riverine system to have and sustain a majority of the identified functional components of a wetland ecosystem directly correlates to the quality, quantity, and type of riparian habitat that can establish and survive.

In arid regions, biological resources are typically concentrated along riparian systems. This feasibility study relies on the results of a Hydrogeomorphic Approach to Wetlands Assessment Methodology to yield quantitative descriptions of biological resources along and adjacent to the Salt River in the study area. HGM was chosen for its broad analysis of processes and conditions necessary for support of riparian habitat. Riparian components including size, substrate characteristics, and species composition will be considered in quantification of the biological resource function and value.

An HGM approach treats the biota of an area as the outcome of an ecological process. It also merges these biological events with hydrologic and geologic process at work in a region. Wetlands under this method are measured in terms of functional capacity. This concept is based on the inherent capacity of a wetland to perform a function under its physical, chemical, and biological components, and the level of functioning is determined by interactions between the wetland and surrounding environment. The inherent capacity of a wetland is dynamic and its functional capacity is based on an assessment model defining the relationship between the ecosystem and landscape scale variables and functional capacity. The assessment method develops a Functional Capacity Index (FCI).

The FCI is a quantitative estimate of functional capacity for a wetland. The ideal goal of an FCI is to quantify and produce an index that reflects fully functional capacity at the site. The results of an FCI analysis can be quantified based on a standard 0.0-1.0 scale, where 0.0 represents the lowest functional capacity for the wetland and 1.0 represents the highest. The Functional Capacity Unit (FCU) is a measure of the ability of a wetland to perform a certain function and is calculated by multiplying an FCI by the corresponding wetland area that is producing that FCI. When evaluating and comparing alternative ecosystem restoration plans or scales of plans, the with-project FCU is compared to the future without-project FCU. The net change in FCU represents increases in the biological function of the ecosystem directly attributable to the implementation of alternative plans.

Using this methodology, the Salt River was classified as Riverine Over bank. The Salt River is also characterized regionally as arid and Southwestern. As such, the functions developed in an existing Riverine Over bank Subclass model were modified for Arizona low gradient rivers to be applied in the standard HGM approach for this study. The model for Arizona was further calibrated in a workshop with the Environmental Laboratory of ERDC, the Los Angeles District Corps, local sponsor representatives from the City of Phoenix, City of Tucson, Town of Marana, Pima County Flood Control District, Salt River Pima-Maricopa Community, AGFD, U.S. Fish and Wildlife Service (USFWS), and representatives from the scientific community. Field sampling results based on the calibration of the model during the workshop are used in the analysis of alternatives.

As a first approximation, the HGM approach uses seven wetland classes (groups) as shown below. Detailed descriptions of these groups can be found in Appendix I, Functional Assessment Methodology.

- Depression
- Tidal Fringe
- Lacustrine Fringe
- Slope
- Mineral Soil Flats

- Organic Soil Flats
- Riverine

The level of variability in the continental-scale wetland hydrogeomorphic classes presented above is too large to develop assessment models that can be rapidly applied while still being sensitive enough to detect changes in function at a level of resolution appropriate to the USACE planning process in Arizona. As such, the three classification criteria (geomorphic setting, water source, and hydrodynamics) were applied at a smaller, regional geographic range to identify regional wetland subclasses.

The resulting regional riverine wetland subclasses adopted for the Rio Salado Oeste Project were all associated with low-gradient perennial and ephemeral river systems in Arizona. Within these regional subclasses, homogenous zones exhibiting analogous vegetative species, geographic similarities, and physical conditions that make the area unique were defined as a Partial Wetland Assessment Area (PWAA). In all, five PWAAs were defined for the Rio Salado Oeste Project on the basis of species recognition and dependence, soil types, and topography. The dominant vegetative cover types within the PWAAs included Cottonwood/Willow, Wetland Marsh, Mesquite, and Scrub-Shrub. River Bottom was defined as the active channel and included pool/riffle aquatic areas and open areas characterized by sand, cobble, and/or gravel. During the planning and project formulation processes, various combinations of PWAAs were located within the project area and used to develop a range of restoration alternatives.

Wetland Functions Evaluated

A desired result of this study process was to assess the functional values of wetland habitat types (PWAAs) currently existing within the project area. Wetland functions under this method are measured in terms of functional capacity. This concept is based on the inherent capacity of a wetland to perform a function under its physical, chemical, and biological components, and the level of functioning is determined by interactions between the wetland and surrounding environment. The inherent capacity of a wetland is dynamic and its functional capacity is based on an assessment model defining the relationship between the ecosystem- and landscape-scale variables and functional capacity. The assessment method develops an FCI.

Further, estimates of the functional values were needed for PWAAs at selected times in the future considering the without-project scenario, as well as with-project. Wetlands perform a wide variety of functions, although not all wetlands perform the same functions, nor do similar wetlands perform the same functions to the same level of performance. The ability to perform a function is influenced by the characteristics of the wetland and the physical, chemical, and biological processes within the wetland.

Wetland characteristics and processes influencing one function often also influence the performance of other functions within the same wetland system. The ten functions evaluated with HGM FCI models used in this study are found in Table IV-7.

Table IV-7: Wetland Functions Evaluated

Wetland Function (symbol)	Description
Function 1: Maintenance of Characteristic Channel Dynamics (CHANNELDYN) $(V_Q+V_{FPA}+V_{SED})/3$	Physical processes and structural attributes that maintain characteristic channel dynamics. These include flow characteristics, bedload, in-channel coarse woody debris inputs, channel dimensions, and other physical features (e.g. bank vegetation, slope).
Function 2: Dynamic Surface Water Storage/Energy Dissipation (WATSTORENR) $(V_{FREQ}*(V_{FPA}+((V_{TOPO}+V_{TVV}+V_{CWD})/3)/2))^{1/2}$	Dynamic water storage and dissipation of energy at bankfull and greater discharges. These are a function of channel width, depth, bedload, bank roughness (coarse woody debris, vegetation, etc.), presence and number of in-channel coarse woody debris jams, and connectivity to off-channel pits, ponds, and secondary channels.
Function 3: Long Term Surface Water Storage (WATSTORLNG) $(((V_{TOPO}*V_{FREQ})^{1/2})*(((1 - V_{PORE})+V_{SUBIN})/2))^{1/2}$	The capability of a wetland to temporarily store/retain surface water for long durations; associated with standing water not moving over the surface. Water sources may be overbank flow, overland flow, and/or channelized flow from uplands, or direct precipitation.
Function 4: Dynamic Subsurface Water Storage (WATSTORSUB) $(V_{DEPSATSED})$	Availability of water storage beneath the wetland surface. Storage capacity becomes available due to periodic drawdown of water table.
Function 5: Nutrient Cycling (NUTRIENT) $((V_{TVV}+(3*V_{AGSA})/4)+((V_{DECAY}*((V_{LITTER}+V_{FWD}+V_{CWD})/3))^{1/2}))/2$	Abiotic and biotic processes that convert elements from one form to another; primarily recycling processes.
Function 6: Detention of Imported Elements and Compounds (ELEMENTS) $(((V_{FREQ}+V_{SURFIN}+V_{SUBIN})/3)+((V_{AGSA}+V_{LITTER}+(1-V_{PORE}))/3)+V_{TVV})/3$	The detention of imported nutrients, contaminants, and other elements or compounds.
Function 7: Detention of Particles (DETPARTICL)	Deposition and detention of inorganic and organic particulates (> 0.45 µm) from the water column, primarily through physical processes.

Wetland Function (symbol)	Description
$((2*V_{FPA})+V_{TOPO}+((V_{CWD}+V_{FWD}+V_{SED}+V_{TVV})/4))/4$	
Function 8: Maintain Characteristic Plant Communities (PLANTS) Cottonwood/willow and Mesquite Communities: $(((((V_{SPECRICH}+V_{WIS}+V_{INVASIVES})/3)*((V_{CANHERB}+V_{CANSHRUB}+V_{CANTREE})/3))^{1/2})*V_{LANDBUFF})^{1/2}$ Scrub-Shrublands Communities: $(((((V_{SPECRICH}+V_{WIS}+V_{INVASIVES})/3)*((V_{CANHERB}+V_{CANSHRUB})/2))^{1/2})*V_{LANDBUFF})^{1/2}$ River Bottom Communities: $(((((V_{SPECRICH}+V_{WIS}+V_{INVASIVES})/3)*(V_{CANHERB}))^{1/2})*V_{LANDBUFF})^{1/2}$	Species composition and physical characteristics of living plant biomass. The emphasis is on the dynamics and structure of the plant community as revealed by the species of trees, shrubs, seedlings, saplings, and herbs, and by the physical characteristics of the vegetation.
Function 9: Maintain Spatial Structure of Habitat (HABSTRUCT) $(((V_{VEGSTRATA}+((V_{CWD}+V_{FWD}+V_{LITTER})/3))/2)*V_{LANDBUFF})^{1/2}$	The capacity of the wetland to support animal populations and guilds by providing heterogeneous habitats.
Function 10: Maintain Interspersion and Connectivity (INTERSPERS) $(((V_{FREQ}+V_{TOPO}+V_{CONTIG}+V_{TRIB})/4)*V_{LANDBUFF})^{1/2}$	The capacity of the wetland to permit aquatic organisms to enter and leave the wetland via permanent ephemeral surface channels, overbank flow, or unconfined hyporheic gravel aquifers. The capacity pf the wetland to permit access for terrestrial or aerial organisms to contiguous areas of food and cover.

Selecting and Modifying the HGM Models

In the HGM methodology, an FCI is a quantitative estimate of functional capacity for a wetland. The ideal goal of an FCI is to quantify and produce an index that reflects functional capacity at the site. The results of an FCI analysis can be quantified based on a standard 0.0-1.0. scale, where 00.00 represents low functional capacity for the wetland and 1.0 represents high functional capacity for the wetland.

FCU is the unit of measure of the ability of a wetland to perform a certain function and is calculated by multiplying an FCI by the area of the wetland. FCI x acreage = FCU. When evaluating restoration alternatives, with-project FCU will be compared to without-project FCU. The change in FCU will be the unit of measurement of the outputs from restoration measures.

Environmental Output

Baseline (existing conditions) results for the Rio Salado Oeste Project area are shown below in Table IV-8. These results show that riparian and wetland habitats within the study area have low functional values and are therefore highly degraded. Figure IV-9 below depicts the FCI graphically.

Table IV-8: Baseline Conditions Analysis Results

Function	Function Name	Baseline FCI	Baseline FCU
01	Maintenance of Characteristic Channel Dynamics	0.23	41.4
02	Dynamic Surface Water Storage/Energy Dis.	0.42	74.9
03	Long Term Surface Water Storage	0.25	45.2
04	Dynamic Subsurface Water Storage	0.44	78.3
05	Nutrient Cycling	0.28	49.6
06	Detention of Imported Elements and Compounds	0.38	66.9
07	Detention of Particulates	0.33	58.9
08	Maintain Characteristic Plant Communities	0.42	74.8
09	Maintain Spatial Structure of Habitat	0.30	53.1
10	Maintain Interspersion and Connectivity	0.23	40.1
	AVERAGE/TOTAL	0.33	583

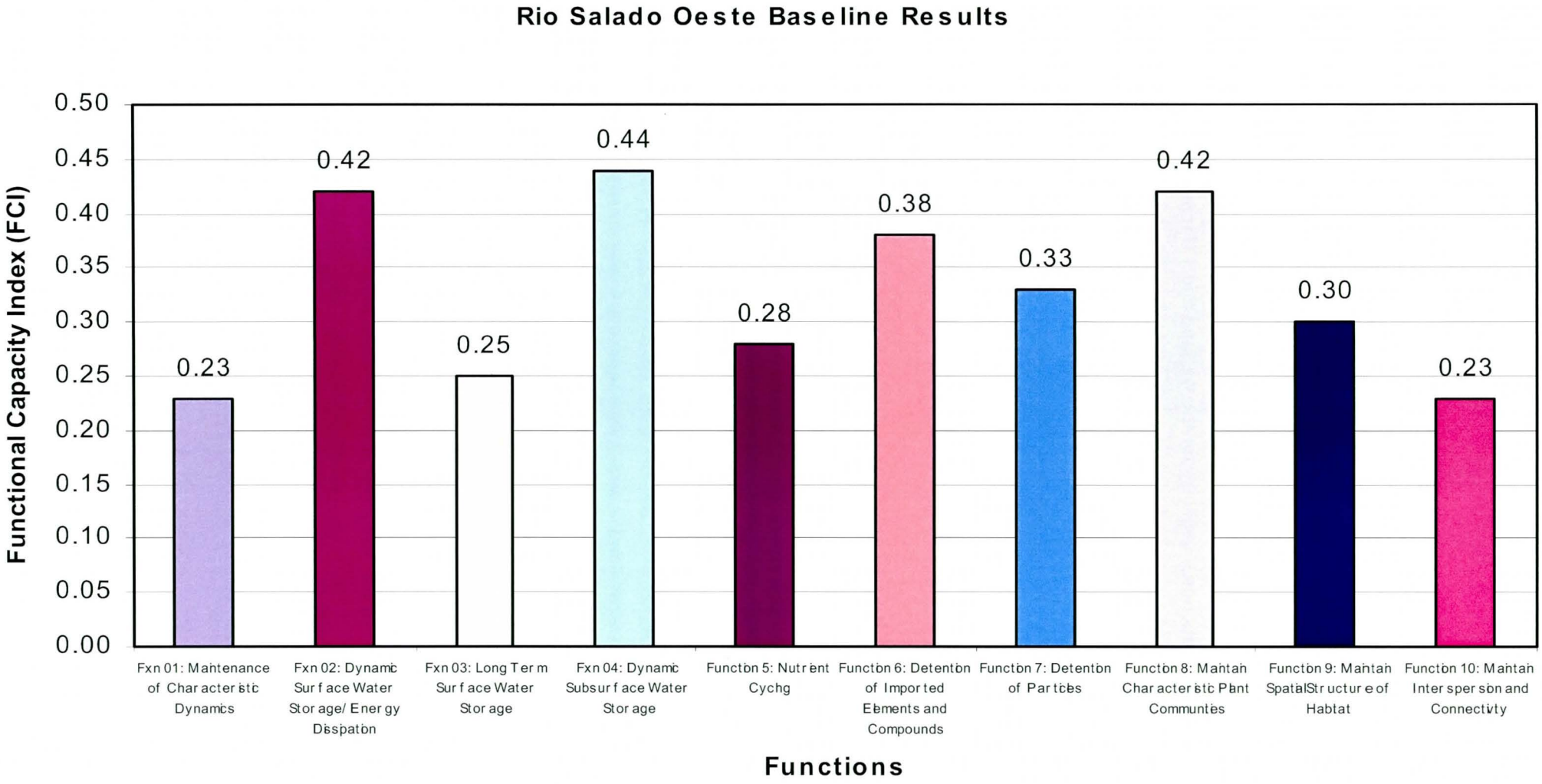


Figure IV-9: FCI for the Rio Salado Oeste Study Area

4.2.7 Hazardous, Toxic, or Radioactive Waste

The presence of Hazardous, Toxic, and Radioactive Wastes (HTRW) within the study area was evaluated for the study. Because of the size of the project study area, approximately 20 square miles total, a typical Phase I ESA was not possible. Consequently, a Modified Phase I ESA was decided to be most appropriate for the size of the project. The basic difference is that a site reconnaissance of every property within the project area would not be conducted, as infeasible. The Modified Phase I ESA was conducted to review past and current land use practices along the site corridor to identify areas of known or suspected contamination that may environmentally impact the subject property. URS completed the assessment under contract to the City of Phoenix. The entire report is found in Appendix F of this report.

The Modified Phase I ESA was accomplished by, and limited to, a visual reconnaissance of the site from existing rights-of-way and public areas, a drive-by survey of the site corridor (or vicinity), a review of publicly available records (including aerial photographs), and a review of pertinent documentation presently and readily available from the client and/or through URS' standard resources. The site corridor is defined as the neighboring properties and facilities along the Salt River within an approximate distance of 1 mile north and south of the river's centerline, the nature of which may adversely affect or have affected environmental conditions at the site due to the presence and/or release of hazardous substances or petroleum products to the environment. The following activities were conducted in accomplishing the Phase I ESA:

- Review of aerial photographs
- Review and interpretation of available archival topographic maps, historical land use maps of the site for information regarding historical site land use that could have involved the manufacture, generation, use, storage and/or disposal of hazardous substances
- Review of the following State and Federal agency lists of known or potential hazardous waste sites, and sites currently under investigation for potential environmental violations as prescribed by the American Society for Testing and Materials. All databases were

searched for areas approximately 1 mile from the Salt River centerline to include the project corridor study area (or buffer area):

Federal National Priorities List (NPL) site list

Federal Comprehensive Environmental Response, Compensation, and Information System (CERCLIS) list

Federal Resource Conservation and Recovery Act (RCRA) CORRACTS TSD facilities list

Federal RCRA non-Corrective Action Report (CORRACTS) Treatment, Storage, and Disposal (TSD) facilities list

Federal RCRA generators list

Federal Emergency Response Notification System (ERNS) list

State lists of hazardous waste sites identified for investigation or remediation:

State-equivalent NPL

State-equivalent CERCLIS

State landfill and/or solid waste disposal site lists

State LUST lists

State-registered UST lists

- Review of previous environmental reports conducted within or relating to the Oeste study area
- Performance of an onsite visual reconnaissance of the subject property and the area within 1-mile of the Salt River centerline in each direction to make visual observations of existing site conditions, activities, and types of land use and businesses within the project corridor area

Sites identified with possible HTRW concerns are for the most part outside the 100-year floodplain and location where project features would be located. Project features are located within the 100-year floodplain and avoid the known HTRW sites. In accordance with Engineer Regulation 1165-2-132, the Corps would not participate in clean up of materials regulated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or by the RCRA.

4.2.7.1 "Wildcat" Dumping

"Wildcat" or uncontrolled, random dumping of materials has occurred and continues to occur along the river and study area. This dumping includes soils, concrete, asphalt, household and landscape waste, etc. The reach between 35th and 51st Avenues was at one time littered with such waste materials. However, the City of Phoenix has implemented changes that significantly reduced the amount of dumping in this through barricades and increased policing. It should be assumed that some waste is still present within the study area.

4.2.7.2 Landfills

There are three closed landfills within the study area. These include the 27th Avenue Landfill which was closed in 1995, and the SRP landfill (North of the river at 67th Avenue), closed in 2000. The 19th Avenue landfill, located east of 19th Avenue, has been closed and a remediation plan has been implemented. Groundwater monitoring is conducted at the landfills. Although these landfills are within the study area they are outside the possible location for project features and should not have any impact on the project.

4.2.7.3 Leaking Underground Storage Tanks (LUSTs)

Thirteen LUST sites with monitoring wells on record with ADWR were identified within the study area. Description of the sites can be found within Appendix D, Groundwater Quality and Hydrogeology Report. These sites may have impacts to local soil and water conditions but are not considered likely to affect the project to be implemented within the floodplain.

4.2.8 Cultural Resources

4.2.8.1 ***Prehistory***

Paleoindian and Archaic

Thus far there are no known Paleoindian sites in the Phoenix Basin or surrounding environs. Little is known of the archaic occupation of the area, but newly acquired excavation data is becoming available. The current construction boom in Scottsdale has required new surveys,

which in turn has prompted excavation of previously unknown archaic sites. Presently, much of that information is locked up in unpublished, possibly proprietary reports.

Hohokam

The principal prehistoric cultural manifestation in the project area is the Hohokam culture. Hohokam is a Pima word that means "those who have gone" (Gladwin and Gladwin, 1933), or more poetically, "those who have vanished" (Wormington, 1973). The name Hohokam has endured and is still the preferred name in spite of the renaming of some other prehistoric cultures being renamed. The four southern O'odham tribes crafted a policy statement that stated, "We recognized Indian Tribes have mutually agreed to promote and protect the archaeological artifacts and remains of our ancestors, the Hohokam..." (SRPMICC, 1989).

4.2.8.2 History

The potential value of the Salt River was realized when, in 1867, John W. "Jack" Swilling first ventured from Wickenburg to John Y. T. Smith's Hay Station, approximately 4 miles from present-day Phoenix (Granger, 1960). In 1867, as a farmer visiting Smith's Hay Station, he observed the long, low earthen ridges radiating out from the Salt River and concluded that these were the remnants of a long-forgotten irrigation system (SRP, 1979; Myers, 1961). This observation prompted him to envision the irrigation potential of the Salt River.

Other canals followed Swilling's Ditch, developing the agricultural potential of the Salt River Basin. The Maricopa Canal was completed in 1869, the Arizona Canal in 1887, and the Highlands Canal was constructed in 1888. The early canals were beset by their own problems stemming from Salt River floodwaters. Flooding washed out the diversion dams, leaving the headgates high and dry and rendering them useless (Walker and Bufkin, 1986). A number of the historic canals were reconstructed from the old Hohokam canals. The only functional difference between the Hohokam and modern canals is the lack of drop structures and drainage canals in the Hohokam systems, according to Nials and Gregory (1989).

By 1871, Phoenix was an official town. The number of townspeople had risen to 300, a far cry from the old Smith Hay Station: population 1. All the original lots had been sold and the town

was formally mapped. Phoenix was one-mile-long and one-half mile wide, and encompassed 96 blocks. Washington Street was the first main street running east-west. The Salt River Valley Post Office was moved to Phoenix, and the first County election was held. In 1872, the 320-acre town site of Phoenix was officially filed in Prescott.

4.2.8.3 ***Previous Work in the Study Area***

The earliest known archaeological work in the vicinity of the Rio Salado Oeste project area included Adolph Bandelier and Frank Cushing's studies in the 1880s of Pueblo Grande, approximately 15 miles to the east (Downun and Bostwick, 1993:17-21), and investigations of the prehistoric Hohokam canals (Hodge, 1893; Patrick, 1903).

The eastern portion of Cashion Ruin was recorded by Frank Midvale in 1923. Turney documented the western portion of Cashion Ruin in 1925 with updates in 1929 and 1935. Cashion Ruin was recorded again and trenched in 1939 by Audie R. Kelley as part of the Salt River Valley Stratigraphic Survey financed by the U.S. Works Progress Administration and headquartered at Pueblo Grande Museum under Director Odd Halseth (Downum and Bostwick 1993:212-220).

Glen Rice (personal communication 1999) said that Midvale's Canal Cashion may not have actually been a canal, and that Midvale's site map was of an area south of the site's actual location. During the Museum of Northern Arizona's (MNA's) excavation of the Cashion Site, Antieau (1981) noted that he was unable to locate the Canal Cashion and three Casa Grande-type ballcourts, probably due to this locational error. Midvale mapped all the ruins in the Palo Verde project area right-of-way in 1967 and in some cases corrected Turney's locations (cf. Legend on Midvale's map of the Cashion ruins in Antieau (1981:42). Antieau's excavations verified that Turney was correct and Midvale was incorrect (Antieau 1978).

Following Turney, Frank Midvale developed an interest in prehistoric irrigation and spent the 1920s, 30s, and 60s investigating every lead he could in an attempt to retrace the flow of irrigation water through the Salt-Gila Basin (Antieau 1981:8). He had also mapped the 5 sites that were excavated by the MNA for the Palo Verde Nuclear Generating Station Wastewater Conveyance System.

The Cashion site, NA 14690, was excavated by the MNA in 1977 and 1978 (Antieau 1981). Midvale originally mapped the Cashion site in 1927 when he called it Los Conejos (Antieau 1981:144). Estimated to cover approximately 640 acres, the Cashion site was listed on the National Register of Historic Places on December 19, 1978 (Reference No. 78000547). It is the largest site excavated near the confluence of the Salt and Gila Rivers, one of the largest and the most complex in the Salt-Gila River Valley (Stein, 1977), and it equals Snaketown in size (Antieau, 1981). Encompassing dates from A.D. 500 - 1150, the Cashion site was occupied from the Pioneer through the Classic Periods (Stein, 1977; Antieau, 1981). By the end of the Classic Period, Cashion was largely abandoned.

4.2.8.4 Records and Literature Search

For the purposes of the record and literature investigation, the following description was used. The study area is approximately 8 miles long extending from 19th Avenue on the east to 83rd Avenue on the west and from Lower Buckeye Road on the north to approximately Baseline Road on the south. The project implementation area extends from 19th Avenue on the east and 83rd Avenue on the west and is the area within the 100-year floodplain of the Salt River. The study area is approximately 4-miles wide and consists of approximately 20,480 acres. The project Area of Potential Effect (APE) is on average approximately 1-mile wide and consists of approximately 3,315 acres, and almost entirely of the outfalls and adjacent or nearest terrace.

A literature search of the proposed project APE was performed through the Arizona State Museum, Arizona State Office of Historic Preservation, the City of Phoenix, and Corps of Engineers files. This search indicated that archeologists had never surveyed the APE.

4.2.8.5 Recommendations

Geoarchaeological investigations were conducted for the Tres Rios project (Onken et al. 2004), which provide a very good reconstruction of the floodplain history just west (downstream) of the Rio Salado Oeste Project, at the junction of the Salt and Agua Fria Rivers with the Gila River. The results of the Tres Rios geomorphological investigation suggest that 94% of that project area has no or low sensitivity for buried prehistoric sites.

Given the Oeste project's location upstream of Tres Rios, it is reasonable to conclude that the alluvial stratigraphy of the lower Salt River might be comparable. The entire length of the Salt River within the Oeste project boundary appears to have been more disturbed than downstream, and has been modified through natural scouring action of periodic flooding, sand and gravel mining, and dumping.

Surveys of selected portions of the river, at all outfalls and adjacent or nearest terrace, were conducted by a Corps of Engineers staff archeologist. No cultural material was observed at any of these areas. The effects of the above mentioned impacts on the river are evident at the outfalls and surrounding areas. Based on the reconnaissance survey, level of disturbance, and data provided by the Tres Rios geological assessment, the Corps believes that the potential for buried archeological resources within the project area is low. Additional surveys will be conducted as alternatives are refined.

A letter was sent to the Arizona State Historic Preservation Officer (SHPO) on July 6, 2005 with our determinations in accordance with 36 CFR 800.4(d). We received a letter of response dated August 10, 2005. This letter concurred with the APE as described in Section 4.4.5 above. The SHPO requested a written report of the survey conducted by Corps personnel. A Memorandum of Record (MFR) was completed describing the survey conducted in March 2004. Copies of all these documents can be found in Appendix N of the EIS.

All supporting documentation required under 36 CFR 800.11(d) will be sent to the SHPO. This includes the draft environmental impact statement (EIS). The archeologist representing the City of Phoenix will receive copies of SHPO communications in addition to a copy of the draft EIS.

4.2.8.6 Native American Concerns

Section 106 of the National Historic Preservation Act, as amended 16 U.S.C. 470 et seq. and the American Indian Religious Freedom Act of 1978, Public Law 95-341, 42 U.S.C 1996 require consultation and Coordination with Indian Tribal Governments all require that government agencies consult with Native Americans to determine their interests in federal projects.

Letters including project descriptions and requests for comments were sent to the interested tribes noted below on July 6, 2005. The MFR was transmitted to the tribes on October 6, 2005. Ak-Chin Indian Community, Gila River Indian Community, Hopi Tribe, Pascua Yaqui Tribe, Salt River Pima-Maricopa Indian Community, Tohono O'odham Nation, and Yavapai-Apache Nation. The draft EIS will also be sent to the above groups for comment along with all identification, evaluation, and mitigation studies.

4.2.9 Socioeconomics

Benefits and costs for flood damage reduction analysis was computed at FY05 price levels, but was recomputed at 5 1/8%. Costs for the restoration and recreation alternatives are FY06 price levels, and we are using 5 1/8%. Since no flood damage reduction alternatives are being pursued, additional price level update of the structure inventory was not necessary. The period of analysis is 50 years. The Base Year for economic computations is 2010.

4.2.9.1 Flood Damages

SRP maintains four dams on the Salt River, as well as two on the Verde River, of which only one dam on the Salt River has flood-control capacity. Granite Reef Diversion Dam is located about 5 miles downstream of the confluence of the Salt and Verde Rivers. At this dam site, all water is taken from the Salt River and diverted into the Arizona and South Canals, which deliver drinking and irrigation water to the greater Phoenix area. During significant flood events, the SRP is forced to release water over Granite Reef Dam into the normally dry Salt River.

Historical Flood Damages

The highest release from Granite Reef Dam since the construction of the Salt and Verde River dams occurred in February 1980, when 178,000 cfs was released because of heavy rains and rapid snowmelt in the watersheds. All downstream bridges through Phoenix were forced to close during that flood except the Central Avenue Bridge. Subsequently, most of the remaining bridges crossing the Salt River have been rebuilt to withstand flow rates of 200,000 cfs and greater. (However, the Roosevelt Dam has been modified so it is unlikely that such a large release would occur.)

High releases were also experienced in 1993 (approximately 130,000 cfs). Winter floods during the first three months of 1993 caused extensive damage to property and crops throughout Maricopa County. Total flood damages throughout the State during this storm were estimated at over $250 million in current dollars.

Information regarding damage estimates specific to the study reach was not available. However, current hydrologic data for the Salt River through the study area shows that peak discharges for the 100-year event are approximately 172,000 cfs. Current hydraulic analysis indicates that there are very few structures in the 100-year floodplain. Therefore, it is likely that damages throughout the study area reach were limited during these storms.

Floodplain Boundaries

An inventory of structures possibly susceptible to damage, and estimates of the value of these structures must first be developed in order to determine potential flooding damages. Floodplain boundaries depicted in Appendix A were used to determine properties susceptible to flooding up to the 500-year floodplain. The Rio Salado Oeste 500-year floodplain encompasses a large area, primarily to the south of the Salt River.

The floodplain has been further segmented into sub-areas, or Reaches, for analysis purposes. Those reaches are shown in Table IV-9 below. Critical factors used to determine reach boundaries include discharge/frequency characteristics, overflow spatial characteristics, and economic activity. Table IV-9 below provides a summary of reach characteristics, including approximate upstream and downstream boundaries.

Table IV-9: Floodplain Reach Definitions

Reach Name	Upstream Limit	Downstream Limit	Notes
1L	75th Ave.	91st Ave.	Only a few structures in this reach
2L	67th Ave.	75th Ave.	Small number of large-lot industrial and agricultural properties/structures along Southern Ave.; some residential development along Baseline Road
2R	67th Ave.	75th Ave.	Small number of structures at northwest corner of Roeser & 67th
3L	51st Ave.	67th Ave.	Under existing conditions, reach includes residential development at downstream end – northwest of Baseline and 67th. Removed under Base Year conditions
4L	43rd Ave.	51st Ave.	Small number of structures along 51st Ave. north of Southern
4R	43rd Ave.	51st Ave.	Includes a few structures just west of 51st Ave. adjacent to floodway
5L	35th Ave.	43rd Ave.	Large residential development in this reach on south side of Salt River; most of development removed from floodplain under Base Year conditions
5R	35th Ave.	43rd Ave.	Mostly industrial structures, concentrated south of Lower Buckeye, between 35th and 39th Aves
6L	27th Ave.	35th Ave.	Limited industrial/commercial development, primarily along Broadway Road
6R	27th Ave.	35th Ave.	Mostly industrial structures, concentrated along east side of 35th Ave., Lower Buckeye to floodway
7R	19th Ave.	27th Ave.	Small number of structures near 27th Ave. on north side of Salt River under existing conditions – removed under Base Year conditions

* Number of structures

The number of structures in the 100- and 500-year floodplains was determined based upon an analysis of aerial photography, parcel maps, real estate assessor's data, and a site survey. Table IV-10 shows that there are approximately 386 structures in the Rio Salado Oeste 500-year floodplain. Of these, 59 percent are residential (single-family residential/multi-family housing [SFR/MH]). Roughly 139 structures are located within the 100-year floodplain boundaries (about 36 percent of the structures in the 500-year floodplain). Reach 5L contains the majority (51 percent) of floodplain structures. This area contains numerous structures, primarily residential (including both single-family residences and mobile homes). Structures in this area are generally of fair to low-cost construction. Most single-family residential structures are of

block construction. The other area with the greatest number of structures is within Reach 6L (19 percent), east of 35th Avenue on the south side of the Salt River.

Table IV-10: Number Of Structures

Structure Type	100-Year	500-Year
SFR	15	207
MH	19	22
Industrial	78	114
Office/Commercial	27	43
Public	0	0
Total	**139**	**386**

Without-Project Damages

Expected annual damages by reach and structure type are shown on Table IV-11. Damages to industrial and agricultural structures and contents, primarily located in Reaches 2L and 5R, comprise most of the expected annual damages. This is attributable to the fact that these two reaches contain structures in close proximity to the floodway, and therefore are susceptible to more frequent flood events. It should be noted that these results reflect planned bridge improvements at 35th Avenue. Preliminary analysis indicates that expected annual damages without these improvements would be substantially higher (approximately $670,000 vs. $235,000).

Without-project damages by event for Base Year conditions, as calculated by the HEC-FDA program (see Table IV-11). The non-damaging event is approximately the 10-year event. However, most reaches do not incur damages until less frequent events. Damages calculated for the 20-year event are approximately $1.14 million. A majority of these damages are attributable to one parcel within Reach 5R. There are approximately 11 industrial structures on this parcel (located adjacent to the floodway on the west side of 35th Avenue) owned by a metal scrap recycling business.

Table IV-11: Without-Project Damages by Reach & Event (Base Year – 2010)

(in $1,000s)

Reach	10-year	20-year	50-year	100-year	500-year
1L	$ -	$ -	$ -	$ 1	$ 13
2L	$ -	$ 88	$ 754	$ 1,183	$ 1,561
2R	$ -	$ -	$ -	$ 8	$ 30
3L	$ -	$ -	$ 10	$ 87	$ 254
4L	$ -	$ 4	$ 52	$ 90	$ 125
4R	$ -	$ -	$ -	$ -	$ 10
5L	$ -	$ -	$ 59	$ 1,163	$ 4,039
5R	$ 38	$ 1,050	$ 2,615	$ 3,929	$ 5,633
6L	$ -	$ -	$ 52	$ 378	$ 1,056
6R	$ -	$ -	$ 2	$ 78	$ 659
7L/7R	$ -	$ -	$ -	$ -	$ -
Total	$ 38	$ 1,142	$ 3,544	$ 6,917	$ 13,380

Damages increase significantly for the 50-year event, and approximately double subsequently for the 100-year and 500-year events. A majority of the damages for these flood events are expected to occur in Reaches 5R and 2L (primarily industrial properties) and 5L (which is the reach with the large residential development discussed previously).

4.2.9.2 Demographics

Population

The southern portion of the study area lies in the southwest portion of the City of Phoenix, which has a total population of 1,321,045 (U.S. Census Bureau, 2000). Table IV-12 shows the 2000 population and household characteristics for the county and study area. In 2000, the county population totaled 3,072,149 (U.S. Census Bureau, 2000). The MAG projects that the county's population will grow to approximately 3,709,566 by 2010, and to approximately 4,516,090 by 2020, increases of 637,417 and 1,443,941, respectively (MAG, 2002). The study area makes up only 0.1 percent of the total county population (U.S. Census Bureau, 2000).

Table IV-12: Population and Household Characteristics in the Vicinity of the Study Area

Jurisdiction	Population	Number of Households	Persons per Household	Number of Families	Persons per Family
Maricopa County	3,072,149	3,027,366	2.67	763,110	3.21
Study Area	48,854	11,504	3.93	9,362	4.20
Source: U.S. Census Bureau, 2000					

Population Projections

Table IV-13 displays population estimates and growth projections for Maricopa County and the City of Phoenix, obtained from the MAG and U.S. Census Bureau Web sites. Strong growth for the county and city is expected through year 2050, although the rates of growth will be substantially lower than those experienced in the past decade.

Table IV-13: Projected Population and Annual Growth Rate (AGR) for Maricopa County and the City of Phoenix

Year	Maricopa County	AGR	City of Phoenix	AGR
1995	2,529,000		1,154,000	
2000	3,072,000	4.0	1,321,000	2.7
2010	3,710,000	2.0	1,544,000	1.6
2020	4,516,000	2.0	1,796,000	1.5
2050	7,265,000	1.6	2,568,000	1.2

Source: U.S. Census Bureau and Arizona Department of Economic Security

The Arizona Department of Economic Security projects that population within the Phoenix metropolitan area will total over 7.26 million by the year 2050. Growth rates for the region are anticipated to be more than double the National average throughout the period of analysis.

Ethnicity

The approximate population breakdown of the county by ethnicity is 66.2 percent White, 24.8 percent Hispanic, 3.5 percent African American, 1.4 percent American Indian and Alaskan Native, 2.1 percent Asian, 0.05 percent Native Hawaiian or other Pacific Islander, 0.1 percent other races, and 1.5 percent two or more races (U.S. Census Bureau, 2000). The ethnic composition of the study area differs from that of the county as a whole, most notably in the proportions of White and Hispanic residents (refer to Table IV-14). The proportions of the other

races do differ as well, although not as much. The approximate population breakdown in the study area is: 24.3 percent White, 62.0 percent Hispanic, 5.9 percent African American, 6.2 percent American Indian and Alaskan Native, 0.3 percent Asian, 0.06 percent Native Hawaiian or other Pacific Islander, 0.09 percent other races, and 0.85 percent more than two races.

Table IV-14: Ethnic Population Characteristics in the Vicinity of the Study Area

Jurisdiction	White	Black or African American	American Indian or Alaskan Native	Asian	Native Hawaiian or other Pacific Islander	Other	Hispanic or Latino	Two or more Races
Maricopa County	2,034,530	108,521	45,703	64,562	3,725	4,086	763,341	47,681
Percent of County Total	66.2%	3.5%	1.5%	2.1%	0.1%	0.1%	24.8%	1.6%
Rio Salado Oeste Study Area	11,714	2,918	3,019	166	31	47	30,543	416
Percent of Study Area Total	24.0%	6.0%	6.2%	0.3%	0.1%	0.1%	62.5%	0.9%

Source: U.S. Census Bureau, 2000

Income

Table IV-15 shows median household income for residents within Maricopa County and the study area for the year 1999. In 1999, the median household income for the county was $45,358; the median household income for the study area was substantially less, at $27,847 (U.S. Census Bureau, 2000).

Table IV-15: Median Household Income in the Vicinity of the Study Area

Jurisdiction	Median Income Amount
Maricopa County	$45,358
Study Area	$27,847

Source: U.S. Census Bureau, 2000

Additional demographic information can be found in Appendix F, Modified Phase I Environmental Site Assessment, and Appendix G, Economic Evaluation.

4.2.10 Real Estate

The majority of the land within the project area is privately owned. Within the floodplain, or the area where restoration measures will be proposed, this ownership includes sand and gravel companies, the State of Arizona, Maricopa County, and the City of Phoenix (Figure IV-10). The City of Phoenix currently owns approximately 511 acres in the project area and has a Recreation and Public Purposes Lease on an additional 159 acres of Bureau of Land Management property. A general summary of ownership of land within the 100-year floodplain is presented in Table IV-16. See Appendix G, Economic Evaluation, for more details.

Table IV-16: Property Ownership within the Study Area (100-Year Floodplain)

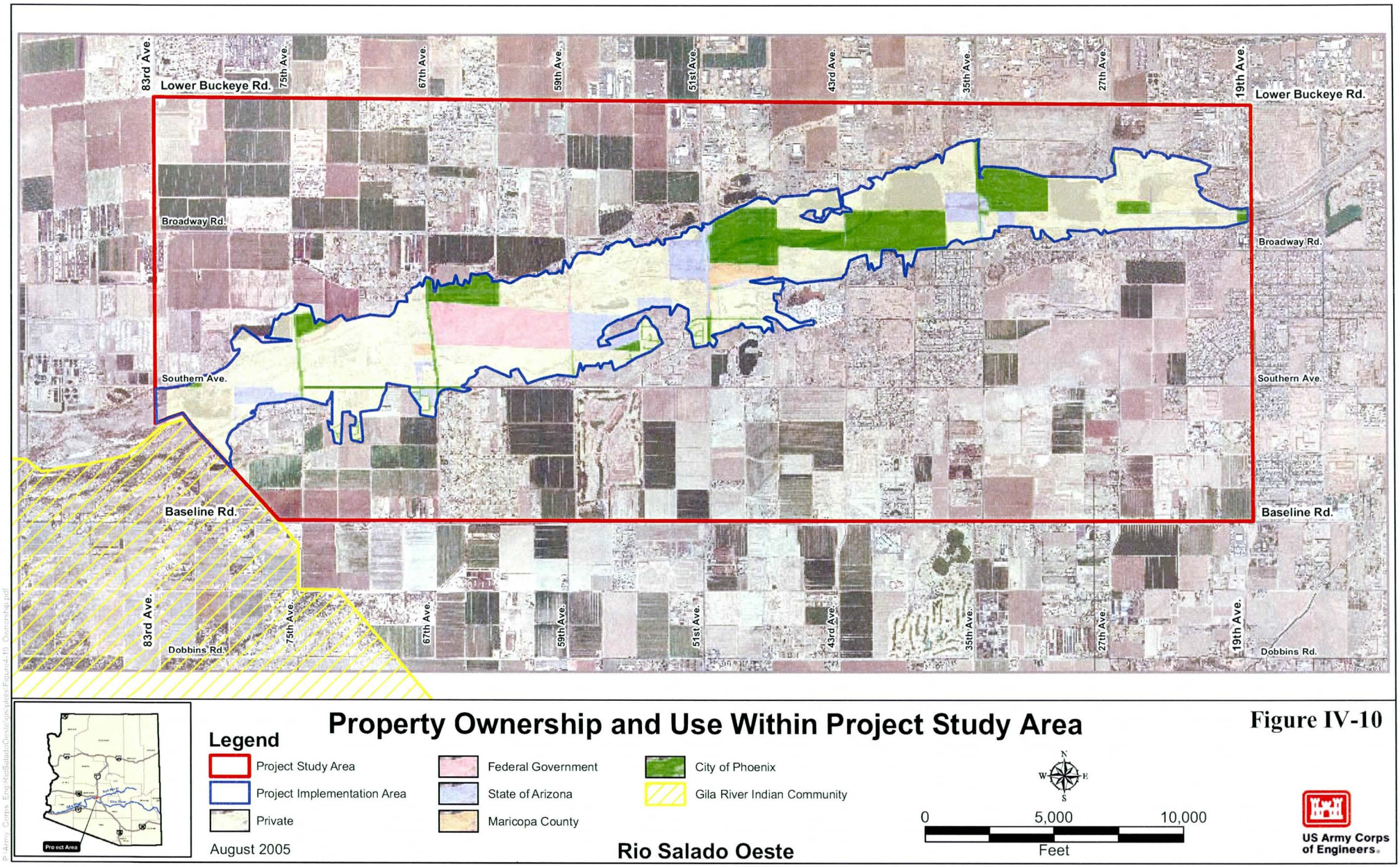
Owner Type	Acres
City of Phoenix	511
Maricopa County	118
State of Arizona	261
Federal	190
Private	2094
Total	3174

4.2.11 Recreation

4.2.11.1 Nearby Recreation Resources

Arizonans place high importance on the State's outdoor recreation resources. In the 1994 Statewide Comprehensive Outdoor Recreation Plan survey, 94 percent of respondents stated that parks and recreation areas are important to their everyday lifestyles. The greater Phoenix area does not currently have any significant riparian habitat areas with supporting recreation facilities. The major existing parks in the area consist primarily of desert mountain preserves, which do not contain the types of habitat that could be supported in the study area. For purposes of this analysis, the market area will be defined as the greater Phoenix metropolitan area, which would

include Maricopa and Pinal Counties, although it is likely that many visitors would be drawn from even greater distances.



Property Ownership and Use Within Project Study Area

Figure IV-10

Legend

- Project Study Area
- Project Implementation Area
- Private
- Federal Government
- State of Arizona
- Maricopa County
- City of Phoenix
- Gila River Indian Community

N W E S

0 5,000 10,000

Feet

August 2005

Rio Salado Oeste

US Army Corps of Engineers

Estrella Mountain Regional Park, South Mountain Park, and Papago Park are three of the largest recreation areas nearby the study area. Estrella Mountain Regional Park is owned and managed by the Maricopa County Parks and Recreation Department. The rugged and scenic Sierra Estrella Mountains are the most dominant features of Estrella Mountain Regional Park. The terrain of these mountains is characterized by very steep slopes, numerous rock out-crops, shallow soils, and sparse desert vegetation.

South Mountain Park is located about 3 miles south of the Salt River. It extends from about 48th Street on the east to 43rd Avenue on the west—a distance of over 10 miles. The park encompasses about 17,000 acres of desert mountain landscape and is the largest municipal park in the United States. It is bounded on the north by Baseline Road and on the south by Chandler Boulevard, and is over 3 miles wide in some places. It contains an activity complex, hiking and riding trails (extending over 40 miles), an interpretive center, lookouts, ramadas, picnic areas, and restrooms. According to the *Sonoran Preserve Master Plan*, annual park visitation during the 1990s exceeded 3 million.

Papago Park is located just north of the Salt River in eastern Phoenix and western Tempe. It includes about 1,400 acres bounded on the north by Oak Street, on the south by State Highway 202, on the west by 52nd Street, and on the east by 68th Street. The park includes rock formations dating back 15 million years, ramadas, picnic facilities, three fish ponds stocked with rainbow trout and channel catfish, a baseball stadium, a softball complex, volleyball courts, the Phoenix Zoo, botanical gardens, a state historical museum, two golf courses, an archery shooting range, nature trails, and restrooms. Annual visitation exceeds 2 million.

In addition to South Mountain Park, the Phoenix Mountain Preserve is the other major mountain-preserve area in greater Phoenix. Located in the northeastern section of the city, the Phoenix Mountains comprise combination of regional parks and preserves. The regional parks represent the partially developed areas, while the preserves represent the areas which are completely undeveloped except for trails. There are about 1,800 acres of regional parks embedded within the preserves, including the North Mountain, Phoenix Mountain Park (formerly Squaw Peak), and Shaw Butte recreation areas. These parks include extensive trails systems, picnic areas, and

restrooms. North Mountain recreation area also features basketball and volleyball facilities and a playground. The combined visitation at North Mountain and Phoenix Mountain Park and Recreation Area has totaled approximately 1.5 million in recent years.

Study Area Recreation Resources

Recreation in the study area is highly dependent upon the availability of surface water and riparian habitat, both of which are dependent upon the supply and availability of groundwater. The portion of the Salt River that passes through the City of Phoenix has, until the recently authorized Rio Salado and Tres Rios Projects and the upstream Tempe Town Lake, consisted of dry river bottom. As a result, virtually no recreation activities took place.

The only improved recreation area adjacent to the Salt River was Rio Salado Park, which is located at 12th Street and Elwood. The park encompasses about 14 acres and contains picnic facilities and racquetball and basketball courts. Most of the users are employees who work at industrial businesses located in the area. According to the City of Phoenix Parks Department, fewer than 200 people visit the park on a weekly basis (or fewer than 10,400 annually). There are currently no plans for expansion of the park, and visitation is not expected to increase in the absence of a Corps project.

The following shows the names and annual visitation for other community parks in the Phoenix area.

Table IV-17: Parks and Annual Visitors for Community Parks

Park	Visitation	Features
Hayden Park	121,000	14 acres, with picnicking, softball, basketball, playground, restrooms
Estaban Park	58,000	62 acres, with picnicking, softball, soccer, volleyball, tennis, playground, restrooms
El Prado	61,000	40 acres, with swimming pool, softball, picnicking, playground, restrooms
Cesar Chavez	310,000	353 acres, with 25-acre lake with fishing/sailing/canoeing, picnicking, restrooms
Encanto	1,200,000	63 acres, with fishing lagoon, 18-hole golf course, clubhouse, swimming pool, racquetball, tennis, basketball, softball, children's play area
Echo Canyon	350,000	387 acres with hiking trails.

The Rio Salado Project stretches from an upstream limit of 28th Street to a downstream limit of 19th Avenue (which is the upstream limit for this study) and comprises environmental restoration and passive recreation components along the Salt River. Approximately 5 miles (and 580 acres) of the Salt River will be restored to create riparian and wetland habitat. Passive recreation facilities, including over 10 miles of trails and interpretive signage, are also included. Construction commenced on the project in 2000. Recreation project features include parking lots, information kiosks, a visitor center, overlooks, shade structures, bridges, trails, an equestrian staging area, signage, and landscaping. Recreation activities provided by the plan include walking, hiking, biking, horseback riding, rollerblading, picnicking, and bird watching. Scenic overlooks will be included for the enjoyment of the restored desert riparian habitat. Information kiosks and the visitor center will provide education on the resource, including restoration of the habitat, the hydro cycle, a historical perspective of the Salt River, and flora and fauna within the project area. As documented in the Rio Salado Feasibility Study, annual visitation is expected to exceed 500,000.

In addition to the Rio Salado Project, the Tres Rios Project just downstream of the study area will also provide recreation opportunities. The Tres Rios Project is located immediately downstream of the study area, beginning at the 91st Avenue WWTP. Components of this plan include new levee alignments for flood control, the establishment of wetland, marsh, and riparian habitat, and passive recreation/environmental education facilities.

Immediately upstream of the Rio Salado Project is Tempe Town Lake. The lake was constructed within the existing Salt River flood control channel (about 850 feet in width), extending from the Salt River's confluence with Indian Bend Wash to approximately 2 miles downstream. The river's flood control conveyance capacity is retained through the use of a system of rubber dams that can be deflated during significant floods. The lake contains about 220 surface acres and 20,000 feet of shoreline supporting paddle boating, canoeing, sailing, and fishing. Tempe is hoping to establish the State's largest urban fishing program. Over 1,000 acres of adjacent land has been dedicated for recreational development and open space. Activities will include picnicking, hiking, bicycling, horseback riding, softball/baseball, volleyball, golfing, water slides

and play areas. Other possible recreational uses include soccer and major sports events, such as marathons.

While water is a highly attractive feature for recreationists, park trails and facilities have presently been planned away from the Gila River. Once the county completes its Sun Circle Trail System through this reach of the Gila and Salt Rivers, recreation use patterns are expected to expand throughout the study area. The Sun Circle Trail, a component of the National Recreation Trail system, is a 110-mile loop encompassing the Phoenix metro area. The trail offers a unique opportunity for hiking, horseback riding, and bicycling throughout the urban area. Approximately 70 percent of the Sun Circle trail system is in place. The county has an agreement with the FCDMC to establish the Sun Circle Trail within the flood control district corridor from Skunk Creek to the Gila River–Salt River confluence. The Rio Salado Oeste Project is an excellent opportunity to designate a segment of the Sun Circle Trail. This would benefit Tres Rios, Rio Salado, and Rio Salado Oeste with a major nonmotorized travel way connecting the three river-restoration projects to the other valley areas.

Educational Opportunities

There are no formal environmental-education opportunities associated with the existing Salt River corridor in the study area. As agricultural land near the river is converted to residential, the need for recreation will increase. The 27th Avenue Solid Waste Recycling Facility (just north of the river) has an existing environmental-education master plan. The facility provides tours for children and adults. The 23rd Avenue WWTP also does environmental-education programming and touring for water treatment. These existing facilities provide an opportunity to link environmental education that could be developed for a restored river corridor. Upstream of the study area, the Rio Salado Project will include over 10 miles of trails, an environmental-education facility, and passive recreation opportunities. Passive recreation facilities are also planned downstream for the Tres Rios Project. There are opportunities to link recreation facilities at the study area with those that will be constructed upstream and downstream.

4.2.12 Summary of historic and existing conditions

As can be seen by the existing conditions presented in this section, the problems associated with this reach of the Salt River are significant. Federal dams constructed in the early 1900s on the upper Salt and Verde Rivers have limited flows in the lower Salt River. In pre-settlement times, the Salt River was one of the few perennial streams supporting riparian areas of the Sonoran desert with highly productive cottonwood, willow, and mesquite habitats. These areas were rich in habitat diversity, supporting a wide variety of wildlife species. As the lower Salt River Valley became developed, riparian habitat was degraded significantly. The upstream Federal water projects curtailed year-round water flows and converted the once perennial Salt River into a dry riverbed devoid of habitat. In addition, the area is experiencing rapid growth and most areas adjacent to the river have been or are being developed. Only sporadic vegetation exists in the study area today, and those few native vegetation communities are seriously degraded. However, many opportunities to address problems through environmental restoration measures do exist. Since recreation opportunities in the study are limited and since recreation is compatible and desired in conjunction with ecosystem restoration, they will be evaluated during plan formulation. Although not repeated in this chapter, detailed description of additional resources and areas of environmental compliance are included in the companion Environmental Impact Statement.

4.3 EXPECTED FUTURE WITHOUT-PROJECT CONDITION (2010-2060)

The future without-project condition is defined as that condition expected to exist in the absence of any action taken (by the Federal Government) to solve the stated problems. This condition is vitally important to the evaluation and comparison of alternative plans and the identification of impacts (both beneficial and adverse) attributable to proposed Federal actions. The future without-project condition forecast provides a description of anticipated actions external to the project and the anticipated consequences of these actions.

4.3.1 Hydrology

The hydrologic analysis for Rio Salado Oeste first considered baseline conditions. Baseline flow rates for the Salt River were available from a 1996 Corps analysis of the river, completed as part

of a modification project for the Roosevelt Dam. This report contained flow rates for the 5-, 10-, 25-, 50-, 100-, and 500-year events along the river at Central Avenue and 67th Avenue. The flow rates at these two locations were similar to each other for each event, and overall the flow rates varied from 20,000 to 240,000 cfs with the 100-year event equating approximately 166,000 cfs. The values presented from this analysis were for baseline hydrologic conditions.

For future hydrologic conditions, the same flow rates as the baseline conditions were used. However, a continuous hydrograph of the Salt River was used to simulate the erosion and deposition for the study reach. This hydrograph had a period of record from 1889 to 1993, and the worst 50-year period (1889 to 1938) effectively represented the period of record for use in the future-conditions models. The peak flow in this period was about 190,000 cfs, which placed it between the 100- and 500-year events in magnitude. After the sediment simulation, the n-year flood events described above were used to simulate the future without-project condition. For purposes of ecosystem restoration it was assumed that base flow is virtually non existent with the exception of storm water runoff and effluent which is discussed in Section 4.2.4 Water Supply.

4.3.2 Hydraulic Conditions

For the hydraulic analysis of current conditions, the effective HEC-RAS (RAS) model that was created as part of the FEMA Flood Insurance Study of this portion of the Salt River was used. The cross sections from this model that were located between 19th Avenue and 91st Avenue were extracted and supplemented with additional cross sections. Terrain data for all of these cross sections was mostly acquired from a TIN terrain data set created for the Salt/Gila River Master Plan completed in 1992. Additional terrain data were taken from available two-foot contours and 30-meter Digital Elevation Maps. Other changes made to the effective RAS model included slight modifications to the Manning's *n* values, the addition of new bridges at 27th and 51st Avenues, and the adjustment of the ineffective flow areas. The discharges used in this model were taken from the 1996 Corps report mentioned earlier. It is unclear how these flows compared to the flows found in the effective FEMA model.

The results of these updated baseline models were compared to the effective FEMA model. From the downstream end of the models to River Station 204.25, the profiles were essentially

identical. At this location, the geometries began to differ between the two models, and this difference caused the updated model to have an elevation 0.45 foot higher than the FEMA model. Between Stations 204.34 and 205.15, the differences between the models increased, with the FEMA model calculating elevations 0.6 to 2.54 feet higher than the updated model. In this area, most of the differences were attributed to variations in the placement of ineffective flow areas. Between Stations 205.25 and 206.51, the two profiles approached each other to within 0.4 foot. However, between Stations 206.6 and 207.07, where there are mining pits within the channel that were handled differently by each model, the updated model produced elevations 0.53 to 2.07 feet higher than the FEMA model. At cross section 207.34, the updated model was 0.78 foot higher, but the difference approached zero at sections 207.48 and 207.49. By Station 207.53, the updated model was 0.49 foot higher. Between Stations 207.62 and 208.75, the models once again produced nearly the same results, but between cross sections 208.85 and 209.24, the update model generated values 0.46 to 2.15 feet higher. Over the remainder of the models, which extended from Station 209.42 to 211.54, the models produced significantly different results based on the differing geometries used to represent the 35th Avenue Bridge.

For analysis of future without-project conditions, the changes to the bed profile were predicted over the next fifty years due to erosion. The geometry from the current conditions RAS model were used to create a sediment-transport model. The sedimentation model used was HEC-6T, and this model produced results within 10 percent or within 1 foot of the depths in the existing conditions RAS model, whichever was smaller, for the 5-, 10-, and 100-year events under fixed bed conditions.

The Corps program SAMAID was used to determine the most appropriate sediment transport relationship, and this investigation determined that Madden's 1985 modification of Laursen's equation and Yang's equation were the best and second best choices, respectively. Based on its use of Yang's equation in previous studies of the Salt River upstream and downstream of this project's extent, Yang's equation was chosen to model the future conditions sediment transport.

The sedimentation model was then run over a 50-year period using the Salt River hydrograph from 1889 to 1938, and bed profiles were output at the end of each ten-year interval. For ease of modeling computations, all of the relevant 105 years of historical discharge information were

effectively represented by needing only to simulate the period of record from 1989 to 1939. In addition, the constructed continuous 50-year hydrograph also reflects Salt River flood flows that have been normalized by flow regulation at the upstream Roosevelt Dam. The results of this model were used to create the geometry for the future-conditions RAS model. Overall, areas along the Salt River with ongoing mining operations experienced the greatest changes. In areas where mining was not present, the bed changes reached a maximum of 5.8 feet after 50 years with an overall average change of 1.9 feet.

Five new RAS models representing future conditions in 10, 20, 30, 40, and 50 years were created from the bed profiles predicted by the HEC-6T model. Otherwise, the future RAS models used parameters identical to those found in the existing-conditions RAS model. Overall, the future-conditions RAS models had smoother water surface profiles based on a smoothing of the stream bed over time. The major differences in water surface elevation occurred upstream of the 35th Avenue Bridge, with the future RAS models predicting lower water surface elevations due to erosion at this bridge. There are some other small stretches of the Salt River where moderate decreases in water surface elevations occur over time, but overall the future conditions RAS models mostly predicted decreases in the water surface profile of less than 1 foot within the study reach.

4.3.3 Biological Resources

Modifications of the river system, such as damming and flow diversion, currently allow no natural flow through the project study area except during flood events. The Salt River below Granite Reef Diversion Dam is essentially devoid of vegetation. Vegetation communities in the project study area have been highly modified from their original state and currently contain a mosaic of degraded natural communities and manmade artificial communities. These include a number of open water areas that are essentially old or abandoned borrow pits resulting from sand and gravel mining. Dense vegetation dominated by tamarisk or salt cedar, with some cottonwood and willows as well as the occasional cattail or bulrush, lies adjacent to some of these abandoned pits. Without the project, the biological resources within the study area are expected to continue to degrade. Without modifications to improve the functional components and improve the efficiency and effectiveness of the water resources available the diversity of species that are

currently supported are expected to decline, and most of the remnant high value habitat (cottonwood, willow, and mesquite bosque) would be replaced with undesirable invasive plant species would become or devoid of vegetation altogether.

Habitat Evaluation

Table IV-18 below displays cover types and projected acreages in the study area (100-year floodplain only) and how they are projected to change under future without-project conditions. Figure IV-11 shows that the without-project AACFU output is forecast to remain essentially unchanged (the slight decline from 583 AAFCU to 579 AAFCU is due to rounding error).

Key assumptions in projecting the future conditions include:

- All remaining agricultural land (133 acres) will be developed within five years.
- Remaining cottonwood/willow forest will decrease from 112 acres to 25 acres over 50 years due to reduced water supply, increased urbanization, and expansion of non-native saltcedar.
- Emergent wetlands will decrease slightly from 30 to 25 acres but will remain in areas of surface discharge and stormwater outfalls. O&M activities at these outfall locations will disturb and result in periodic reductions in quantity and quality of the existing emergent wetland areas
- The amount of dry river bottom is expected to increase from 66 acres to 71 acres, as the wetlands are lost.
- The amount of open water will decrease from 240 to 80 acres as other uses for effluent and dewatering are established. Existing areas of open water will likely be converted to bare earth or support undesirable low-value and/or non-native and invasive species, eventually converting to scrub-shrub and desert-wash cover. The amount of scrub shrub will increase from 1,566 to 1,653 acres.
- It is not possible to project acreage changes in sand and gravel operations, but it is assumed that some operations will go out of operation while others start operating. In

general, these activities would migrate downstream, to the west end of the study area following the urban development.

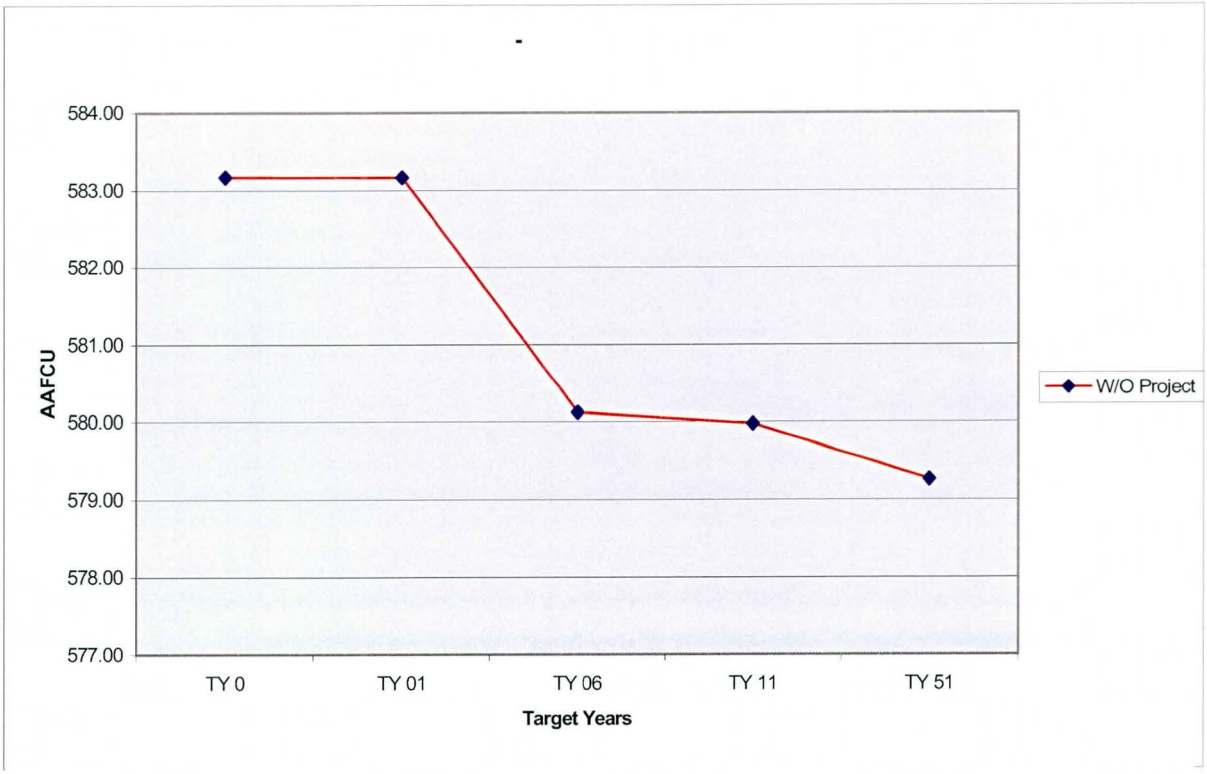


Figure IV-11: Future Without Project

- The reduction in water supply and decrease in surface flows will result in the reduction and/or elimination of one of the key mechanisms that drive many biochemical and biogeochemical processes that are associated with movement and cycling of nutrients.
- No establishment of new: cottonwood/willow forest, wet river bottom, emergent wetlands, open water, or mesquite woodlands or bouquets is expected.
- There will be a decrease in the connectivity and spatial structure of the remnant high-value cottonwood/willow strands and a disconnect between the authorized Rio Salado Restoration and Tres Rios Demonstration Projects.
- The biological diversity within the study area is expected to decrease with the reduction in high valley cottonwood/willow forest for cover, breeding, nesting, foraging, and fledging

activities. The reduction of open water and emergent wetland areas reduces and/or eliminates a key habitat or life history/cycle component for many native wildlife species and neo-tropical migratory songbirds and over-wintering waterfowl and wading birds.

- The disturbance from unregulated recreation, OHV traffic, and "wildcat" dumping is expected to continue and potentially increase in some areas, further degrading the riparian system and the remaining higher value remnant habitat it currently supports.

Table IV-18: Cover Types and Projected Acres Without Project

COVER	DESCRIPTION	Target Year 0	Target Year 01	Target Year 06	Target Year 26	Target Year 51
AGCROP	Farms and croplands in the uplands - dairy, cotton, and alfalfa	133.00	133.00	0.00	0.00	0.00
CWWFOREST	Existing cottonwood/willow forests in the active channel	112.00	112.00	80.00	50.00	25.00
DITCHES	Existing ditches in the uplands	3.00	3.00	3.00	3.00	3.00
WETRVRBOTTOM	Existing emergent wetlands in the uplands - cattails, cienegas and grasses	30.00	30.00	25.00	25.00	25.00
MESQUITE	Existing mesquite woodlands - on the terraces and in the active channel	0.00	0.00	0.00	0.00	0.00
NEWWETRVRBOTTOM	Newly constructed river channel, includes emergent wetlands within the channel	0.00	0.00	0.00	0.00	0.00
NEWCWWFOR	Newly planted cottonwood/willow forests in the active channel	0.00	0.00	0.00	0.00	0.00
NEWDRYRVRBOTTOM	Newly developed dry river bottom areas in the active channel – largely unvegetated	0.00	0.00	0.00	0.00	0.00
NEWMESQUIT	Newly planted mesquite woodlands - on the terraces and in the active channel	0.00	0.00	0.00	0.00	0.00
NEWOPENWAT	Newly developed open water in the active channel	0.00	0.00	0.00	0.00	0.00
OPENWATER	Existing open water in the active channel - inactive sand and gravel operations	240.00	240.00	168.00	118.00	80.00
DRY RIVER BOTTOM	Existing river bottom in the active channel - largely unvegetated	66.00	66.00	71.00	71.00	71.00
SCRUBSHRUB	Existing scrub-shrub lands in the active channel - rabbitbush, quailbush, ironwood, and saltbush	1566.00	1566.00	1598.00	1628.00	1653.00
SANDGRAVEL	Existing sand and gravel operations/extractions in the active channel	671.00	671.00	671.00	671.00	671.00
DESERT	Desert or bare earth	0.00	0.00	72.00	122.00	160.00
URBAN	Existing residential, industrial and transportation avenues in the uplands	327.00	327.00	460.00	460.00	460.00
	TOTAL ACRES:	3148.00	3148.00	3148.00	3148.00	3148.00

4.3.4 Land Use

Based upon the City of Phoenix General Plan (Revised February 2001), most of the land area on the north side of the Salt River between 19th Avenue and 59th Avenue is zoned as industrial, with some high-density residential between 43rd Avenue and 60th Avenue. From 60th Avenue to 83rd Avenue, the primary land use is low-density residential. South of the Salt River, there is some land between 19th Avenue and 35th Avenue zoned as commercial. Otherwise the prevailing land use designation is low- to medium-density residential. Estrella Village and Laveen Village are the two primary planning areas that lie adjacent to the Salt River between 19th Avenue and 83rd Avenue. Estrella Village is characterized by an ample supply of undeveloped land, large parcels, natural and scenic amenities, and excellent transportation access. As noted on the City of Phoenix Web site, the village also poses unique challenges given the isolation of its existing residential neighborhoods and the extensive industrial activities that have developed over the years. Approximately 62 percent of the Village is undeveloped, either vacant or with agricultural uses. However, there are 21 residential developments in various phases of approval and development (Figure IV-12). Over 8,000 new single-family housing units were

Figure IV-12: New Subdivision along Southern Avenue South of the Project Area

approved in this area in 1999 alone. Primary agricultural crops grown in the area include cotton, citrus, and corn. Farmers, equestrians, and those looking for solitude and mountain access have valued the area.

Land use is quickly changing within the study area as farmland is quickly converted to residential subdivisions, and associated commercial development follows. The study team assumed that within 5 years the lands adjacent to the floodplain would all be developed in some way, maybe sooner. Lands within the floodplain, however, are not expected to be developed unless by future aggregate operations or closure of existing operations.

4.3.5 Recreation

Based upon conversations with representatives from the City of Phoenix Parks and Recreation Department, the AGFD, and other agencies, the proposed habitat and recreation features would attract visitors throughout the Phoenix Valley region. The greater Phoenix area does not currently have any significant riparian habitat areas with supporting recreation facilities. The major existing parks in the area consist primarily of desert mountain preserves, which do not contain the types of habitat that could be supported in the study area. For purposes of this analysis, the market area will be defined as the greater Phoenix metropolitan area, which would include Maricopa and Pinal Counties, although it is likely that many visitors would be drawn from even greater distances. Currently, there are no recreation features that exist in this reach of the Salt River. The activities that do take place in the river corridor in general serve to accelerate the rate of degradation. As the area degrades over time, fewer people will select the study area for recreational activities.

4.3.6 Economics

4.3.6.1 Results – Future Conditions (2059)

Hydrologic and hydraulic analyses were conducted for future without-project conditions to determine the impacts of processes such as sedimentation and channel degradation and the resulting impacts on potential flooding. Updated water surface profiles and stage/discharge uncertainty data were used to re-compute expected annual damages under future conditions. The

results are summarized in Table IV-19. A more detailed description of the estimates can be found in Appendix G, Economic Evaluation.

Table IV-19: Without-Project Expected Annual Damages – Future Conditions (2059) ($1,000)

Reach	SFR/MH	Ind/Ag	Office/Com	Public	Total
1L	$ -	$ -	$ -	$ -	$ -
2L	$ 4	$ 16	$ 1	$ -	$ 21
2R	$ -	$ -	$ -	$ -	$ -
3L	$ 2	$ -	$ -	$ -	$ 2
4L	$ 1	$ -	$ -	$ -	$ 1
4R	$ -	$ -	$ -	$ -	$ -
5L	$ 8	$ 4	$ 1	$ -	$ 13
5R	$ -	$ 98	$ 14	$ -	$ 112
6L	$ 1	$ 5	$ 2	$ -	$ 8
6R	$ -	$ 1	$ 1	$ -	$ 2
7L/7R	$ -	$ -	$ -	$ -	$ -
Total	$ 16	$ 124	$ 19	$ -	$ 159

Without-project expected annual damages actually decrease from about $245,000 under Base Year conditions to about $159,000 under future conditions (a drop of about 35 percent). Water surface elevations are generally lower throughout the study area under future conditions due primarily to projected channel degradation and resulting in creases in channel capacity (refer to Appendix A, Hydrology and Hydraulics).

Equivalent annual damages were computed based upon forecast annual damages using a discount rate of 5 3/8 percent (see Table IV-20).

Table IV-20: Without-Project Equivalent Annual Damages (50 Yrs, 5 1/8 Percent) ($1,000s)

Reach	SFR/MH	Ind/Ag	Office/Com	Public	Total
1L	$ -	$ -	$ -	$ -	$ -
2L	$ 7	$ 24	$ 2	$ -	$ 32
2R	$ -	$ -	$ -	$ -	$ -
3L	$ 2	$ -	$ -	$ -	$ 2
4L	$ 2	$ -	$ -	$ -	$ 2
4R	$ -	$ -	$ -	$ -	$ -
5L	$ 24	$ 4	$ 1	$ -	$ 29
5R	$ -	$ 126	$ 16	$ -	$ 142
6L	$ 1	$ 6	$ 3	$ -	$ 10
6R	$ 1	$ 2	$ 2	$ -	$ 5
7L/7R	$ -	$ -	$ -	$ -	$ -
Total	$ 37	$ 161	$ 24	$ -	$ 222

As shown on Table IV-21, equivalent annual damages are concentrated in a few reaches. Reach 5R accounts for about 60 percent of total without-project damages. This reach contains a small concentration of industrial structures along 35th Avenue, primarily south of Lower Buckeye Road. There are several parcels with multiple structures that are within the 50-year floodplain, and just outside the 20-year floodplain. The risk and uncertainty analysis indicates that these structures may be flooded by events more frequent than the 20-year event.

Table IV-21: Without-Project Equivalent Annual Damages (in $1,000s)

Reach	Structure and Content	Cleanup	Temp. Housing	Total
2L	$ 32	$ 10	$ 0.4	$ 42
3L	$ 2	$ 1	$ 0.1	$ 3
4L	$ 2	$ -	$ 0.1	$ 2
5L	$ 29	$ 4	$ 0.9	$ 34
6L	$ 10	$ 3	$ 0.1	$ 13
Total - S. of River	$ 75	$ 18	$ 1.6	$ 95
5R	$ 142	$ 5	$ -	$ 147
6R	$ 5	$ 0.5	$ -	$ 6
Total - N. of River	$ 147	$ 6	$ -	$ 153
Total	$ 222	$ 24	$ 2	$ 247

Note: Damages for Reaches Not Shown are Minimal

On the south side of the Salt River, Reach 2L has the highest amount of expected annual damages. Damages in this reach are attributable to the proximity of several structures to the floodway on the north side of Southern Avenue between 75th and 67th Avenues.

The highest concentration of residential damages is located in Reach 5L. Although there are nearly 200 structures in this reach, damages are limited due to the low per-unit structure values and because most are outside the 100-year floodplain. Most of the structures in this reach are located just southwest of Broadway Road and 35th Avenue.

The only other reach with significant damages is Reach 6L. This reach includes industrial and commercial structures located along Broadway Road between 35th and 27th Avenues.

Impact of Assumed Rio Salado Marsh on Without-Project Damages

Under existing conditions there is potential for flood damages in the study area. However, the planned improvements to the 35th Avenue Bridge and the Rio Salado Marsh that will take place from 37th to 51st Avenues virtually eliminate the potential for damage in the adjacent reaches. Additional floodplain delineations showing Base Year floodplain boundaries with both the bridge improvements and the channel excavation have not been prepared. However, water surface profiles have been developed, and an analysis of these water surface profiles shows that the potential for flooding in the 35th Avenue area is greatly reduced.

A detailed analysis of without-project flood damages reflecting the assumed Rio Salado Marsh between 37th and 51st Avenues has not been completed. However, water surface profiles have been developed for with-project alternatives that reflect the impacts of both the excavation and the features of the alternatives. It has been determined that the impacts of the excavation, particularly in Reach 5 area, are significant. In fact, it appears that the additional channel capacity created by this excavation will greatly reduce the potential for any flooding in this area. As this was the primary damage area under previous assumptions, the removal of the flood threat for this area essentially leaves only minor residual flooding, primarily in Reach 2, under without-project conditions.

CHAPTER V
PLAN FORMULATION AND EVALUATION

This chapter presents the results of the plan formulation process used in the development of alternatives to address the planning objectives for the Rio Salado Oeste study area. This chapter describes the analysis used to arrive at the final set of alternatives as well as the decision-making process that leads to the selection of a recommended plan. Alternative plan development includes identification of all reasonable solutions to address the identified problems and an initial screening to eliminate inefficient and ineffective solutions. These solutions include operational changes or project features or "measures," that form the building blocks of an alternative plan.

5.1 PLANNING PROCESS

This section presents the rationale used in the development of this plan. The Corps of Engineers' six-step planning process specified in ER 1105-2-100 (Planning Guidance Notebook) is used to develop, evaluate, and compare the array of candidate plans that are considered. The plan formulation process includes the following steps:

1. The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified.

2. Existing and future without-project conditions are identified, analyzed, and forecasted. The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.

3. The study team formulates alternative plans that address the planning objectives. An initial set of alternatives is developed and is evaluated at a preliminary level of detail.

4. Each plan is evaluated for its ability and extent of meeting the specified planning objectives and constraints, as well as efficiency, completeness, and acceptability. The impacts of alternative plans are evaluated using the system of accounts framework specified in the Principles and Guidelines and ER 1105-2-100.

5. Alternative plans are compared to each other. A benefit-cost analysis is conducted to prioritize and rank flood damage reduction alternatives. Cost effectiveness and incremental cost analysis is used to prioritize and rank ecosystem restoration alternatives. A public involvement program obtains public input to the alternative identification and evaluation process.

6. The plan with the greatest net benefits is selected for recommendation if at least one plan exists displaying Federal interest. A locally preferred plan may be recommended and approved if the non-Federal sponsor desires other acceptable project features than those in the National Economic Development (NED) or National Ecosystem Restoration (NER) Plans.

5.2 PROBLEMS AND OPPORTUNITIES

Water resources projects are planned and implemented to solve problems, meet challenges, and seize opportunities. In the planning setting, a problem can be thought of as an undesirable condition, while an opportunity offers a chance for progress or improvement. The identification of problems and opportunities gives focus to the planning effort and aids in the development of planning objectives. Although they are considered in plan formulation they should not be confused with planning objectives for which solutions will be formulated or plans recommended. Problems and opportunities can also be viewed as local and regional resource conditions that could be modified in response to expressed public concerns. This section identifies the problems and opportunities in the study area based on the assessment of existing and expected future without-project conditions.

5.2.1 Public Concerns

Local experience with similar restoration projects and public input were considered during all phases of plan formulation. The initial public meeting was held on September 13, 2001. Meetings and presentations were also held with the Rio Salado and Tres Rios Advisory Committees to seek stakeholder and agency input. Areas of concern included technical considerations based upon the specifics of the study, vector control, flood damage reduction, and opportunities for recreation. Additional public meetings are being scheduled to correspond with release of the Draft Feasibility Report.

The planning effort included extensive involvement by the various offices of the City of Phoenix, as well as agencies (e.g., USFWS, FCDMC, AGFD). Numerous plan formulation workshops and meetings were held during the feasibility phase. These workshops and meetings introduced the project to the public, gave individuals and agencies an opportunity to identify issues for consideration in this feasibility report, and solicited input on the project.

5.2.2 Problems

- Degraded river and adjacent overbank areas, due to upstream water resources development, has eliminated native riparian plant species and wildlife habitat. Perennial base flow conditions, critical to the needs of native plants, no longer exist in the river corridor through the study area.

- The average depth to groundwater beneath the river channel is much greater than historic conditions. Riparian vegetation that depends on groundwater has largely disappeared from the river channel.

- The construction of dams has reduced natural flooding. Records show that there were two to four floods per year prior to dam construction in 1941. These changes in the river system have adversely impacted the surface/groundwater interactions and sedimentation dynamics that are important for sustaining and regenerating riparian vegetation.

- The greater Phoenix area is lacking in significant riparian habitat areas with supporting recreation facilities. The major parks in the area consist primarily of desert mountain preserves, which do not contain the types of habitat that could be supported in the study area. There are no formal existing recreation or environmental-education opportunities associated with the existing river corridor. As agricultural land near the river is converted to residential, the need for recreation will increase. The 27th Avenue Solid Waste Recycling Facility (just north of the river) has an existing environmental-education master plan. The facility provides tours for children and adults. The 23rd Avenue WWTP also does environmental-education programming and touring for water treatment.

- Land use changes, including landfills and sand and gravel mining, bridges, pipes, stabilization measures, and outfalls, have degraded and are contributing towards continued degradation of the river corridor.

- Unsuitable bank conditions exist at many locations. Surface dumping and manmade bank changes have resulted in a degraded and unsafe bank in many locations.

- Previous reports identified the existence of contaminated sediments, including contamination by DDT, from approximately 51st Avenue continuing downstream. The contaminated sediments have been documented to extend continuously in the Salt-Gila River corridor all the way to the Corps-owned-and-operated Painted Rock Dam, near Gila Bend, Arizona. Although a previous report cited concern about the presence of DDT in the sediments from 51st Avenue downstream, there has not been a recent detection of it within the project area.

- Flooding and drainage problems exist in the Salt River. Contributing to these problems are flooding and drainage issues addressed by the Laveen and Durango Area Drainage Master Plans, which are being prepared by the MCFCD.

- Contributing interior drainages lack current hydrology information at all discharge points into the Salt River. Adequate points of disposal do not exist at many interior drainage discharge locations.

- There is a flooding problem on the south side of the river, within the 100-year floodplain, between 67th Avenue and 75th Avenue.

- Existing cultural resources need protection from erosion and vandalism.

- The extent and significance of existing cultural resources are unknown.

5.2.3 Opportunities

- There is an opportunity to restore degraded river and adjacent overbank area by restoring perennial base flow conditions. There is an opportunity to link other upstream and downstream projects to provide a continuous restoration and flood control corridor.

These would include the authorized Rio Salado Project and the authorized Tres Rios Project.

- There is an opportunity to utilize groundwater for restoration and other needs, as agricultural groundwater pumping phases out. This opportunity may be the greatest in the Laveen area.

- There is an opportunity to simulate the natural flood regime to sustain and regenerate riparian vegetation.

- There is an opportunity to increase recreation opportunities by taking advantage of existing open water bodies, locations in the river, and adjacent properties as potential recreation sites (i.e., public fishing areas). There is also an opportunity to incorporate trails and other passive recreational features. The existing WWTPs on 27th Avenue and 23rd Avenue provide an opportunity to link environmental education that could be developed for a restored river corridor.

- There is an opportunity to reduce and/or modify land use changes (i.e., landfills and sand and gravel mining, bridges, pipes, stabilization measures, and outfalls) that have degraded and are contributing towards continued degradation of the river corridor.

- There is an opportunity to restore degraded and unsafe banks in the river corridor.

- There is an opportunity to remove contaminated sediments from portions of the study area. This would be a local sponsor responsibility.

- There is an opportunity to reduce flooding and drainage problems in the Salt River floodplain including along the south side of the river between 67th Avenue and 75th Avenue.

- There is an opportunity to protect existing cultural resources from erosion and vandalism.

- There is an opportunity to document the extent and significance of existing cultural resources.

- There is an opportunity to use effluent water from the 23rd Avenue WWTP to supplement surface water and groundwater sources for restoration and other needs. The plant produces a high quality effluent, which meets the water quality standards for numerous uses including Partial Body Contact, Fish Consumption, Aquatic and Wildlife (effluent dependent), Agricultural Irrigation, and Agricultural Livestock.

5.3 PLANNING OBJECTIVES AND CONSTRAINTS

5.3.1 Federal Planning Objectives

Principles and Guidelines state that the Federal objective of water and related land resources project planning is to contribute to the NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways to contribute to this objective. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units.

Ecosystem restoration is also one of the primary missions of the Corps of Engineers Civil Works Program. The Corps' objective is to contribute to NER through increasing the net quality and/or quantity of desired ecosystem resources. NER measurements are based upon changes in ecological resource quality as a function of improvement in habitat quality or quantity and expressed quantitatively in physical units or indices (not monetary units).

One purpose of this feasibility study is to determine if ecosystem restoration with incidental flood damage reduction and recreation in this reach of the Salt River are consistent with the Federal objectives stated above.

5.3.2 Specific Planning Objectives

Clear statements of specific planning objectives and constraints act as basic building blocks for developing alternative management measures and plans to alleviate stated problems and achieve opportunities. Through coordination with local and regional agencies, the public involvement process, site assessments, interpretation of prior studies and reports, and review of existing water projects, specific planning objectives were identified for this feasibility effort. The water and

related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. The planning objectives listed below reflect the problems and opportunities and represent desired positive changes along the Rio Salado Oeste reach:

- Restore native riparian, wetland, and floodplain habitats and manage undesirable plant, fish, and wildlife species.
- Reduce flood damages to infrastructure and structures.
- Improve passive recreation and environmental-education opportunities.

5.3.3 Planning Constraints

The feasibility of restoring the river over this reach will be challenging. Surface water from storm drains and shallow aquifer groundwater is of poor quality and sporadically available. Land adjacent to the study reach causes additional challenges. Once the mining operations in the area are concluded, the final configuration of the abandoned operations will place additional land use burdens on the community.

These problems, however, may become integral components of the environmental restoration of the river. Abandoned gravel operations can be incorporated as water features into a restoration plan. Incidental water quality improvement can be obtained through incorporation of wetlands into the restoration plan.

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in the reconnaissance study and considered in this feasibility study are as follow:

- In the 2000 reconnaissance report it was stated that, "51st Avenue to Painted Rock Dam may soon be designated as a state superfund site." This constraint was listed due to a study finding organochlorines in the Salt and Gila Rivers. Since then there has been no listing of the area as a "state superfund site" but the reach is on the EPA 303(d) list of impaired waters. The Arizona Department of Environmental Quality is planning to initiate monitoring and investigations in 2008 and complete TMDLs in 2010 to deal with

the legacy pollutants (DDT, toxaphene, and chlordane). There are no known site-specific areas of contamination that may affect a restoration project.

- Coordination is required with Federal Aviation Administration (FAA) to minimize bird strikes within a 5-mile radius of the Sky Harbor International and Goodyear airports. FAA's regulations oppose open water within 10,000 feet of the airport operational taxiway. In addition, safety must be kept as a priority within a 5-mile radius of the airport. However, the Rio Salado Oeste study area is well outside the zone of concern of local airports.
- Proposed restoration features must be coordinated with the proposed South Mountain Freeway, which will cross the river corridor.
- Existing Federal, State, county, tribal, and private land ownership, including sand and gravel ownership and leases, will impact real estate appraisals and acquisitions.
- Issues associated with existing landfills must be incorporated into plan formulation efforts. The plan must not alter the migration of contamination plumes from landfills nor increase leachate from existing landfills.
- AMA water conservation requirements associated with the State of Arizona Groundwater Management Act must be adhered to.
- The project must not impact the safety of existing bridges.
- Because the introduction of water bodies could provide increased opportunities for mosquito breeding, vector control should be incorporated into the design, operation, and maintenance aspects of the project.
- The existing level of flood protection must be maintained. The addition of vegetation must not compromise the level of flood protection in the channel. Project-induced bank erosion must be avoided.
- Potential damage to restored habitat areas from flood flows should be prevented. Restoration features should benefit from, or take advantage of, the infrequent flood flows, with a goal towards self-sustaining regeneration and recruitment from restored seed sources.

- Restoration features and implementation must be compatible with continued operation of sand and gravel mining in the river corridor.
- The proposed project must have strong public support.

5.4 DEVELOPMENT OF ALTERNATIVE PLANS

Alternative plans were developed during this feasibility study to meet the specified problems and opportunities and planning objectives and constraints. As such, the alternatives described in this feasibility report are not proposals for actual construction, nor are they of sufficient design detail to be constructed. Following the completion of the feasibility report, EIS, public feedback, and project authorization by Congress, if such action occurs, detailed design analysis and preparation of plans and specifications would take place.

Alternatives plans have been formulated in consideration of current Federal, State, and local planning and environmental guidance, laws, and policy concerning ecosystem restoration, flood damage reduction, recreation, water quality, and related purposes, to:

- Comply with the National Environmental Policy Act (NEPA) and other environmental laws and regulations.
- Restore a diversity of riparian and associated floodplain fringe habitats to a more natural state.
- Provide an acceptable means of capturing storm water or relocating other existing water sources and conveying it into restored habitat areas.
- Maintain or enhance existing conveyance of peak discharges and ensure that the system of stormwater collection would not increase flood flows or worsen flooding conditions downstream in existing developed areas.
- Address specific flooding problems within the floodplain.
- Produce NER benefits while positively contributing to the NED Account, Regional Economic Development (RED) Account, and the Other Social Effects (OSE) Account.
- Provide decision-makers with information that could be utilized to help determine the balance between construction costs, real estate costs, and social issues and concerns.

- Provide a framework for responding to future urban development in the floodplain consistent with Executive Order 11988.
- Match existing and proposed improvements, where possible, to take advantage of local improvements and to be consistent with the future master planning efforts of the local community.

5.5 ALTERNATIVE DEVELOPMENT AND EVALUATION PROCESS

The feasibility study process involves successive iterations of alternative solutions to the defined problems. These solutions are based upon the study objectives and constraints and address problems and opportunities that have been previously defined. As part of Federal guidelines for water resources projects, there are general feasibility criteria that must be met. According to USACE Engineering Regulation (ER) 1105-2-100 for planning, a project in a Feasibility Report or GRR must be analyzed with regard to the following four criteria:

Completeness Does the plan include all necessary parts and actions to produce the desired results?

Effectiveness Does the alternative substantially meet the objectives? How does it measure up against constraints?

Efficiency Does the plan maximize net NER and/or NED benefits?

Acceptability Is the plan acceptable and compatible with laws and policies?

In the initial phase of the study, measures were developed to satisfy the four feasibility criteria. This initial list of measures to be evaluated (Section 5.6) was based on public input and suggestions, experience with similar projects, and technical considerations based upon the characteristics of the area.

An assessment of the need for flood damage reduction measures is presented in Section 5.7.1. The combination of measures for ecosystem restoration that formed a preliminary array of 20 alternative plans is addressed in Section 5.7.3. After the initial analysis and screening of the preliminary alternative plans, a secondary array of twelve more refined alternative plans was developed (Section 5.7 4). Key features common to the alternatives are described in more detail in Section 5.7.5. Section 5.8 describes the final array of five action alternatives. Each alternative

plan was then independently evaluated and compared to the No Action Alternative. The final array of alternatives was analyzed and compared to use as the basis for selecting the recommended plan (Section 5.9).

5.6 PRELIMINARY MANAGEMENT MEASURES

A management measure is a feature or activity at a site that addressed one or more of the planning objectives. A wide variety of measures are being considered, some of which may be found to be infeasible due to technical, economic, or environmental constraints. Each measure will be assessed and a determination will be made regarding whether it should be retained in the formulation of alternative plans. Descriptions of the preliminary measures considered in the reconnaissance phase of the study are presented below.

- **Create Water Supply:** A water supply and distribution system will be formulated as part of the feasibility study. The system is required in order to return some form of surface (base flow) and groundwater hydrology to the river, as required to support the other objectives. Potential sources of water supply include discharges from the 23rd Avenue WWTP, groundwater, groundwater wells, storm-drains and other interior drainage tributaries. Therefore, human intervention and infrastructure measures would be required in order to reestablish base flow conditions.

- **Establish Mesquite Bosque:** Establish mesquite trees at higher elevations from the river bottom. These areas would include terraces and overbank areas. Low-water-use irrigation or site conditions would need to be implemented in order to establish and maintain the mesquite trees. Once established, mesquite trees are expected to not require continuous water supply or maintenance.

- **Create Cottonwood/Willow Gallery:** Plant and establish cottonwood and willow tree plant communities along the wetted perimeter (fringe area locations within the river). The adjacent fringe areas where the plants would be established include the areas around existing open water areas, created wetlands, and flowing water.

- **Establish Wetlands:** Establish wetlands at appropriate locations in order to create a diverse and high-value project habitat. Appropriate locations for wetlands would be

determined during the feasibility phase, but typically involve river backwater areas or ponded water locations.

- **Incorporate Existing Ponds:** Utilize existing open-water areas created by abandoned gravel mining operation to create habitat and recreation areas. The habitat and recreation would take advantage of the existing open-water value to further increase project outputs.

- **Create Base Flow:** Return the conditions of a perennial environment to the study area. This linear feature would also support appropriate plant communities, such as cottonwood/willow galleries and aquatic riparian vegetation.

- **Incorporate Vector Control:** Incorporate mosquito-control measures as an integral part of the selected plan design and maintenance.

- **Clean-Up Debris:** Clean-up debris and reshape the bank and channel where manmade changes have occurred, to create a suitable restoration substrate. This is expected to be site specific and details would be determined during the design phase.

- **Improve Levee/Channel:** Evaluate flood control levees and/or channel improvements to improve conveyance capacity at flood problem locations.

- **Create Recreational Corridor:** Incorporate trails and other passive recreational features in support of the other restoration management measures. In addition to trails, these features could include access locations, signage, and comfort stations to support eco-recreation activities.

- **Consider Cultural Resources Mitigation:** Incorporate cultural resources mitigation features, if feasibility analysis determines cultural mitigation is required as part of the recommended plan.

Locally implemented non structural measures for restoration such as allocation of water for restoration, zoning controls, elimination of aggregate mining, land set asides, re-operation of Salt River Project Dams, and BMP's were also recommended for consideration. However, most of these measures are both impractical and publicly infeasible. Allocation of water, zoning controls and land set asides by themselves would not provide a solution to the

degradation that has occurred and the existing zoning regulations and Best Management Practices contribute to reducing the decline of remaining habitat value to the extent possible. Re-operation of dams and elimination of aggregate mining are both infeasible and publicly unacceptable solutions as they would affect both the regional water supply and economy.

5.7 ALTERNATIVE DEVELOPMENT

The eleven preliminary measures described above were refined and incorporated into the development of alternatives discussed below. Those refinements and modifications to alternatives were completed in plan-formulation meetings with numerous study participants, and took into account study findings and public/agency input.

5.7.1 Flood Damage Reduction

Evaluation of flood damages and solutions to reduce those damages was a large part of this study. The flood damage reduction analysis was performed first to determine what measures could be implemented to reduce damages and if they were economically justified. Alternatives evaluated to reduce flood damages included levees, channelization, floodwalls, and relocation. Those alternatives focused on reducing damages from the 100- and 500-year events. While there are damages from the more frequent events (see Appendix G, Economic Evaluation) those damages are mainly to a single parcel and are less likely to be economically justified for flood damage reduction measures than the larger, less frequent events. After completing an initial evaluation of flood damage reduction measures, a proposed plan to modify the reach of river between 35th and 51st Avenues was proposed by the City of Phoenix. That plan, described in section 3.1.5 Rio Salado Marsh, is considered to be part of the future without-project and future with-project condition. Most damages previously considered as without-project conditions are reduced by that action. Results of the analysis below are left in this report for informational purposes.

5.7.1.1 Structural Measures

Structural measures include construction of structures to reduce damages and are most effective when damages are concentrated. In this case, damages are most concentrated in Reach 5. Although there are damages in Reach 2L, the structures are dispersed and the construction of

levees or channels in that reach does not appear to be feasible, either technically or economically.

Levees: Two levee scenarios were evaluated including extension of a levee for approximately 5,000 feet along the north bank and for approximately 6,000 feet along the south bank (Figure V-1). These levees encompass most of Reaches 5 and 6. Each levee would have a top width of 12 feet and a slope of 3:1. A 100-year level of protection for the two reaches would be approximately 3 feet high and a 500-year level would be 6 feet high. Construction of levees on both banks would be necessary to prevent flooding on

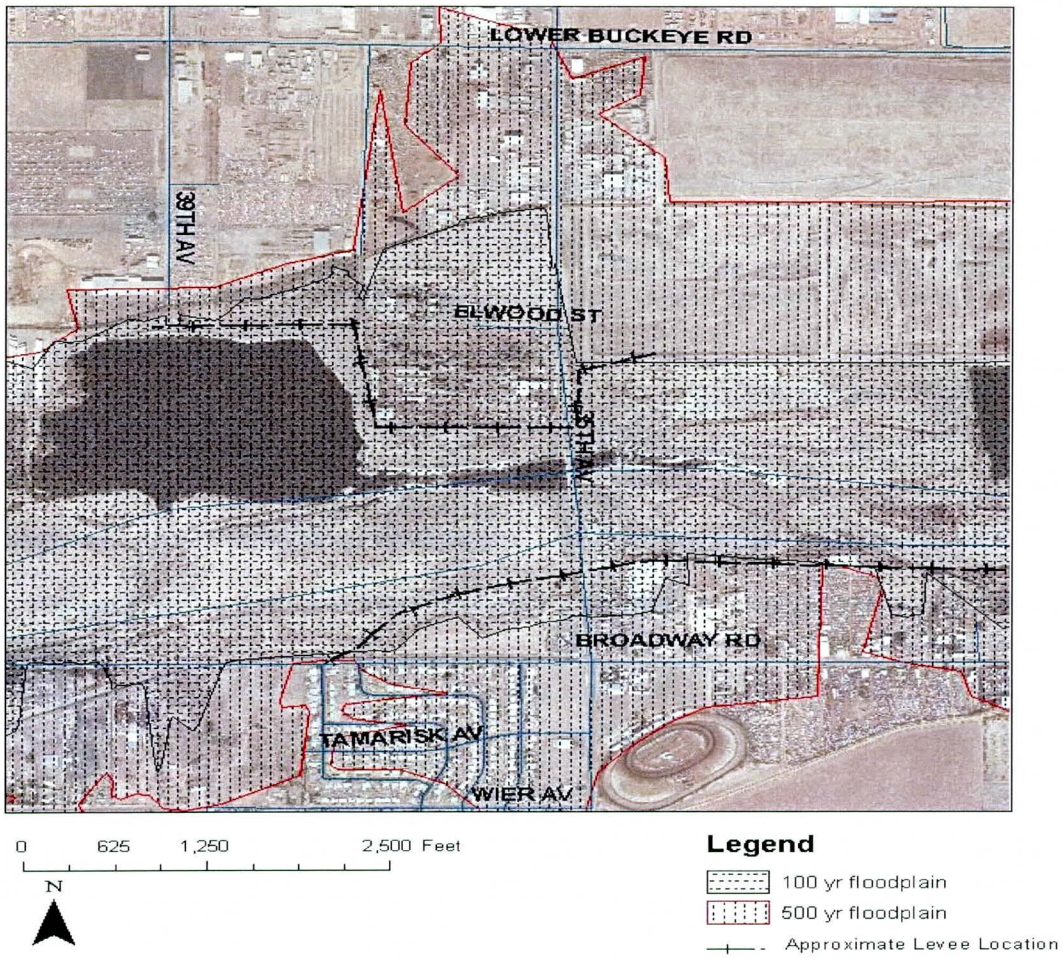


Figure V-1: Approximate Levee Locations

the opposite bank of the river. Since the damages within the two reaches appeared to be marginal for justifying levee construction, a preliminary construction estimate was calculated. This estimate used unit costs from the Tres Rios Project downstream to develop a preliminary estimate of $2,022,000.

Channel: Excavation and construction of a low-flow channel to pass flood flows for both the 100- and 500-year events were calculated. The excavation required for the Reaches 5 and 6 Channelization Alternative extends from Station 209.69 to 208.1, a distance of 1.59 miles, and includes excavation of approximately 1.4 million cubic yards (c.y.) of material. Modeling showed that for the 500-year level of protection this excavation would need to extend from Station 210.7 to 207.9, a distance of 2.27 miles, and would require the removal of approximately 2.4 million c.y. of material. Cost estimates for this alternative were estimated at $9.3 million for the 100-year and $16.6 million for the 500-year level of protection.

Results

For a flood control alternative to be feasible and economically justified, the benefits that it delivers (damages reduced) must exceed the costs to implement.

Levee: Table V-1 shows that the cost of implementation is more than the benefits produced from constructing levees. This analysis was preliminary to determine if further refinement of the structural alternatives and more detailed estimates were warranted. The results with benefit/cost ratios of less than 1:1 led the study team to consider other alternatives to reduce flood damages.

Table V-1: Benefit/Cost Analysis - Levee Improvements

	Without Project	100-Year	500-Year
EAD			
Reach 5L	$ 32,400	$ 29,800	$ 10,300
Reach 5R	$ 127,800	$ 53,900	$ 12,800
Total	$ 160,200	$ 83,700	$ 23,100
Annual Benefits			
Reach 5L		$ 2,600	$ 22,100
Reach 5R		$ 73,900	$ 115,000
Total		**$ 76,500**	**$ 137,100**
First Cost		$ 2,148,000	$ 2,636,000
IDC		$ 60,000	$ 73,000
Investment Cost		$ 2,208,000	$ 2,709,000
Annual Cost		**$ 133,000**	**$ 163,000**
Net Benefits		($56,500)	($25,900)
Benefit/Cost Ratio		**0.58**	**0.84**

Note - Does not include any Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs and does include the Lands, Easements, Rights-of-way, Relocations, and Disposal Areas (LERRD) estimate.
EAD = Equivalent Annual Damages
IDC = Interest During Construction

Channel: Table V-2 below summarizes the analysis of benefits for channelization of the reaches of the river where damages are greatest. The cost of implementation significantly exceeds the benefits that could be expected.

Table V-2: Benefit/Cost Analysis – Channel Improvements

	Without Project	100-Year	500-Year
EAD			
Reach 5L	$ 32,400	$ 6,100	$ 800
Reach 5R	$ 127,800	$ 48,900	$ 20,600
Reach 6L	$ 14,300	$ 2,900	$ 1,900
Reach 6R	$ 4,800	$ 400	$ 200
Total	$ 179,300	$ 58,300	$ 23,500
Annual Benefits			
Reach 5L		$ 26,300	$ 31,600
Reach 5R		$ 78,900	$ 107,200
Reach 6L		$ 11,400	$ 12,400
Reach 6R		$ 4,400	$ 4,600
Total		**$ 121,000**	**$ 155,800**
First Cost		$ 10,019,000	$ 17,819,000
IDC		$ 278,000	$ 494,000
Investment Cost		$ 10,297,000	$ 18,313,000
Annual Cost		**$ 619,000**	**$ 1,101,000**
Net Benefits		$ (498,000)	$ (945,200)
Benefit/Cost Ratio		**0.20**	**0.14**

Note - Does not include any Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs or Lands, Easements, Rights-of-way, Relocations, and Disposal Areas (LERRD) costs.
EAD = Equivalent Annual Damages
IDC = Interest During Construction

5.7.1.2 Non-Structural Measures

Non-structural measures reduce flood damages without significantly altering the nature or extent of flooding by changing the use of the floodplain or accommodating existing structures within the floodplain. The non-structural measures evaluated here include floodwalls and relocation. Cost estimates for nonstructural measures were adapted from the National Flood Proofing Committee.

Flood Walls: Concrete floodwalls that are confined to specific parcels were evaluated. Elevations of either 2 or 4 feet high were the options considered. Parcels that could be protected with a floodwall were identified. Estimates were made of the length of floodwall around each structure necessary to prevent inundation. It was assumed that

floodwalls would be more suited to and more likely to be feasible for commercial/industrial rather than residential structures.

Relocation: Purchase and relocation of structures within the floodplain was evaluated also. This would include purchase of a property at fair market value, allowing the owner to relocate to a different location. Relocation was considered only for residential structures; relocation of commercial/industrial structures is highly unlikely to be feasible.

Results

Table V-3 below summarizes the results for those parcels that were evaluated either for floodwalls or for relocation. The results of the benefit/cost analysis were negative for all but one individual parcel. The Economic Evaluation (Appendix G) presents a more detailed analysis that was completed for that parcel. The parcel is a scrap-metal processing facility located at the northwest corner of the 35th Avenue Bridge. Because the property is occupied by a single owner/beneficiary, it is not eligible for Federal involvement in a cost-shared flood damage reduction project. However, the preliminary analysis shows that construction of floodwalls at that structure may be feasible. The single owner/beneficiary issue does not preclude local or private interests from implementing such measures to reduce damages.

Summary

Analysis of flood damages within the study reach showed that there are approximately $236,000 in expected annual damages to structures. The area with the most damages is the industrial area between 35th and 43rd Avenues on the north of the river. Damages also occur in Reach 5R, with additional damages across the river in Reach 5L in an area including residential, commercial, and industrial property. Reach 2L is made up of large-lot industrial and agricultural properties, but these are widely dispersed in the floodplain.

However, flood damage reduction alternatives do not meet the criteria for being economically justified at this time as the costs to implement the measures exceed the damages that they would prevent. One parcel did have a benefit/cost ratio greater than 1:1 and flood damage reduction measures may be economically justified, but Federal policy prohibits single-beneficiary

Table V-3: Non-Structural Flood Damage Reduction Alternatives

Rio Salado Oeste

Non-Structural Flood Damage Reduction Alternatives -p reliminary Benefit/Cost Analysis (in $1,000s)

		Relocation Benefit/Cost Analysis			2' Floodwall Analysis					4' Floodwall Analysis			
Parcel	Approx EAD ($1,000s)	Estimated Reloc Costs	Reloc. Costs Annualized	Relocation B/C	Cost/Parcel	Annualized	Max Benefit	Approx Benefits	Approx BC	Cost/Parcel	Annualized	Approx Benefits	Approx BC
10544007B	$ 4.9				$ 280	$ 17.5	$ 4.9	NJ		$ 411	$ 25.6	NJ	
10546004B/4G	$ 83.4				$ 331	$ 20.6	$ 83.4	$ 24.2	1.17	$ 486	$ 30.3	$ 51,161	1.69
10471005	$ 0.6				$ 284	$ 17.7	$ 0.6	NJ		$ 417	$ 26.0	NJ	
10471007Y	$ 0.9	$ 79	$ 4.9	0.18									
10471007X	$ 1.9	$ 88	$ 5.5	0.34									
10471007F	$ 2.0	$ 179	$ 11.1	0.18									
10471015	$ 7.8				$ 123	$ 7.7	$ 7.8	$ 4.9	0.63	$ 181	$ 11.3	$ 6.5	0.57
10471014	$ 4.2				$ 72	$ 4.5	$ 4.2	$ 3.1	0.70	$ 105	$ 6.5	$ 4.2	0.64
10471007L	$ 2.5				$ 128	$ 8.0	$ 2.5	NJ		$ 188	$ 11.7	NJ	
10471013A	$ 2.4				$ 129	$ 8.0	$ 2.4	NJ		$ 189	$ 11.8	NJ	
10483003C	$ 5.3				$ 155	$ 9.7	$ 5.3	NJ		$ 227	$ 14.2	NJ	
10483002N	$ 0.8	$ 269	$ 16.7	0.05									
10463004A	$ 1.0	$ 44	$ 2.8	0.37									
10569008D	$ 3.7				$ 294	$ 18.3	$ 3.7	NJ		$ 432	$ 26.9	NJ	
10568002A	$ 1.1				$ 220	$ 13.7	$ 1.1	NJ		$ 324	$ 20.2	NJ	
10550002A	$ 0.7				$ 82	$ 5.1	$ 0.7	NJ		$ 121	$ 7.5	NJ	

Relocation scenario analyzed for parcels with residential structures
Floodwall scenarios analyzed for industrial/commercial parcels
NJ = Not Justified - based upon maximum potential benefits

involvement in a project. Therefore, there is no Federal interest in primary-purpose flood damage reduction alternatives.

River channel restoration is being considered as a measure within the ecosystem restoration component of this project and may have incidental benefits of reducing flood damages. That component will be discussed further later in this report.

5.7.2 Ecosystem Restoration

Project features were developed that will meet the primary project objective of ecosystem restoration while observing the constraints. The following list of restoration measures was derived from the initial list of management measures used in the reconnaissance phase and further developed based upon experience from similar restoration projects, technical considerations based upon the study area, input from the public and non-Federal sponsor, and coordination with other agencies.

Channel Restoration: A restored channel would provide a connection through the study reach, connecting upstream and downstream projects. Restoration would be accomplished by grading and terracing to restore an active channel through the entire reach.

Stormwater Outfalls: Existing outfalls would be modified to discharge to a concrete/stone channel that flows onto the river terrace, and the water would be directed toward the low-flow channel. Within that channel there would be a low weir to capture the low flows and allow floodwaters to pass. The weir would direct flows to a stormwater wetland constructed for the purpose of harvesting storm water and supporting adjacent habitat. Although the wetland would in some cases be ephemeral, it would provide habitat value.

Cottonwood/Willow: This measure would restore riparian cottonwood/willow stands adjacent to water sources and low terraces throughout the study area. Cottonwood/willow would be dominated by Fremont's cottonwood (*Populus fremontii*) and Gooding's willow (*Salix gooddingii*).

Mesquite: Mesquite habitat would be restored over a potentially large portion of the project area. Mesquite bosques would be dominated by velvet mesquite (*Prosopis velutina*), with scattered honey mesquite (*Prosopis glandulosa*), and some understory shrubs such as desert thorn (Lycium spp.) palo verde (*Cercidium floridum*) and brittlebush (*Encelia farinose*), and forbs.

Wetlands: Although rare in the Southwest wetland existed in the Salt River, and other Arizona rivers, in combination with the other riparian habitat types. In less degraded systems such as the Hassuyampa, Verde or San Pedro emergent wetlands can still be found. Cattail, willow, bulrush and other emergent wetland vegetation dominate emergent wetlands found in those natural systems. Due to the porous nature of soils now found in this project area, modificatoins will be required to assist in maintaining surface water. Excavation and layering of a silt/clay soil substrate approximately 12 inches thick is assumed to be sufficient to reduce permeability.

Lakes: There are existing features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. These modifications are recommended to restore the floodplain landscape and improve the functionality of these features. Although lakes are not necessarily consistent with historic, conditions they are existing features of the landscape for which restoration measures are being formulated to restore the area to a less degraded condition.

Invasive Species Control: Invasive species such as saltcedar (Tamarix spp.) and Arundo (*Arundo donax*) would require removal and management with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. Saltcedar is currently found in stands throughout the study area. Arundo, although not yet a significant problem in Arizona, is a problem in neighboring California. A stand of Arundo can be found on the south side of the river near a stormwater outfall at 43rd Avenue.

Water Supply: In addition to the stormwater runoff that would be harvested with the modificiatoin of stormwater outfalls, additional water supply would be required. Effluent from the 23rd Avenue WWTP is available for the restoration project. This

would also require construction of a pump and piping system to deliver water throughout the project area.

5.7.3 Preliminary Array of Alternatives

The preliminary measures described above were combined into alternatives with consideration of combinability and dependence. Table V-4 lists the preliminary alternatives considered for implementing ecosystem restoration. Development of those alternatives assumes that restoration of all specific habitat types is dependent on both water supply and control of invasive species. It was also assumed that restoration in the vicinity of the gravel pits (lakes) is dependent on both restoration of various riparian habitats and water supply.

Ctiteria were established to determine what alternaive plans to consider further. Those criteria are listed below. The criteria are meant to be a qualitative evaluatoin as to whether the plans meet minimum standards for being carried forward and evaluated in detail.

5.7.3.1 Screening Criteria

Principles and Guidelines describes the use of four evaluation criteria, two of which were applied at this phase of plan formulation. The other two criteria (efficiency and acceptability) not considered at this time will be evaluated and compared to the final set of alternatives in more detail, and described later in the report.

Completeness: "Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects".(P&G Section VI.1.6.2(c)(1)). This is the consideration as per whether the alternative includes all of the necessary actions to carry out the objective. The table below lists + or – depicting whether or not the team thought the individual alternative contained all necessary components to achieve the objective of restoration.

Effectiveness: "Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities." (P&G Section VI.1.6.2(c)(2)). In order to provide an initial measurement of how the effectiveness of the alternatives contribute to the planning objective (restoration) they were considered against the potential for restoring the most significant habitats. The significance of

riparian habitat has been discussed earlier in this report. Restoration goals pertaining to different riparian habitat cover types were developed with the recommendation of the USFWS and AGFD. Those include in priority order: cottonwood/willow, mesquite, wetland, and open water. To be minimally acceptable for further consideration it was decided that to be effective an alternative needs to include restoration of at least two significant habitat types.

Flooding: Since this is an urban environment with development adjacent to the river the consideration of induced flooding is an important one. Alternatives that install significant vegetation to the floodplain—but neither include channel restoration nor restrict the location of that vegetation—could raise water surface elevations and should be avoided. Therefore those alternatives were dropped from further consideration at this point in the study.

This preliminary screening of alternatives reduced the 20 alternatives to 12, including no action. It was meant to narrow the focus to those alternatives that are suitable for further detailed consideration.

Table V-4: Preliminary Screening of Possible Alternatives

#	Description	Complete	Effective	Flooding
1	No Action	-	0	Y
7	Water Supply	-	0	Y
8	Water Supply, Invasive Control	-	0	Y
2	Invasive Control	-	0	N
3	Channel Restoration	-	1	N
4	Channel Restoration, Invasive Control	-	1	N
9	Water Supply, Channel Restoration	-	1	N
10	Water Supply, Channel Restoration, Invasive Control	-	1	N
11	Water Supply, Channel Restoration, Emergent, Invasive Control	-	1	N
12	Water Supply, Channel Restoration, Mesquite	+	2	N
13	Water Supply, Channel Restoration, Mesquite, Emergent, Invasive	+	2	N
14	Water Supply, Cottonwood, Channel Restoration, Invasive	+	2	N
15	Water Supply, Cottonwood, Channel Restoration, Emergent, Invasive	+	2	N
5	Storm Water	+	3	N
6	Storm Water, Channel Restoration	+	3	N
16	Water Supply, Cottonwood, Channel Restoration, Mesquite, Invasive	+	3	N
17	Water Supply, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive	+	3	N
18	Water Supply, Storm Water, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive	+	3	N
19	Water Supply, Lake, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive	+	3	N
20	Water Supply, Lake, Storm Water, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive	+	3	N

Note: Effectiveness: Numbers designate number of habitat cover types that would be restored by that alternative. For example the number 2 indicates that 2 habitat types would be restored.
+ or – indicate if that alternative meets the subject criteria as described.

5.7.3.2 Alternative Formulation Rationale

The above alternatives are combinatoins of measures that could be implemented at any location within the study area. The next step in formulating alternatives was to begin placing these features into suitable locations within the project area. For that purpose, measures have been broken into two categories: site-specific and systemic.

Site-Specific Measures:

Site-specific measures are dependent on the location of a specific feature already in place, such as a gravel pit, channel, or stormwater outfall. Site specific conditions at the various locations throughout the study area provide opportunities for restoration.

Lake Restoration: This feature would occur at existing gravel pit lakes within the study area. Specifically, the large lakes in the vicinity of 27th and 37th Avenues (Figure V-2) are focus sites. Lake restoration is dependent on both riparian and wetland restoration and must be combined with those measures for success. Control of water levels is also necessary for success. This may be accomplished by modifying the substrate to make it impermeable and providing water supply.

Figure V-2: Abandonned Gravel-Pit "Lake" (37th Avenue)

Stormwater Outfalls: There are restoration opportunities at existing stormwater outfalls sited throughout the study area (Figure V-3 and Table V-5). Specific restoration would follow recommendations considering runoff amount, soil conditions, location in

Figure V-3: Stormwater Outfall at 19th Avenue

floodplain, and existing habitat. Further information on the individual stormwater outfalls is included in Appendix M, Wetland Restoration.

Table V-5: Summary of Stormwater Outfalls with Recommended Restoration Potential

Location	Restoration
19th Avenue NW	Mesquite Bosque/Palo Verde
19th Avenue SW	Wetland and Riparian Corridor
27th Avenue SE	Wetlands and Riparian
35th Avenue NW	Cottonwood/willow
43rd Avenue N	Wetland/Cottonwood-Willow
43rd Avenue S	Wetland
51st Avenue NW	Wetland/Mesquite
67th Avenue	Wetland/Cottonwood-Willow

Although stormwater runoff is seasonally inconsistent, observations in the study area indicate that there is sufficient runoff to support wetland vegetation. In many cases the existing vegetation is mostly exotic. Table V-6 below lists the locations of each stormwater outfall and the amount of habitat acreage that could be supported by the water available at each site. Potential runoff at each storm drain was calculated using the seven inches of annual rainfall and the drainage area size. Since there is not a consistent supply

of water, a conservative estimate was used to calculate water available to support habitat. The acreage of habitat that could be supported was based on utilizing one-half of the estimated water supply currently found at each site. It was assumed that when stormwater wetland is combined with cottonwood/willow riparian, the wetland would utilize one-third of the potential supply, with the cottonwood/willow utilizing the remainder.

Table V-6: Restoration Potential at Each Stormwater Outfall

Location and Estimated Runoff (ac-ft)			Acreage of Habitat		
	Estimated	1/2	Cottonwood/ Willow	Mesquite	Wetland
19th Ave NW	79	39.5		13	
19th Ave SW	231	115.5	10		4
27th Ave SE	196	98	8		4
35th Ave NW	224	112	14		
43rd Ave N	274	137	11		5
43rd Ave S	Unknown			x	x
51st Ave NW	274	137		30	5
67th Ave N	558	279	23		10

Note: Assumed water demand (ac-ft/acre): Cottonwood/willow = 8, Mesquite = 3 , Wetland = 9.

Channel Restoration: This measure is largely based upon historic conditions, hydraulics, and geomorphology. Therefore, implementation of this measure would be mainly within the 10-year area of inundation. Restoration would be accomplished through grading and excavation of materials to recreate a natural channel through the study reach. Channel restoration would serve several purposes: it would link upstream and downstream river reaches, transport low flows to adjacent habitats, convey flood flows, and reduce flood elevation on adjacent terraces and floodplains.

Systemic Measures

Systemic measures could be applied anywhere within the project area but would be based upon specific criteria for location. For example, all of the revegetation strategies, including establishment of cottonwood/willow, mesquite, and emergent wetland cover types, are systemic measures. In this case, existing data (soils, groundwater depth, flood elevation, etc.) was used to help determine optimum placement of individual habitat cover types. However, data was lacking in sufficient detail to do so across the entire area.

Floodplain Location: Elevation within the floodplain was a siting constraint adopted by the study team. Construction of permanent infrastructure and installation of woody vegetation would avoid the 10-year area of inundation and maintain an active channel to convey flood flows and minimize losses of project features during flood events.

Water Availability: Consideration was given to the availability of water (surface water, runoff, stormwater outfalls, or groundwater) at a given site or the liklihood of delivering water to that area cost effectively.

Ecological: Siting of restoration features took into account ecological conditions and strived to place restoration features in the most natural locations within the floodplain as possible. Doing so would produce a sustainable and successful restoration project and minimize operations and maintenance (O&M) costs. Cottonwood/willow cover type was placed either near the channel where the 10-year event would provide a wetted area, or where possible surface runoff would contribute the same effect. Mesquite bosques were located at the first floodplain terrace, and mesquite (xeric) higher in elevation in the floodplain.

5.7.4 Screening of Second Array of Alternatives

Although the second array of alternatives appeared to be complete and effective at meeting the restoration objective, the study team observed that further refinement would be necessary to aid the selection process. One final screening process was carried out by the study team using the following criteria:

1. Cottonwood/willow is an important and scarce cover type in Arizona and the Southwest. The study team, including the U.S. Fish and Wildlife Service and Arizona Game and Fish, decided that cottonwood/willow cover type was the highest priority for restoration followed by mesquite and wetlands. Due to its significance and scarcity it was decided that alternatives not including it should be eliminated from further consideration.

2. Existing storm water outfalls within the study area provide opportunities for restoration and for potential water harvesting. Outfalls include the inexpensive

opportunity of providing additional water to the project area and associated restoration features. Since the watershed is developed tributaries to the river have been replaced by outfalls. The decision was made that the storm water measure is a necessary component to any alternative because of the restoration opportunities and potential water source. Therefore, alternatives not including that individual component should be eliminated from further consideration.

3. Channel restoration an important project component for various reasons. It provides a connection to other projects, is a potential means of water distribution, is important for the ecosystem, and contributes to reducing flooding potential. Therefore, alternatives not including that component were not considered.

4. Lake restoration to maintain an open water body and to provide potential urban fishery is an important component for the local community.

Table V-7 shows the second array of alternatives along with the reasons for dropping individual alternatives from further consideration. As noted in the table at least 3 of the alternatives not only fail to meet criteria listed above but also are very similar to other alternatives.

Table V-7: Second Array of 12 Alternatives

#	Preliminary Alternatives	Reason Dropped
1	No Action	
2	Storm Water	3
3	Storm Water, Channel	
4	Water Supply, Channel, Mesquite	1
5	Water Supply, Channel, Mesquite, Emergent, Invasive	1
6	Water Supply, Cottonwood, Channel, Invasive	2
7	Water Supply, Cottonwood, Channel, Emergent, Invasive	2, similar to alternative 8
8	Water Supply, Cottonwood, Channel, Mesquite, Invasive, added Storm Water	
9	Water Supply, Cottonwood, Channel, Mesquite, Emergent, Invasive	2, similar to alternative 10
10	Water Supply, Storm Water, Cottonwood, Channel, Mesquite, Emergent, Invasive	
11	Water Supply, Lake, Cottonwood, Channel, Mesquite, Emergent, Invasive	2 water, with inclusion of it same as alternative 12.
12	Water Supply, Lake, Storm Water, Cottonwood, Channel, Mesquite, Emergent, Invasive	

The study following set of five alternatives were carried further for development of designs and cost estimates. Those alternatives are:

1. No Action
2. Storm Water and Channel
3. Water Supply, Cottonwood, Channel, Mesquite, Invasive, Storm Water
4. Water Supply, Storm Water, Cottonwood, Channel, Mesquite, Emergent, Invasive
5. Water Supply, Lake, Storm Water, Cottonwood, Channel, Mesquite, Emergent, Invasive

5.7.5 Detailed Description of Project Measures

5.7.5.1 Provide Water Supply

Project water is a constraint and a limiting factor across all alternatives. The project area can be split into two reaches based on water supply: (1) 19th to 51st Avenues where effluent and storm water are primary sources and (2) 51st to 83rd Avenues where groundwater is more likely to be

shallow enough to support vegetation after it is established. Water supply and distribution has been evaluated and planned by the City of Phoenix and is described in more detail within Appendix J, Design and Cost Estimate.

Effluent: Effluent from the 23rd Avenue WWTP is the primary source of water available for the restoration project. The City of Phoenix estimates that approximately 8 mgd (8,964 ac-ft) is available to the project. This would require construction of a means to deliver effluent to the project from the 23rd Avenue Plant.

Storm Water: Stormwater outfalls within the project area have been identified and possible discharges from them quantified. This includes 8 different outfalls from which an estimated average of 2,863 ac-ft was estimated to discharge based upon a 7-inch annual rainfall. Additional future outfalls may be implemented by the county at 51st Avenue (south) and 75th Avenue (north). While not a reliable constant source of project water, there are opportunities for future use of this water with proper design at the outfall locations. Currently, various forms of habitat are being supported by stormwater runoff, and design of a restoration plan would include site-specific measures maximizing use of that runoff.

Groundwater: Depth to groundwater through the project area varies from an average of 20 to 60 feet. In general, the depth to groundwater decreases to the west end of the study area where dewatering is required at 91st Avenue. In an analysis of ADWR well data and interpolation of surface water in gravel pits, there appears to be a zone of shallow (20-feet deep) groundwater between 51st and 19th Avenues in the river channel. This is likely due to excavation and is known to fluctuate as much as 20 feet annually (Rinker Materials Observation). Groundwater is being pumped in the vicinity of 23rd Avenue for sand and gravel mining where it contributes to the large lake near 27th Avenue. It was also assumed that the lake in the vicinity of 37th Avenue was excavated to groundwater depth, although observations in 2004 appear to indicate that the level has dropped significantly and that the elevations in the lake appear to be influenced more by effluent discharge.

Supply Well: A supplemental well providing up to 1.85 mgd from the Upper Alluvial Unit is part of the proposed system. This would provide redundancy in the event that there is a prolonged outage and effluent becomes unavailable for a period of time.

5.7.5.2 Provide Water Distribution

A water distribution system is needed to deliver water from the sources described above through the study area to locations of revegetation.

Flood Irrigation: Flood irrigation may be accomplished through a series of canals or channels delivering water to revegetation sites. Distribution within the revegetation sites may be through a braided network of channels. Effluent and pumped groundwater may be utilized for flood irrigation.

Drip Irrigation: This would be a temporary drip irrigation system consisting of small diameter pipes and drip emitters. Pumping would be required as a portion of this system. Drip irrigation works best with groundwater; effluent tends to clog the system and requires high maintenance.

Stormwater Harvesting: This measure is similar to creating a perched aquifer by providing water to a location with a below-grade low permeable layer. Although this could be accomplished with any water source and proper site-specific soil conditions, it appears that at several of the stormwater outfalls, similar conditions already exist. At constructed wetlands or ponds, a design option may include features that allow or encourage subsurface recharge to percolate down gradient and provide moist conditions, thereby irrigating adjacent vegetation.

5.7.5.3 Revegetation

Cottonwood/Willow

Due to groundwater depth, cottonwood/willow habitat could only be restored in proximity to existing or future surface water. This habitat would require a constant water source for the life of the project unless it can be verified that groundwater would be available within 6 to 7 feet of surface—in which case surface water would only be required for the first five years. Cottonwood/willow habitat would also require richer soils than some other habitat types.

Generally, cottonwoods occur at a greater distance from surface water than willows. Willows require more moisture at the surface for optimal growth. Besides cottonwoods and willows, plant species that would be included in the restoration of this habitat include Baccarus sp., arrowweed, and possibly ash. Cottonwood/willow would be dominated by Fremont's cottonwood (*Populus fremontii*) and Gooding's willow (*Salix gooddingii*). Other understory species would be planted, depending upon individual site conditions, but could include arrowweed (*Pluchea sericea*), elderberry (*Sambucus mexicana*) or burrobush (*Hymenoclea spp.*).

Two planting options are being considered for establishment of cottonwood willow. It is assumed that a combination of techniques would be utilized with specific planting techniques to be determined during project design.

Plant Poles: Plant poles are dormant pole cuttings harvested from living woody plants and planted vertically into the substrate. Poles need to be 3 to 4.5 inches in diameter and at least 6 to 8 feet long. Unless planted in saturated soils or near stable groundwater, temporary irrigation would be required. Pole plantings of cottonwood and willow have shown high rates of success with this technique. Plant materials should be available nearby, and may even be obtained from the other Salt River projects.

Plant Containers: Nursery grown potted containers would be planted on site. One gallon containers have shown the greatest success rates (80 percent +) at Lower Las Vegas Wash, Nevada. They are also the least expensive container plants available. Plantings would require a source of irrigation, at least temporarily.

Mesquite

This habitat would be restored over a potentially large portion of the project area. It would require periodic watering for the first five years after planting, although with less frequency than cottonwood/willow. Watering could possibly be discontinued after five years or when roots are expected to reach groundwater. Mesquite bosques would be dominated by velvet mesquite (*Prosopis velutina*), with scattered honey mesquite, and some understory shrubs, such as desert thorn (Lycium spp.) palo verde (*Cercidium floridum*), brittlebush (*Encelia farinose*), and forbs.

Bosque: Mesquite bosques are commonly found 5 to 20 feet above the river channel where water is adequate. They require a water table, or semi-saturated soil conditions 10 to 30 feet below the surface elevation and rely on occasional saturated conditions 1 to 3 feet below the surface. Soil requirements range from fine to gravelly, with some rocky areas. The mesquite bosques would be planted with a density of approximately 100 velvet mesquite, 10 honey mesquite, and 40 understory shrubs per acre. Understory forbs will also be planted using a seed mix.

Xeric: In locations throughout the study with less water supply, xeric stands of mesquite would be established. It is assumed that mesquite will survive under drier conditions and on higher terraces than mesquite bosque. Planting densities would be less, with approximately 25 velvet mesquite, 5 honey mesquite, and 10 understory shrubs per acre.

Riparian scrub shrub

As was discussed in Chapter IV the study area contains substantial acreage of scrub shrub habitat. Although portions of that cover type will be converted to the other riparian habitats others will be maintained, as they provide connection between other habitat types and contribute to the important mosaic of vegetative cover types that maximizes structural habitat complexity. It is assumed that some portions maintained will remain a more xeric desert scrub but others adjacent to the wetter riparian habitats will develop into more distinctive riparian cover containing species such as Seepwillow, desert broom, or Desert willow. Estimated acreages for both scrub shrub and riparian scrub are included in the listed acreages with each alternative below. It is estimated that if the active river channel is approximately 500 acres between 25 to 60% will be occupied by riparian scrub in the with project conditions depending on water supply.

5.7.5.4 Wetlands

Wetlands can consist of open water, submerged vegetation, or mud flats, all requiring a high water table at or near the surface. Due to the porous soils found in this project area, lining the site would be required to maintain surface water. Excavation and layering of a silt-clay soil substrate overlain by a mixed gravel, and finally, cobble layer, is recommended. This soil structure would reduce disturbance of the soil-clay layer by reducing piping of fine material and reducing turbulent forces acting on the layer.

Stormwater Wetland: Stormwater wetland restoration would take place at individual stormwater outfalls. Techniques would be site specific and would include grading or excavation, removal of exotics, and planting of suitable vegetation for the site conditions. Supplemental water would be required via an irrigation source, and structures would be installed to contain high-energy inputs and avoid erosion during storm events.

Emergent Wetland: Emergent wetlands contain primarily cattails (*Typha domingensis*), tule (*Scirpus acutus*), and sedges (Carex spp.). Because the river will not flow year round, the wetlands would need to be constructed specifically to retain water. In addition to grading and excavation, an impermeable layer would be added to retain water on site.

5.7.5.5 Lake Restoration

There are existing features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. These modifications are recommended to better utilize the existing water and improve the functionality of these features. The existing banks would need to be reshaped for public safety and restoration. Potential substrate modification may be required to reduce the annual fluctuation in the lake levels. In addition, aeration would need to be considered to retain water quality.

Grading: Banks would be reshaped to create "irregular random terraces" (variable in length, width and depth below the water surface) that would become submerged to different depths to provide more diversity in the littoral zone. This is the nearshore area where sunlight penetrates all the way to the sediment and allows aquatic plants to grow. The irregularity and randomness of the terraces provides more opportunities for the establishment of submerged, floating, and emergent vegetation and a more diverse and natural shoreline habitat. The random terracing would provide different thermo strata for aquatic organisms, potentially improving mixing and maintaining a less stratified body of water, making it less susceptible to turnover (reducing oxygen levels). These terraces or shelves may be exposed periodically, functioning as emergent wetlands or mud flats during seasonal fluctuations in the lake level. The terraces, when exposed, provide an opportunity for voluntary native vegetation to become established. When these areas are again submerged, some vegetation would persist and that which cannot would contribute

to the organic content of the benthic zone. The productivity of the benthic zone is largely dependent on the organic content of the sediment and amount of physical structure.

Substrate: It would be necessary to modify the substrate of existing bodies of water within the study area to implement restoration at the lakes. This may include the addition of impermeable materials to both maintain water elevations and grow vegetation. There are some preferred alternatives for lake bottoms that improve the benthic zone productivity. There are tradeoffs in productivity, refuge, diversity, and food production associated with the various lake bottom characteristics. A sandy substrate contains relatively small amounts of organic matter for organisms and provides limited protection from predation. Higher plant growth is limited and sparse in sandy sediment; the sand is unstable and nutrient deficient. A rocky bottom has a high diversity of potential habitats offering protection (refuge) from predators, substrate for attached algae, and pockets of organic "ooze." A flat mucky bottom offers abundant food for benthos organisms; however, there is less protection and the diversity of structural habitats may be reduced unless higher plants colonize the lake bottom.

5.7.5.6 Invasive Species Management

Invasive Species Removal/Control: It would be necessary to remove and manage invasive species such as saltcedar and Arundo with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. Saltcedar is currently found in stands throughout the study area. Arundo, though not yet a significant problem in Arizona, is a problem in neighboring California. A stand of Arundo can be found on the south side of the river near a stormwater outfall at 43rd Avenue.

5.7.5.7 River Channel Restoration

Project implementation would restore the river channel to a more natural state based on hydraulics and geomorphology. This would be accomplished by grading and terracing to help restore an active channel through the entire reach. Average depth of grading is assumed to be 5 feet, with a width varying from 200 to 400 feet. The average width of the river channel ,including adjacent river terrace, thorughout the study area will be approximatley 500 feet. The

channel design passes a 5-year event (~22,000 cfs) with occasional flooding on the terrace 2 to 4 feet depth at 1-7 cfs. Due to a drop in the channel downstream of the 35th Avenue Bridge, a grade control structure is recommended in that vicinity. At this time, erosion and scour do not appear to be a concern with project features or infrastructure. However, should it appear in future analysis that it is a concern, appropriate protection would be included. An estimated 660,000 c.y. would be removed from the channel to implement this measure. Material removed would be native riverbed material and would utilized on site for terracing and construction of other project components, such as lake restoration.

River channel habitats

As discussed earlier in this report the river channel itself can include different habitat cover types depending on site specific conditions. These may include dry river bottom, emergent wetland, riparian scrub or desert scrub. The team assumed that after construction a low flow channel similar to that in the Rio Salado Project area and the existing channel in the reach near 43rd Avenue would become established. The total acreage of this low flow channel through the project reach was assumed to be 170 acres. It was projected that between 10-20% of that would become vegetated with emergent wetlands. The remainder of the channel will vegetate with either riparian scrub or desert scrub depending on conditions within this active channel.

5.8 THIRD/FINAL ARRAY OF ALTERNATIVES

While evaluating the future conditions that would occur with each of the five remaining alternatives, two additional alternatives—modifications of Alternative 5—came to light. These were developed by the study team and made the final array of project alternatives, which then became seven, including the No Action Alternative. Note that Alternatives 3 and 4 were nearly identical, apart from the emergent wetlands in Alterative 4. These two very similar alternatives were therefore combined as Alternative 4. The final set of project alternatives is shown in Table V-8 below, including short descriptions and the restored acreage associated with each alternative. Plates depicting each alternative and features therein are included at the end of the report.

1. **No Action**: No Federal Action to be conducted and no habitat restored. This is the future without-project condition.

2. **Storm Water and Channel:** This alternative includes the modification of existing stormwater outfall areas to improve retention and water spreading as well as increase the existing habitat currently supported by these outfalls. It also includes modification and/or restructuring of the primary conveyance channel to a more natural state by grading and terracing the river corridor from 19th Avenue to 83rd Avenue. No additional water source is included in this alternative other than temporary irrigation to establish vegetation.

3. **This alternative was merged with Alternative 4 below.**

4. **Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent:** This alternative includes the features described in Alternative 2 and adds supplemental water supply in the form of effluent. It also includes restoration of emergent wetlands at the existing lake in the channel immediately downstream of 19th Avenue. At locations identified as suitable throughout the project area, cottonwood/willow and mesquite cover types would be restored. This alternative would also address the management, control, and removal of invasive species within the study area.

5. **Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent, Lake:** This alternative includes the features described in Alternative 4 and adds lake restoration at the existing gravel pits at 27th and 37th Avenues.

5A. Wetland restoration in lieu of permanent open water and lakes: In lieu of lake restoration, this alternative includes regrading the existing gravel pits to restore them to the floodplain, and restoring emergent wetland and riparian areas.

5B. Hybrid of 5 and 5A: This alternative includes restoration of one gravel pit to a wetland/riparian complex, and the other to include the lake.

Table V-8: Final Array of Restoration Alternatives Evaluated

Action Alternative	Cover Type	Acres
2. Storm Water and Channel	Cottonwood/Willow	66
	Mesquite	43
	Open Water	0
	Scrub Shrub*	305
	Wetlands	28
	Channel **	
	Low flow channel	170
	In-Channel Wetlands	17
	Riparian scrub	125
4. Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent	Cottonwood/Willow	348
	Mesquite	409
	Open Water	0
	Scrub Shrub*	63
	Wetlands	33
	Channel **	
	Low flow channel	170
	In-Channel Wetlands	34
	Riparian scrub	165
5. Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent, Lake	Cottonwood/Willow	375
	Mesquite	417
	Open Water	40
	Scrub Shrub*	92
	Wetlands	76
	Channel **	
	Low flow channel	170
	In-Channel Wetlands	34
	Riparian scrub	296
5A. Wetland/riparian restoration in lieu of permanent open water and lakes	Cottonwood/Willow	375
	Mesquite	417
	Open Water	0
	Scrub Shrub*	52
	Wetlands	156
	Channel **	
	Low flow channel	170
	In-Channel Wetlands	34
	Riparian scrub	296
5B. Hybrid of 5 and 5A with one gravel pit restored to a lake and the other wetland//riparian complex	Cottonwood/Willow	375
	Mesquite	417
	Open Water	20
	Scrub Shrub*	52
	Wetlands	136
	Channel **	
	Low flow channel	170
	In-Channel Wetlands	34
	Riparian scrub	296

* Scrub shrub acres are dispersed among and between the other restored cover types within the floodplain.
** Note that the acres of river channel is made up of (low flow, wetland, or riparian scrub)

Comparison and Evaluation of the Third Array of Alternatives

5.8.1.1 Water Supply and Water Budget

Water sources within the project area available for the alternatives are evaluated within Appendix A, Hydrology and Hydraulics. Available sources for the project include effluent and harvested storm water. Approximately 8 mgd (8,961 ac-ft/yr) of effluent would be made available from the 23rd Avenue WWTP. Stormwater runoff within the project area was also calculated based upon average monthly rainfall in Phoenix, and approximately 2,900 ac-ft can be expected to runoff into the project area from the approximately 8 adjacent outfalls. Water demand for individual alternatives is summarized in Table V-9 below, with more detail included in Appendix B, Water Budget Report and Interior Drainage Report.

Table V-9: Water Demand for Alternative Plans

Alternative	Water Demand (A/F)	Water Demand (mgd)
Alternative 2	1,583	1.41
Alternative 4	4,701	4.20
Alternative 5	7,752	6.92
Alternative 5A	9,293	8.30
Alternative 5B	9,234	8.24

5.8.1.2 Hydraulics

The hydraulic model of the study area was modified to reflect with-project conditions for a range of modifications including low, medium, and high amounts of vegetation restored in the floodplain. The high end of the range mimics Alternative 5. Results indicate that with-project conditions do not induce flood damages anywhere in the study area. Detailed results of the modeling can be found in Appendix A, Hydrology and Hydraulics.

5.8.1.3 Cultural Resources

While there are cultural resources at sites adjacent to the project area, surveys conducted by a Corps of Engineers staff archaeologist failed to locate any cultural material within selected portions of the project area. Based upon the reconnaissance survey, level of previous disturbance, and data provided from the geological assessment downstream in the Tres Rios Project area, the Corps believes that the potential for buried archaeological resources is low. If

project alternatives change or additional information is located, further surveys and coordination with the SHPO would be completed. More detailed description of cultural resources and reasons for this determination are provided in Appendix F, Modified Phase I Environmental Site Assessment.

5.8.1.4 Hazardous, Toxic, or Radioactive Waste

A groundwater quality analysis and a Modified Phase I ESA were completed during the study and may be seen in Appendix D and Appendix F, respectively. Landfills, LUSTs, and groundwater contamination are known to occur within the study area. This includes an area in the vicinity of 19th Avenue with elevated concentrations of 1,1 DCE. Although these sites mentioned above are known to exist adjacent to the river, they have been avoided throughout the plan formulation process, to the greatest extent possible, in accordance with Corps guidelines.

Experience during construction of the Rio Salado Project upstream has shown that due to the nature of the riverbed and dumping that has occurred over the years, it is likely that debris would be unearthed during excavation. This could include inert construction debris, tires, or miscellaneous household waste. The reach of the river between 35th and 51st Avenues has a high occurrence of illegal dumping of household and landscape waste, as well as occasional construction debris. Much of this area has been cleaned and monitoring has increased, though some waste is likely to remain.

A remediation and management plan would need to be developed for unknown HTRW and other deleterious material encountered during construction. Project features are for the most part located within the 100-year floodplain and avoid the known HTRW sites. In accordance with Engineer Regulation 1165-2-132, the Corps would not participate in clean-up of materials regulated by the CERCLA or by RCRA.

5.8.1.5 Environmental Benefits

Riparian ecosystems in the Southwest are invaluable. Although they represent less than 1 percent of the region's area (Knopf, F. L., 1989), a large proportion (75 to 80 percent) (Gillis 1991) of vertebrate wildlife species depend on riparian areas for food, water, cover, and migration routes. Riparian zones also improve water quality because they filter sediments and nutrients.

Accumulated sediments in riparian zones store large amounts of water, which helps sustain stream flow during drier times. Estimation of environmental benefits was accomplished using the functional model described in Section IV and in Appendix I, Functional Assessment Methodology.

Functional Capacity Index

The Functional Capacity Index (FCI) describes the quality of the functional capacity of the habitat. Of the 10 functions evaluated in the without-project conditions, all had low to moderate functional capacity. Implementation of project alternatives caused an increase in each FCI, with the average increasing by approximately 30 percent and into the ranges considered moderate to moderate-high functional capacity. The most improved functions included Function 1 (Maintenance of Characteristic Channel Dynamics), Function 7 (Detention of Particles), and Function 10 (Maintain Interspersion and Connectivity). Those functions showing the least improvement included Function 4 (Dynamic Subsurface Water Storage), Function 5 (Nutrient Cycling), and Function 6 (Detention of Imported Elements and Compounds). Table V-10 below displays the FCI for the baseline condition as well as for each alternative.

Table V-10: With-Project Functional Capacity Indices (FCI)

Function Name	Existing	Alt 2	Alt 4	Alt 5	Alt 5A	Alt 5B
Fxn 01: Maintenance of Characteristic Dynamics	0.23	0.27	0.4	0.39	0.4	0.39
Fxn 02: Dynamic Surface Water Storage/Energy Dissipation	0.42	0.45	0.57	0.57	0.57	0.57
Fxn 03: Long Term Surface Water Storage	0.25	0.27	0.34	0.33	0.34	0.34
Fxn 04: Dynamic Subsurface Water Storage	0.44	0.50	0.51	0.51	0.52	0.52
Function 5: Nutrient Cycling	0.28	0.28	0.33	0.33	0.34	0.33
Function 6: Detention of Imported Elements and Compounds	0.38	0.39	0.45	0.45	0.46	0.45
Function 7: Detention of Particles	0.33	0.36	0.48	0.47	0.48	0.48
Function 8: Maintain Characteristic Plant Communities	0.42	0.43	0.51	0.51	0.51	0.51
Function 9: Maintain Spatial Structure of Habitat	0.30	0.32	0.42	0.41	0.42	0.41
Function 10: Maintain Interspersion and Connectivity	0.23	0.29	0.33	0.34	0.34	0.34

Acres Restored

In the future without-project condition, existing cottonwood/willow cover type was projected to decrease from 112 acres to 25 acres, and existing wetland was projected to decrease from 30 to 25 acres as well. It is assumed that the quality of that habitat would be low with high concentrations of invasive species such as salt cedar. Although there are scattered mesquite trees within the study area, none are dense enough to consider a mesquite cover type.

Alternative 2 relies mainly on restoration at storm water outfalls and restoration of the river channel itself without large amounts of restoration elsewhere. Alternatives 3 through 5A all maintain and improve the highly degraded 112 acres of cottonwood/willow, and include restoration of mesquite and wetland habitats. Alternative 5A, which has the highest AAFCU outputs, includes restoration of 375 acres of cottonwood/willow, 417 acres of mesquite, and 190 acres of wetlands, including restoration of two large gravel pits within the floodplain. Also included in this alternative are 348 acres of scrub shrub and 170 acres of river channel.

Average Annual Functional Capacity Units (AAFCUs)

Based upon the functional assessment completed for this study, the number of acres and functional capacity indices were projected in order to derive with-project estimates AAFCUs. The same methodology that was employed for assessing without-project conditions was also employed to assess the habitat output of each alternative. Benefits are defined as the increase in AAFCUs for each alternative relative to without-project conditions. As a reminder, the Functional Capacity Unit (FCU) represents the factor of habitat quality multiplied by the quantity or FCI from above multiplied by acreage of habitat restored.

Table V-11 shows the results. The proposed alternatives result in increased AAFCUs (relative to without-project conditions) ranging from 51 for Alternative 2 to 267 for Alternative 5A.

Table V-11: With-Project Average Annual Functional Capacity Units (AAFCUs)

Target Year	Without Project	Alt 2	Alt 4	Alt 5	Alt 5A	Alt 5B
T0	583	583	583	583	583	583
T1	580	619	691	766	791	778
T6	580	627	717	796	822	809
T26	579	635	755	828	857	842
T51	579	633	775	851	879	865
Average (T0-T51)	580	631	745	820	847	833

As can be seen in the table above, the without-project conditions change only slightly over 50 years; the existing conditions within the project area are highly degraded and are not expected to change without some action. Each column numbered with different alternatives displays the number of FCUs that are expected in that year, with the associated features of that alternative. The overall increase shown at the bottom of the table is the expected benefits to be accrued with that alternative between project year 1 and project year 50.

Associated Planning and Future Conditions

With any proposed project the associated local planning and zoning adjacent to the project area will affect each alternative similarly. The City of Phoenix has existing zoning regulations in place that in combination with a constructed restoration project will continue to ensure that any project implemented will not be adversely affected by development changes. Best Management Practices are in place as they relate to storm water outfalls entering the river and those will remain in tact in the future. The area adjacent to the Rio Salado Project upstream has an area plan and overlay district titled "Beyond the Banks" as described in Section 3.1.3. That connection between a restored river and adjacent community could expand downstream to the Rio Salado Oeste project area.

5.8.1.6 Costs

Project Construction Costs

Preliminary costs were developed for each project alternative. Estimates utilized a contingency of 25 percent of the First Cost and allowed 10 percent of the First Cost for engineering and design. One percent and 6 1/2 percent were utilized in estimating Engineering During Construction (EDC) and Construction Management. The Gross Investment for an alternative includes the first cost added to the other costs defined above plus Interest During Construction (IDC) calculated at the current 5.375 percent interest rate. Detailed cost estimates can be found in Appendix J, Design and Cost Estimate.

Real Estate

The proposed project features are located on areas of land that can be best described as the river corridor and floodplain mostly occurring within the 100-year floodplain. On some portions of the project, terraces or banks that are situated above floodplains may be incorporated into the project and used for ecosystem restoration and recreation. The lands are all undeveloped with the principle economic or industrial use being sand and gravel extraction. For project planning, an average cost of $20,000 per acre was utilized.

Operation and Maintenance (O&M) Consideration

A priority during formulation of project alternatives was to minimize flood damages to project features. Therefore, the placement of plantings or infrastructure within the 10-year area of inundation was avoided to the extent possible. However, any river restoration project is inherently at risk of some damage by flood flows and inundation. O&M costs would include replacement of vegetation and structures damaged during flood events, wetland and channel maintenance, invasive species control, and inspections and surveys. Annual O&M costs for the alternatives range from $98,000 to nearly $2,200,000. The Monitoring and Adaptive Management estimates range from $373,000 to approximately $4,900,000.

Associated Costs

For the duration of project, authorization the Non-Federal sponsor must provide sufficient water supply for construction, operation, and maintenance of the project. The cost of providing this water is 100 percent non-Federal. Based on current and future water demand, a unit cost of $106 per ac-ft of CAP water was used. Associated cost of Water Delivery refers to the estimate to provide a system of delivery to the adjacent farm.

Table V-12 below displays a summary of project costs for each alterative evaluated. Detailed cost estimates are provided in Appendix J, Design and Cost Estimate.

Table V-12: With-Project Average Annual Costs by Alternative (in $1,000s)

	Alt 2	Alt 4	Alt 5	Alt 5A	Alt 5B
Construction	$12,102	$41,623	$94,676	$69,683	$82,180
Contingency (25%)	$3,025	$10,406	$23,669	$17,421	$20,545
PED/EDC (11%)	$1,331	$4,579	$10,414	$7,665	$9,040
S&A (6.5%)	$787	$2,705	$6,154	$4,529	$5,342
Real Estate	$21,994	$36,313	$49,485	$49,485	$49,485
Subtotal	$39,238	$95,625	$184,398	$148,784	$166,591
Monitoring & Adapt. Mgmt.	$690	$2,373	$5,397	$3,972	$4,684
Total First Cost	**$39,928**	**$97,998**	**$189,795**	**$152,756**	**$171,275**
IDC	$2,011	$8,741	$19,385	$15,641	$17,513
Gross Investment	$41,939	$106,739	$209,180	$168,397	$188,788
Annualized Investment Cost	$2,342	$5,960	$ 11,680	$9,403	$10,524
Associated Cost (Water Delivery) System)	$ -	$34	$34	$34	$34
Associated Cost (Water Supply)	$ -	$331	$654	$817	$811
O&M	$101	$1,698	$2,224	$2,080	$2,134
Total Annual Cost	**$2,443**	**$8,022**	**$14,592**	**$12,334**	**$13,524**

Cost-Effectiveness and Incremental Cost Analysis

Cost-Effectiveness (CE) and Incremental Cost Analyses (ICAs) were performed on the above alternatives. CE identifies the least-costly solution for each level of output. The three criteria used for identifying non-cost-effective plans or combinations include (1) the same level of output could be produced by another plan at less cost, (2) a larger output level could be produced at the same cost, or (3) a larger output level could be produced at the least cost.

ICA compares the incremental costs for each additional unit of output. The first step in developing "best buy" plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the incremental cost per unit for maximum level of output is determined. The intent of the incremental analysis is to identify increases in cost relative to output.

Table V-13 summarizes average annual output and cost by alternative, as well as average annual cost per AAFCU. Figure V-4 below depicts graphically the comparison of annual costs versus annual benefits for the alternatives.

Table V-13: Average Annual Costs Per Annual FCU by Alternative (in $1,000s)

Alternative	AAFCU	AA COST	AAC/AAFCU
Alt 2	51	$2,443	$47.73
Alt 4	165	$8,022	$48.55
Alt 5	240	$14,592	$60.71
Alt 5A	267	$12,334	$46.15
Alt 5B	253	$13,524	$53.50

Cost Effectiveness Analysis

Alternatives are considered cost effective if there are no other alternatives that provide greater output for the same cost or provide the same output for a lesser cost. This step eliminates alternatives that are inefficient from further consideration. As can be seen in Table V-13 and Figure V-4 Alternatives 5 and 5B have higher costs but fewer benefits than Alternative 5A and therefore are not cost effective.

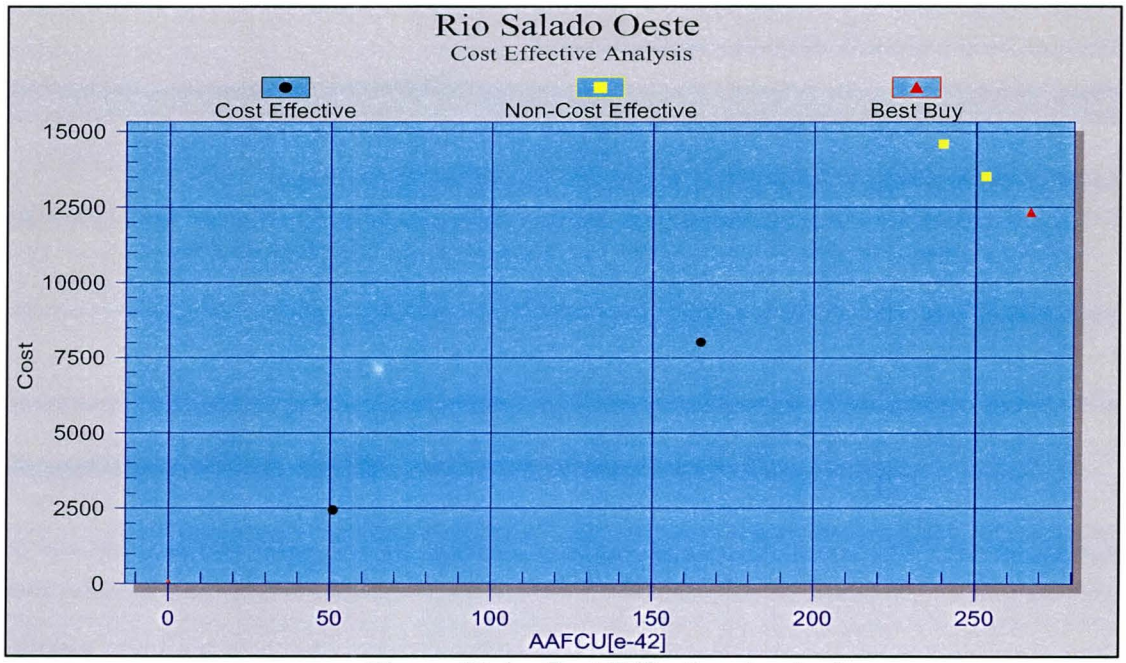


Figure V-4: Cost Effective Analysis

Incremental Cost Analysis

ICA goes beyond cost effectiveness analysis to consider the incremental change in cost and outputs from one alternative to the next. As you step through the successive levels of outputs in the AAFCU column in Table V-14 below you can see an increasing level of outputs (AAFCU's) from 51 to 267. Likewise the annual cost increases. The incremental increase in cost between

alternatives displays the additional cost to implement one alternative over the next and likewise the benefits over the next. This information can be used to weigh the difference in levels of cost versus benefits and contributes to the plan selection process. Incremental cost analysis is also used to identify "best buy" plans. Best Buy plans are those that have the lowest incremental average annual cost per incremental increase in output. Of the alternatives formulated for this study, Alternative 5A has the greatest output and the lowest average annual cost per average annual functional capacity unit. Therefore, it is the only Best Buy plan (Table V-14).

Table V-14: Incremental Cost Analysis

	AAFCU	Annual Cost	Cost/AAFCU	Incremental Cost/Incremental AAFCU
Alt 2	51	$2,433	$47.73	$47.71
Alt 4	165	$8,022	$48.55	$49.03
Alt 5A	267	$12,334	$46.15	$42.27

As can be seen above there is a large increase in both costs and benefits from Alternative 2 to the other alternatives. This difference can be explained by looking at the differences between what is included in each alternative. Alternative 2 includes restoration of the active channel and takes advantage of existing storm water outfalls by modifying them and adding native riparian vegetation, without addition of a water supply system. It is the minimal and most economical option by taking the least action to achieve restoration by relying on existing storm water outfalls and a restored channel. To achieve alternatives with greater environmental outputs required additional investment including in a water supply and distribution system and additional habitat acreage. Alternative 2 includes restoration of approximately 154 acres of cottonwood-willow, wetland and mesquite with a large amount of riparian scrub. Conversely Alternatives 4 and 5A include nearly 600% more of the scarce and high quality riparian habitats and less riparian scrub.

Recommended Ecosystem Restoration Plan

Alternative 5A has been identified as the NER Plan. It has the highest environmental outputs, is cost effective, and has the lowest incremental cost/output.

5.8.1.7 Recreation

The Rio Salado Oeste Project provides a unique opportunity to enhance resource-based recreation and environmental education. The restoration of the dry Salt River channel would

bring a riparian open space feature to the rapidly expanding Laveen and Estrella Planning Areas. Rio Salado Oeste would provide a habitat and recreational connection to the desert riparian habitat corridor created by the Rio Salado and Tres Rios Projects. By connecting the 7-mile gap between the two projects, Rio Salado Oeste would enhance the unique recreation and education opportunities for residents and out-of-town visitors. Drawing on a population base of over two million in the Valley, it is estimated that visitation to the Rio Salado Oeste Project would exceed 350,000 annually (see Table V-15). Primary use times for this unique resource would coincide with the "visitor season" between October and May when temperatures are moderate.

Table V-15: Rio Salado Oeste Recreation Plan
Baseline Visitation Estimate

	Days	Turnover/Day	Visits*
Winter (Oct-May)	243		
Prime Time	78	1.50	160,875
Non-Prime Time	165	.50	113,438
Winter Total			274,313
Summer (Jun -Sep)	122		
Prime Time	36	1.00	49,500
Non-Prime Time	86	0.25	29,563
Summer Total			79,063
Grand Total (by vehicle)			**353,376**
Add - Arrive by Alternative Mode (10%)			35,338
Total Visitation			**388,714**
Less Transfers (10%)			38,871
Baseline Visitation for Benefit Analysis (rounded)			**350,000**

Note: Based upon parking capacity for 500 spaces.
Average of 2.75 Persons/Vehicle

The City of Phoenix developed the recreation plan for the project, which may be found in Appendix L, Recreation. The plan is consistent with Corps policy on development of recreation at ecosystem restoration projects as outlined in Policy Guidance Letter No. 59, USACE 1998. Major recreation features include multipurpose trails, shelters, signage, shelters, utilities, park furniture, and interpretive media. Access points are identified in the plan, with four drive-in points with parking facilities and 5 smaller access points for walk-in use. Additionally, 9 minor points for walk-in access from adjacent neighborhoods will be completed. Table V-16 below includes the recreation features and associated cost estimates. Although an environmental education center is included in the estimate below, it is not a cost-shareable portion of the project and would be a local sponsor cost.

Table V-16: Rio Salado Oeste Recreation Plan with Costs

Component	Quantity	Unit Cost	Rec. Cost
Access Point, Maintenance Facility and Edu. Center (35th Ave.)	**1**		
Site Preparation			
Site Prep to include: clearing, grubbing, and grading	1	Lump Sum	$50,000.00
Vegetative Restoration	1	Lump Sum	$150,000.00
Access and Circulation			
Entry Road w/Turnaround to include: curb, gutter, driveway, & road	1	Lump Sum	$150,000.00
Parking Lot	250	$1500/space	$375,000.00
Sidewalks and Ramps	2,500 sf.	$6.00 each	$15,000.00
Multi-Use Trails	555 sy.	$6.00/sy	$3,330.00
Bridges and Culverts (small)	4	$7,500 each	$15,000.00
Protection Access Control			
Access Control Gates (vehicular)	2	$7,500 each	$15,000.00
Access Control Gates (pedestrian)	2	$3,500 each	$7,000.00
Handrails	500 l.f.	$50.00 each	$25,000.00
Guardrails	100 l.f.	$50.00 each	$5,000.00
Fencing	500 l.f.	$30.00 each	$15,000.00
Walls	150 l.f.	$125.00 each	$18,750.00
Security lights	18	$4,000 each	$72,000.00
Signage			
Entrance Identification Signage	2	$15,000 each	$15,000.00
Traffic Control (vehicular)	5	$500 each	$2,500.00
Traffic Control (pedestrian)	5	$500 each	$2,500.00
Instructional/Directional	10	$500 each	$5,000.00
Shelters			
Picnic (large)	1	$60,000 each	$60,000.00
Picnic (small)	2	$25,000 each	$50,000.00
Restroom Facility/Comfort Station	1	$250,000 each	$250,000.00
Shelter w/Bulletin Boards	1	$25,000 each	$25,000.00
Trail Shelter w/Railing (large)	1	$40,000 each	$40,000.00
Trail Shelter w/Railing (medium)	1	$30,000 each	$30,000.00
Trail Shelter w/Railing (small)	2	$20,000 each	$40,000.00
Utilities			
Municipal Water Supply and Wastewater Disposal	1	Lump Sum	$100,000.00
Storm Drainage	1	Lump Sum	$20,000.00
Drinking Fountain w/Chiller	2	$5,000 each	$10,000.00
Electrical	1	Lump Sum	$50,000.00
Park Furniture			
Benches:	2	$1,500 each	$3,000.00
Off-the-Shelf	5	$800 each	$4,000.00
Recycled/Custom	8	$500 each	$4,000.00
Picnic Tables	5	$1000 each	$5,000.00
Trash Receptacles	10	$500 each	$5,000.00
Interpretive Guidance Media			
Display Boards	16	$600 each	$9,600.00
Interpretive Markers	16	$600 each	$9,600.00
Bulletin Boards	2	$2,500 each	$5,000.00

Component	Quantity	Unit Cost	Rec. Cost
(*) Environmental Education Center/ Visitor Center	1	Lump Sum	$4,500,000.00
Access Points- 4 drive in (35th, 51st N&S, 75th) and 5 walk in (19th, 23rd, 43rd, 75th, 83rd) Minor Access points in 9 locations.			
Site Preparation			
Site Prep to include: clearing, grubbing, and grading	9	Lump Sum	$250,000.00
Vegetative Restoration (drive-in access)	4	Lump Sum	$600,000.00
Vegetative Restoration (walk-in access)	5	Lump Sum	$75,000.00
Access and Circulation			
Entry Road w/Turnaround to include: curb, gutter, driveway, & road	4	Lump Sum	$600,000.00
Parking Lot	250	$1500/space	$375,000.00
Sidewalks and Ramps	40,000 sf.	$6.00 each	$240,000.00
Multi-Use Trails (24mi * 5280 * 5ft)	70,400 sy	$6.00 / sy	$422,400.00
Bridges and Culverts (small) @ Canals, and Localized Drainage Areas	10	$7,500 each	$75,000.00
Minor Access points (2 benches, gate, sign)	9	$6000/each	$54,000.00
Protection Access Control			
Access Control Gates (vehicular)	8	$7,500 each	$60,000.00
Access Control Gates (pedestrian)	18	$3,500 each	$63,000.00
Handrails	5,000 l.f.	$50.00 each	$250,000.00
Guardrails	3,000 l.f.	$50.00 each	$150,000.00
Fencing	50,00 l.f.	$30.00 each	$150,000.00
Walls	1,500 l.f.	$125.00 each	$187,500.00
Security lights	100	$4,000 each	$400,000.00
Signage			
Entrance identification signage	8	$15,000 each	$120,000.00
Traffic Control (vehicular)	20	$500 each	$10,000.00
Traffic Control (pedestrian)	27	$500 each	$13,500.00
Instructional/Directional	45	$500 each	$22,500.00
Shelters			
Picnic (large)	4	$60,000 each	$240,000.00
Picnic (small)	5	$25,000 each	$125,000.00
Restroom Facility/Comfort Station	4	$250,000 each	$1,000,000.00
Shelter w/Bulletin Boards	4	$25,000 each	$100,000.00
Trail Shelter w/Railing (large)	9	$40,000 each	$360,000.00
Trail Shelter w/Railing (medium)	4	$30,000 each	$120,000.00
Trail Shelter w/Railing (small)	10	$20,000 each	$200,000.00
Utilities			
Municipal Water Supply and Wastewater Disposal	4	Lump Sum	$400,000.00
Storm Drainage	4	Lump Sum	$80,000.00
Drinking Fountain w/Chiller	12	$5,000 each	$60,000.00
Electical	4	Lump Sum	$200,000.00
Park Furniture			
Benches:	14	$1,500 each	$21,000.00
Off-the-Shelf	40	$800 each	$32,000.00
Recycled/Custom	50	$500 each	$25,000.00
Picnic Tables	40	$1000 each	$40,000.00
Trash Receptacles	75	$500 each	$37,500.00
Interpretive Guidance Media			

Component	Quantity	Unit Cost	Rec. Cost
Display Boards	50	$600 each	$30,000.00
Interpretive Markers	100	$600 each	$60,000.00
Bulletin Boards	9	$2,500 each	$22,500.00
TOTAL COST (No Environmental Education Center)		**Subtotal**	**$8,932,180.00**
NOTE: (*) = Betterment (Environmental Education Center)	Contingency	20%	$1,786,436.00
	PED	10%	$893,218.00
	EDC	1%	$89,321.80
	S&A	7%	$625,252.60
		Total	**$12,326,408.40**

5.9 EVALUATION OF FINAL ARRAY OF ALTERNATIVES

5.9.1 System of Accounts

The comparison and evaluation of alternatives involves the consideration of the effects that the plans would have on planning objectives and constraints. The following discussions address the differences and similarities between the future without project conditions and alternatives. The four national accounts are also considered in the comparison and evaluation of alternative plans, as are the associated evaluation criteria.

In the 1970 Flood Control Act, Congress identified four equal national accounts for use in water resources development planning. They are National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). Policy in the 1970s regarded making contributions to only two of these, NED and EQ, as national objectives. The Federal objective is taken from the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" also known as Principles and Guidelines or P&G.

5.9.1.1 National Economic Development (NED)

The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable Executive orders, and other Federal planning requirements.

"Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the

direct net benefits that accrue in the planning area and the rest of the nation. Contributions to NED in clued increases in the net value of those goods and services that are marketed, and also those that may not be marketed" (P&G).

For this project, with the primary outputs being ecosystem restoration, the Environmental Quality (EQ) Account below includes those benefits. Benefits of recreation and flood damage reduction, if any, are accounted for within the NED Account.

Recreation Benefit Analysis

Visitation at the resource would be limited based upon the available parking in the area. Phoenix's design includes several parking lots with a total of 500 spaces. Visitation data maintained by the City for other recreation sites indicates an average number of visitors per vehicle of 2.75. In addition, it is estimated that ten percent of visitors arrive to the site by an alternative mode of transportation (e.g., bicycle, foot traffic and public transportation).

Annual visitation has been estimated for both the winter (October - May) and the summer (June - September) seasons. In addition, visitation has also been broken down by prime time (weekends and holidays) and non-prime time (weekdays). Transfers are expected to be minimal due to the unique recreation opportunities and setting offered at the restoration site. The City expects the primary transfers to be in the categories of education field trips, bird watchers, passive nature watchers, canal joggers, and recreational cyclists. Annual transfers were estimated at ten percent of total visitation. Excluding transfers, annual visitation is estimated at 350,000.

The above visitation projections were also compared to standards established by the National Recreation & Parks Association (NRPA), regarding trail usage and capacity. NRPA standards for trail capacity and use range from 40 to 90 users per day per trail mile (or between 14,600 to 32,850 users per year per trail mile). The proposed recreation plan includes approximately 24 miles of multipurpose trails. With baseline visitation projected at 350,000, this equates with a value of about 14,600 users per year per trail mile, which supports that the proposed facilities should be able to accommodate the projected visitation. Further, the proposed facilities should also be able to support likely increases in visitation over time, as the general population growth in the study area will inevitably increase demand and use of the facilities.

Unit Day Point Value Estimates

A panel of Phoenix Parks, Recreation and Library department personnel including Park Managers, Recreation Supervisors, Recreation Coordinators, and Landscape Architects reviewed the recreation plan in light of its location within the planned environmental restoration study area and derived the following point values for the Unit Day Value analysis:

Criteria	Range of Point Values	Assigned Value
Recreation Experience	0-30	29
Availability of Opportunity	0-18	12
Carrying Capacity	0-14	14
Accessibility	0-18	18
Environmental	0-20	17
Total	0-100	90

Recreation experience was rated very high, although most recreation activities could be described as general recreation. This is because of the context within which the recreation takes place. There are very few recreation sites in the market area located in a riparian and wetland environmental setting. This enhances the value of these activities. In addition, non-general recreation and education opportunities are provided, such as interpretive areas and scenic overlooks, birding, etc. The project would be designed to maximize recreational values in the other categories to the extent possible. Please refer to the City's recreation analysis for additional details (Appendix L).

Economic Guidance Memorandum 05-05 dated 24 November 2004 provides ranges for point value to dollar value conversion. The dollar value corresponding with a point value of 90 is $9.17. This point value was applied to projected annual visitation to derive the annual value of the recreation resource. The resulting annual recreation value totals $3,209,500.

Recreation Costs & Benefit/Cost Analysis

Table V-17 details the cost estimates for the proposed recreation plan.

Table V-17: Recreation Plan Expected Annual Costs

First Cost	
Site Preparation	$1,125,000
Parking Lots (500 Spaces)	$750,000
Entry Roads	$750,000
Sidewalks & Ramps	$255,000
Multi-Use Trails	$425,730
Bridges & Culverts	$90,000
Minor Access Points	$54,000
Access Control	$946,250
Security Lighting	$472,000
Signage	$191,000
Picnic/Trail Shelters	$1,390,000
Restroom Facilities	$1,250,000
Utilities	$920,000
Park Furniture	$176,500
Interpretive Guidance Media	$136,700
Subtotal – Construction	$8,932,180
Contingency (20%)	$1,786,436
PED/EDC (11%)	$982,540
S&A (7%)	$625,253
Total First Cost	**$12,326,000**
Interest During Construction	$632,000
Gross Investment	**$12,958,000**
Annualized Investment Cost	$723,100
OMRR&R	$2,055,000
Total Annual Cost	**$2,778,500**

Average annual benefits have been estimated at **$3,209,500**, and average annual costs are estimated at about $**2,778,500**. Therefore, the proposed recreation plan is economically justified, with net benefits of **$431,000** and a benefit/cost ratio of **1.16**.

5.9.1.2 Regional Economic Development (RED)

The RED Account is intended to illustrate the effects that the proposed plans would have on regional economic activity, specifically, regional income and regional employment. The comparison of possible effects that the plans may have on these resources is shown in Table V-18.

Table V-18: Regional Economic Development Account

	No Action	Alt 2	Alt 4	Alt 5A
Employment	No effect	Short-term increase in employment during project construction.	Short-term increase in employment during project construction.	Short-term increase in employment during project construction.
Business and Industry	No effect	Increased recreation and tourist visitation to the area may increase revenues of local businesses.	Increased recreation and tourist visitation to the area may increase revenues of local businesses.	Increased recreation and tourist visitation to the area may increase revenues of local businesses.
Local Government Finance	No effect	Financing required for construction, $24M. O&M $101,000/yr restoration $2.1M recreation	Financing required for construction, $42M. O&M $1,697,000/yr restoration, $2.1M recreation	Financing required for construction, $53M. O&M. $2,078,000/yr $2.1 recreation
Growth Inducing Impacts	No effect	No impact on growth. Potential benefit in contribution to neighborhood revitalization.	No impact on growth. Potential benefit in contribution to neighborhood revitalization.	No impact on growth. Potential benefit in contribution to neighborhood revitalization.

It can safely be assumed that river restoration would contribute significantly to local and regional economic development and revitalization of the neighborhoods adjacent to the river. Land being developed and redeveloped within several miles of the Salt River is taking the potential for a restored river into account. Model homes and developments advertise the restored Rio Salado and the City has a local plan for revitalization and future development upstream of the Rio Salado Oeste study area.

Rio Salado Beyond the Banks

The Rio Salado *Beyond the Banks* area plan is a local policy document for revitalization of the area, which includes approximately 7 square miles between the I-17/I-10 freeways, Broadway Road to the south, 19th Avenue to the west and 32nd Street to the east. City support of private sector investment will be provided through public improvements, financial incentives, technical assistance, and zoning enforcement. Improvements that will increase property values in the area are expected to occur incrementally over time in response to market forces, through private investment, and as a result of City revitalization efforts. As incompatible uses and blight are reduced and new developments, facilities, and amenities are added, the *Beyond the Banks* area will begin to realize its broad potential. Four major areas of emphasis for new development will help spur area revitalization in general. Estimates of redevelopment that has occurred since the

Rio Salado Interim Overlay zoning went into place in January, 2002 are between $325 and $400 million.

Local Property Values

Studies have documented higher property values associated with riparian areas and wetlands. One such study in Tucson, Arizona, documented a 6 percent difference in property value due to proximity to the riparian corridor (Colby and Wishart, 2002). It can be assumed that the change from a degraded floodplain to restored riparian and wetland habitat would have a similar effect on property values in the area.

5.9.1.3 Environmental Quality (EQ)

The EQ account is another means of evaluating the alternatives to assist in making a plan recommendation. This account is intended to display the long-term effects the alternative plans could have on significant environmental resources. Table V-19 shows the accounts for each alternative.

Table V-19: Environmental Quality (EQ) Account

	No Action	Alt 2	Alt 4	Alt 5A
AAFCU	580	631	745	847
Increase in AAFCU	-	51	165	267
Average Annual Cost ($1,000)	-	$2,433	$8,022	$12,334
Average Annual Cost/AAFCU ($1,000)	-	$47.73	$48.55	$46.15
Water Quality	Water quality is expected to decline slightly as the watershed continues to urbanize.	Water quality could decrease temporarily during construction. Best Management Practices would be implemented for mitigation. However, positive impacts over current conditions would occur in the long-term.	Water quality could decrease temporarily during construction. Best Management Practices would be implemented for mitigation. However, positive impacts over current conditions would occur in the long-term.	Water quality could decrease temporarily during construction. Best Management Practices would be implemented for mitigation. However, positive impacts over current conditions would occur in the long-term.
Air Quality	Existing air quality levels created by business, traffic, and industry would continue. It can be assumed that dust levels would increase with additional dry river bottom disturbed by off road vehicles.	Temporary air quality decrease during construction but would be mitigated through implementation of Best Management Practices. This alternative would have positive long-term impacts when compared to the No Action Alternative.	Temporary air quality decrease during construction but would be mitigated through implementation of Best Management Practices. This alternative would have positive long-term impacts when compared to the No Action Alternative.	Temporary air quality decrease during construction but would be mitigated through implementation of Best Management Practices. This alternative would have positive long-term impacts when compared to the No Action Alternative.
Noise	No impacts to noise would occur.	A temporary increase in construction noise would occur but long term conditions would be no more than existing levels.	A temporary increase in construction noise would occur but long term conditions would be no more than existing levels.	A temporary increase in construction noise would occur but long term conditions would be no more than existing levels.
Vegetation	Existing native vegetation would decline within the study area.	Restoration of habitat at storm water outfalls would have some positive effect on vegetation.	Restoration of habitat throughout the study area would have a positive effect by restoring native vegetation.	Restoration of habitat throughout the study area would have a positive effect by restoring native vegetation.
Fish and Wildlife	Loss to habitat of fish and wildlife populations due to vegetation changes would occur.	Habitat would improve slightly where restoration occurs. Some connection of wildlife corridor would occur.	Habitat would improve through the study area and connect upstream and downstream habitats for wildlife movement.	Habitat would improve through the study area and connect upstream and downstream habitats for wildlife movement.

	No Action	Alt 2	Alt 4	Alt 5A
Endangered Species	No impacts to threatened or endangered plant species would occur.	Although no endangered species are known in the study area, habitat restoration could attract them and contribute to positive effects on their habitat.	Although no endangered species are known in the study area, habitat restoration could attract them and contribute to positive effects on their habitat.	Although no endangered species are known in the study area, habitat restoration could attract them and contribute to positive effects on their habitat.
Cultural Resources	No impacts on cultural resources.	Potential for impacts to cultural resources is believed to be low. If resources are located, consultation with SHPO would occur.	Potential for impacts to cultural resources is believed to be low. If resources are located, consultation with SHPO would occur.	Potential for impacts to cultural resources is believed to be low. If resources are located, consultation with SHPO would occur.
Aesthetics	Existing aesthetic environment would remain relatively unaffected with continued illegal dumping throughout portions of the study area.	Could be affected during construction, however, many of these areas are not highly visible and affects are short term. Implementation would result in improved views of riparian vegetation.	Could be affected during construction, however, many of these areas are not highly visible and affects are short term. Implementation would result in improved views of riparian vegetation.	Could be affected during construction, however, many of these areas are not highly visible and affects are short term. Implementation would result in improved views of riparian vegetation.

5.9.1.4 Other Social Effects (OSE)

The OSE Account typically includes long-term community impacts in the areas of public facilities and services, recreational opportunities, transportation and traffic, and manmade and natural resources. A comparison of the effects that the proposed alternatives would have on OSE resources is shown in Table V-20.

Table V-20: Other Social Effects Account

	No Action	Alt 2	Alt 4	Alt 5A
Life, Health and Safety	No change	Improvement to river environment would improve safety and health in adjacent community.	Improvement to river environment would improve safety and health in adjacent community.	Improvement to river environment would improve safety and health in adjacent community.
Recreation	Recreation conditions would stay substantially the same. Recreational experiences would also not be enhanced.	Implementation of recreation plan would increase availability and enjoyment of recreation opportunities.	Implementation of recreation plan would increase availability and enjoyment of recreation opportunities.	Implementation of recreation plan would increase availability and enjoyment of recreation opportunities.
Community Cohesion	No change	River restoration is preferred over the No Action Alternative and contributes to community cohesion.	River restoration is preferred over the No Action Alternative and contributes to community cohesion.	River restoration is preferred over the No Action Alternative and contributes to community cohesion.

5.9.2 Associated Evaluation Criteria

The selection of a recommended plan from the alternative plans requires a combination of decision-making factors. As suggested by the U.S. Water Resources Council, the alternative plans are compared using the following criteria: completeness, effectiveness, efficiency, and acceptability. The evaluation of the alternative plans by established criteria are described below.

5.9.2.1 Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure realization of the planning objectives. A complete alternative (1) meets the objectives, (2) needs no further actions for complete fulfillment of the project, (3) is consistent and reliable, (4) is capable of being physically implemented, and (5) mitigates unavoidable adverse environmental effects, as appropriate. In

general, all of the final alternatives are fully formulated and complete. Completeness was a factor considered in screening of the first set of alternatives. No further measures are needed to allow for the functioning of the final set of alternatives.

5.9.2.2 Effectiveness

Effectiveness is the extent to which an alternative resolves the identified problems and achieves the specified objectives. The proposed plans must restore the long-term health of the ecosystem structure, function, and dynamic processes in the Rio Salado Oeste portion of the Salt River. The No Action Alternative is ineffective in meeting any of the planning objectives. Action alternatives evaluated are all effective to some extent, although some are more effective than others to the extent to which they meet the objectives.

5.9.2.3 Efficiency

Efficiency is the extent to which an alternative is the most cost-effective means of addressing the identified problems while realizing the specified objectives consistent with protecting the Nation's environment. Cost effectiveness analysis identifies the plans that have the highest levels of output relative to costs. The No Action Alternative is the least cost alternative, but fails to restore valuable habitats, which have suffered historic losses and provide important habitat to many species. It also does not address un-met recreation demand in the study area.

5.9.2.4 Acceptability

Acceptability is the workability and viability of an alternative to other Federal agencies, affected State, tribal, and local agencies, and public entities, given existing laws, regulations, and public policies. The comparison of acceptability is defined as acceptance of the plan by the local sponsor and the concerned public. It is assumed that the action alternatives are all acceptable, although this will be assessed further with public review of the draft report.

Table V-21: Associated Evaluation Criteria

Criteria	No Action	Alternative 2	Alternative 4	Alternative 5A
Completeness	Does not meet objective	Technically feasible, limited size of restoration, least acreage required and restored.	Technically feasible, meets restoration objectives, restores 5 times more priority habitat than Alt 2.	Technically feasible, meets restoration objectives, restores the most acreage of priority habitat types.
Effectiveness	Does not meet objective	Restores river channel and provided connectivity but restores least acreage of habitat.	Also includes a restored river channel and restores many more acres of habitat throughout the area than Alt 2.	Restores the river channel and provides connectivity and continuity along river with most acreage of habitat restored.
Efficiency	Does not meet objective	Restores least output (51 AAFCUs) with annual cost per output ($47,730/AAFCU)	Restores more than three times the output (165 AAFCU's) but highest annual cost per output ($48,550/AAFCU)	Restores most output (267 AAFCU) and at a lower annual cost per output ($46,150/AAFCU)
Acceptability	Does not meet objective	Not supported by Non Federal sponsor. Public support will be identified in the public review.	Not supported by Non Federal sponsor. Public support will be identified in the public review.	Supported by Non Federal sponsor. Public support will be identified in the public review.

5.10 RESTORATION PLANS CONSIDERED FOR RECOMMENDATION IN THE FEASIBILITY REPORT

The plans identified for selection are described below. It should be noted that the Locally Preferred Plan (LPP), if different from the NER Plan, would not be officially selected or approved by the local sponsor until after the public review process. The Recommended Plan will not be finalized until the Final Feasibility Report, after continuing coordination with the local sponsors, results of the public review and public involvement process, and continuing refined evaluation of the ecosystem restoration alternatives.

5.10.1 National Ecosystem Restoration Plan

The NER Plan is identified by the Federal Government as the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective. It is cost-effective and justified to achieve the desired level of outputs. The NER Plan is the restoration alternative that the Federal Government will recommend in the Final Feasibility Report, unless an exemption from the NER is required, as with an LPP, for example. The Federal government will cost share up to the price of the NER Plan, at 65 percent Federal and 35 percent non-Federal for ecosystem restoration features including provisions of all Lands, Easements, Rights-of-way, Relocations, and Disposal Areas (LERRDs). Recreation features will be cost-shared at 50-50 or 0-100, Federal and non-Federal, respectively, depending upon the features.

No Action, Alternatives 2, 4 and 5A have been carried forward for comparison. Alternative 5A is the tentatively recommended NER Plan at this point as it maximizes restoration benefits compared to costs.

5.10.2 Locally Preferred Plan

Although there is not currently a Locally Preferred Plan, one may be identified in the Final Feasibility Report if the NER, or increments of the NER, are not supported by the public; do not include particular increments desirable to the local sponsor; or are not implement able because of management or funding constraints of the local sponsor. When the LPP is clearly of lesser scope and cost and meets the Administration's policies for high-priority outputs, the Assistant Secretary for the Army usually grants an exception for deviation. The increased scope of any plan more expensive than the NER would not warrant Federal cost-sharing participation. Thus, if the LPP is larger in scope than the NER, the local sponsor would pay 100 percent of the difference between that plan and the NER.

5.11 SELECTION OF THE RECOMMENDED PLAN

The Draft Feasibility Report is presenting a tentatively recommended plan based on the analyses conducted to date. Based on continuing coordination with the non-Federal sponsors, results of the public involvement/review process, and continuing refined evaluation of the final array of alternatives, a recommended plan will be identified for the Final Feasibility Report and Final EIS.

Table V-22: Comparison of Alternatives (in $1,000)s

	No Action	Alt 2	Alt 4	Alt 5A
AAFCU	580	631	745	847
Increase in AAFCU	0	51	165	267
Acres Restored	0	737	1188	1500
Average Annual Cost	0	$2,443	$8,022	$12,334
Average Annual Cost per AAFCU	0	$47.73	$48.55	$46.15

Based on the cost-effectiveness and incremental cost evaluation together with the analysis of impacts in the system of accounts and associated evaluation criteria, Alternative 5A is the plan that reasonably maximizes net ecosystem restoration benefits by having the maximum amount of restoration benefits compared to costs. Therefore, Alternative 5A is identified as the NER Plan and is presented as the tentatively recommended plan to be considered for implementation.

That alternative includes restoration of approximately 1,500 acres of riverine habitat throughout the 8-mile study area. Approximately 847 AAFCUs would be available with the project, an increase of nearly 47 percent over without-project conditions where there were projected to be 580 AAFCUs. Alternative 5A has an estimated cost of $168,397,000 with an annual cost of $12,334.000 including $2,078,000 Annual O&M.

Restoration features of the alternative include restoration of the river channel to a more natural state by grading and terracing the channel from 19th Avenue to 83rd Avenue; modification of stormwater outfalls to improve water retention; restoration of cottonwood/willow, mesquite, and wetland cover types throught the project area; and the restoration of two old gravel pits to wetland and riparian complexes. The alternative also includes control of invasive species such as saltcedar and Arundo throughout the life of the project . Water supply and distribution for the alternative is to be provided through a combination of 8 mgd of reclaimed effluent from the 23rd Avenue WWTP, and harvesting of storm water.

Table V-23: Acres of Habitat Restored with the Tentatively Recommended Plan

Habitat	Acres
Cottonwood/Willow	375
Mesquite	417
Open Water	0
Scrub Shrub	52
Wetlands	156
Channel	
Low flow channel	170
In-Channel Wetlands*	34
Riparian scrub	296
*Note that the acreage of in channel wetlands are a part of the 170 acres of low flow channel	

Ecosystem Restoration Significance

As discussed earlier in this report riparian habitat is significant in the Desert Southwest. Historically comprising a mere three percent of the landscape, over 95 percent has already been lost in Arizona. This type of river-connected riparian and fringe habitat is of an extremely high value due to its rarity. Arid southwest riparian ecosystems are recognized as a critically endangered habitat type. It has been estimated that 75 to 90 percent of all wildlife in the arid Southwest is riparian dependent during some part of its life cycle. The significance of riparian habitat in the Desert Southwest is recognized at various levels. Institutional, public and technical significance of riparian habitat restoration and that of the tentatively recommended plan are summarized here.

Executive Order No. 91-6 Protection of Riparian Areas and issued by the Governor of Arizona in 1989 recognizes that "protection and restoration of riparian areas are of critical importance to the state". The order determines a policy statement of the State of Arizona in regards to the protection and restoration of riparian areas.

The Arizona Game and Fish Department Strategic Plan (2001) recognizes riparian habitat as the states richest wildlife habitat and includes focus of conservation on those riparian habitats. It also states that since lowland riparian forest and woodland declined so severely between the 1800 and 1900's that species occupying them comprise more than ½ of the non raptorial birds listed as Wildlife of Special Concern in Arizona.

The U.S. Fish and Wildlife Service describes Southwestern Riparian areas as contributing "significantly to the biological integrity, including biodiversity, of our Nation's waters." It goes on to describe the abundance of breeding birds, as well as its importance as habitat to threatened and endangered species (USFWS, 1993).

The Nature Conservancy in An Ecological Analysis of Conservation Priorities in the Sonoran Desert Ecoregion, lists desert riparian woodland as a very rare although significantly important cover type and describes restoration of riparian systems in the Sonoran Desert as critical. (Marshall et al 2000).

Arizona Partners in Flight Bird Conservation Plan (1999) recommends that maintenance and restoration of riparian deciduous forests should be a top conservation priority in the state. This is due to both the biological significance and the extent to which the habitat has been lost.

Audubon Arizona recognizes the significance of restoration on the Salt River and has entered an agreement with the City of Phoenix to construct the Rio Salado Audubon Center at Central Avenue. This will be an educational conservation center and be adjacent to the constructed Rio Salado project upstream from the Oeste study area.

The references discussed above describe the importance of riparian habitat in Arizona and the region. Restoration of 8 miles of the Salt River in Phoenix goes beyond the footprint of the tentatively recommended plan. It also provides a connection between the Rio Salado and Tres Rios projects, when all are combined nearly 18 river miles will be restored. Although significant themselves, once completed the entire reach will be even more so. Restoration will provide a large corridor of restored habitat of extreme importance to breeding and migratory birds and other wildlife that depend on it.

Riparian habitat is recognized in Arizona and the Desert Southwest as being biologically significant, scarce, and threatened due to the losses over the past 100 years. With the recognition of this importance it can be seen that the tentatively recommended plan contributes to restoration of a significant ecological resource.

5.12 RISK AND UNCERTAINTY

Uncertainty and variability are inherent in water resources planning and therefore the consideration of risk and uncertainty is important. Situations of risk are conventionally defined as those in which the potential outcomes can be described in reasonably well known probability distributions. In situations of uncertainty, potential outcomes cannot be described in objectively known probability distributions. Risk and uncertainty arise from measurement errors and from the underlying variability of complex natural, social, and economic situations. The degree of risk and uncertainty generally differs among various aspects of a project. It also differs over time, because benefits from a particular purpose or costs in a particular category may be relatively certain during one time period and uncertain during another.

5.12.1 Flood Damage Reduction

A risk-based analysis (RBA) procedure has been used to evaluate without-project flood damages in the study area. Guidance for conducting RBA is included in Corps ER 1105-2-101, *Risk-Based Analysis for Evaluation of Hydrology/Hydraulics, Geotechnical Stability and Economics in Flood Damage Reduction Studies (1 March 1996).*

Expected annual flood damage must take into account the uncertainty in hydrologic, hydraulic, and economic factors. Risk and uncertainty are intrinsic in water resource planning and design. They arise from measurement errors and the inherent variability of complex physical, social, and economic situations. Best estimates of key variables, factors, parameters and data components are developed, but are often based on short periods of record, small sample sizes, measurements subject to error, and innate residual variability in estimating methods. RBA explicitly analytically incorporates these uncertainties by defining key variables in terms of probability distributions, rather than single-point estimates. Uncertainties in flood damage analysis includes discharge/probability, stage/discharge, geotechnical features, structure elevation and values, and inundation depth/damage.

The Corps of Engineers Hydrologic Engineering Center has developed software specifically designed for conducting RBA, referred to as the HEC-FDA Program (Version 1.2 used for this analysis). This program applies a Monte Carlo simulation process, whereby the expected value of damages is determined explicitly through a numerical integration technique accounting for uncertainty in the basic parameters described above. Data requirements for the program include:

- Structure data, including structure I.D., category (sfr, mfr, etc.), stream location, ground and/or first floor elevation, structure value and content value. This data was developed in a Microsoft Excel spreadsheet and imported into the HEC-FDA program.

- Hydrologic and hydraulic data, including water surface profiles, frequency/discharge relationships, and stage/discharge relationships. For this study, water surface profiles were developed using the HEC-RAS program. These functions were imported into the HEC-FDA program.

- Depth/Damage functions. Functions for residential and non-residential structures were obtained from the Institute for Water Resources and FEMA's National Flood Insurance Program.

- Risk & Uncertainty Parameters, as described in detail previously, were also entered into the program.

More detailed discussion of risk and uncertainty in the flood damage analysis and hydrologic and hydraulic data can be found in Appendix A, Hydrology and Hydraulics, and Appendix G, Economic Evaluation.

5.12.2 Ecosystem Restoration

Some risk and uncertainty are assumed in nearly every aspect of a water resources project. The variability of outcome associated with the recommended plan does not fit the definition of risk. That variability is better characterized as uncertainty in that the potential outcomes cannot be described in known probability distributions. Natural systems are dynamic and change depending upon physical, chemical, and biological processes. While some of these factors can be controlled or compensated for, others cannot. Unpredictable physical changes may include changes in land use (e.g., sand and gravel operations), a dramatic alteration of the river course due to flood damages, or anthropogenic influences such as increases in trash and debris, structures, or human presence.

A higher than normal amount of uncertainty exists regarding landscape-scale ecosystem restoration in the arid southwest. This is because the few such projects that have been completed are of recent origin and detailed data is not yet available to assess the outcomes. Given the lack of precedent and scarcity of empirical data regarding restoration of Sonoran riparian systems, there is a degree of uncertainty regarding a number of aspects of the design, construction, and operation of the recommended alternative.
Within planning for the Rio Salado Oeste Project several areas of uncertainty were identified and addressed. Those areas of uncertainty include:

- **Storm Water availability**: In order to account for uncertainty in the volume of runoff at stormwater outfalls, the estimated annual volume of runoff was halved prior to planning the quantity of habitat that could be supported. While observations of existing vegetation at some of the existing outfalls suggest that there is sufficient water to support the

proposed restoration, the reduced volume accounts for the uncertainties with rainfall in any given year. Additional water supply to each outfall was also planned for establishment period and as a back-up in severe drought conditions.

- **Trash/Debris unearthed during construction**: As observed in the Rio Salado Project under construction, more trash and debris than previously estimated were unearthed during construction. While a Modified Phase I ESA was performed for this project and field observations have not identified known areas of extensive trash and debris, 2 percent of the construction cost was added to account for this unknown.

- **River discharges**: In order to reduce the unknown effects of river discharges on restoration features as well as the risk of damages, efforts were made during plan formulation to minimize placement of project features within the 10-year discharge area of inundation. Also, the channel restoration measure in addition to providing for restoration allows conveyance of flood flows and reduced the potential for damages to project features on the terraces.

- **Land use changes**: During project planning, efforts were made to account for any possible land use changes that may affect the project area. The largest area of uncertainty is the duration that existing aggregate operations will be in existence and the potential for new ones to be established prior to implementation. Should conditions change prior to project implementation, it can be assumed that the configuration of restoration features may change with them.

- **Revegetation success**: The success of revegetation measures is vulnerable to some uncertainty. While the proposed actions to restore vegetation have taken place and are in progress in the arid southwest, including immediately upstream of the study area, uncertainties remain. Mortality due to poor stock, disease, insect infestation, herbivore damage, and other unforeseen circumstances contribute to uncertainties. Revegetation techniques assumed with the proposed project features are very similar to those being implemented successfully elsewhere, including Rio Salado immediately upstream. It is assumed that by the time any authorized project is implemented, more will have been learned about the success of that project and any changes necessary would be

incorporated at the time of construction. An O&M plan and costs include estimates for vegetation replacement. A Monitoring and Adaptive Management Plan will also be in place and would provide time to monitor success and make any changes to features that require it.

CHAPTER VI
DESCRIPTION OF THE RECOMMENDED PLAN

6.1 THE RECOMMENDED PLAN

Based on the results of the analyses conducted and described in Chapter V above, Alternative 5A has been identified as the tentatively recommended NER Plan. Alternative 5A is shown on Plate 5 at the end of the report.

6.2 PLAN FEATURES

The Tentatively Recommended Plan (Alternative 5A) includes restoration of four significant habitat types throughout the project area. These are habitats that are scarce and ecologically significant in the desert southwest, including cottonwood/willow (375 acres), mesquite (417), wetlands including within the river channel (190 acres), and restoration of 8 miles of river channel made up of approximately 500 acres of active channel and riparian scrub. Multiple measures make up the restoration plan, including, water supply and distribution, channel restoration, revegetation, and invasive-species removal.

6.2.1 River Channel Restoration

Restoring the river channel to a more natural state would be accomplished by grading and terracing to help restore an active channel through the entire 8-mile reach. Average depth would be 5 feet, with a width varying from 200 to 400 feet. The channel design passes a 5-year event (~22,000 cfs) with occasional flooding on the terrace 2 to 4 feet depth at 1-7 cfs. An estimated 660,000 c.y. would be removed from the channel to implement this measure. Material removed would be native riverbed material and would be used on site for terracing and construction of other project components, such as reshaping of the two "lakes" within the project area.

Grade Control Structure. Due to a drop in grade downstream of the 35th Avenue Bridge, a grade-control structure is recommended within that vicinity. This structure would be similar to those installed in the upstream Rio Salado Project, and would consist of roller-compacted concrete and grouted stone.

River Channel Habitats: The habitats restored within the active channel will include a combination of dry river bottom, emergent wetland, riparian scrub or desert scrub, depending on the specific site. Total acreage of the active river channel is assumed to be nearly 500 acres comprised of a 170 acre low flow channel, 34 acres of emergent wetland and the remainder riparian scrub.

6.2.2 Stormwater Wetlands

Stormwater outfalls within the project area have been identified and average discharges from them quantified, with an estimated 2,863 ac-ft available for use in restoration. This measure includes the addition of grouted rock channels extending from the banks into the channel from existing pipe outfalls. The grouted rock would extend approximately 100 feet from the existing pipe outfall and would vary from 2 to 4 feet in height. The required grout is approximately thirty percent of the needed rock. Each outfall would require 221 c.y. of rock and 67 c.y. of grout. The outfall sites would require a total of 1989 c.y. of rock and 603 c.y. of grout. Large storm flows would be conveyed to the channel while smaller discharges would be directed into adjacent wetland and riparian habitat areas. Techniques would be site-`specific and would include grading or excavation, removal of exotics, and planting of suitable vegetation for the site conditions. Supplemental water would be required via an irrigation source, and structures would be installed to contain high-energy inputs and avoid erosion during storm events. It was assumed that approximatley 28 acres of wetlands would be associated with the outfalls within the study area.

New Stormwater Outfalls: As the land to the west of 51st Avenue is developed, additional stormwater runoff to the river would be possible. At 75th Avenue, a future storm drain may provide additional source water for project features. However, current drainage regulations require onsite retention of runoff. Changes to local zoning regulations and implementation of stormwater drainage plans for lands nearby the river could provide the benefit of additional project water, increased habitat values, and management of stormwater quality and quantity as the area is devleoped.

6.2.3 Revegetation

Planting of riparian vegetation to restore the various cover types is included in the plan. General locations of the restored habitats are shown on Plates at the end of the report.

Cottonwood/Willow: Cottonwood/willow would be dominated by Fremont's cottonwood (*Populus fremontii*) and Gooding's willow (*Salix gooddingii*). Other understory species would be planted, depending upon individual site conditions, but may include arrowweed (*Pluchea sericea*), elderberry (*Sambucus mexicana*) or burrobush (*Hymenoclea spp.*). The feasibility design includes approximately 60 to 100 trees and 5 shrubs per acre, with a combination of pole and containerized plantings. Hydroseeding of ground cover and additional shrubs is also included in the design.

Mesquite: This habitat would be restored over a potentially large portion of the project area. It would require periodic watering for the first five years after planting, though with less frequency than cottonwood/willow. Watering could possibly be discontinued after five years or when roots are expected to reach groundwater. Mesquite bosques would be dominated by velvet mesquite (*Prosopis velutina*), with scattered honey mesquite, and some understory shrubs, such as desert thorn (Lycium spp.), palo verde (*Cercidium floridum*), brittlebush (*Encelia farinose*), and forbs.

Bosque: Mesquite bosques are commonly found 5 to 20 feet above the river channel where water is adequate. They require a water table or semi-saturated soil conditions 10 to 30 feet below the surface elevation, and rely on occasional saturated conditions 1 to 3 feet below the surface. Soil requirements range from fine to gravelly with some rocky areas. The mesquite bosques would be planted with a density of approximately 100 velvet mesquite, 10 honey mesquite, and 40 understory shrubs per acre. Understory forbs would also be planted using a seed mix.

Xeric: In locations throughout the study with less water supply, xeric stands of mesquite would be established. It is assumed that mesquite would survive under drier conditions and on higher terraces than mesquite bosques. Planting densities

would be less, with approximately 25 velvet mesquite, 5 honey mesquite, and 10 understory shrubs per acre.

Riparian Scrub: It is assumed that some portions maintained will remain a more xeric desert scrub but others adjacent to the wetter riparian habitats will develop into more distinctive riparian cover containing species such as Seepwillow, desert broom, or Desert willow. Approximately 296 acres of the active river channel will be riparian scrub.

6.2.4 Wetlands

A total of approximately 156 acres of wetlands would be restored with Alternative 5A. This would include the stormwater wetlands described above, in the vicinity of the "lakes," and within the restored channel. Wetlands could consist of open water, submerged vegetation, or mud flats, all requiring a high water table at or near the surface. Due to the porous soils found in this project area, lining the site would be required to maintain surface water. Excavation and layering of a silt-clay soil substrate overlain by a mixed gravel, and finally, cobble layer, is recommended. This soil structure would reduce disturbance of the soil-clay layer by reducing piping of fine material and reducing turbulent forces acting on the layer. Emergent wetlands contain primarily cattails (*Typha domingensis*), tule (*Scirpus acutus*), and sedges (Carex spp.). Because the river will not flow year round, the wetlands would need to be constructed specifically to retain water. In addition to grading and excavation, an impermeable layer would be added to retain water on site.

6.2.5 Lake Restoration

There are existing lake features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. Under Alternative 5A, the proposed measures include significant regrading to restore the lake features into a more natural state coinciding with the floodplain environment. This would include the movement of approximately 3 million c.y. of materials. With the reshaping of the two areas, additional measures described above would be incorporated, including the wetland and riparian habitat restoration that would be carried out within them.

6.2.6 Invasive Species Management

Invasive species such as saltcedar and Arundo would require removal and management with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. Saltcedar is currently found in stands throughout the study area. Arundo, although not yet a significant problem in Arizona, is a problem in neighboring California and some stands are found within the project area. It was assumed that an approximate 120 acres would require invasive-species control measures prior to restoration.

6.2.7 Water Supply and Distribution

The City of Phoenix developed the water supply and distribution plan for the project. The primary water supply for the Rio Salado Oeste project would be effluent obtained directly from the 23rd Avenue WWTP with supplemental water (if necessary) potentially from several sources. An estimated 8 mgd is available from the 23rd Avenue Plant.

The sustainable water supply and distribution system would consist of the following features:

- 20 mgd pump station
- Supply well
- Monitoring wells
- Electronic flow regulated valves
- Reservoirs
- Pump stations
- Open channel canals
- Irrigation system
- Pressurized distribution piping

A combination of irrigation approaches could be implemented in the project and would be determined in detail during design. These could include temporary drip systems for establishment of vegetation, subsurface liners to create an artificially perched aquifer, and canal or rill (ditch or flood) irrigation, as well as water-harvesting polymer, or polymer-type products, planted with vegetation. The estimated cost of the water supply and distribution for the tentatively recommended alternative is $22,037,500.

6.3 PROJECT OUTPUTS

The tentatively recommended plan provides a habitat value of 847 AAFCUs, or a net increase of 267 AAFCUs over without-project conditions. This is a 46 percent increase in AAFCUs with project implementation.

In addition, the restoration included in this project would provide an important and significant linkage between the other restoration projects on the river. Restoration of this 8-mile reach would tie together Rio Salado upstream and Tres Rios downstream, providing approximately 21 miles of contiguous Sonoran desert riparian habitat. This type of river-connected riparian and fringe habitat is of an extremely high value due to its rarity. Arid southwest riparian ecosystems are recognized as a critically endangered habitat type. It has been estimated that 75 to 90 percent of all wildlife in the arid southwest is riparian-dependent during some part of its life cycle.

Table VI-1 Alternative 5A Cost Estimate

Estimate MCACES Cost Estimate ($1,000s FY 06 PL 5 1/8%)	
Construction	$64,633
Contingency (20%)	$12,927
Subtotal	$77,560
PED/EDC (11%)	$8,532
Subtotal	$86,091
S&A (6.5%)	$5,596
Total Construction Cost	$91,687
Real Estate (including 25% contingency)	$55,900
Subtotal	$147,587
Monitoring and Adaptive Management	$3,667
Total First Cost	$151,254
IDC	$15,515
Gross Investment	$166,769
Annualized Investment Cost	$9,312
Associated Cost (water supply)	$817
O&M	$2,080
Total Annual Cost	**$12,209**

Notes: *EDC= Engineering During construction*
S&A= Supervision and Administration

6.4 MAINTENANCE CONSIDERATIONS

O&M activities would occur after project construction in order for project features to function as designed. O&M activities are detailed within the cost estimate and would include the activities listed below.

Replacement Costs. Up to 25 percent of vegetation could require replacement following a flood event at some time during the project life.

Invasive Species Control. Annual removal of exotic species was assumed to be necessary. This would include removal of non-native species that threaten to overtake an area and become a monoculture. This wouldn't necessarily include removal of 100 percent of non-natives through the project area.

Stormwater Wetlands. Regrading and excavation was assumed to be necessary once every 10 years. It was assumed that 50 percent of the construction quantity would need to be regraded in this period.

Irrigation System. Maintenance of the irrigation infrastructure, including replacement of infrastructure, would occur annually. Costs were estimated on a per-acre basis for those acres planted to vegetation.

Lakes/Wetlands. The restored wetlands at existing lakes (gravel pits) would require regrading and excavation once every 20 years of up to 1 foot of material over the 40 acres of wetlands.

Channel. The active channel would require regrading up to once every 20 years for up to 50 percent of the estimated construction quantity or 330,000 c.y.

Water Supply. The water supply and distribution system would require periodic maintenance and inspection of pumps and pipelines. Inspection, repair, and replacement would be necessary for the irrigation system and infrastructure. More detailed description of maintenance is included in Appendix J, Design and Cost Estimate.

6.5 RECREATION PLAN

The City of Phoenix developed the recreation plan for the project, which may be found in Appendix L. The plan is consistent with Corps policy on development of recreation at ecosystem restoration projects, as outlined in Policy Guidance Letter No. 59, USACE 1998. Major recreation features include multipurpose trails, shelters, signage, utilities, park furniture, and interpretive media. Access points are identified in the plan, with four drive-in points with parking facilities and five smaller access points for walk-in use. Additionally, nine minor points for walk-in access from adjacent neighborhoods will be completed. Although an environmental-education center is included in the estimate below, it is not a cost-shareable portion of the project and would be a local sponsor cost. Table VI-2 below summarizes the locations and features included in the recreation plan.

Table VI-2 Recreation Plan

Features	Quantity
Access Point, Maintenance Facility and Education Center (35th Ave.)	**1**
Site Preparation	
Site Prep to include: clearing, grubbing, and grading	1
Vegetative Restoration	1
Access and Circulation	
Entry Road w/Turnaround to include: curb, gutter, driveway, & road	1
Parking Lot	250
Sidewalks and Ramps	2,500 sf.
Multi-Use Trails	555 sy.
Bridges and Culverts (small)	4
Protection Access Control	
Access Control Gates (vehicular)	2
Access Control Gates (pedestrian)	2
Handrails	500 l.f.
Guardrails	100 l.f.
Fencing	500 l.f.
Walls	150 l.f.
Security lights	18
Signage	
Entrance Identification Signage	2
Traffic Control (vehicular)	5
Traffic Control (pedestrian)	5
Instructional/Directional	10
Shelters	
Picnic (large)	1
Picnic (small)	2
Restroom Facility/Comfort Station	1
Shelter w/Bulletin Boards	1
Trail Shelter w/Railing (large)	1
Trail Shelter w/Railing (medium)	1
Trail Shelter w/Railing (small)	2
Utilities	
Municipal Water Supply and Wastewater Disposal	1
Storm Drainage	1
Drinking Fountain w/Chiller	2
Electrical	1
Park Furniture	
Benches:	2
Off-the-Shelf	5
Recycled/Custom	8
Picnic Tables	5
Trash Receptacles	10
Interpretive Guidance Media	
Display Boards	16

Features	Quantity
Interpretive Markers	16
Bulletin Boards	2
(*) Environmental Education Center/ Visitor Center	1
Access Points- 4 drive in (35th, 51st N&S, 75th) and 5 walk in (19th, 23rd, 43rd, 75th, 83rd) Minor Access points in 9 locations.	
Site Preparation	
Site Prep to include: clearing, grubbing, and grading	9
Vegetative Restoration (drive-in access)	4
Vegetative Restoration (walk-in access)	5
Access and Circulation	
Entry Road w/Turnaround to include: curb, gutter, driveway, & road	4
Parking Lot	250
Sidewalks and Ramps	40,000 sf.
Multi-Use Trails (24mi * 5280 * 5ft)	70,400 sy
Bridges and Culverts (small) @ Canals, and Localized Drainage Areas	10
Minor Access points (2 benches, gate, sign)	9
Protection Access Control	
Access Control Gates (vehicular)	8
Access Control Gates (pedestrian)	18
Handrails	5,000 l.f.
Guardrails	3,000 l.f.
Fencing	50,00 l.f.
Walls	1,500 l.f.
Security lights	100
Signage	
Entrance identification signage	8
Traffic Control (vehicular)	20
Traffic Control (pedestrian)	27
Instructional/Directional	45
Shelters	
Picnic (large)	4
Picnic (small)	5
Restroom Facility/Comfort Station	4
Shelter w/Bulletin Boards	4
Trail Shelter w/Railing (large)	9
Trail Shelter w/Railing (medium)	4
Trail Shelter w/Railing (small)	10
Utilities	
Municipal Water Supply and Wastewater Disposal	4
Storm Drainage	4
Drinking Fountain w/Chiller	12
Electical	4
Park Furniture	
Benches:	14
Off-the-Shelf	40
Recycled/Custom	50
Picnic Tables	40

Features	Quantity
Trash Receptacles	75
Interpretive Guidance Media	
Display Boards	50
Interpretive Markers	100
Bulletin Boards	9

The cost-shareable portion of the recreation plan is estimated at $12,326,405, with Annual O&M of $2,055,000.

6.6 ASSOCIATED NON-FEDERAL CONSIDERATIONS

The non-Federal sponsor (Sponsor) for the project would be required to purchase all lands, easements, rights-of way and disposal areas (LERRDs) needed for project implementation. Real estate is described in more detail in Appendix H. Approximately 1,500 acres are required for the project and currently estimated at $55,900,000. The estate to implement this project is recommended as fee simple, however if the acquisition of a permanent and assignable easement proves sufficient for the project and can be obtained they will be recommended in the final report. Any use of an easement estate would be submitted to Headquarters USACE for required approval in accordance with ER-405-1-12, Chapter 12 Paragraph 12-9 c.

The Sponsor would be responsible for remaining implementation costs required to bring the total non-Federal share to 35 percent of the total first cost of construction. The Sponsor would also be responsible for Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs (estimated at $2,078.000 per year). The sponsor would also be responsible for 50 percent of the cost to implement the selected recreation plan. Annual OMRR&R costs of $2,055,000 associated with the selected recreation plan would also be the Sponsor's responsibility.

6.7 MONITORING AND ADAPTIVE MANAGEMENT PLAN

The Salt River, although highly modified and controlled, remains a natural river system where changes may occur. While planning for this project has accounted for the possible factors affecting the study area, it is inevitable that uncertainty would remain with the outcome of the recommended plan. Implementation of a monitoring and adaptive management plan would not

alleviate all uncertainty, but would provide flexibility to account for changing environmental conditions and new information, as well as measure project success.

The Monitoring and Adaptive Management Plan is an essential element for the overall implementation of the proposed plan. It would provide a mechanism to evaluate the effectiveness of the restoration measures implemented in this project and to implement adaptive changes, if required, to realize project objectives. As described in ER 1105-2-100 Planning Guidance Notebook page 3-25 (8) Monitoring and adaptive management:

> "Monitoring may be necessary to determine if the predicted outputs are being achieved and to provide feed back for future projects … The cost of monitoring included in the total project cost and cost shared with the non-Federal sponsor shall not exceed one percent of the total first cost of ecosystem restoration features. For complex specifically authorized projects that have high levels of risk and uncertainty of obtaining the proposed outputs, adaptive management may be recommended. The cost of the adaptive management action, if needed, will be limited to 3 percent of the total project cost excluding monitoring costs."

It was assumed that the Monitoring and Adaptive Management Plan for the tentative recommended plan would be 4 percent of total construction, or $3.7 million over five years. The plan includes cost-shared monitoring and adaptive management actions during the first five years after initial project implementation. After the first five years, monitoring and/or adaptive management would become the responsibility of the local sponsor (City of Phoenix). However, the local sponsor can use this plan to help guide the monitoring efforts and refine the project features such that project goals and objectives are achieved.

It is recommended that the plan, found in Appendix N (Monitoring and Adaptive Management) be reevaluated and updated during PED, taking into account lessons learned from the Rio Salado and Tres Rios Projects in the immediate vicinity, as well as other projects such as Va Shly'ay Akimel further upstream on the Salt River.

CHAPTER VII
PLAN IMPLEMENTATION

This chapter summarizes cost-sharing requirements and procedures necessary to implement the Tentatively Recommended Plan.

7.1 STUDY RECOMMENDATION

The Tentatively Recommended Plan would provide the maximum NER benefits relative to project costs while achieving the stated project objectives and while meeting the criteria established by the study team and Federal Principles and Guidelines. Because of its highly positive environmental contribution to restoration within the study area, the Recommended Plan is recommended for implementation.

7.2 DIVISION OF PLAN RESPONSIBILITIES

The Water Resources Development Act (WRDA) of 1986 (Public Law 99-662) and various administrative policies have established the basis for the division of Federal and non-Federal responsibilities in the construction, maintenance, and operation of Federal water resource projects accomplished under the direction of the Corps of Engineers. Anticipated Federal and non-Federal responsibilities are described in this section. The final division of specific responsibilities will be formalized in the project cooperation agreement (PCA).

7.2.1 Federal Responsibilities

The estimated Federal share of the total first cost of the project is 65 percent of first costs related to ecosystem restoration and 50 percent related to recreation. (First costs are all costs to implement the project less O&M costs). The Federal Government's responsibilities are anticipated to be:

1. Design and prepare detailed plans and specifications.

2. Identify the real estate requirements for implementation of the project.

3. Administer contracts for construction and supervision of the project after authorization, funding, and receipt of non-Federal assurances. .

4. Conduct all necessary cultural resource investigations and coordinate and implement any necessary preservation or mitigation measures

5. Conduct periodic inspections with the non-Federal sponsor to determine adherence to the post-construction maintenance requirements

7.2.2 Non-Federal Responsibilities

Non-Federal or local responsibilities are anticipated to be:

1. Provide 35 percent of the total project costs allocated to ecosystem restoration and 50 percent of the total project costs allocated to recreation, as further specified below:

   a. Enter into an agreement that provides, prior to execution of a project cooperation agreement for the project, 25 percent of design costs.

   b. Provide, during construction, any additional funds needed to cover the non-Federal share of design costs.

   c. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project.

   d. Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project.

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7.2.1 Federal Responsibilities

The estimated Federal share of the total first cost of the project is 65 percent of first costs related to ecosystem restoration and 50 percent related to recreation. (First costs are all costs to implement the project less O&M costs). The Federal Government's responsibilities are anticipated to be:

1. Design and prepare detailed plans and specifications.

2. Identify the real estate requirements for implementation of the project.

e. Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the total project costs allocated to ecosystem restoration and 50 percent of the total project costs allocated to recreation.

2. Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features, without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRRR&R manual and any subsequent amendments thereto

3. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

4. Comply with Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended, 42 U.S.C 1962d-5b. and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, 33 U.S.C. 2213 which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

5. Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

6. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

7. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

8. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

9. Agree that, as between the Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project and otherwise perform its obligations in a manner that will not cause liability to arise under CERCLA.

10. Prevent obstructions of, or encroachments on, the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might reduce the level of protection it affords, hinder its operation and maintenance, or interfere with its proper function, such as any new developments on project lands or addition of facilities which would degrade the benefits of the project.

11. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended 42 U.S.C 4601-4655, and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

12. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).

13. Provide the non-Federal share of that portion of the costs of archeological data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with cost sharing provisions of the agreement.

14. Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

15. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

16. For so long as the project remains authorized, provide the quantity of water for such periods that the Government determines is necessary to construct, operate, repair, replace, rehabilitate, and otherwise maintain the project.

17. Provide the non-Federal cost share of that portion of the costs of archeological data recovery activities associated with historic preservation, that are in excess of one percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement.

7.3 COST APPORTIONMENT

Cost sharing for construction of this project would be in accordance with applicable law whereby for environmental restoration projects, the non-Federal sponsor shall provide all lands, easements and rights-of-way, and dredged material disposal areas; provide relocations of bridges and roadways; provide alteration of utilities or facilities; and maintain and operate the project after construction. During the construction phase, the non-Federal sponsor shall contribute any additional funds as are necessary so that the non-Federal contribution would be at least 35 percent of total environmental restoration costs.

Table VII-1 provides a summary of project costs, apportioned between the Federal and non-Federal sponsors, for the recommended plan. The total project cost is currently estimated at $163,581,307.00 at a current Federal discount rate of 5 1/8 percent. Based on the requirements of WRDA 1986, as amended cost sharing for ecosystem restoration features including provisions of all LERRDs would be 65 percent Federal and 35 percent non-Federal. Cost sharing for recreation features would be 50 percent Federal and 50 percent non-Federal.

USACE guidance (ER 1105-2-100, Appendix E) specifies that the level of financial participation by the Corps in recreation development may not increase the Federal cost of the project by more than 10 percent. Recreation cost for this project is currently estimated at $12,326,000. The cost for all O&M would be the responsibility of the non-Federal sponsor. O&M of the ecosystem restoration is currently estimated at $2,078,000 annually and $2,055,000 annually for the recreation component. In addition, all water rights and costs associated with providing water to the project shall be borne by the non-Federal sponsor. The value of this water has been estimated at $817,000 annually.

Table VII-1: Cost Apportionment Tentatively Recommended Plan

Item	Federal	Non-Federal	Total
Construction of Ecosystem Restoration Features*	$ 59,596,811.95	$ 32,090,591.05	$ 91,687,403.00
Monitoring and Adaptive Management	$ 2,383,872.40	$ 1,283,623.60	$ 3,667,496.00
LERRDs**	-	$ 55,900,000.00	$ 55,900,000.00
Total First Cost of Ecosystem Restoration	$ 61,980,684.35	$ 89,274,214.65	$ 151,254,899.00
Cost Share Adjustment	$ 36,355,000.00	$ (36,355,000.00)	
Total Cost-Shared Costs	$ 98,315,608.35	$ 52,939,214.65	$ 151,254,899.00
Percentage of Total Cost-Shared Amount – Ecosystem Restoration	*65%*	*35%*	
Total Cost-Shared Costs for Recreation	$ 6,163,204.00	$ 6,163,204.00	$ 12,326,408.00
Percentage of Total Cost-Shared Amount – Recreation	*50%*	*50%*	
TOTAL FIRST COSTS	$ 104,478,888.35	$ 59,102,418.65	$ 163,581,307.00

**Construction, S&A, PED/EDC and Contingency, does not include IDC or OMRR&R*
*** Lands, easements, rights of way, relocations, and disposal areas.*
**** Non-Federal cost shared amount exceeds the 35% requirement for ecosystem restoration projects. Adjustment to the first cost amounts result to the 65-35 percent cost sharing requirement.*

7.4 CURRENT AND FUTURE WORK ELIGIBLE FOR CREDITS

There is no current and future work planned or in construction which is part of the Corps' Selected Plans, or which would be eligible for Section 104 credit.

7.5 INSTITUTIONAL REQUIREMENTS

The non-Federal sponsor will prepare the following preliminary financial analysis.

1 Assess project-related yearly cash flows (both expenditures and receipts where cost recovery is proposed), including provisions for major rehabilitation and operational contingencies and anticipated but uncertain repair costs resulting from damages from natural events.

2 Demonstrate ability to finance their current and projected-future share of the project cost and to carry out project implementation operation, maintenance, repair, and rehabilitation responsibilities.

3 Investigate the means for raising additional non-Federal financial resources including, but not limited to, special assessment districts.

4 Complete any other necessary steps to ensure that they are prepared to execute their project-related responsibilities at the time of project implementation.

7.6 ENVIRONMENTAL REQUIREMENTS

7.6.1 National Environmental Policy Act (NEPA)

NEPA ensures public involvement and notification of a proposed project. An initial public meeting was held on September 13, 2001, and a final public meeting was held on TBD. Multiple public workshops, information sessions, and meetings were also held as part of the scoping process. Public and agency review of the Draft and Final EIS will be completed and a Record of Decision will be prepared.

7.6.2 Endangered Species Act

Endangered Species Act, Section 7 informal consultation will be completed during the production of the study's Final EIS. The USFWS has been involved throughout the study and has no information on any known federally listed threatened or endangered species within the project area. The need for formal consultation is not anticipated.

7.6.3 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act Report provided by the USFWS supports the proposed restoration project and listed four recommendations to pursue in project implementation. These include the following:

1. Focus significant attention on securing a permanent and sufficient source of water, perhaps through a combination of effluent, groundwater, and storm water.

2. Maximize opportunities to restore a mosaic of heterogeneous vegetative cover types that maximizes structural habitat complexity.

3. Ensure that site-specific microhabitat conditions would be conducive to establishment and growth of native riparian plants, especially cottonwood, willow, and mesquite.

4. Encourage the non-Federal sponsor to evaluate Safe Harbor Agreements, Candidate Conservation Agreements, or Habitat Conservation Plans.

The first two recommendations have been implemented during formulation and evaluation of restoration alternatives. During project design site specific microhabitat conditions will be revisited and evaluated to ensure conditions are conducive to native riparian plants. The Corps will encourage and participate in evaluation of Safe Harbor Agreements, Candidate Conservation Agreements, or Habitat Conservation Plans as necessary during PED and Construction.

7.6.4 Clean Water Act, Section 404(b)(1)

Pursuant to sect 404 of the Clean Water Act, 33 U.S.C. 1251 et seq, the Corps regulates the discharge of fill materials into waters of the United States. Where, as here, the discharge is

part of a Federal construction project that Congress authorizes the Corps to perform, the Corps does not issue itself a permit, but rather evaluates the impacts of the discharge utilizing the section 404(b)(1) guidelines and includes the evaluation in the environmental impact statement (EIS) for the project. The Draft EIS for this project contains a 404(b)(1) analysis as Appendix A to the Draft EIS. Although no section 404 permit is required for Corps construction activities, the non-Federal sponsor may be required to obtain a Section 404 permit for discharges of material associated with post construction operation and maintenance activities, unless granted a 404(r) exemption.

The tentatively recommended plan would result in discharge of fill material into waters of the United States during the period of construction. Pursuant to section 404 of the Clean Water Act, 33 U.S.C. 1251 et seq, the Corps regulates the discharge of fill materials into waters of the United States. Where, as here, the discharge is part of a Federal construction project that Congress authorizes the Corps to perform, the Corps does not issue itself a permit, but rather evaluates the impacts of the discharge utilizing the Section 404(b)(1) guidelines and includes the evaluation in the environmental impact statement (EIS) for the project.

The tentatively recommended plan may result in discharges associated with O&M activities. A Section 404(b)(1) evaluation has been prepared to address practicable alternatives, and can be found in the accompanying EIS. Based on this analysis, the feasibility report recommends that the project receive a 404(r) exemption for the construction period when Congress authorizes the project. Discharges into waters of the U.S. for future OMRR&R activities by the non-federal sponsor would require separate authorization pursuant to the Clean Water Act.

7.6.5 National Historic Preservation Act

Archeological investigations have been conducted as described in Sections 4.2.8.4 and 4.2.8.5 of this report. A letter was sent to the Arizona State Historic Preservation Officer (SHPO) on July 6, 2005 with our determinations in accordance with 36 CFR 800.4(d). We received a letter of response dated August 10, 2005. This letter concurred with the APE as described in Section 4.4.5 above. The SHPO requested a written report of the survey conducted by Corps personnel. A Memorandum of Record (MFR) was completed describing the survey conducted in March

2004. The Rio Salado Oeste project is in compliance with Section 106 of the National Historic Preservation Act, Public Law 89-665, as amended, 16 U.S.C. 470a, and its implementing regulations found at 36 C.F.R. Part 800.

Unanticipated Discovery: Pursuant to Section 106 of the National Historic Preservation Act, Public Law 89-665, as amended, 16 U.S.C. 470a, and its implementing regulations found at 36 C.F.R 800.12(2), any discoveries of either human remains or archeological deposits during construction activities shall result in the following process:

- Corps of Engineers Archeology Staff shall be notified of discovery.
- Corps Archeology Staff shall determine if discovered cultural mater is an isolated find, or consists of a deposit of some extent. If needed, hand excavations shall be conducted to determine if the deposit is of sufficient content and integrity to be eligibly for listing on the National Register of Historic Places.
- The Corps shall determine eligibility, and effect in consultation with the State Historic Preservation Officer pursuant to 36 CFR 800.

7.7 SPONSORSHIP AGREEMENTS

Prior to the start of construction, the non-Federal sponsor would be required to enter into an agreement with the Federal Government that it would comply with Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended U.S.C. 1962d-5b, and the Water Resources Development Act of 1986 , Public Law 99-662, as amended 33 U.S. 2201 et seq.

7.8 PROCEDURES FOR IMPLEMENTATION

Future actions necessary for authorization and construction of the tentatively recommended Plan are summarized as follow:

1. The Draft and Final Feasibility Report/Environmental Impact Statement will be reviewed by the Headquarters of USACE, Washington, D.C, City of Phoenix, EPA, and the public.
2. The Chief of Engineers will seek formal review and comments by the Governor of the State of Arizona and interested Federal agencies.

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2. The Chief of Engineers will seek formal review and comments by the Governor of the State of Arizona and interested Federal agencies.

3. Following State and Agency review, the report will be sent to the Assistant Secretary of the Army for Civil Works.

4. Upon approval of the Assistant Secretary, the report will be forwarded to the Office of Management and Budget to obtain the relationship of the project to programs of the President.

5. The final report of the Chief of Engineers will then be forwarded by the Assistant Secretary of the Army for Civil Works to Congress.

6. Congressional review of the feasibility report and possible authorization of the project would follow.

7. Pending project authorization for construction, the Chief of Engineers could include funds, where appropriate, in his budget requests for preconstruction engineering and design of the project. The objective is to ready each project for construction start established with the feasibility study.

8. Following receipt of funds, preconstruction engineering and design would be initiated and surveys and detailed engineering designs would be accomplished.

9. Following Congressional authorization of the project, plans and specifications would be accomplished by the District Engineer.

10. Subsequent to appropriation of construction funds by Congress, but prior to construction, formal assurances of local cooperation would be required from non-Federal interests.

11. Bids for construction would be initiated and contracts awarded.

CHAPTER VIII
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PLATES

Plate 1: Alternative 1 No Action

Plate 2: Alternative 2

Plate 3: Alternative 4

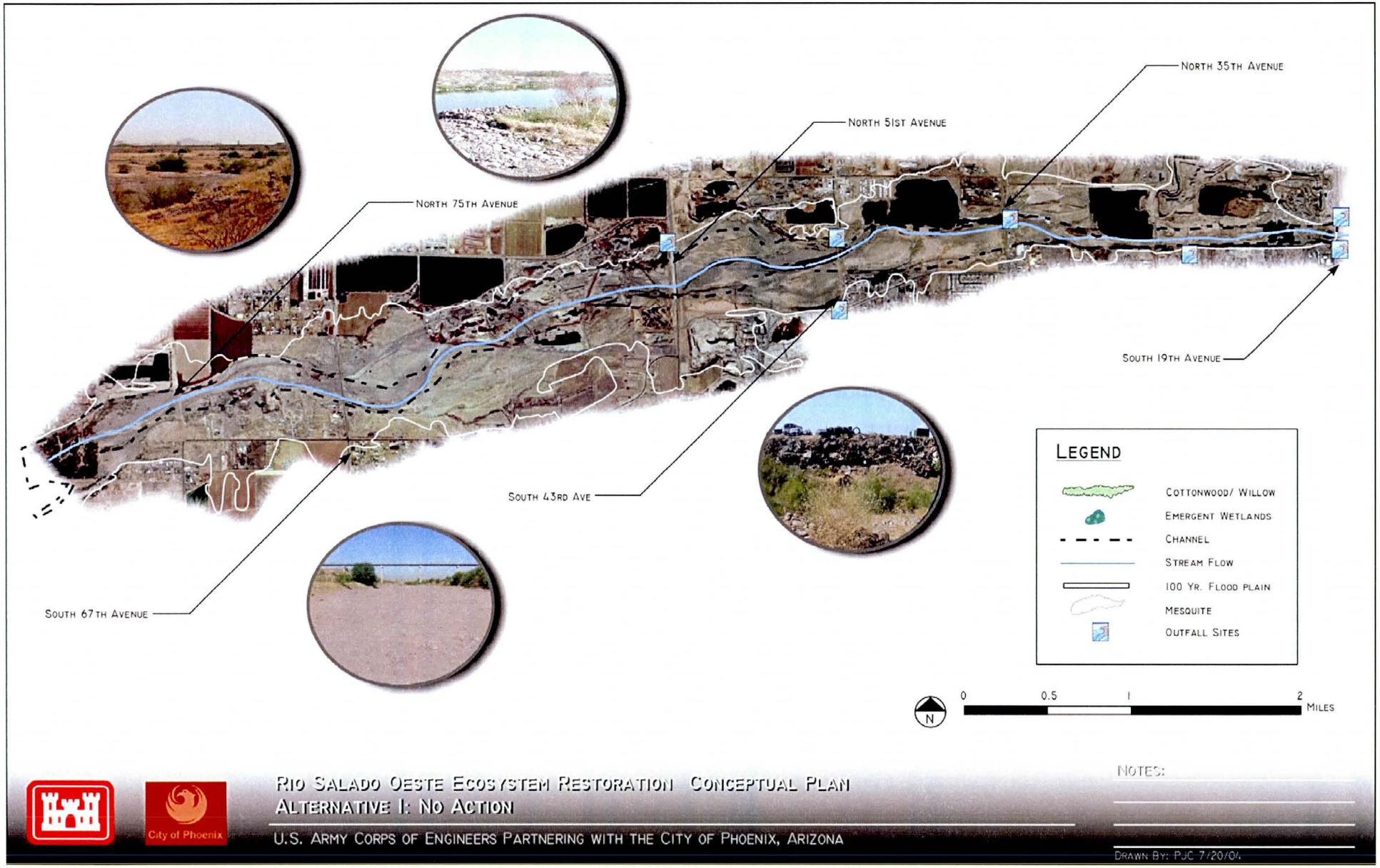
Plate 4: Alternative 5

Plate 5: Alternative 5A

Plate 6: Alternative 5B

Plate 7: Recreation Plan with Alternative 5A

Alternative 1: No Action



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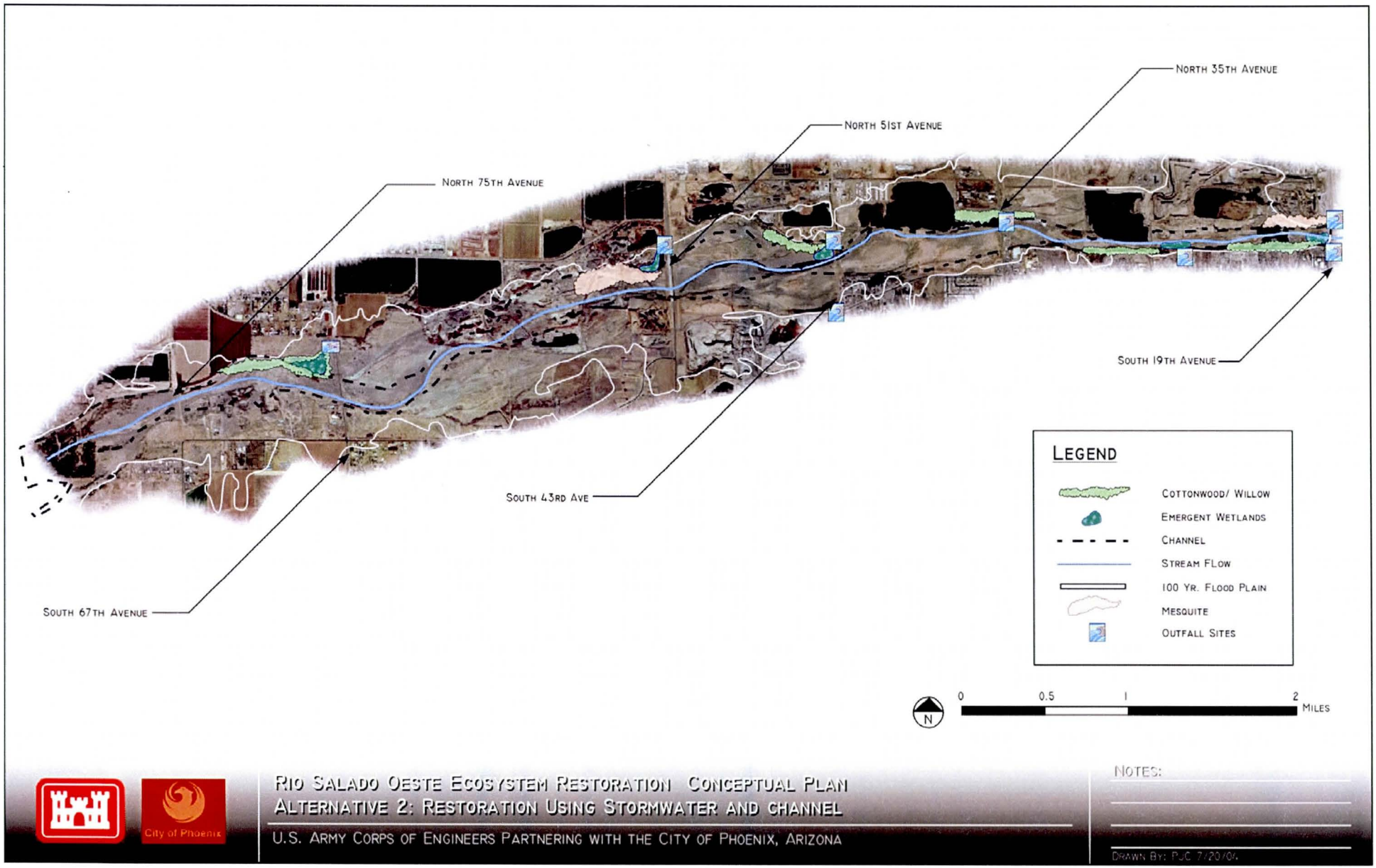

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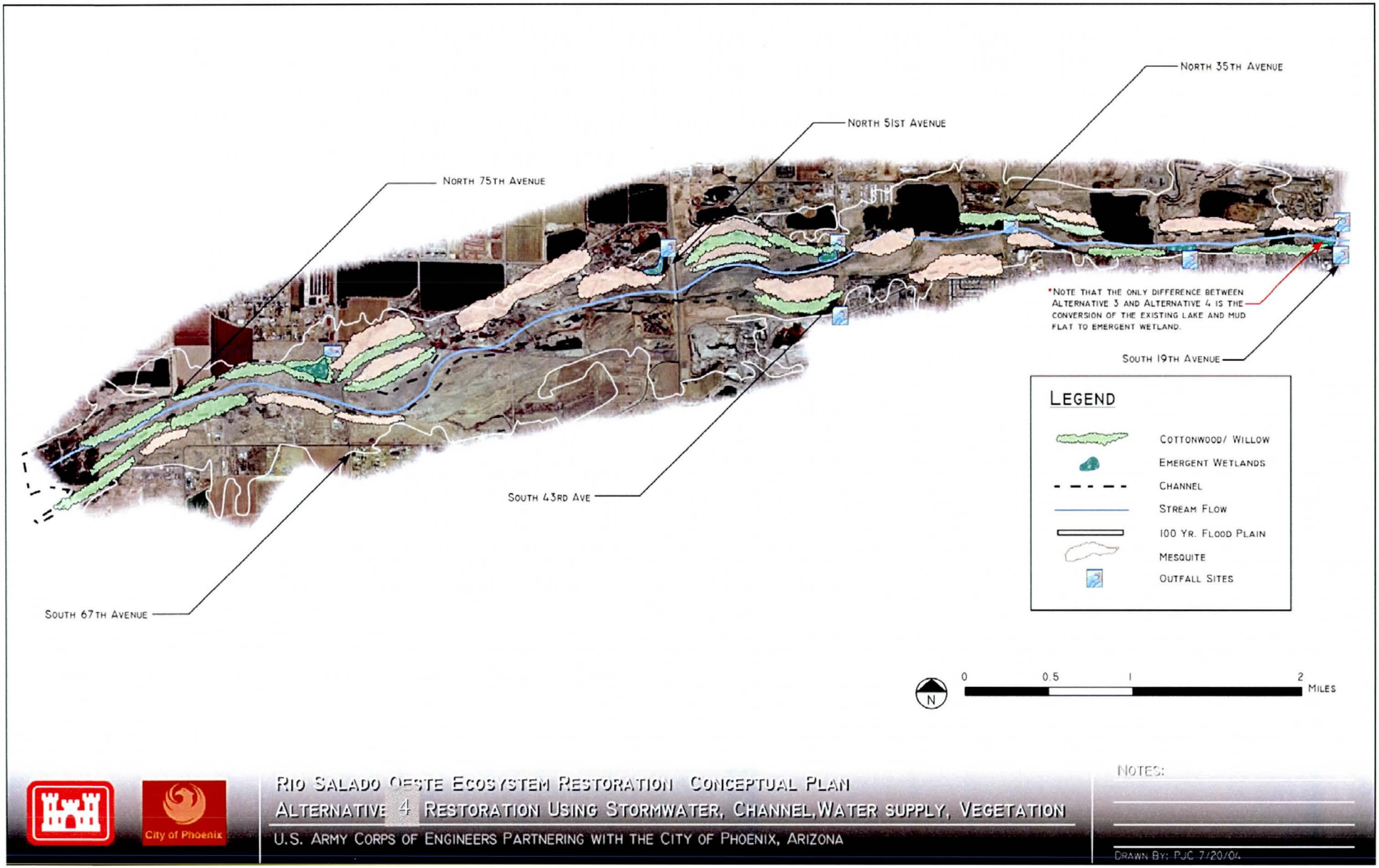

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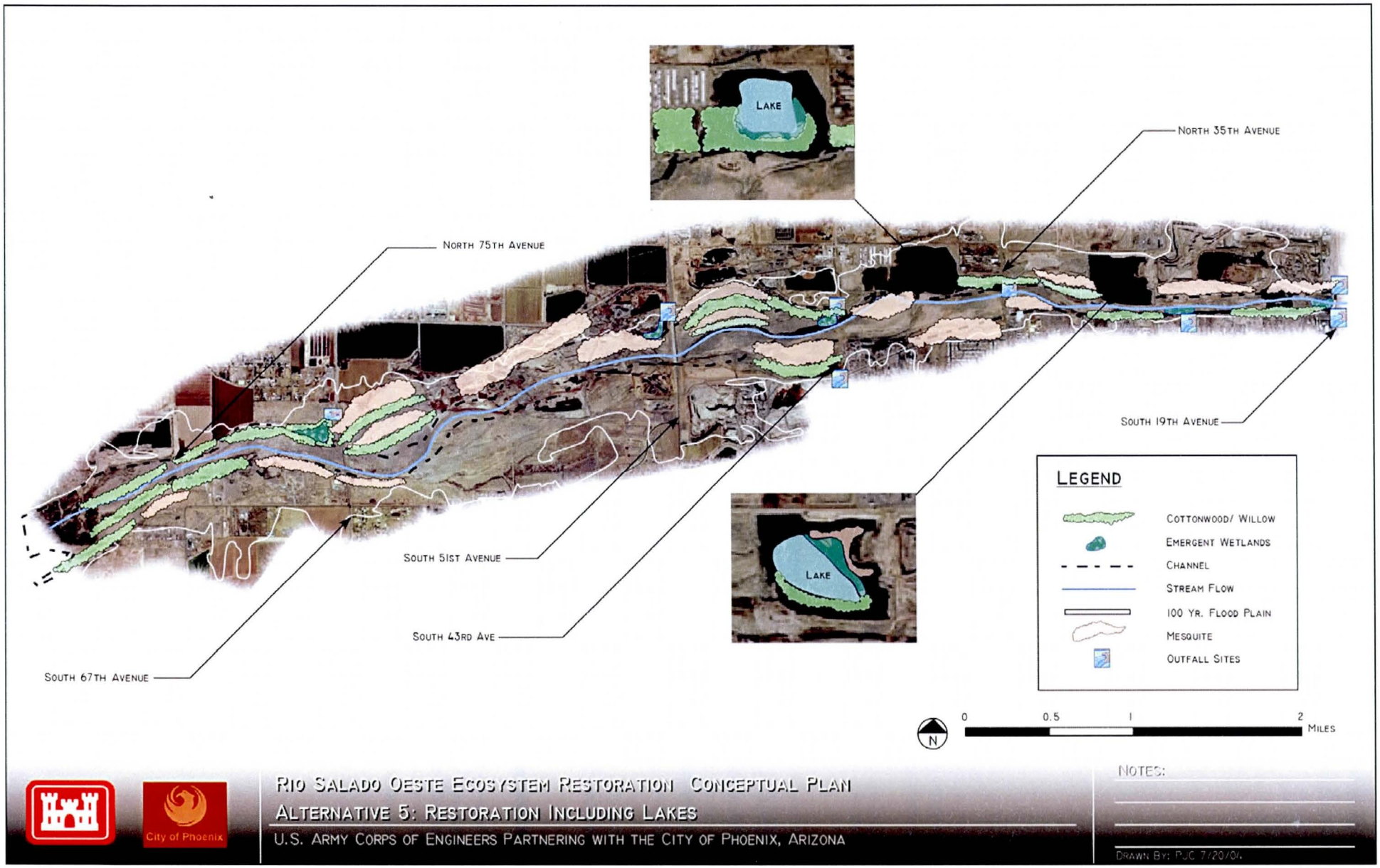
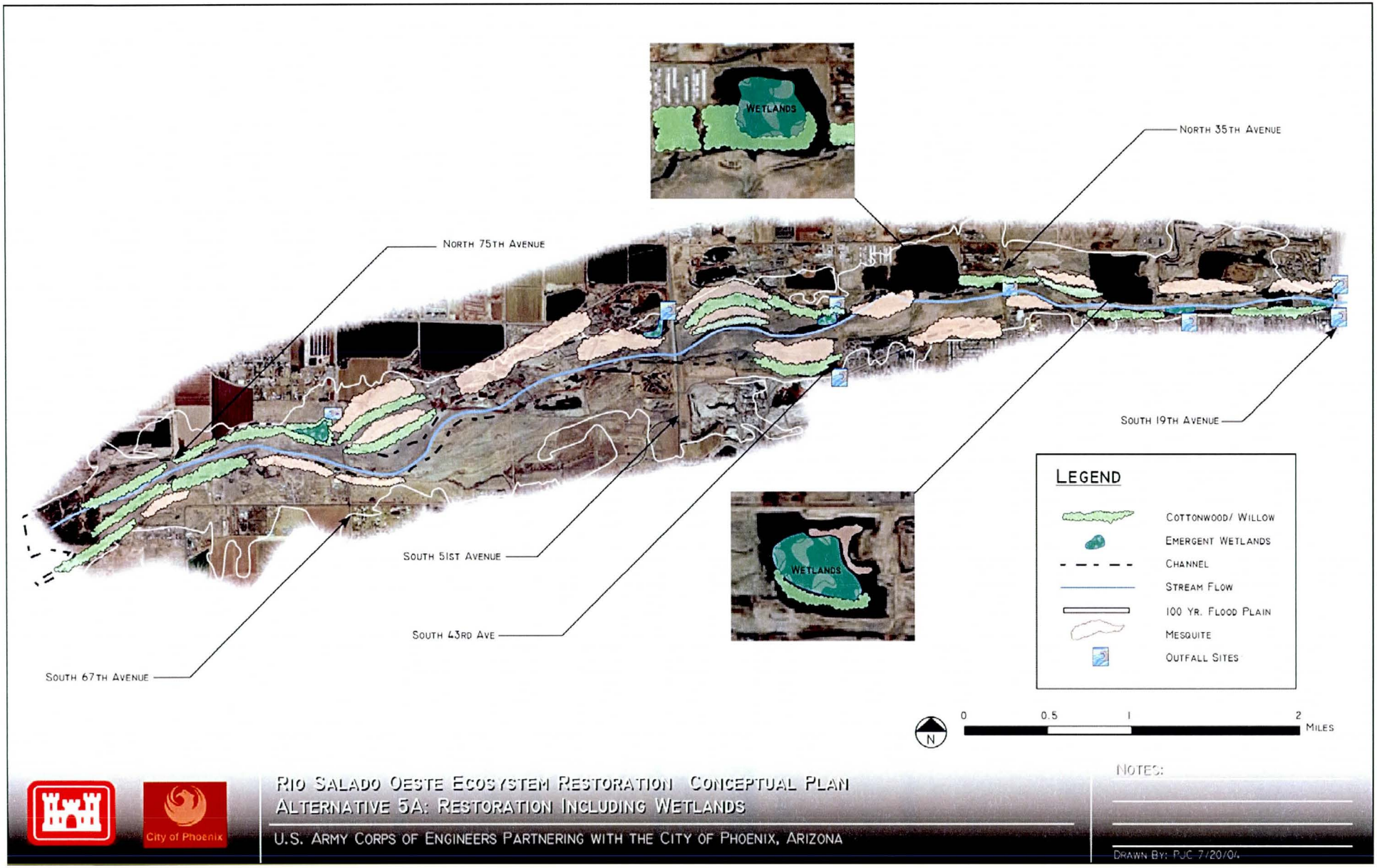


Alternative 5A



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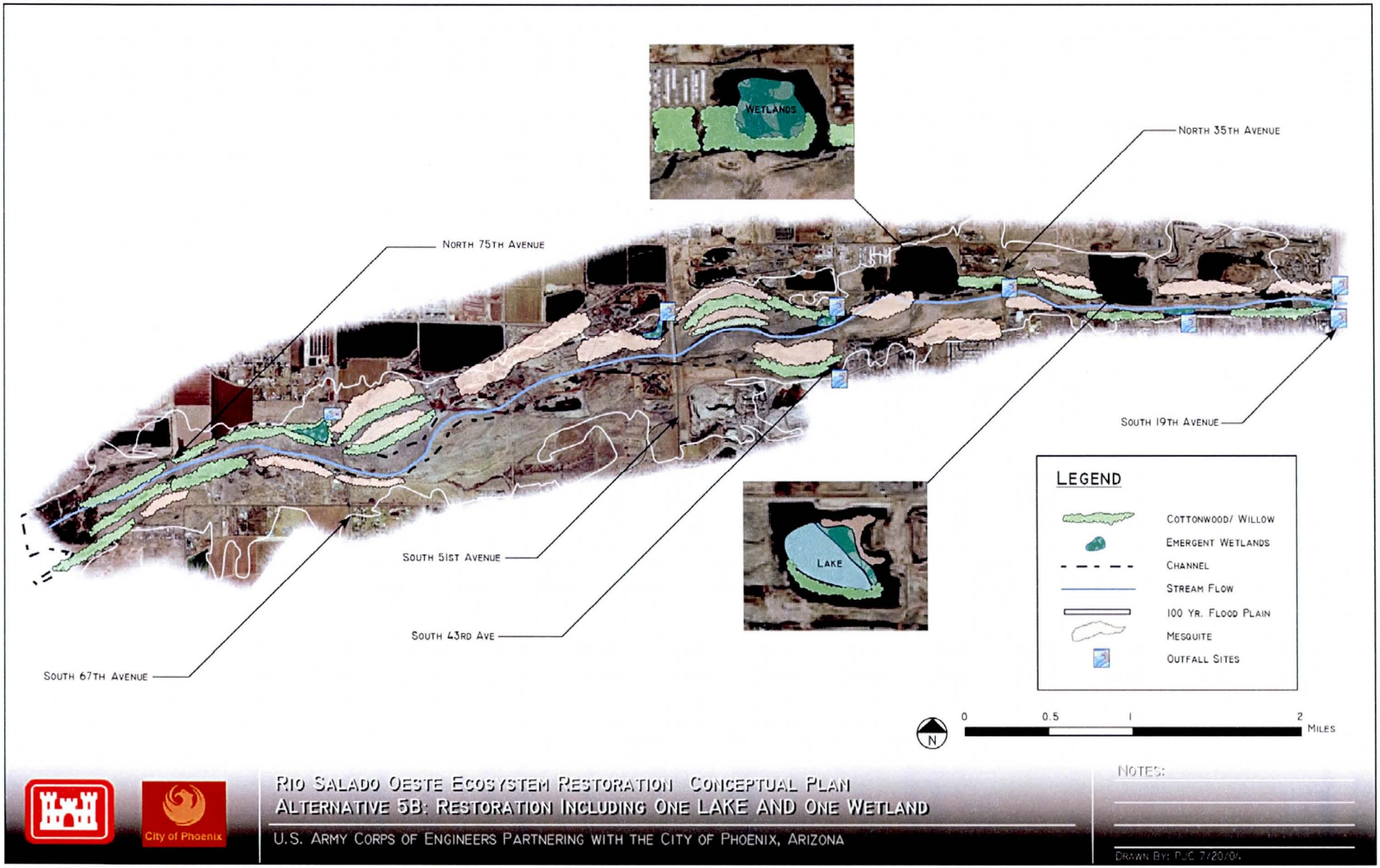
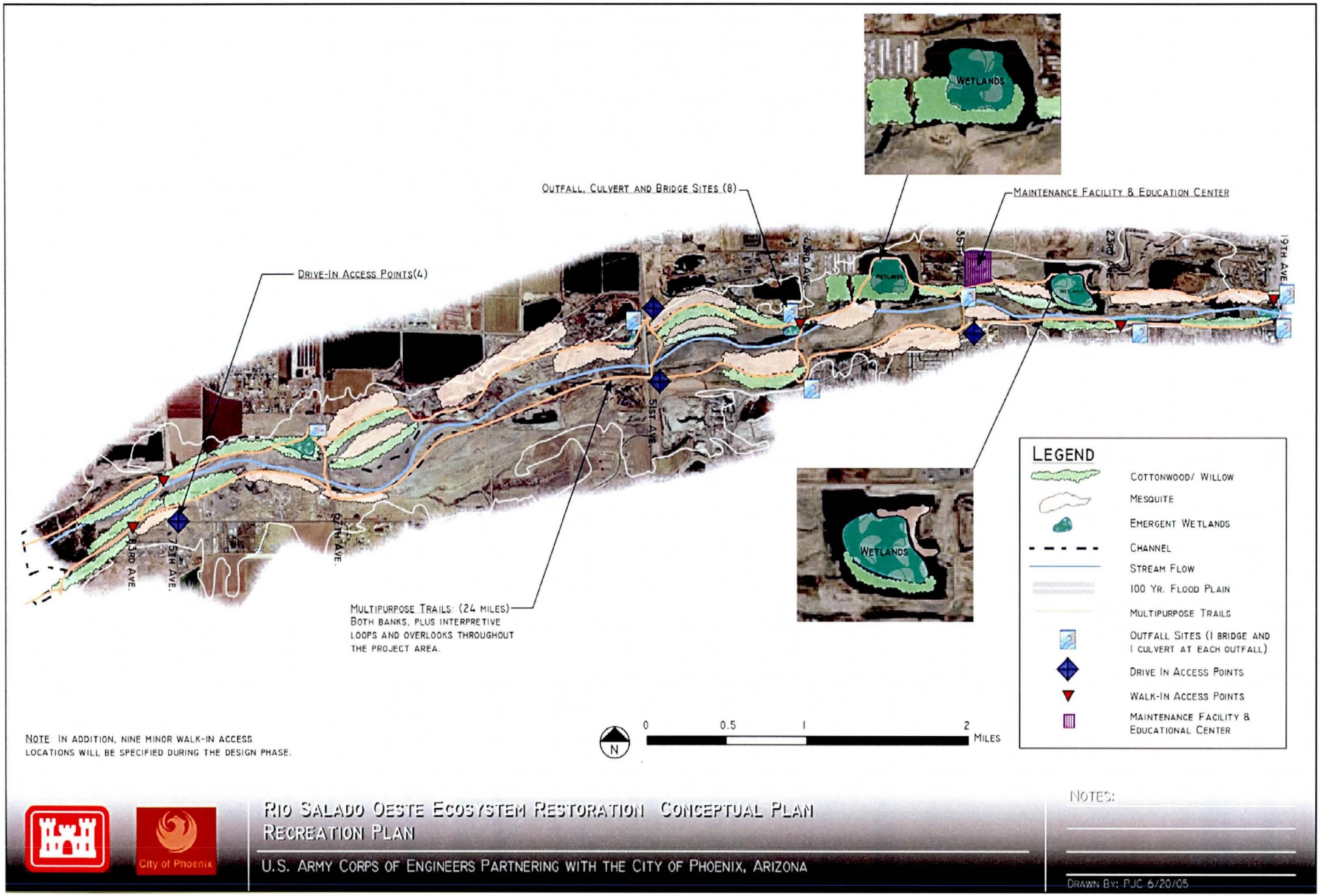


Recreation Plan with Alternative 5A



US Army Corps of Engineers
Los Angeles District
South Pacific Division

Rio Salado Oeste
Draft Environmental Impact Statement

Salt River-Phoenix, Arizona

Prepared by:

U.S. Army Corps of Engineers, Los Angeles District
Arizona Nevada Area Office
3636 North Central Avenue, Suite 740
Phoenix, AZ 85012-1936

March 2006

Proposed Action:	Ecosystem restoration along an eight mile reach of the Salt River
Type of Statement:	Draft Environmental Impact Statement (DEIS)
Lead Agency:	U.S. Army Corps of Engineers, Los Angeles District
Cooperating Agency:	City of Phoenix
For Further Information:	Scott K. Estergard U.S. Army Corps of Engineers, Los Angeles District Arizona-Nevada Area Office, Planning Section C 3636 N. Central Ave., Suite 900, Phoenix, AZ. 85012-1939 (602)640-2003, X-242, Scott.K.Estergard@usace.army.mil

Abstract: This draft environmental impact statement (DEIS) analyzes the potential environmental impacts associated with the proposed Rio Salado Oeste project on the Salt River in Maricopa County, Arizona. The primary purpose of the proposed action is ecosystem restoration. The responsible federal lead agency is the Department of the Army, U.S. Army Corps of Engineers, Los Angeles District. The City of Phoenix is the non-federal sponsor.

The study area for the project consists of an eight mile reach of the Salt River and adjacent lands in and near southwestern Phoenix, Maricopa County, Arizona. More specifically, the study area consists of the Salt River corridor from 19th Avenue downstream (west) to 83rd Avenue, between Lower Buckeye Road and Baseline Road. This study area is three miles wide and encompasses approximately 23.5 square miles.

This document addresses the No-Action Alternative, the Preferred Alternative, and four additional alternative plans developed to restore and improve native vegetation and wildlife habitat values in the project area. The preferred alternative would entail earth moving, planting of vegetation and irrigation installation to facilitate restoration of 1,466 acres of riparian habitats along the Salt River. Restored habitats would consist of 170 acres of river channel (including 34 acres of in-channel wetland), 375 acres of cottonwood/willow forest, 417 acres of mesquite, 156 acres of other wetlands, 296 acres of riparian scrub and 52 acres of scrub shrub.

Additional benefits would include recreational opportunities, general improvements in aesthetic quality, and a slight reduction in the potential for flood damage. Each alternative has been designed to minimize adverse impacts to the maximum extent practicable. The anticipated cumulative effects of implementation of the proposed action have been considered and addressed. Analyses and documentation are consistent with the National Environmental Policy Act (NEPA) and other applicable laws, regulations, and policies, and have been conducted in coordination with the City of Phoenix, the Gila River Indian Community, concerned resource agencies, and members of the public. Information referred to in this document, as well as in the accompanying feasibility report and appendices, is incorporated by reference.

A 45-day comment period on this DEIS begins with publication of the U.S. Environmental Protection Agency Notice of Availability in the Federal Register. A public hearing to discuss and receive comments on the DEIS will be held at a time and location to be announced in the Notice of Availability. Individuals and agencies may present written comments relevant to the DEIS, or request to be placed on the mailing list for announcements and for the Final EIS, by sending the information to Mr. Michael Fink, Environmental Coordinator, by e-mail to Michael.J.Fink@usace.army.mil, or at the physical mailing address provided above. The comments received during the comment period will be considered in the preparation of the Final EIS. Late comments will be considered to the extent practicable. Unless otherwise requested, copies of the Final EIS will be provided on CD-ROM

EXECUTIVE SUMMARY

ES. 1 INTRODUCTION

This Draft Environmental Impact Statement (DEIS) has been prepared by the U.S. Army Corps of Engineers (Corps), Los Angeles District, to analyze potential environmental impacts associated with the implementation of alternatives for the Rio Salado Oeste ecosystem restoration project. The study area is geographically located in the City of Phoenix, which lies within Maricopa County, Arizona. The study area is approximately eight miles long extending from 19th Avenue on the east downstream to 83rd Avenue on the west, and from Lower Buckeye Road on the north to Baseline Road on the south. The study area is approximately three miles wide and comprises approximately 23.5 square miles. While this is a large study area extending beyond the riverbanks, any implementation of project features would be associated with the river floodplain in an area referred to as the project implementation area. The project implementation area extends from 19th Avenue on the east to 83rd Avenue on the west, and is the area within the 100-year floodplain of the Salt River. The project implementation area averages two-thirds of a mile in width, and consists of approximately 3,315 acres. The study area lies between two other U.S. Army Corps of Engineers ecosystem restoration projects; Rio Salado Phoenix upstream and Tres Rios downstream.

Information referred to in this DEIS, as well as in the accompanying Feasibility Report titled *Rio Salado Oeste Interim Feasibility Report, Salt River – Phoenix, Arizona* (hereafter variously referred to as main report, feasibility report and main feasibility report) and its appendices, is incorporated by reference.

The DEIS provides a description of restoration alternatives and the No-Action Alternative; provides an analysis of the existing and future conditions of the area without the project, and; analyzes the impacts associated with five action alternatives that have been determined to be the most feasible. Alternative 5A has been identified as the tentatively recommended plan based on its achievement of project objectives and for its level of attainment of completeness, efficiency, effectiveness, and preliminary public acceptability criteria.

ES.2 MAJOR CONCLUSIONS

ES.2.1 FORMULATION AND SCREENING OF ALTERNATIVES

The purpose of the proposed action is to restore degraded riparian ecosystem structure, function and dynamic processes to a more self-sustaining, diverse, and functional condition. Flood damage reduction was evaluated as an additional project purpose, but could not be economically justified. However, incidental flood damage reduction benefits would likely be obtained from an ecosystem restoration project. Potential additional benefits in the project area would include the following: passive recreation; improved water quality, air quality and aesthetics, and; noise reduction.

Specific planning objectives reflect the problems and opportunities for desired positive changes along the Rio Salado Oeste reach of the Salt River. The established objectives were: to restore native riparian, wetland, and floodplain habitats and manage undesirable plant, fish, and wildlife species; to reduce flood damages to infrastructure and structures, and; to improve passive recreation and environmental-education opportunities.

Alternative plans were developed during the feasibility study to meet the specified problems and opportunities and planning objective and constraints. The alternatives were then ranked based on completeness, effectiveness, efficiency, and acceptability and twelve were selected for further review. To narrow the array further, the study team determined the most significant criteria to use in comparing alternatives. These were:

- Cottonwood/willow is an important and scarce cover type in Arizona and the Southwest. The study team, including the U.S. Fish and Wildlife Service (USFWS) and Arizona Game and Fish Department (AGFD), decided that cottonwood/willow cover type was the highest priority for restoration, followed by mesquite and wetlands. Due to the significance and scarcity of cottonwood/willow, alternatives not including this cover type were eliminated from further consideration.

- Since the watershed is developed, tributaries to the river have been replaced by stormwater outfalls. These stormwater outfalls provide opportunities for restoration and for potential water harvesting. These outfalls also provide an inexpensive opportunity to direct additional water to the project area and associated restoration features. The stormwater measure is a necessary component of any alternative because of the restoration opportunities and potential water source. Therefore, alternatives not including that individual component were eliminated from further consideration.

- Channel restoration is an important project component for various reasons. It provides a connection to other projects, is a potential means of water distribution, is important for the ecosystem, and contributes to reducing flooding potential. Therefore, alternatives not including that component were not considered.

- Lake restoration to maintain an open water body and to provide a potential urban fishery is an important component for the local community.

Applying these criteria to the array of alternatives narrowed the list to five alternatives, plus the No-action Alternative. The remaining five alternatives all include channel modification to maximize stormwater retention for habitat use. Alternative 4 includes active restoration of cottonwood and mesquite and emergent habitat, as well as active management to control invasives. Alternative 5 includes all of the above, plus the development of two existing gravel pits into lakes. Alternative 5A, the Preferred Alternative, was similar to Alternative 5, except that it proposed filling the pits to restore them to emergent wetland and riparian areas. Finally, Alternative 5B combines Alternatives 5 and 5A to develop one gravel pit into a lake and the other pit into an emergent wetland/riparian area. Table ES-1 summarizes this information below, and quantitatively shows expected restored acres for each cover type.

Alternative 5A is the tentatively selected plan. It would restore 375 acres of cottonwood/willow, 417 acres of mesquite, 170 acres of wetlands (including 34 acres of in-channel wetlands), 156 acres of other wetlands, 296 acres of riparian scrub, and 52 acres of scrub-shrub habitat. In addition to restoration, the proposed alternative includes incidental flood damage reduction, incidental noise reduction, incidental air quality benefits, incidental water quality benefits, incidental aesthetic improvements and passive recreation.

Incidental flood damage reduction benefits would include a slightly lowered water-surface elevation, the creation of attenuation within the channel, reduced surface roughness, a reduction in the erosion potential, and a reduction in sedimentation issues. In addition, there would be reduced potential for head-cutting west of the 35th Avenue bridge where a grade control structure would be constructed. This grade control structure would also reduce potential damages to the bridge. Restored vegetation would help attenuate noise and PM-10 emissions, thus providing incidental benefits of noise reduction and improved air quality. The increase in wetlands provides for filtration and attenuation of stormwater pollutants, thus providing incidental water quality benefits. Improvements to the quality of vegetative habitats and new recreation features would improve the aesthetic quality of the project implementation area. Major features of the recreation component include multipurpose trails, shelters, signage, utilities, park furniture, and interpretive media.

Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) activities have also been identified for the project and have been evaluated in this DEIS. These activities include maintenance and replacement of pumps, pipelines, and other water delivery and irrigation infrastructure features, annual invasive species control, channel and wetland regrading and excavation and periodic removal of sediment, surface reshaping, or replanting of project features damaged by flood events.

ES 2.2 AREAS OF CONTROVERSY AND UNRESOLVED ISSUES

The public scoping process was initially conducted on September 13, 2001, between the City of Phoenix and Corps of Engineers' staff. Continuing meetings were also held with the Rio Salado and Tres Rios Advisory committees to seek stakeholder and agency input. Meetings have been held throughout the planning process to gain further public input into the screening of alternatives. Major areas of concern included technical considerations based upon the specifics of the study, vector control, flood damage reduction, and opportunities for recreation.

The public comment period for this DEIS will begin when the availability of this document is announced in the Federal Register (FR). Therefore, additional public concerns will be addressed in future versions of this document. Additional information regarding the public involvement and scoping process is provided in Chapter 9.

Initiation and completion of activities associated with Rio Salado Oeste restoration project depends on the resolution of the following issues:

- Compliance with the Clean Water Act. The Clean Water Act Section 404(b)(1) Compliance Evaluation can be found in Appendix A of this document.

- Water Quality Certification under Section 401 of the Clean Water Act.

- Further evaluations of cultural resources in the project area would need to be conducted in accordance with Section 106 of the National Historic Preservation Act (NHPA). If resources were determined to be National Register of Historic Places (NRHP)-eligible and avoidance is not feasible, further mitigation measures would be detailed in a Memorandum of Agreement (MOA) between all necessary parties, including the State Historic Preservation Officer (SHPO), the City of Phoenix and the tribes. These measures would include field surveys, testing, and data recovery. Mitigation measures would also contain provisions that if cultural or paleontological resources are encountered during construction or other activities, work in the area would stop until a qualified archaeologist can evaluate the finds and determine whether further investigation is necessary. All necessary parties would be notified if buried cultural resources are encountered.

- Consultation with U.S. Fish and Wildlife Service pursuant to Section 7 of the Endangered Species Act.

- Future operational activities associated with sand and gravel mining in the project area would need to be defined.

It is expected that these issues would be resolved during the preliminary engineering design phase of the project after the Final EIS has been published.

Table ES-1: Array of Alternatives and Associated Habitat Acres Restored

Alternative	Channel[1]			Cottonwood/ Willow	Mesquite	Open Water	Scrub-Shrub[2]	Other Wetlands	TOTALS
	Low-Flow Channel	In-Channel Wetlands[3]	Riparian Scrub						
2. Stormwater and Channel	170	17	125	66	43	0	305	28	737
4. Stormwater, Channel, Water Supply, Cottowood, Mesquite, Invasive and Emergent	170	34	165	348	409	0	63	33	1188
5. Stormwater, Channel, Water Supply, Cottowood, Mesquite, Invasive and Emergent, Lake	170	34	296	375	417	40	92	76	1466
5A. Wetland/riparian restoration in lieu of permanent open water and lakes	170	34	296	375	417	0	52	156	1466
5B. Hybrid of 5 & 5A with one gravel pit restored to a lake and the other a wetland/ riparian complex	170	34	296	375	417	20	52	136	1466

[1] River channel consists of low flow, wetland or riparian scrub.
[2] Scrub shrub acres are dispersed among and between the other restored cover types within the floodplain.
[3] Alternative 2 assumes that 10% of the low-flow channel would consist of wetlands; the remaining alternatives assume that 20% of the low-flow channel would consist of wetlands.

ES 2.3 SUMMARY OF POTENTIAL ENVIRONMENTAL EFFECTS

Each of the alternatives has been analyzed to determine the environmental effects that would result should that alternative be implemented. Mitigation measures have been developed to avoid, minimize, or reduce the effects of any substantial adverse impacts. A cumulative impact analysis has also been prepared for each resource area. Table ES-2 provides a summary of the adverse impacts and mitigation measures for each resource area by alternative. These adverse impacts include unavoidable significant impacts on prehistoric and historic cultural resources. Unavoidable significant impacts are impacts that remain following the implementation of mitigation measures or impacts for which there are no mitigation measures. These significant impacts could occur as a result of implementing any of the analyzed construction alternatives (Alternatives 2, 4, 5, 5A, and 5B). More detailed information on unavoidable significant impacts is provided in Chapter 4 of the DEIS. Chapter 4 also includes potential beneficial impacts that may result from project implementation. Chapter 8 of the DEIS provides more detailed information on the mitigation measures.

Based on the Hydrogeomorphic Model (HGM, see Section 2.5.1.1) and Incremental Cost Analysis (ICA, see Section 2.5.1.3), Alternative 5A was determined to be the environmentally preferable alternative. Alternative 5A is also the locally preferred plan of the non-federal sponsor.

Table ES-2. Potential Adverse Effects Environmental Impact Summary Matrix

Environmental Element	*Alternative 2*	*Alternative 4*	*Alternative 5*	*Alternative 5A*	*Alternative 5B*	*No-Action*
4.1 GEOLOGY AND TOPOGRAPHY						
Impact: Minor Geomorphologic Changes in River Channel						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	Significant
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	Significant
4.2 HYDROLOGY AND WATER RESOURCES						
Impact: Changes in 100-year Water Surface Elevations						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No mitigation
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
Impact: Potential Changes in Groundwater Depths						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No mitigation
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
4.3 WATER QUALITY*						
Impact: Temporary Adverse Effects on Water Quality during Project Construction						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	Implement Mitigation Measure (MM) WQ-1	Implement Mitigation Measure WQ-1	Implement Mitigation Measure WQ-1	Implement Mitigation Measure WQ-1	Implement Mitigation Measure WQ-1	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Potential Adverse Effects on Water Quality Associated with Accidental Spills of Fuels or Other Toxic Materials During Project Construction						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	Implement MM WQ-2	Implement MM WQ-2	Implement MM WQ-2	Implement MM WQ-2	Implement MM WQ-2	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Potential Adverse Effects on Water Quality Associated with Effluent						
Level of Significance	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No mitigation

*** Mitigation Measures are described in Chapter 8 of the EIS.**

Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
Impact: Potential Adverse Effects on Groundwater Quality associated with Introduction of Effluent Water Source						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No mitigation
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
4.4 BIOLOGICAL RESOURCES*						
Impact: Short-Term Decrease in Vegetation due to Construction						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	Implement MM BR-1 & BR-2	Implement MM BR-1 & BR-2	Implement MM BR-1 & BR-2	Implement MM BR-1 & BR-2	Implement MM BR-1 & BR-2	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Long-Term Decrease in Vegetation						
Level of Significance	N/A	N/A	N/A	N/A	N/A	Significant
Mitigation Measure(s)	N/A	N/A	N/A	N/A	N/A	No mitigation
Residual Significance	N/A	N/A	N/A	N/A	N/A	Significant
Impact: Short-Term Decrease in Fish & Wildlife Populations due to Construction and OMRR&R Activities						
Level of Significance	< Significant	< Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	Implement MM BR-5	Implement MM BR-5	Implement MM BR-5	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Long-Term Decrease in Fish & Wildlife Populations						
Level of Significance	N/A	N/A	N/A	N/A	N/A	Significant
Mitigation Measure(s)	N/A	N/A	N/A	N/A	N/A	No mitigation
Residual Significance	N/A	N/A	N/A	N/A	N/A	Significant
Impact: Potential Adverse Effects of Recreation to Wildlife and Vegetation						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
Impact: Short-Term Decrease in Potential for Special Status Species due to Construction and OMRR&R Activites						

*** Mitigation Measures are described in Chapter 8 of the EIS.**

Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	Implement MM BR-3 & BR-4	Implement MM BR-3 & BR-4	Implement MM BR-3 & BR-4	Implement MM BR-3 & BR-4	Implement MM BR-3 & BR-4	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Long-Term Decrease in Potential for Special Status Species						
Level of Significance	N/A	N/A	N/A	N/A	N/A	Significant
Mitigation Measure(s)	N/A	N/A	N/A	N/A	N/A	No Mitigation
Residual Significance	N/A	N/A	N/A	N/A	N/A	Significant
4.5 CULTURAL RESOURCES*						
Impact: Potential Disturbance of Loss of Properties Listed or Eligible for Listing on the National Register						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	< Significant
Mitigation Measure(s)	Implement MM C-1	Implement MM C-1	Implement MM C-1	Implement MM C-1	Implement MM C-1	No Mitigation
Residual Significance	Significant and Unavoidable	Significant and Unavoidable	Significant and Unavoidable	Significant and Unavoidable	Significant and Unavoidable	< Significant
4.6 AESTHETIC RESOURCES						
Impact: Potential Short-Term Adverse Aesthetic Effects Due to Construction						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Potential Long-Term Adverse Aesthetic Effects						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	No Impact
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant
4.7 AIR QUALITY*						
Impact: Generation of Construction-Related and Tailpipe Emissions (CO, VOC, $N0_X$)						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Generation of Construction-Related and Operational Fugitive Dust (PM-10) Emissions						
Level of Significance	Implement MM AQ-1	Implement MM AQ-1	Implement MM AQ-1	Implement MM AQ-1	Implement MM AQ-1	N/A

*** Mitigation Measures are described in Chapter 8 of the EIS.**

Mitigation Measure(s)	Implement MM AQ-1	Implement MM AQ-1	Implement MM AQ-1	Implement MM AQ-1	Implement MM AQ-1	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Determination of Conformity						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Potential Adverse Effects on Air Quality due to Recreational Use						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	Implement MM AQ-2	Implement MM AQ-2	Implement MM AQ-2	Implement MM AQ-2	Implement MM AQ-2	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
4.8 NOISE						
Impact: Short-Term Effects to Ambient Noise Conditions due to Construction and OMRR&R Activities						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Long-Term Effects to Ambient Noise Conditions						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
4.9 SOCIAL AND ECONOMIC RESOURCES						
Impact: Detectable Increases or Decreases to Population, Housing, Employment or Income due to the Project						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Effects on Environmental Justice						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
4.10 TRANSPORTATION*						

*** Mitigation Measures are described in Chapter 8 of the EIS.**

Impact: Temporary Increase in Traffic on Existing Roadways during Project Construction						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	Implement MM T-1	Implement MM T-1	Implement MM T-1	Implement MM T-1	Implement MM T-1	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Potential Damage to Roadway Surfaces during Project Construction						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	Implement MM T-2	Implement MM T-2	Implement MM T-2	Implement MM T-2	Implement MM T-2	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Generation of Additional Vehicle Trips by Recreationists						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
4.11 LAND USE						
Impact: Temporary Adverse Effects on Land Use During Project Construction						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Compatibility with Land Use and Planning Policies of Local Government Jurisdictions						
Level of Significance	Compatible	Compatible	Compatible	Compatible	Compatible	Not Compatible
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation
Residual Significance	Meets Goals	Meets Goals	Meets Goals	Meets Goals	Meets Goals	Not Compatible
4.12 RECREATION						
Impact: Temporary Adverse Effects on Recreation During Project Construction						
Level of Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Mitigation Measure(s)	No Mitigation	No Mitigation	No Mitigation	No Mitigation	No Mitigation	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
4.13 PUBLIC HEALTH AND SAFETY*						
Impact: Temporary Construction-Related Water Quality Impacts						
Level of Significance	Potentially	Potentially	Potentially	Potentially	Potentially	N/A

*** Mitigation Measures are described in Chapter 8 of the EIS.**

	Significant	Significant	Significant	Significant	Significant	
Mitigation Measure(s)	Implement MM PHS-1	Implement MM PHS-1	Implement MM PHS-1	Implement MM PHS-1	Implement MM PHS-1	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Temporary Construction and OMRR&R-Related Area Safety Issues						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	N/A
Mitigation Measure(s)	Implement MM PHS-2	Implement MM PHS-2	Implement MM PHS-2	Implement MM PHS-2	Implement MM PHS-2	N/A
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	N/A
Impact: Potential for Increases in Vector Control						
Level of Significance	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	Potentially Significant	< Significant
Mitigation Measure(s)	Implement MM PHS-3	Implement MM PHS-3	Implement MM PHS-3	Implement MM PHS-3	Implement MM PHS-3	No Mitigation
Residual Significance	< Significant	< Significant	< Significant	< Significant	< Significant	< Significant

*** Mitigation Measures are described in Chapter 8 of the EIS.**

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CHAPTER 1
PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 INTRODUCTION

The Salt River (*Rio Salado* in Spanish) is a major tributary to the Gila River. It originates in eastern Arizona and flows westward to its confluence with Gila River, west of downtown Phoenix. Prior to agricultural development and urbanization of the Phoenix metropolitan area, the Salt River was a perennial stream fed by snowmelt from mountains in eastern Arizona. Early in the 20th century, major modifications to the river system occurred as part of the Salt River Project (SRP). Several dams were placed along the river allowing diversions of water for agricultural and urban uses. Sand and gravel mining operations and other activities induced additional changes to the river channel and hydrology. As water diversions increased, the groundwater table lowered, separating riparian communities on the surface from a principal water source. Groundwater depletion, coupled with damming of the river by the SRP, caused perennial flow in the Salt River to cease. These changes in hydrological conditions caused the natural riparian ecosystem to decline. Only small, isolated fragments of former habitat remain. Changes in hydrology have also allowed salt cedar, an invasive non-native plant species with minimal habitat value, to become established in the region. Presently, the study area consists of a highly disturbed riverbed with minimal existent native vegetation.

1.2 PURPOSE AND NEED

The purpose of the proposed action is to restore degraded ecosystem structure, function and dynamic processes to a more natural condition. Indicators of success would include the presence of a variety of native plants and animals, and the ability of the area to sustain larger numbers of certain indicator species or more biologically desirable species. There is a need to restore the area in such a manner that the function and desired outputs can naturally evolve with a minimum of continuing human intervention. Potential benefits include increasing wildlife habitat, improving water and air quality, improving the aesthetic quality, reducing ambient noise levels, providing incidental flood damage reduction, and offering passive recreational opportunities.

Further, flood damage reduction and water supply projects within the Gila River watershed have resulted in substantial alteration of the hydrological regime. This alteration, increased agricultural development and urbanization of Phoenix, has resulted in substantial alteration of native cottonwood/willow, mesquite bosque, freshwater marsh and willow woodland desirable habitat types. Without restoration, habitat values in the Rio Salado Oeste reach of the Salt River are expected to further decline within the next 50 years. This would decrease the overall habitat value for federally listed Threatened and Endangered species, as well as Wildlife of Special Concern to the Arizona Game and Fish Department (AGFD). These species include the Yuma clapper rail and southwestern willow flycatcher.

This project is needed to provide an ecological connection between other riparian restoration projects on-going along the Salt River. Without this connection we will see a spread of invasive non-native plants into those restored ecological areas up stream and down stream of this proposed action due to the high level of disturbance within the proposed reach. Also, there is substantial need for additional recreational areas within Phoenix. While recreation is not a major goal of this project, restoration of the area may provide passive recreational benefits.

1.3 STUDY SCOPE

The Rio Salado Oeste Feasibility Study is being conducted by the U.S. Army Corps of Engineers (Corps, Los Angeles District, and the City of Phoenix, in cooperation with the Flood Control District of Maricopa County (FCDMC). The purpose of this study is to identify whether or not it is feasible to implement a project along the Salt River in Phoenix. This study will identify ecosystem restoration, flood damage reduction and recreation alternatives that are technically feasible, economically practicable, and sound with respect to environmental considerations, and that are publicly acceptable. The City of Phoenix, as the non-federal sponsor for the project, supports the proposed project purpose to restore and improve native vegetation and wildlife habitat values in the project area.

1.4 SCOPE OF THE ENVIRONMENTAL IMPACT STATEMENT

The EIS contains the following major elements that are required under the Council on Environmental Quality (CEQ) NEPA Regulations:

- Coversheet, which includes a list of the responsible agencies, the title of the proposed action and its location, the name, address, and telephone number of the person at the agency who can supply further information, the statement's current designation, a one paragraph abstract, and the date by which comments must be received.

- Executive Summary, which stresses the major conclusions, areas of controversy, and the issues to be resolved.

- Chapter 1. Purpose and Need. This chapter also includes an overview of the elements necessary for the U.S. Army Corps of Engineers' participation in the planning of Rio Salado Oeste.

- Chapter 2. Alternatives Including the Proposed Action. This section explores and evaluates all reasonable alternatives, selected and eliminated, in a way that allows reviewers to evaluate their comparative merits. It includes reasonable alternatives not within the Corps' jurisdiction, includes the alternative of No-Action, identifies the Corps' preferred alternative, and includes appropriate mitigation measures.

- Chapter 3. Affected Environment. This section includes relevant data and analyses used to determine affects the alternatives would have on the environment.

- Chapter 4. Environmental Consequences. The section includes environmental impacts of the alternatives, including the No-Action alternative. It includes discussions related to mitigation; however mitigation is further discussed in Chapter 8. The remaining requirements of the NEPA Regulations were broken out into separate chapters.

- Chapter 5. Cumulative Impacts. This section describes possible beneficial, adverse, and unavoidable significant cumulative impacts within the Rio Salado Oeste Cumulative Impact Zone.

- Chapter 6. Irreversible or Irretrievable Commitments of Resources and Unavoidable Significant Impacts. This section articulates damages to the environment that cannot be reversed, even after the life of a project and resources that are lost for a long period of time.

- Chapter 7. Environmental Compliance. This section discusses the major state and federal environmental laws potentially applicable to the project.

- Chapter 8. Mitigation Measures. This section describes mitigation measures as applicable for each of the 13 affected resource categories.

- Chapter 9. Public Involvement. This section discusses scoping, the public involvement process to date, and agency coordination completed by the Corps.

- A List of Preparers is provided in Chapter 10.

- References cited in the text are listed in Chapter 11.

- A List of Agencies, Organizations, and persons to whom copies of the statement are sent is provided in Chapter 12.

- An Index.

- Appendices: Appendix A - 404(b)(1), Appendix B – Biological Appendix, and Appendix C – Air Quality

The EIS focuses on major issue areas including:

- Geology and topography,
- Hydrology and water resources,
- Water quality,
- Biological resources,
- Cultural resources,

- Aesthetic resources,
- Air quality,
- Noise,
- Social and economic resources (including environmental justice),
- Transportation,
- Land use,
- Recreation, and
- Public health and safety.

1.5 STUDY AUTHORIZATION

The study was conducted under two separate authorities provided by Congress.

- The first authority is given by Public Law 761, Seventy-fifth Congress, dated June 28, 1938, known as Section 6 of the Flood Control Act of 1938, which reads in part as follows: *"the Secretary of War (now Secretary of the Army)is hereby authorized and directed to cause preliminary examinations and surveys...at the following localities ...Gila River and tributaries, Arizona."*
- The second and most recent authority is provided by House Resolution 2425 (HR 2425), dated May 17, 1994, which states: "*...the Secretary of the Army is requested to review the reports of the Chief of Engineers on the State of Arizona...in the interest of flood damage reduction, environmental protection and restoration, and related purposes.*"

1.6 STUDY AREA AND PROJECT LOCATION

The study area for the project consists of an eight mile reach of the Salt River and adjacent lands in and near southwestern Phoenix, Maricopa County, Arizona (see Figure 1.6-1). More specifically, the study area consists of the Salt River corridor from 19th Avenue downstream (west) to 83rd Avenue, between Lower Buckeye Road and Baseline Road. This study area is three miles wide and encompasses approximately 23.5 square miles. The study area lies between two other U.S. Army Corps of Engineers ecosystem restoration projects; Rio Salado Phoenix upstream and Tres Rios downstream.

While this is a large study area extending beyond the riverbanks, any implementation of project features would be associated with the river floodplain. For the purpose of alternative formulation, the project implementation area was defined as the area within one mile of the centerline of the Salt River from 19th Avenue to 83rd Avenue (Figure 1.6-2). With the formulation of alternatives now complete, the project implementation area has been reduced to encompass only the area within the 100-year floodplain of the Salt River. The project implementation area is, on average, approximately two-thirds of a mile wide and consists of approximately 3,315 acres. Figure 1.6-2 displays the study area and project implementation areas.

1.7 PREVIOUS STUDIES

The Salt River has been extensively utilized for irrigation since prehistoric times. In the 1800s, settlers reestablished many historical irrigation canals. Since then, the Phoenix metropolitan area has established itself around the river. The Salt River has presented many opportunities and challenges, and has been studied extensively.

Various agencies and engineering consulting firms have conducted or published over 50 studies and reports on the Salt River since 1980. The topics of the reports or studies include water resources, flood damage reduction, recreation and urban development, and environmental assessment. Two of these studies supported implementation of water resources projects immediately upstream and downstream of the Rio Salado Oeste reach Figure 1.7-1. These studies are as follows:

- In April 1998, the Corps completed the feasibility report and EIS for the Rio Salado Salt River, Arizona project. The report identified plans that would provide environmental restoration benefits and serve the public interest to this upstream reach of the Salt River. The project is currently in the final year of construction.

- In April 2000, the Corps completed a feasibility report and EIS for the Tres Rios, Arizona Project. The study examined a portion of the Salt River and Gila River from 83rd Avenue downstream to the Agua Fria River, and selected a plan that includes environmental restoration and flood damage reduction components. The project is currently in the design phase.

Other previous studies can be found in Chapter 3 of the feasibility report. The findings in these reports and the chronology of change within the Salt River corridor are important and essential in describing the changes over time and in outlining the importance of this project.

1.8 PLANNING OBJECTIVES

This study has specific planning objectives that provided the focus for the formulation of alternatives. The study objectives reflect the problems and opportunities for desired positive changes along the Rio Salado Oeste reach, and are as follows:

- restore native riparian, wetland, and floodplain habitats and manage undesirable plant, fish, and wildlife species;

- reduce flood damages to infrastructure and structures, and;

- improve passive recreation and environmental-education opportunities.

1.9 PUBLIC INVOLVEMENT

The National Environmental Policy Act (NEPA) ensures public involvement and notification of a proposed project. The release of this document will coincide with a public hearing. The outcomes of this meeting along with other public involvement information can be found in Chapter 9 of this report.

VICINITY MAP

Figure 1.6-1

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Miles

March 2006

Rio Salado Oeste

US Army Corps of Engineers®

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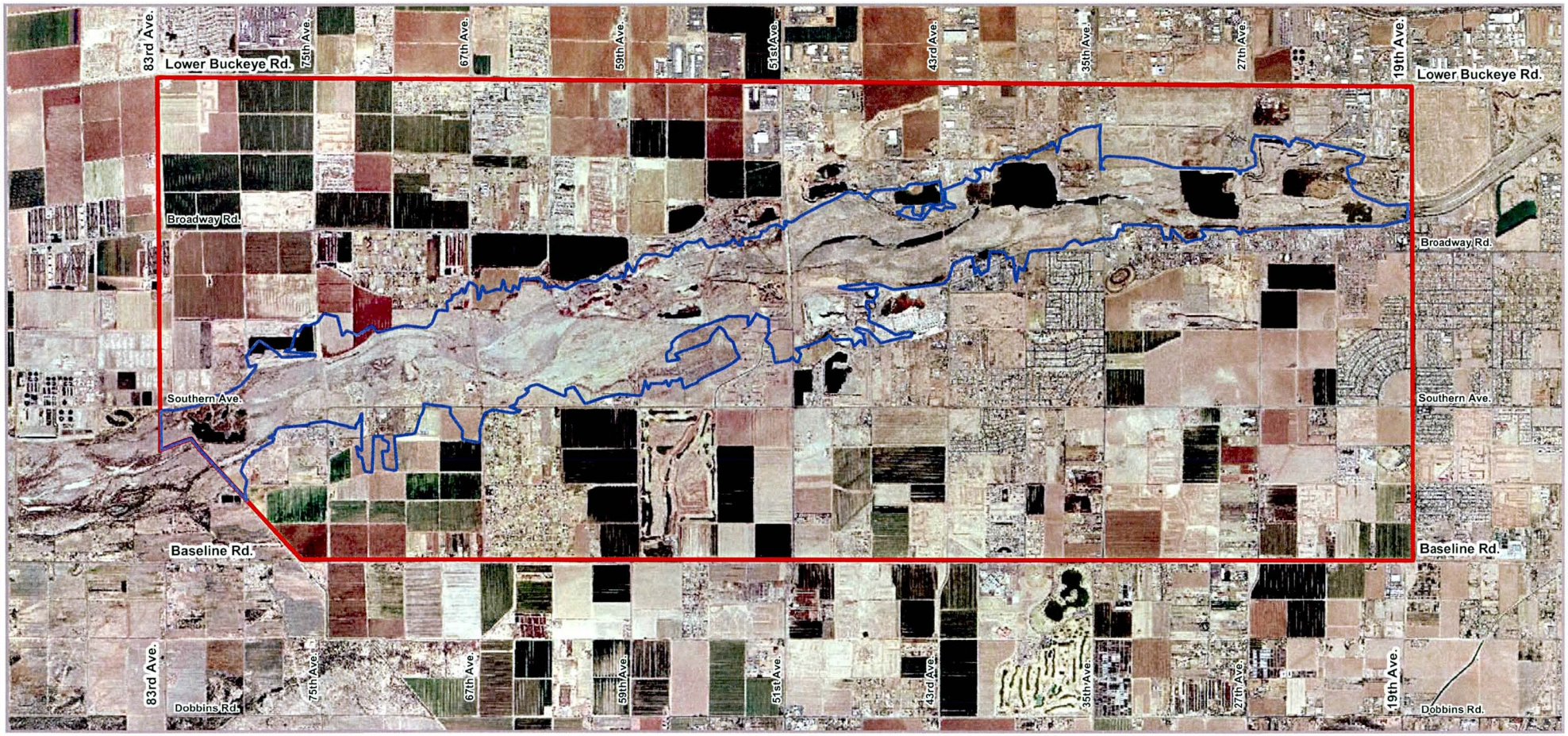

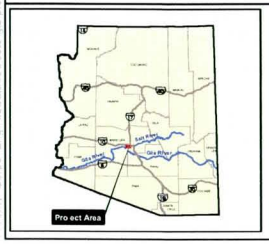

Legend

- Project Study Area
- Project Implementation Area

March 2006

PROJECT STUDY AREA AND PROJECT IMPLEMENTATION AREA

Rio Salado Oeste

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Figure 1.6-2

US Army Corps of Engineers

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CHAPTER 2
ALTERNATIVES

The purpose of this section is to provide a comprehensive description of alternatives for the Rio Salado Oeste Feasibility Study, including alternatives outside the Corps' jurisdiction, abandoned alternatives, the no-action alternative and identification of the proposed alternative. Chapter 5 of the Main Feasibility Report discusses the alternatives, their development and screening in further detail and should be referred to for additional information.

This section provides:

- an overview of the alternative formulation and screening process conducted for the Rio Salado Oeste Feasibility Study;
- descriptions of the biologically and incrementally cost effective alternatives (including the No-Action Alternative) selected for evaluation in this document;
- brief descriptions of the alternatives that were evaluated and eliminated from consideration during the screening process, and;
- a recreation plan that could be implemented with any of the alternatives selected for evaluation.

2.1 INTRODUCTION

This Environmental Impact Statement is part of the U.S. Army Corps of Engineers and City of Phoenix and planning effort to restore degraded ecosystem structure, function and dynamic processes to a more natural condition. There is a need to restore the area in such a manner that the function and desired outputs can naturally evolve with a minimum of continuing human intervention. The alternatives would have to achieve the project purpose while complying with Corps federal planning objectives and the more specific objectives set during the Rio Salado Oeste planning effort.

In Section 209 of the Flood Control Act of 1970, Pub, L. No. 91-611, 42 U.S.C. 1962-2, Congress identified four general objectives to be included in federally financed water resource projects. These objectives are: enhancing regional economic development, the quality of the total environment, including its protection and improvement, the well-being of the people of the United States, and the national economic development. These four objectives remain important considerations of water resource projects and address long-term impacts, defined in such a manner that each proposed plan can be easily compared to the no action plan and other alternatives. However, ecosystem restoration projects focus on a fifth objective, the National Ecosystem Restoration (NER) objective. That objective is to contribute to the Nation's ecosystems through restoration, with contributions measured by changes in the amounts and values of habitat.

The more specific objectives for Rio Salado Oeste were developed through coordination with local and regional agencies, public involvement, site assessments, interpretation of prior studies and reports, and review of existing water projects. The planning objectives reflect the problems and opportunities, represent desired positive changes along the Rio Salado Oeste reach and provide focus for the formulation of alternatives. These objectives are to: restore native riparian, wetland, and floodplain habitat and manage undesirable plant, fish and wildlife species; reduce flood damages to infrastructure and structures, and; improve passive recreation and environmental recreation and environmental-education opportunities.

2.2 ALTERNATIVES NOT WITHIN CORPS' JURIDICTION

There are several alternatives that do not fall within the programs, missions and authorities of the U.S. Army Corps of Engineers (Corps). These alternatives would contribute to the planning objective of restoring the degraded ecosystem structure, function and dynamic processes to a more natural condition. These alternatives include locally implemented non structural measures for restoration such as allocation of water for restoration, zoning controls, implementation of Best Management Practices (BMP's), and elimination of aggregate mining or land set asides. Re-operation of Salt River Project Dams was also recommended for consideration. However, most of these measures are both impractical and publicly infeasible. Allocation of water, zoning controls and land set asides by themselves would not provide a solution to the degradation that has occurred and the existing zoning regulations and Best Management Practices contribute to reducing the decline of remaining habitat value to the extent possible. Re-operation of dams and elimination of aggregate mining are both infeasible and publicly unacceptable solutions as they would affect both the regional water supply and economy.

Planning objectives may also be partially addressed if the need for additional recreational facilities were addressed by the City of Phoenix or Maricopa County agencies to develop additional parklands within or adjacent to the river.

None of these potential outcomes suggest an alternative approach to meeting planning objectives outside Corps jurisdiction. The Corps authorities with respect to environmental restoration, recreation and flood damage reduction allow these opportunities to be addressed in an integrated fashion.

2.3 FORMULATION AND SCREENING OF ALTERNATIVES

2.3.1 THE SIX-STEP PLANNING PROCESS

The Corps' six-step planning process is used to formulate, evaluate, and compare the array of candidate plans that are considered. The plan formulation process includes the following steps:

1. The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints identified.
2. Existing and future without-project conditions are identified, analyzed, and forecasted. The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.
3. The study team formulates alternative plans that address the planning objectives. An initial set of alternatives is developed and is evaluated at a preliminary level of detail.
4. Alternative project plans are evaluated for effectiveness, efficiency, completeness, and acceptability.
5. Alternative plans are compared. Cost-effectiveness and incremental cost analysis is used to prioritize and rank ecosystem restoration alternatives. A public involvement program obtains public input for the alternative identification and evaluation process.
6. The plan with the greatest net benefits is selected for recommendation if at least one plan demonstrating federal interest exists.

2.3.2 DEVELOPMENT OF ALTERNATIVE PLANS

The alternative formulation begins initially by developing measures based on public input and suggestions, Corps and other federal and state agencies experiences with similar restoration opportunities, technical considerations based upon the characteristics of the area, and flood damage reduction considerations for improving or maintaining the existing level of protection. Preliminary management measures addressed such categories as ecosystem restoration, channel stabilization, public education, and recreation.

The study team combined these measures to form the first array of twenty preliminary alternative plans. Table 2.3-1 lists the preliminary alternatives considered for implementing ecosystem restoration. Development of those alternatives assumes that restoration is dependent both on water supply and control of invasive species. Also, implementation of the City of Phoenix recreation plan is assumed for all but the No-Action alternative.

These preliminary alternatives were evaluated using three screening criteria: completeness – the extent to which a given alternative provides and accounts for all necessary investments or other actions to ensure realization of the planned effects; effectiveness – the extent to which an alternative alleviates the specified problem and achieves the specified opportunities, and;

induction of flood damages – alternatives that install significant vegetation to the floodplain but neither include channel restoration nor restrict the location of that vegetation could raise water surface elevations and should be avoided. Alternatives that did not meet the three criteria were dropped from further evaluation. These alternatives are shown in the table below with grey shading.

Table 2.3-1. Preliminary Screening of Possible Alternatives

#	Description	Complete	Effective	Flooding
1	No Action	-	0	Y
7	Water Supply	-	0	Y
8	Water Supply, Invasive Control	-	0	Y
2	Invasive Control	-	0	N
3	Channel Restoration	-	1	N
4	Channel Restoration, Invasive Control	-	1	N
9	Water Supply, Channel Restoration	-	1	N
10	Water Supply, Channel Restoration, Invasive Control	-	1	N
11	Water Supply, Channel Restoration, Emergent, Invasive Control	-	1	N
12	Water Supply, Channel Restoration, Mesquite	+	2	N
13	Water Supply, Channel Restoration, Mesquite, Emergent, Invasive	+	2	N
14	Water Supply, Cottonwood, Channel Restoration, Invasive	+	2	N
15	Water Supply, Cottonwood, Channel Restoration, Emergent, Invasive	+	2	N
5	Storm Water	+	3	N
6	Storm Water, Channel Restoration	+	3	N
16	Water Supply, Cottonwood, Channel Restoration, Mesquite, Invasive	+	3	N
17	Water Supply, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive	+	3	N
18	Water Supply, Storm Water, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive	+	3	N
19	Water Supply, Lake, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive	+	3	N
20	Water Supply, Lake, Storm Water, Cottonwood, Channel Restoration, Mesquite, Emergent, Invasive	+	3	N

Note: Effectiveness: Numbers designate number of habitat cover types that would be restored by that alternative. For example the number 2 indicates that 2 habitat types would be restored.
+ or – indicate if that alternative meets the subject criteria as described.

Applying the three screening criteria to the preliminary alternatives reduced the number of alternatives from 20 to 12. In order to obtain a smaller number of alternatives that were more easily comparable and that more precisely met the project objectives, the study team screened the second array of alternatives with more specific criteria. The four criteria eliminated alternatives that did not include: creating cottonwood/willow habitat, harvesting water from stormwater outfalls for restoration, restoring the channel, and maintaining an open water body to provide potential urban fishery. The results are shown in Table 2.3-2, below. Again, alternatives that did not meet the criteria and were dropped from further evaluation are shown in grey.

Table 2.3-2. Second Array of 12 Alternatives

#	Preliminary Alternatives	Reason Dropped
1	No-Action	
2	Stormwater	No channel restoration included.
3	Stormwater, Channel	
4	Water Supply, Channel, Mesquite	Does not include cottonwood/willow
5	Water Supply, Channel, Mesquite, Emergent, Invasive	Does not include cottonwood/willow
6	Water Supply, Cottonwood, Channel, Invasive	Does not include stormwater
7	Water Supply, Cottonwood, Channel, Emergent, Invasive	Does not include stormwater, similar to alternative 8
8	Water Supply, Cottonwood, Channel, Mesquite, Invasive, added Stormwater	
9	Water Supply, Cottonwood, Channel, Mesquite, Emergent, Invasive	Does not include stormwater, similar to alternative 10
10	Water Supply, Stormwater, Cottonwood, Channel, Mesquite, Emergent, Invasive	
11	Water Supply, Lake, Cottonwood, Channel, Mesquite, Emergent, Invasive	Does not include stormwater, with inclusion of it same as alternative 12.
12	Water Supply, Lake, Stormwater, Cottonwood, Channel, Mesquite, Emergent, Invasive	

Applying these four criteria produced an array of four alternatives, plus the No-Action alternative. Upon further evaluation, alternatives eight and ten (from the table above) were too similar to one another to be evaluated separately and, thus, were combined into the final array Alternative 4. Alternative 12, above (Alternative 5 in the final array), includes restoring both sand/gravel pits into open water lakes. The study team realized that this alternative could be broken down into different levels of sand/gravel pit restoration. One level would restore the two pits into riparian complexes instead of lakes (Alternative 5A) and the other alternative would restore one pit to an open water lake and one to a riparian complex (Alternative 5B). Thus, the five alternatives, plus the No-Action alternative, originated.

2.4 DESCRIPTION OF THE PROJECT ALTERNATIVES

This section begins by discussing the measures that are common to multiple alternatives. The five action alternatives are then discussed in detail including the acres of each habitat type that would be restored by each.

2.4.1 MEASURES COMBINED TO FORM CONSTRUCTION ALTERNATIVES

The following measures were used in various combinations for the five construction alternatives (Alternatives 2, 4, 5, 5A and 5B, see Table 2.5-1).

2.4.1.1 Provide Water Supply

Project water is a constraint and a limiting factor across all alternatives. The project area can be split into two reaches based on water supply: (1) 19th to 51st Avenues where effluent and stormwater are primary sources and (2) 51st to 83rd Avenues where groundwater is more likely to be shallow enough to support vegetation after it is established. Water supply and distribution has been evaluated and planned by the City of Phoenix and is described in more detail within Appendix J, *Design and Cost Estimate*, of the feasibility report.

Effluent: Effluent from the 23rd Avenue wastewater treatment plant (WWTP) is the primary source of water available for the restoration project. The City of Phoenix estimates that approximately 8 mgd (8,964 ac-ft) is available to the project. Use of this water would require construction of a means to deliver effluent to the project from the 23rd Avenue Wastewater Treatment Plant (WWTP).

Stormwater: Stormwater outfalls within the project area have been identified and possible discharges from them quantified. This includes eight different outfalls from which an estimated average of 2,863 ac-ft was estimated to discharge based upon a 7-inch annual rainfall. Additional future outfalls may be implemented by the county at 51st Avenue (south) and 75th Avenue (north). While not a reliable, constant source of project water, there are opportunities for future use of this water with proper design at the outfall locations. Various types of habitat are currently being supported by stormwater runoff. Design of a restoration plan would include site-specific measures maximizing use of that runoff. Table 2.4-1, below, provides a summary of the eight stormwater outfalls potential for restoration.

Table 2.4-1. Summary of Stormwater Outfalls with Recommended Restoration Potential

Location	Restoration
19th Avenue NW	Mesquite Bosque/Palo Verde
19th Avenue SW	Wetland and Riparian Corridor
27th Avenue SE	Wetlands and Riparian
35th Avenue NW	Cottonwood/willow
43rd Avenue N	Wetland/Cottonwood-Willow
43rd Avenue S	Wetland
51st Avenue NW	Wetland/Mesquite
67th Avenue	Wetland/Cottonwood-Willow

Groundwater: Depth to groundwater through the project area varies from an average of 20 to 60 feet. In general, the depth to groundwater decreases to the west end of the study area where dewatering is required at 91st Avenue. In an analysis of Arizon Department of Water Resources well data and interpolation of surface water in gravel pits, there appears to be a zone of shallow (20-feet deep) groundwater between 51st and 19th Avenues in the river channel. This is likely due to excavation and is known to fluctuate as much as 20 feet annually (Rinker Materials Observation). Groundwater is being pumped in the vicinity of 23rd Avenue for sand and gravel mining where it contributes to the large lake near 27th Avenue. It was also assumed that the lake in the vicinity of 37th Avenue was excavated to groundwater depth; however, observations in 2004 appear to indicate that the level has dropped significantly and that the elevations in the lake appear to be influenced more by effluent discharge.

Supply Well: A supplemental well providing up to 1.85 mgd from the Upper Alluvial Unit is part of the proposed system. This would provide redundancy in the event that there is a prolonged outage and effluent becomes unavailable for a period of time.

2.4.1.2 Provide Water Distribution

A water distribution system is needed to deliver water from the sources described above through the study area to locations where native vegetation is being reestablished.

Flood Irrigation: Flood irrigation may be accomplished through a series of canals or channels delivering water to revegetation sites. Distribution within the revegetation sites may be through a braided network of channels. Effluent and pumped groundwater may be utilized for flood irrigation.

Drip Irrigation: This would be a temporary drip irrigation system consisting of small diameter pipes and drip emitters. Pumping would be required as a portion of this system. Drip irrigation works best with groundwater. Effluent water tends to clog the system and requires high maintenance.

Stormwater Harvesting: This measure is similar to creating a perched aquifer by providing water to a location with a below-grade low permeable layer. Although this could be accomplished with any water source and proper site-specific soil conditions, it appears that at several of the stormwater outfalls, similar conditions already exist. At constructed wetlands or ponds, a design option may include features that allow or encourage subsurface recharge to percolate down gradient and provide moist conditions, thereby irrigating adjacent vegetation.

2.4.1.3 Revegetation

2.4.1.3.1 Cottonwood/Willow

Due to groundwater depth, cottonwood/willow habitat could only be restored in proximity to existing or future surface water. This habitat would require a constant water source for the life of the project unless it can be verified that groundwater would be available within six to seven feet of the surface, in which case surface water would only be required for the first five years. Cottonwood/willow habitat would also require richer soils than some other habitat types. Generally, cottonwoods occur at a greater distance from surface water than willows. Willows require more moisture at the surface for optimal growth. Cottonwood/willow would be dominated by Fremont's cottonwood (*Populus fremontii*) and Gooding's willow (*Salix gooddingii*). Other understory species would be planted, depending upon individual site conditions, but could include *Baccarus spp*, arrowweed (*Pluchea sericea*), elderberry (*Sambucus mexicana*), burrobush (*Hymenoclea spp.*), and possibly ash. Two planting options are being considered for establishment of cottonwood/willow. It is assumed that a combination of techniques would be utilized with specific planting techniques to be determined during project design.

Plant Poles: Plant poles are dormant pole cuttings harvested from living woody plants and planted vertically into the substrate. Poles need to be three to 4.5 inches in diameter and at least six to eight feet long. Unless planted in saturated soils or near stable groundwater, temporary irrigation would be required. Pole plantings of cottonwood and willow have shown high rates of success with this technique. Plant materials should be available nearby, and may even be obtained from the other Salt River projects.

Plant Containers: Nursery grown potted containers would be planted on site. One gallon containers have shown the greatest success rates (80+ percent) at Lower Las Vegas Wash, Nevada. They are also the least expensive container plants available. Plantings would require a source of irrigation, at least temporarily.

2.4.1.3.2 Mesquite

This habitat would potentially be restored over a large portion of the project area. It would require periodic watering for the first five years after planting, although with less frequency than cottonwood/willow. Watering could possibly be discontinued after five years or when roots are expected to reach groundwater. Mesquite bosques would be dominated by velvet mesquite (*Prosopis velutina*), with scattered honey mesquite (*Prosopsis glandulosa Torr.*), and some understory shrubs, such as desert thorn (*Lycium spp.*), palo verde (*Cercidium floridum*), brittlebush (*Encelia farinose*), and *forbs*.

Bosque: Mesquite bosques are commonly found five to 20 feet above the river channel where water is adequate. They require a water table, or semi-saturated soil conditions ten to 30 feet below the surface elevation and rely on occasional saturated conditions one to three feet below the surface. Soil requirements range from fine to gravelly, with some

rocky areas. The mesquite bosques would be planted with a density of approximately 100 velvet mesquite, ten honey mesquite, and 40 understory shrubs per acre. Understory forbes would also be planted using a seed mix.

Xeric: In locations throughout the study with less water available, xeric stands of mesquite would be established. It is assumed that mesquite would survive under drier conditions and on higher terraces than mesquite bosque. Planting densities would be lower, with approximately 25 velvet mesquite, five honey mesquite, and ten understory shrubs per acre.

2.4.1.3.3 Riparian Scrub Shrub

The project implementation area already contains a substantial acreage of scrub shrub habitat. Although portions of this cover type would be converted to the other riparian habitats, other areas would be maintained as scrub shrub. This cover type provides a connection between other habitat types, and contributes to the important mosaic of vegetative cover types that maximizes structural habitat complexity. It is assumed that some portions maintained would remain a more xeric desert scrub, but others adjacent to the wetter riparian habitats would develop into more distinctive riparian cover containing species such as Seepwillow, desert broom, or Desert willow. Estimated acreages for both scrub shrub and riparian scrub are included in the acreages provided in Table 3.4-1. It is estimated that if the active river channel is approximately 500 acres, between 25 and 60 percent would be occupied by riparian scrub in the with-project conditions, depending on water supply.

2.4.1.3.4 Wetlands

Wetlands can consist of open water, submerged vegetation, or mud flats, all requiring a high water table at or near the surface. Due to the porous soils found in the project area, an impervious lining would be required to maintain surface water. Excavation and layering of a silt-clay soil substrate overlain by a mixed gravel, and finally, cobble layer, is recommended. This soil structure would reduce disturbance of the soil-clay layer by reducing piping of fine material and reducing turbulent forces acting on the layer.

Stormwater Wetland: Stormwater wetland restoration would take place at individual stormwater outfalls. Techniques would be site-specific and would include grading or excavation, removal of exotics, and planting of suitable vegetation for the site conditions. Supplemental water would be required via an irrigation source, and structures would be installed to contain high-energy inputs and avoid erosion during storm events.

Emergent Wetland: Emergent wetlands contain primarily cattails (*Typha domingensis*), tule (*Scirpus acutus*), and sedges (*Carex spp.*). Because the river would not flow year round, the wetlands would need to be constructed specifically to retain water. In addition to grading and excavation, an impermeable layer would be added to retain water on site.

2.4.1.3.5 Lake Restoration

There are existing features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. These modifications are recommended to better utilize the existing water and improve the functionality of these features. The existing banks would need to be reshaped for public safety and restoration. Potential substrate modification may be required to reduce the annual fluctuation in the lake levels. In addition, aeration would need to be considered to retain water quality.

Grading: Banks would be reshaped to create "irregular random terraces" (variable in length, width and depth below the water surface) that would become submerged to different depths to provide more diversity in the littoral zone. The littoral zone is the nearshore area where sunlight penetrates all the way to the sediment and allows aquatic plants to grow. The irregularity and randomness of the terraces provides more opportunities for the establishment of submerged, floating, and emergent vegetation and a more diverse and natural shoreline habitat. The random terracing would provide different thermo strata for aquatic organisms, potentially improving mixing and maintaining a less stratified body of water, making it less susceptible to turnover (reducing oxygen levels). These terraces or shelves may be exposed periodically, functioning as emergent wetlands or mud flats during seasonal fluctuations in the lake level. The terraces, when exposed, provide an opportunity for voluntary native vegetation to become established. When these areas are again submerged, some of this vegetation would persist. Vegetation unable to survive the wetter conditions would contribute to the organic content of the benthic zone. The productivity of the benthic zone is largely dependent on the organic content of the sediment and amount of physical structure.

Substrate: It would be necessary to modify the substrate of existing bodies of water within the study area to implement restoration at the lakes. This may include the addition of impermeable materials to both maintain water elevations and grow vegetation. There are various alternatives for lake bottoms that improve the benthic zone productivity. There are tradeoffs in productivity, refuge availability, diversity, and food production associated with the various lake bottom characteristics. A sandy substrate contains relatively small amounts of organic matter for organisms and provides limited protection from predation. Higher plant growth is limited and sparse in sandy sediment; the sand is unstable and nutrient deficient. A rocky bottom has a high diversity of potential habitats offering protection (refuge) from predators, substrate for attached algae, and pockets of organic "ooze." A flat, mucky bottom offers abundant food for benthic organisms; however, there is less protection and the diversity of structural habitats may be reduced unless higher plants colonize the lake bottom.

2.4.1.3.6 Invasive Species Management

Invasive Species Removal/Control: It would be necessary to remove and manage invasive species such as salt cedar and *Arundo* with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. Salt cedar is currently found in stands throughout the study area. Arundo, though not yet a significant problem in

Arizona, is a problem in neighboring California. A stand of Arundo can be found on the south side of the river near a stormwater outfall at 43rd Avenue.

2.4.1.3.7 River Channel Restoration

Project implementation would restore approximately eight miles of river channel to a more natural state based on hydraulics and geomorphology. This work would be conducted along the entire length of the Salt River from 19th Avenue west to 83rd Avenue. The restoration would be accomplished by grading and terracing to help recreate an active channel through the entire reach. Average depth of grading is assumed to be five feet, with a width varying from 200 to 400 feet. The average width of the river channel, including adjacent river terrace, throughout the study area would be approximately 500 feet. The channel design passes a five-year event (~22,000 cfs) with occasional flooding on the terrace two to four feet in depth flowing at approximately 1-7 ft/s. Due to a drop in the channel downstream of the 35th Avenue Bridge, a grade control structure is recommended in that vicinity. At this time, erosion and scour do not appear to be a concern with project features or infrastructure. However, should it appear in future analysis that it is a concern, appropriate protection would be included. An estimated 660,000 cubic yards of material would be removed from the channel to implement this measure. Material removed would be native riverbed material, and would utilized on site for terracing and construction of other project components, such as lake restoration.

> **River Channel Habitats**: The river channel itself can include different habitat cover types depending on site specific conditions. These may include dry river bottom, emergent wetland, riparian scrub or desert scrub. The team assumed that after construction, a low flow channel similar to that in the Rio Salado Project area and the existing channel in the reach near 43rd Avenue, would become established. The total acreage of this low flow channel through the project reach was assumed to be 170 acres. It was projected that between 10-20% of that would become vegetated with emergent wetlands. The remainder of the channel would vegetate with either riparian scrub or desert scrub depending on conditions within this active channel.

2.4.1.3.8 Operation, Maintenance, Repair, Replacement and Rehabilitation

Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) activities would occur after the project is constructed in order to keep project features functioning as designed. These activities may include:

- maintenance and replacement of pumps, pipelines, and other water delivery and irrigation infrastructure features;
- vector control;
- environmental monitoring, and;
- periodic removal of sediment, surface reshaping, or replanting of project features damaged by flood events.

The types of OMRR&R activities necessary would generally be the same for each construction alternative, although the level of effort would be proportional to the amount of new habitat created and the extent of structural features built for that alternative. Alternative 2 would require the least amount of OMRR&R, while Alternatives 5, 5A and 5B would require the greatest amount of OMRR&R because they restore the largest amounts of acres.

Maintenance and Replacement of Water Distribution System and Irrigation Infrastructure

Preventive maintenance and routine repairs would be performed on an as-needed basis on pumps and pipelines, diversion structures, irrigation canals and ditches, and drip irrigation equipment (inspections would occur more frequently).

Vector Control

Depending upon the duration and frequency of surface water flow in wetland and riparian habitat areas, the implementation of vector control management activities may be required to protect public health. Management activities that may be implemented to reduce potential habitat and inhibit the development of mosquito larvae include:

- providing pulse flows/periodic flushes;
- removing vegetation to increase wind-driven circulation;
- scheduling irrigation to avoid creating shallow ponded areas;
- stocking mosquito fish in areas where a regular source of standing water is available;
- spraying larvicides such as *Bacillus thuringiensis israeliensis* and *Bacillus sphaericus* at a frequency of every two to four weeks during the mosquito season, and;
- applying a broad spectrum adulticide such as Malathion in the event of an imminent public health threat.

Environmental Monitoring

Monitoring of habitat and wildlife would occur periodically. This would include monitoring water quality and water supplies as well as vegetation monitoring and management. During the first five years following construction of the project, the Corps would share responsibility for monitoring water quality and the success of the restoration components with the project sponsors. In the succeeding years, monitoring would be accomplished by the non-federal sponsor (City of Phoenix). Appendix N of the Feasibility Report contains a Monitoring and Adaptive Management Plan prepared by the Corps for this project.

Sediment Removal

During high flows, substantial quantities of sediment may be deposited in channelized portions of the Salt River or in newly established habitat areas. To maintain the flow conveyance capacity of the river, channelized portions would need to be excavated and reshaped to restore

design specifications if conveyance is significantly affected. Sediment removal would occur on an as-needed basis (inspections would occur more frequently).

For features within the floodplain, regrading and excavation was assumed to be needed once every ten years. It was assumed that for the stormwater outfalls, 50 percent of the construction quantity would need to be regraded in this period. The restored wetlands at existing lakes (gravel pits) would require regrading and excavation once every 20 years of up to one foot of material over the wetlands. The active channel would require regrading up to once every 20 years for up to 50 percent of the estimated construction quantity, or 330,000 cubic yards.

2.4.2 NO-ACTION ALTERNATIVE (FUTURE WITHOUT PROJECT)

Under the No-Action Alternative, the Corps would take no action to restore the ecosystem and wildlife habitat within the study area. Opportunities for incidental flood damage reduction, noise reduction, water and air quality improvements, aesthetic resource benefits and passive recreation also would not be realized. Although it is possible that local agencies would implement limited improvements, restoration efforts would not occur on the scale of the proposed project. The existing and future without-project conditions are discussed later in this document. Acres of habitat associated with each action alternative are displayed in Table 2-3 below.

Table 2.4-2. Acres of habitat associated with each action alternative

Alternative	Channel[1]			Cottonwood/ Willow	Mesquite	Open Water	Scrub-Shrub[2]	Other Wetlands	TOTALS
	Low-Flow Channel	In-Channel Wetlands[3]	Riparian Scrub						
2. Stormwater and Channel	170	17	125	66	43	0	305	28	737
4. Stormwater, Channel, Water Supply, Cottowood, Mesquite, Invasive and Emergent	170	34	165	348	409	0	63	33	1188
5. Stormwater, Channel, Water Supply, Cottowood, Mesquite, Invasive and Emergent, Lake	170	34	296	375	417	40	92	76	1466
5A. Wetland/riparian restoration in lieu of permanent open water and lakes	170	34	296	375	417	0	52	156	1466
5B. Hybrid of 5 & 5A with one gravel pit restored to a lake and the other a wetland/ riparian complex	170	34	296	375	417	20	52	136	1466

[1] River channel consists of low flow, wetland or riparian scrub.
[2] Scrub shrub acres are dispersed among and between the other restored cover types within the floodplain.
[3] Alternative 2 assumes that 10% of the low-flow channel would consist of wetlands; the remaining alternatives assume that 20% of the low-flow channel would consist of wetlands.

2.4.3 ALTERNATIVE 2

This alternative includes the modification of existing stormwater outfall areas to improve retention and water spreading as well as increase the existing habitat currently supported by these outfalls. It also includes modification and/or restructuring of the primary conveyance channel to a more natural state by grading and terracing the river corridor from 19th to 83rd Avenues. No additional water source is included in this alternative other than temporary irrigation to establish vegetation.

Table 2-4.1 of Section 2.4.1.1 above lists the locations of each stormwater outfall and the amount of habitat acreage that could be supported by the water available at each site. The acreage of habitat that could be supported was based on utilizing one-half of the estimated water supply currently found at each site. It was assumed that when stormwater wetland is combined with cottonwood/willow riparian, the wetland would utilize one-third of the potential supply, with the cottonwood/willow utilizing the remainder.

The 170 acres of restored channel are based upon an active channel varying in width from 200-400 feet. A grade control structure is included in this measure due to an elevation drop in the vicinity of the 35th Avenue Bridge. It was assumed that approximately 10 percent of the channel would naturally regenerate emergent wetlands much like the upstream Rio Salado Phoenix reach low flow channel.

2.4.4 ALTERNATIVE 4

The major components of this alternative include stormwater, channel restoration, water supply, cottonwood, mesquite, invasive control, emergent wetlands.

Stormwater and Channel: This alternative includes the stormwater wetlands and channel restoration measures described in Alternative 2. It was assumed that with implementation of this alternative, however, that 20 percent of the channel would regenerate to emergent wetland vegetation due to additional water supply.

Water Supply: Effluent from the 23rd Avenue WWTP is the primary source of water available for the restoration project. The City of Phoenix estimates that approximately 8 mgd (8,964 ac-ft) is available to the project. This would require construction of a means to deliver effluent to the project from the 23rd Avenue WWTP. Distribution of water would be through a combination of flood and drip irrigation. The water supply plan is described in detail in Appendix J of the Feasibility Report.

Revegetation: This alternative would restore cottonwood/willow riparian stands adjacent to water sources and low terraces throughout the study area, mesquite would also be restored with this alternative. Total acreages of each cover type are shown in the Table 2.5-1 above.

Invasive Control: It would be necessary to remove and manage invasive species such as salt cedar and Arundo with project implementation. This would likely require physical removal and

ongoing maintenance through the life of the project. There is roughly 110 acres throughout the study area where invasive species are of concern.

2.4.5 ALTERNATIVE 5

The major components of this alternative include stormwater, channel restoration, water supply, cottonwood, mesquite, invasive control, emergent wetlands and lake.

Stormwater and Channel: This alternative includes the stormwater wetlands and channel restoration measures described in Alternative 2.

Water Supply: Effluent from the 23rd Avenue WWTP is the primary source of water available for the restoration project. The City of Phoenix estimates that approximately 8 mgd (8,964 ac-ft) is available to the project. This would require construction of a means to deliver effluent to the project from the 23rd Avenue plant. Distribution of water would be through a combination of flood and drip irrigation. The water supply plan is described in detail within Appendix J of the Feasibility Report.

Revegetation: This alternative would restore cottonwood/willow riparian stands adjacent to water sources and low terraces throughout the study area. Mesquite would also be restored with this alternative. Total acreages of each cover type are shown in the Table 2.5-1, above.

Invasive Control: It would be necessary to remove and manage invasive species such as salt cedar and *Arundo* with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. There is roughly 110 acres throughout the study area where invasive species are of concern.

Lake: There are existing features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. These modifications are recommended to better utilize the existing water and improve the functionality of these features. The existing banks would need to be reshaped for public safety and restoration. Potential substrate modification may be required to reduce the annual fluctuation in the lake levels. In addition, aeration would need to be considered to retain water quality.

Alternative 5 inclues approximatley 5.4 million cubic yards of regrading to implement the lake restoration measure. An additional 212,000 cubic yards are included for lining material to reduce infiltration and maintain open water.

2.4.6 ALTERNATIVE 5A (PREFERRED ALTERNATIVE)

The major components of this alternative include stormwater, channel restoration, water supply, cottonwood, mesquite, invasive control, emergent wetlands and lake.

Stormwater and Channel: This alternative includes the stormwater wetlands and channel restoration measures described in Alternative 2.

Water Supply: Effluent from the 23rd Avenue WWTP is the primary source of water available for the restoration project. The City of Phoenix estimates that approximately 8 mgd (8,964 ac-ft) is available to the project. This would require construction of a means to deliver effluent to the project from the 23rd Avenue Plant. Distribution of water would be through a combination of flood and drip irrigation. The water supply plan is described in detail within Appendix J of the Feasibility Report.

Revegetation: This alternative would restore cottonwood/willow riparian stands adjacent to water sources and low terraces throughout the study area, Mesquite would also be restored with this alternative. Total acreages of each cover type are shown in the table above.

Invasive Control: It would be necessary to remove and manage invasive species such as salt cedar and Arundo with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. There is roughly 110 acres throughout the study area where invasive species are of concern.

Lake: In lieu of lake restoration inluding permanent open water, this alternative includes regrading to existing gravel pits to restore them to the floodplain and installs emergent wetlands and riparian vegetation. Regrading of the gravel pits requires moving approximately 3.2 million cubic yards of material and installation of fine materials to support wetland/riparian vegetation.

2.4.7 ALTERNATIVE 5B

The major components of this alternative include stormwater, channel restoration, water supply, cottonwood, mesquite, invasive control, emergent wetlands and lake.

Stormwater and Channel: This alternative includes the stormwater wetlands and channel restoration measures described in Alternative 2.

Water Supply: Effluent from the 23rd Avenue WWTP is the primary source of water available for the restoration project. The City of Phoenix estimates that approximately 8 mgd (8,964 ac-ft) is available to the project. This would require construction of a means to deliver effluent to the project from the 23rd Avenue Plant. Distribution of water would be through a combination of flood and drip irrigation. The water supply plan is described in detail within Appendix J of the Feasibility Report.

Revegetation: This alternative would restore cottonwood/willow riparian stands adjacent to water sources and low terraces throughout the study area mesquite would also be restored with this alternative. Total acreages of each cover type are shown in the table above.

Invasive Control: It would be necessary to remove and manage invasive species such as salt cedar and Arundo with project implementation. This would likely require physical removal and ongoing maintenance through the life of the project. There is roughly 110 acres throughout the study area where invasive species are of concern.

Lake: With this alternative the lake restoration is a variation of alternatives 5 and 5A with one gravel pit converted to a lake and the other a wetland riparian complex.

2.4.8 WATER DEMAND

Available sources for the project include effluent and harvested stormwater. Approximately 8 mgd (8,961 ac-ft/yr) of effluent would be made available from the 23rd Avenue WWTP. Stormwater runoff within the project area was also calculated based upon average monthly rainfall in Phoenix, and approximately 2,900 ac-ft can be expected to run off into the project area from the approximately eight adjacent outfalls. Water demand for individual alternatives is summarized in the table below, with more detail included in Appendix B of the Feasibility Report, Water Budget Report and Interior Drainage Report.

Table 2.4-3. Water Demand for Alternative Plans

Alternative	Water Demand (ac-ft)	Water Demand (mgd)
Alternative 2	1,583	1.41
Alternative 4	4,701	4.20
Alternative 5	7,752	6.92
Alternative 5A	9,293	8.30
Alternative 5B	9,234	8.24

2.5 CHOOSING THE PREFERRED ALTERNATIVE

Cost-Effectiveness (CE) and Incremental Cost Analyses (ICAs) were performed on the above alternatives. CE identifies the least-costly solution for each level of output. The three criteria used for identifying non-cost-effective plans or combinations include (1) the same level of output could be produced by another plan at less cost, (2) a larger output level could be produced at the same cost, or (3) a larger output level could be produced at lower cost.

ICA compares the incremental costs for each additional unit of output. The first step in developing "best buy" plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No-Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify increases in cost relative to output.

2.5.1 HYDROGEOMORPHIC MODEL (HGM)

The HGM analysis provides quantitative estimates of projected habitat benefits over the period of analysis for the alternatives, and also provides a means of comparing the benefits of the different alternatives, including the No-Action alternative. HGM benefits are expressed as Functional Capacity Units (FCUs). Members of the HGM team develop Functional Capacity Indices, which are the indices within the ecosystem that can be quantified to present a range of how the ecosystem is functioning and how it would function with different alternatives. Indices include such functions as: floodwater detention, internal nutrient cycling, organic carbon export, removal and sequestration of elements and compounds, maintenance of characteristic plant communities, and wildlife habitat maintenance. These FCIs can then be multiplied by acreages to derive Functional Capacity Units, or the unit that provides a means of assessing the gains or losses in functional value for a single target year of interest. For all alternatives, a baseline condition of 583 FCUs is used. The FCUs are averaged over the period of analysis for the project (51 years for this study) to determine Average Annual FCUs (AAFCUs) for each alternative. This analysis includes the AAFCUs for each of the alternatives for purposes of comparison. The detailed HGM analysis is included as Appendix I of the Feasibility Report.

2.5.2 COST-EFFECTIVE ALTERNATIVES

An alternative is cost effective if it provides greater AAFCU output for the same or lesser cost than another alternative. Table 2.3-1 shows the cost effective alternatives.

Table 2.5-1. Cost-Effective Alternatives

Alternative	AAFCU	AA Cost*	AAC/AAFCU*
2	51	$2,443	$47.73
4	165	$8,022	$48.55
5A	267	$12,334	$46.15

*Dollar figures are in thousands.

2.5.3 INCREMENTALLY EFFECTIVE ALTERNATIVES

Incremental cost analysis goes beyond cost effective analysis to identify "Best Buy" plans. Best Buy plans are those that have the lowest incremental average annual cost (AAC) per incremental increase in output. For the alternatives included in this study, Alternative 5A has the greatest output and the lowest average annual cost per AAFCU. Therefore, it is the only Best Buy plan. The incremental costs of these alternatives are shown in Table 2.5-2.

Table 2.5-2. Incrementally Cost-Effective Alternatives

Alternative	AAFCU	AA Cost*	Cost/AAFCU*	Incremental Cost/Incremental AAFCU*
2	51	$2,433	$47.73	$47.71
4	165	$8,022	$48.55	$49.03
5A	267	$12,334	$46.15	$42.27

* Dollar figures are in thousands.

Based on the HGM and ICA analyses, Alternative 5A is NER plan. It has the highest environmental outputs, is cost-effective and has the lowest incremental cost/output.

2.6 RECREATION AND ENVIRONMENTAL EDUCATION

2.6.1 INTRODUCTION

The Rio Salado Oeste Project provides a unique opportunity to enhance natural resource-based recreation and environmental education. The restoration of the dry Salt River channel would bring a riparian open space feature to the rapidly expanding Laveen and Estrella Planning Areas. Rio Salado Oeste would provide a habitat and recreational connection to the desert riparian habitat corridor created by the Rio Salado and Tres Rios Projects. By connecting the eight mile gap between the two projects, Rio Salado Oeste would enhance the unique recreation and education opportunities for residents and out-of-town visitors.

Alternative formulation for the project focused on the ecosystem restoration itself. The associated recreation plan has been developed by the City of Phoenix. The recreation plan was added to the restoration plans after the ecosystem restoration alternatives were completed in compliance with Corps' policies on recreation development at ecosystem restoration projects. Recreation features are ancillary to the ecosystem restoration, do not degrade the restoration value but take advantage of the recreational and educational opportunities provided, and follow the checklist of cost shareable recreation features. The Corps and the City of Phoenix would cost-share the recreation plan as allowed by Corps' policies. The conceptual recreation plan is shown in Figure 2.6-1.

2.6.2 VISITATION ESTIMATES

Drawing on a population base of over two million in the Valley, it is estimated that visitation to the Rio Salado Oeste Project would exceed 350,000 annually (Table 2.6-1). Primary use times for this unique resource would coincide with the "visitor season" between October and May when temperatures are moderate.

Table 2.6-1. Rio Salado Oeste Recreation Plan Baseline Visitation Estimate

	Days	Turnover/Day	Visits
Winter (Oct-May)	243		
Prime Time	78	1.50	160,875
Non-Prime Time	165	.50	113,438
Winter Total			274,313
Summer (Jun -Sep)	122		
Prime Time	36	1.00	49,500
Non-Prime Time	86	0.25	29,563
Summer Total			79,063
Grand Total (by vehicle)			353,376
Add - Arrive by Alternative Mode (10%)			35,338
Total Visitation			388,714
Less Transfers (10%)			38,871
Baseline Visitation for Benefit Analysis (rounded)			350,000
Note: Based upon parking capacity for 500 spaces. Average of 2.75 Persons/Vehicle			

2.6.3 RECREATION PLAN FEATURES

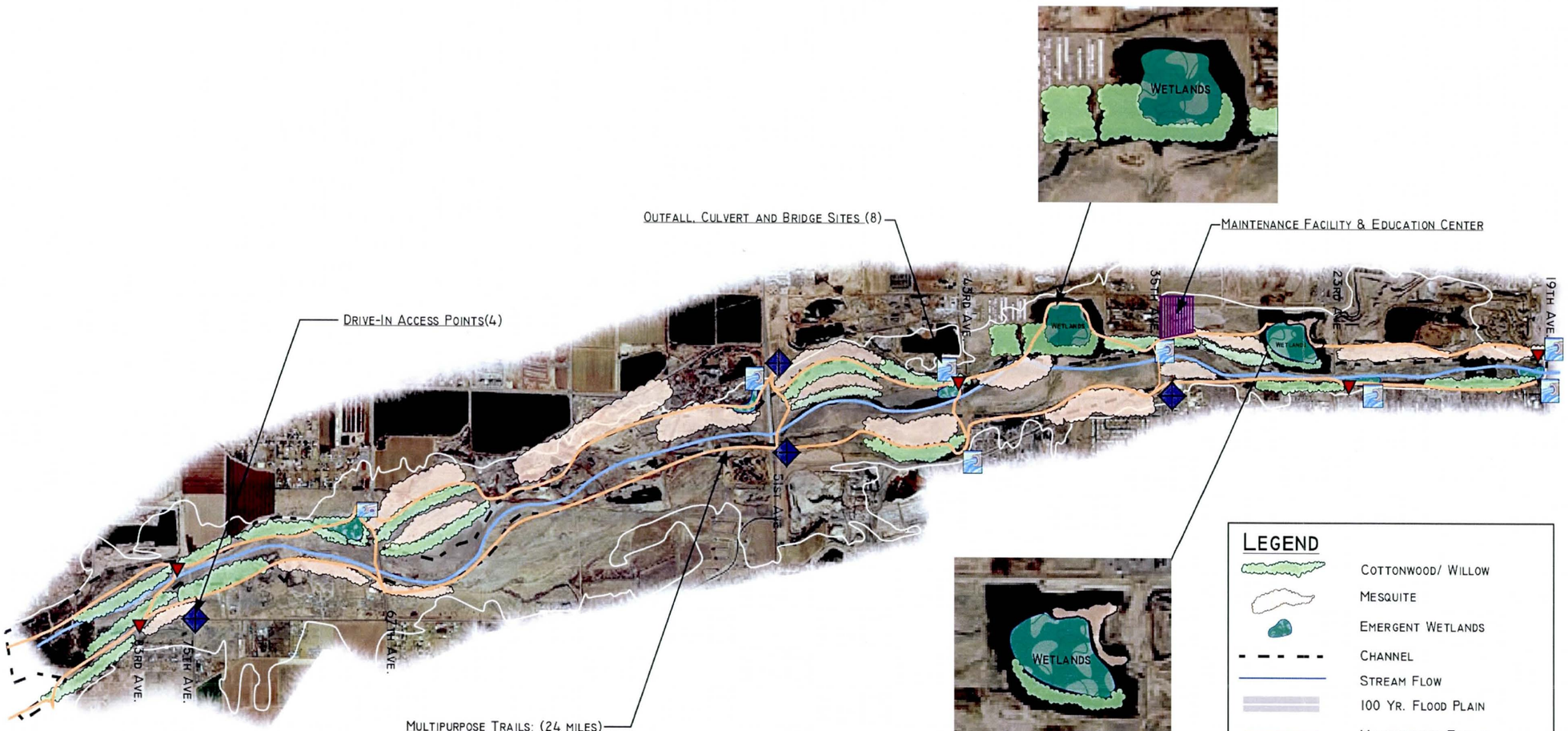
The City of Phoenix developed the recreation plan for the project, which may be found in Appendix L of the Feasibility Report. This recreation plan would be implemented for all five action alternatives. Major recreation features include multipurpose trails, shelters, signage, shelters, utilities, park furniture, and interpretive media. Access points are identified in the plan, with four drive-in points with parking facilities and five smaller access points for walk-in use. Additionally, nine minor points for walk-in access from adjacent neighborhoods would be completed. Table 2.6-2 below includes the recreation features.

Table 2.6-2. Rio Salado Oeste Recreation Plan Components

Component	Quantity
Access Point, Maintenance Facility and Edu. Center (35th Ave.)	**1**
Site Preparation	
Site Prep to include: clearing, grubbing, and grading	1
Vegetative Restoration	1
Access and Circulation	
Entry Road w/Turnaround to include: curb, gutter, driveway, &	1

Component	Quantity
road	
Parking Lot	250
Sidewalks and Ramps	2,500 sf.
Multi-Use Trails	555 sy.
Bridges and Culverts (small)	4
Protection Access Control	
Access Control Gates (vehicular)	2
Access Control Gates (pedestrian)	2
Handrails	500 l.f.
Guardrails	100 l.f.
Fencing	500 l.f.
Walls	150 l.f.
Security lights	18
Signage	
Entrance Identification Signage	2
Traffic Control (vehicular)	5
Traffic Control (pedestrian)	5
Instructional/Directional	10
Shelters	
Picnic (large)	1
Picnic (small)	2
Restroom Facility/Comfort Station	1
Shelter w/Bulletin Boards	1
Trail Shelter w/Railing (large)	1
Trail Shelter w/Railing (medium)	1
Trail Shelter w/Railing (small)	2
Utilities	
Municipal Water Supply and Wastewater Disposal	1
Storm Drainage	1
Drinking Fountain w/Chiller	2
Electrical	1
Park Furniture	
Benches:	2
Off-the-Shelf	5
Recycled/Custom	8
Picnic Tables	5
Trash Receptacles	10
Interpretive Guidance Media	
Display Boards	16
Interpretive Markers	16
Bulletin Boards	2
(*) Environmental Education Center/ Visitor Center	1
Access Points- 4 drive in (35th, 51st N&S, 75th) and 5 walk in (19th, 23rd, 43rd, 75th, 83rd) Minor Access points in 9 locations.	
Site Preparation	
Site Prep to include: clearing, grubbing, and grading	9
Vegetative Restoration (drive-in access)	4

Component	Quantity
Vegetative Restoration (walk-in access)	5
Access and Circulation	
Entry Road w/Turnaround to include: curb, gutter, driveway, & road	4
Parking Lot	250
Sidewalks and Ramps	40,000 sf.
Multi-Use Trails (24mi * 5280 * 5ft)	70,400 sy
Bridges and Culverts (small) @ Canals, and Localized Drainage Areas	10
Minor Access points (2 benches, gate, sign)	9
Protection Access Control	
Access Control Gates (vehicular)	8
Access Control Gates (pedestrian)	18
Handrails	5,000 l.f.
Guardrails	3,000 l.f.
Fencing	50,00 l.f.
Walls	1,500 l.f.
Security lights	100
Signage	
Entrance identification signage	8
Traffic Control (vehicular)	20
Traffic Control (pedestrian)	27
Instructional/Directional	45
Shelters	
Picnic (large)	4
Picnic (small)	5
Restroom Facility/Comfort Station	4
Shelter w/Bulletin Boards	4
Trail Shelter w/Railing (large)	9
Trail Shelter w/Railing (medium)	4
Trail Shelter w/Railing (small)	10
Utilities	
Municipal Water Supply and Wastewater Disposal	4
Storm Drainage	4
Drinking Fountain w/Chiller	12
Electical	4
Park Furniture	
Benches:	14
Off-the-Shelf	40
Recycled/Custom	50
Picnic Tables	40
Trash Receptacles	75
Interpretive Guidance Media	
Display Boards	50
Interpretive Markers	100
Bulletin Boards	9



RIO SALADO OESTE ECOSYSTEM RESTORATION CONCEPTUAL PLAN
RECREATION PLAN

U.S. ARMY CORPS OF ENGINEERS PARTNERING WITH THE CITY OF PHOENIX, ARIZONA

NOTES:

Figure 2.6-1

DRAWN BY: PJC 6/20/05

CHAPTER 3
AFFECTED ENVIRONMENT

The Rio Salado Oeste study area consists of an eight mile reach of the Salt River and adjacent lands in and near southwestern Phoenix, Maricopa County, Arizona. More specifically, the study area consists of the Salt River corridor from 19th Avenue downstream (west) to 83rd Avenue, between Lower Buckeye Road and Baseline Road. This study area is three miles wide and encompasses approximately 23.5 square miles. The much smaller project implementation area consists of the 100-year floodplain of the Salt River within the overall study area (Figure 1.6-2). The project implementation area averages two-thirds of a mile in width, and consists of approximately 3,315 acres.

The regulations at 40 CFR 1502.15 require that an environmental impact statement (EIS) by prepared to describe the environment of the area to be affected by the alternative actions being considered. The area affected by the proposed action is defined as the Salt River between 19th Avenue and 83rd Avenue (Rio Salado Oeste reach). This chapter provides a description of the existing and future without-project conditions for a 50-year period of analysis within the study area. The future without-project conditions serve as the baseline for determining the nature and magnitude of environmental impacts of the proposed action and alternatives (refer to the Feasibility Report for information on the period of analysis).

A variety of resources exist in the study area that may or may not be significantly impacted by the proposed restoration project. This chapter describes the baseline environmental conditions for 13 resources categories:

- Topography and Geology
- Hydrology and Water Resources
- Water Quality
- Biological Resources
- Cultural Resources
- Aesthetic Resources
- Air Quality
- Noise
- Social and Economic Resources
- Transportation
- Land Use
- Recreation
- Public Health and Safety

The scope of the descriptions provided to characterize each resource is guided by the scope of the proposed action as it relates to a particular resource category, which generally defines a region of influence for each resource category. The region of influence consists of the

geographic area in which the proposed action is expected to have a direct or indirect effect on the resource.

3.1 GEOLOGY AND TOPOGRAPHY

This section describes the topography and geographic conditions of the Rio Salado Oeste study area. This section is based on the geotechnical analysis in the *Rio Salado, Salt River, Arizona: Feasibility Report and Environmental Impact Statement* (U.S. Army Corps of Engineers, 1998).

3.1.1 REGIONAL GEOLOGY AND TOPOGRAPHY

The study area is located in the eastern portion of Maricopa County. It is located just north of the southern City Limits of Phoenix, and north of South Mountain. The terrain varies from hills and rock outcrops, south of the study area, to alluvium within the river floodplain. Slope angles in the study area range from 0–2% (Maricopa County, 1992). The project area is in the Phoenix basin of the Salt River Valley. The Phoenix metropolitan area is geomorphically located within the Gila Lowland Section of the Sonoran Desert Subprovince, a part of the Southern Basin and Range Physiographic Province. This province is characterized by broad, gently sloping, connected alluvial valleys (basins) bounded by moderately high, rugged, northwest- to southeast-trending mountain ranges. During the late Miocene epoch (Tertiary period), the mountain ranges were extensively dissected, uplifted, and downdropped by northwest- to southwest- and east- to west-trending sub-parallel normal faults. Extensive volcanic activity accompanied the faulting. From the late Miocene until the late Pliocene, the ranges deeply eroded and filled their downdropped areas (basins) with sediments, which were later consolidated into sedimentary rock. From the end of the Pliocene until recent (Holocene) time, the basins, including the Salt River Valley, filled with unconsolidated and occasional semiconsolidated sediment eroded from the ranges. The thickest accumulations of valley alluvium formed during the early to middle Quaternary period. Alluvium of the Salt River Valley is in the final stages of development, as evidenced by the numerous low-lying isolated hills (inselbergs) that project above the valley surfaces. These hills represent peaks of former mountain ranges that are now almost completely buried by alluvial material. The mountain ranges that border the project area consist mostly of Tertiary-age sedimentary and volcanic rocks that lie unconformable upon an ancient Precambrian igneous and metamorphic basement complex. The complex is composed predominantly of igneous granite and diorite, metamorphosed schist, gneiss and volcanic rock. These Tertiary rocks are made up of volcanic basalt, andesite, rhyolite, sedimentary sandstone, siltstone and conglomerate.

The Phoenix basin consists of Quaternary sediments that constitute the valley fill. These consist mostly of poorly- to well-consolidated (cemented) and unconsolidated gravel, sand, silt and clay, representing several environments and ages of deposition. Total thickness of alluvial materials ranges from nearly nothing along the mountain fronts, to nearly 10,000 feet under the valley interior. Valley fill materials tend to be of a coarser consistency near the mountain fronts and finer in the interior of the valley. Near the Salt River, valley fills have been eroded as the river formed terraces during its evolution.

3.1.2 LOCAL GEOLOGY AND TOPOGRAPHY

The Rio Salado Oeste study area extends east and west along the Salt River. The river flows west into the Phoenix basin from the Superstition and Goldfield mountain ranges. The Salt River floodplain is located within the gentle, flat slopes of the basin. The predominant surface materials within the study area consist of Quaternary-age river sediments, deposited as alluvium, and terraces, to a lesser extent, sheetwash-deposited alluvium and slope-deposited colluvium. Thick layers of alluvium and terrace have accumulated within the major streams, tributaries and floodplains of the Salt River. Streambed alluvium and terraces are flanked, covered and underlain by thinner layers of wind- and sheetwash-deposited alluvium and bedrock colluvium.

Quaternary sediments consist of:

1) Salt River Valley alluvium and terraces — unconsolidated to well-cemented gravel and boulders interbedded with irregular silt, sand and gravel lenses; and

2) Colluvium — loose- to well-cemented silt, sand, clay and gravel.

Salt River Valley terrace deposits lie exposed above the Salt River channel in locations throughout the project area. The terraces consist of thick, well-cemented to non-cemented sand and gravel and are considered older than the alluvium within the confines of the Salt River. Contacts between the two types of deposits are gradational at depth, which means they are undifferentiated and both remain of Quaternary age. The terrace and alluvial deposits overlie thick Tertiary sedimentary and volcanic rocks beneath the basin. They interface with Tertiary rocks along mountain ranges and inselbergs. The very thick Precambrian basement complex underlies basin terrace and alluvium at maximum depths greater than 3,300 feet.

3.1.3 SOILS

Two major soil associations are found within the study area. Within, and immediately adjacent to, the river is the Carrizo-Brios Association, with the Gilman-Estrella-Avondale Association to the south. The Carrizo-Brios Association is characterized by deep, excessively drained soils and nearly level to gently sloping, gravelly sandy loams and sandy loams in stream channels on low-stream terraces. The Gilman-Estrella-Avondale Association is characterized by deep, well-drained soils and nearly level loams and clay loams on valley plains and low stream terraces (Maricopa County, 1992).

3.1.4 RIVER TOPOGRAPHY

The Salt River is characterized by scour-and-fill events, floods and channel shifts. The river was once characterized by meandering flows throughout the river system. Recent urban development in the region has changed the Salt River from a meandering channel to a straight channel with high banks in several reaches. In the central portion of the study area is a large groundwater retention/recharge basin.

The Salt River channel has shifted within the floodplain several times from the 1880s to the present, at times meandering on the north side of the floodplain and on the south side during other times. Channel shifts have distributed alluvial material across the entire width of the floodplain. Alluvium deposited by the river consists of cobbles, sands, silts and clays from numerous tributary streams within the watershed.

Scour-and-fill events over time have degraded the river in some areas and improved it in others. The scour-and-fill transportation of sediment has produced numerous thick deposits within the fluvial system: cobble lag surfaces, sand sheets (macro-forms), channel side bars, mid-channel bars, point bars and overbank deposits. Many of these deposits have recently been disturbed by intensive sand and gravel mining. Mining activity alters later transportation events by removing and compacting material, thereby reducing the amount of sediment transported and loosening other sediments. Sand pits serve as depositional traps for fine sediments.

Sediment transported, in a scour-and-fill setting, will tend to move in waves or pulses, rather than at a constant rate over time. Large amounts of sediment are periodically moved downstream during flow events. Flood flows are probably the most important events in the transportation of sediment and have the highest potential to move material. During a flood, the bulk of the sediment is moved as bedload; however, there is also movement of sediment as washload in solution and suspension. Prior to the damming of the Salt River, smaller flow events moved sediment (fine sands, silts and clays) by incising downward into the larger slugs of sediment found in the channel. The amount of sediment moved in lesser events is small when compared with the amount of material moved during a flood.

3.1.5 GRADIENT

The general gradient of Salt River, between Granite Reef Dam and the confluence with Gila River, is about 0.0021 feet of vertical drop per 1,000 feet of horizontal distance, although there are numerous local variations. The gradient has decreased to a small degree because of erosion in the upper reaches and deposition in the lower reaches.

3.1.6 FAULTING AND SEISMICITY

Faults in central Arizona are generally short, discontinuous, normal faults, some of which have been interpreted to displace Quaternary formations. Most fall within the Jerome-Wasatch Structural Zone, an approximately 47-mile-wide band that extends from Utah into Mexico. In Utah, the zone is associated with current earthquake activity and displays evidence of abundant Quaternary faulting. In Arizona, the zone includes Main Street Fault, in the northwest corner of the state, and Verde Fault, approximately 56 miles north of the Rio Salado Oeste study area. Both faults are considered to be potentially active. The proposed project is located in Zone 1 of the Seismic Zone Map of the Contiguous States, an area of low seismicity. Approximately 30 earthquakes, with maximum epicentral intensities between II and VI on the Modified Mercalli Intensity Scale (MM), have occurred within this seismic zone from 1870 through 1980. The seismic historical record for the last 124 years indicates that only one major damaging earthquake in the region has occurred. This 1887 earthquake was centered in Sonora, Mexico, which is outside Seismic Zone 1. The 7.2-MM Sonora earthquake was located more than 255

miles from Tempe, Arizona and expressed 31 miles of surface rupture with approximately ten feet of normal displacement, causing rockfalls in the project study area. In 1974, events were located northeast of the study area, with recorded Richter Scale magnitudes of 2.5 to 3.0. A 2.1 was recorded in North Central Arizona, approximately 13 miles southwest of Kaibab on 9 August 2005, well outside the area of detection for Rio Salado Oeste.

3.1.7 SUBSIDENCE

Available information suggests that subsidence in the project area has not occurred. Ground failure in the form of (pumping) subsidence and earth fissures has occurred in other areas of the Phoenix Basin. The closest ground failure occurrences are near Luke Air Force Base, west of the study area, where one to three feet of subsidence has been measured and exhibits the shape of a two-mile-diameter "bowl" depression. Earth fissures and subsidence are both produced by groundwater withdrawal, whereby ground (soil) compresses (subsides) because it has lost the support of water within its pores. Earth fissures develop when the soil subsides differentially and pulls apart. The Phoenix area will continue to be affected by subsidence because of groundwater overdraft, principally where groundwater withdrawal is most severe.

3.1.8 REGULATORY SETTING

Topography and geological resources and issues related to geotechnical hazards are primarily under local jurisdiction. Local grading plans and ordinances contain policies for the protection of geologic features and avoidance of geologic hazards. Many local jurisdictions adopt the Uniform Building Code or adopt local building codes to ensure structures meet minimum safety standards. Building codes in each jurisdiction establish standards for construction depending on soil conditions, slopes and potential for ground movement and faulting.

3.2 HYDROLOGY AND WATER RESOURCES

The following discussion characterizes the hydrology and water quality conditions of Rio Salado Oeste. The information presented below is based primarily on the following reports:

- Rio Salado, Salt River, Arizona - Draft Feasibility Report and Draft Environmental Impact Statement (U.S. Army Corps of Engineers, 1997), and;

- Tres Rios Feasibility Study, Salt River, Arizona (U.S. Army Corps of Engineers, 2000)

A number of reference materials cited in the text below were used to characterize the relevant hydrologic and water quality conditions in the study area. Hydrologic investigations and water quality studies have been conducted for the feasibility study and are included in the main Feasibility Report.

3.2.1 REGIONAL HYDROLOGY AND SURFACE WATER RESOURCES

3.2.1.1 Background

The Salt River drains 14,500 square miles of mountainous desert terrain in central and eastern Arizona and is the largest tributary to Gila River. The river rises in the White Mountains of eastern Arizona and flows generally westward to its junction with the Verde River, a northern tributary that drains the edge of the Colorado Plateau near Flagstaff, Arizona. From this junction near the City of Mesa, the Salt River flows westward across the broad Salt River Valley to its confluence with the Gila River, about 14 miles west of Phoenix Sky Harbor Airport. The Phoenix metropolitan area is near the center of the Gila River Basin and lies within the Lower Salt River valley. After its junction with Salt River, the Gila River continues westward and joins the Colorado River near Yuma, Arizona. Annual average rainfall in the lower Salt River Valley is approximately eight inches (Table 3.7-1). Precipitation (rain and melted snow) at the highest elevations of the watershed ranges up to 14 inches annually (U.S. Geological Survey, 1991). Rainfall is less than the evapotranspiration rate in all months of the year. Precipitation is derived primarily from two types of weather systems: summer thunderstorms and regional storms. Summer thunderstorms in July and August typically develop from the flow of subtropical air masses from the Gulf of Mexico and the tropical eastern North Pacific. Regional storms from the Pacific Ocean generate gentle, widespread showers during the late fall and winter. Summers are hot, with daily temperatures exceeding 100° F from mid-June through August. During the summer, mean daily temperatures range from 65° F to 104° F. The relative humidity is low, ranging from approximately 20% to 50%. Winters are mild, with mean daily temperatures ranging from 35° F to 70° F.

3.2.1.2 Dam System

During the 20th century, the Phoenix area changed from an agricultural region to an urban region, resulting in significant changes in the physical characteristics of the rivers in the area. Agricultural and urban activities have given rise to an intricate network of structures associated with river use for irrigation, drainage, erosion protection and flood damage reduction. Numerous upstream dams on the Salt and Gila Rivers have radically altered the natural hydrologic regime of the rivers (Table 3.2-1). The Salt River Project (SRP) operates seven dams and storage reservoirs within the Salt River watershed. Stored water is allocated for hydropower, municipal and industrial supply and agriculture. Modifications to Theodore Roosevelt Dam also include an allocation for flood damage reduction. The total space for water-supply storage behind these dams is approximately 1.9 million acre-feet (ac-ft), with an additional 560,000 ac-ft for flood damage reduction. The modified Theodore Roosevelt Dam is the largest facility and receives drainage from approximately 5,800 square miles. The Verde River is the principal tributary and watershed of the Salt River (6,700 square miles). Its flows are partially controlled by Horseshoe Dam (located furthest upstream) and Bartlett Dam (approximately 25 miles upstream of the confluence with Salt River), which provide an additional 310,000 ac-ft of storage. New Waddell Dam is located on Agua Fria River northwest of Phoenix and downstream of the study area.

Table 3.2-1. Major Dams and Reservoirs in the Gila River Basin

Dam	River	Reservoir	Date of Origin	Storage (acre-feet)
Waddell	Agua Fria	Lake Pleasant	1927	165,000[a]
Bartlett	Verde	Bartlett Lake	1939	182,000
Horseshoe	Verde	Horseshoe Lake	1949	141,000
Stewart Mountain	Salt	Saguaro Lake	1930	71,000
Mormon Flat	Salt	Canyon Lake	1938	59,000
Horse Mesa	Salt	Apache Lake	1927	248,000
Roosevelt	Salt	Roosevelt Lake	1911	1,600,000[b]
Coolidge	Gila	San Carlos Lake	1928	1,222,000
Painted Rock	Gila	Painted Rock Lake	1959	2,500,000

[a] Indicates original storage capacity before modifications that are presently underway to expand capacity.
[b] Black, pers. comm.
Source: Graf et al., 1994

The dams have significantly altered the natural hydrologic regime of the lower Salt River and have changed both the magnitude and timing of flows. The SRP releases water only for flood damage reduction purposes to lower reservoir levels, either prior to winter rains or when the reservoirs are unexpectedly full. The system of dams has eliminated perennial flow and steady, high winter flows. Since Bartlett Dam began operating on the Verde River in 1938, the lower Salt River has contained water only as a result of controlled or uncontrolled releases from the Granite Reef Diversion Dam. The Granite Reef Diversion Dam is located about three miles downstream of the Salt-Verde confluence, and is the most downstream SRP dam. The purpose of this facility is to divert upstream reservoir releases into the Arizona Canal (for the area north of Salt River), and the South Canal (for the area south of Salt River). The canals crisscross the Phoenix metropolitan area for water delivery to agricultural, municipal and industrial users. There are no releases during climatically drier years, as occurred between 1942 and 1964. Except for stormwater runoff, groundwater emergence and effluent, the Salt River is dry during those times.

Before 1938, an average of 413,000 ac-ft of water flowed through the channel annually (U.S. Army Corps of Engineers, 1997). The estimated pre-development, average annual watershed yield was about 1,250,000 ac-ft (U.S. Geological Survey, 1991). Since 1965, the channel has carried an average of only 293,000 ac-ft of water per year, with less than 10,000 ac-ft in almost three-fifths of the years (U.S. Army Corps of Engineers, 1997). Hydrologic modeling used to develop a water-control plan for the Modified Theodore Roosevelt Dam indicates that water would have spilled over Granite Reef Diversion Dam in only 34 of 105 years under the current configuration of dam operations (U.S. Army Corps of Engineers, 2000). The resulting frequency of spills is approximately once every three years. When water is spilled over the Granite Reef Diversion Dam, the flow is typically sustained for several days or more and of a significant

magnitude. Since 1965, there have been about two releases per year. These releases have lasted an average of 22.5 days, with a peak mean daily flow of 13,960 cubic feet per second (cfs). The median predicted spill pattern at Granite Reef Diversion Dam has a peak discharge of 28,000 cfs, a five-day average flow rate of 15,000 cfs, and a ten-day average flow rate of 10,000 cfs (U.S. Army Corps of Engineers, 2000).

Little data exist to document the pre-development, seasonal flow fluctuations in the Salt River. In the pre-settlement era, prior to 1900, the river was one of the few perennially watered riparian areas of the Sonoran Desert with highly productive cottonwood, willow and mesquite habitats. Analyses of pre-development conditions indicate that the Salt River streamflow infiltrated and recharged groundwater upstream from Indian Bend Wash near Scottsdale. Groundwater discharged to the channel provided perennial baseflow in downstream sections of the channel (U.S. Geological Survey, 1991). Under natural conditions, flows peaked in late winter (February and March), supplied by storms and snowmelt. Flows were lowest in June, averaging only 6% of the mean high flows in February. Data for 1965 through 1993 show flows occurring most frequently during March and April, and least frequently during July and August, much like the natural flow pattern. The system of dams upstream of the study area effectively delays the flows by one month. This delay becomes insignificant, however, in light of the length of periods without flow in a river that was perennial under natural conditions.

3.2.1.3 Flood Hazards

During periods of serious flood potential, large volumes of water are released from upstream dams and may cause flood damage in the Phoenix metropolitan area. Damaging floods with flows exceeding 100,000 cfs occurred in the lower Salt River in 1978, 1980, 1983 and 1993. These floods resulted in damages to residences and agricultural areas in and around the study area. Environmental managers have sought a clearer understanding of river forms and processes that are now partly natural but significantly modified. Figure 3.2-1 shows the limits of the 100-year floodplain within the study area. In general, the designated 100-year floodplain is narrowly confined within the limits of the channel banks, and ranges in width from several hundred feet to over one mile, depending on the location. Significant problems related to flooding within the study area include large flood flows that can:

- cause damage to agricultural and residential areas in and around the study area;
- destroy habitat through inundation and scouring effects, and;
- erode landfills, adding sediment, pollutants and debris to the study area.

The magnitudes of peak annual discharges on the Salt River are comparable to those of peak flows before Bartlett Dam began operating, but high flows have occurred less frequently since 1938 (Table 3.2-2). The mean peak annual discharge was 32,000 cfs before 1938, and has been 16,500 cfs from 1938 to the present (Jones & Stokes, 2000). This apparent reduction in flood magnitude results from the frequency of low-flow years. Since 1938, the peak discharge has been greater than 10,000 cfs in only one fourth of the years. Before 1938, flows exceeded 10,000 cfs in two thirds of the years. Upstream dams have exacerbated the high-flow conditions that have occurred by delaying the release of runoff into the river. Prior to damming, a peak annual discharge greater than 100,000 cfs occurred in only one year on record, while three such

flows have occurred in the past 16 years. Table 3.2-2, shows estimated flow values for variable frequency and duration flows within the Salt River channel near immediately upstream of the study area (U.S. Army Corps of Engineers, 1997). The peak 100-year flood flow is 166,000 cfs.

Table 3.2-2. Inundation-Duration Frequency Values for the Salt River

Duration	Frequency (Years)						
	500	200	100	50	20	10	5
Discharge (cfs) Exceeded for Specified Duration, Salt River at Central Avenue[1]							
Peak	240,000	202,000	166,000	135,000	87,000	53,000	20,200
1 Day	190,000	145,000	100,000	70,000	40,000	21,000	8000
3 Day	100,000	75,000	60,000	40,000	22,000	11,000	3500
5 Day	70,000	55,000	40,000	29,000	15,000	7000	2100
10 Day	46,000	33,000	25,000	18,000	10,000	5200	1500
30 Day	25,000	19,000	15,000	10,000	5300	2700	800
60 Day	14,000	9000	7000	5000	2800	1400	(0)[2]

[1] Discharges exceeded for specified frequencies, with durations greater than or equal to 1 day, are approximately equal throughout the Rio Salado Project reach. Central Avenue is used as a reference location.
[2] During the 5-year event, the upstream release from the Salt River Project reservoirs does not last for 60 days. A flow rate of approximately 200 cfs is exceeded for 53 days during this event. Results are based upon simulation of Balanced Hydrographs.
Source: U.S. Army Corps of Engineers, 1997

Although flooding is a natural and even vital process in natural riparian systems, it is of particular concern in downstream reaches of the Salt River because of the prevalence of salt cedar, an invasive nuisance species. Salt cedar is very effective at spreading into disturbed areas, and can generally establish itself more rapidly than native riparian species with one exception. If flooding occurs during spring when cottonwood and willow are dispersing seeds, native vegetation can out-compete salt cedar. An example of this occurred following the 1993 flood when additional vegetation established itself in the river downstream of Phoenix. The Flood Control District of Maricopa County (FCDMC) applied for a Clean Water Act Section 404 permit to resume channel clearing. The permit was denied because of habitat removal concerns expressed by the Arizona Game & Fish Department (AGFD).

3.2.1.4 Local Hydrologic Characteristics

The study area is located downstream of several other planned restoration projects, including the first phases of the Rio Salado Project located between upstream and downstream of the Tempe Town Lakes Project. The approximately 2-mile upstream section of the study area is surrounded by highly urbanized land-use areas. The lower five miles of the study area flow through a mix of residential and agricultural land-use areas with occasional commercial/industrial developments.

Numerous urban drainage channels are located in the study area. They discharge local stormwater runoff to the Salt River channel. Anecdotal information and hydrologic studies conducted for the initial phases of the Rio Salado Project (U.S. Army Corps of Engineers, 1997) indicate that local stormwater drainage is rarely sufficient to generate continuous flow within the Salt River. Modeling results for predicted 10-year frequency flood events in the much larger Indian Bend Wash basin (peak discharge of 9,000 cfs) indicate that flows would be reduced to 1,500 cfs at Mill Avenue and 140 cfs at Central Avenue. Flows would completely infiltrate into the channel substratum just downstream (U.S. Army Corps of Engineers, 1997).

3.2.2 GROUNDWATER

This section provides a brief overview of the hydrogeology, depth to groundwater and direction of groundwater flow in the Salt River Valley. The Salt River Valley lies within the Basin and Range physiographic province and is characterized by broad alluvial valleys separated by rugged mountains. The valley is underlain by a wide variety of unconsolidated to variably consolidated sedimentary deposits that are several thousand feet thick in places. The sediments include unconsolidated clay, silt, sand and gravel, caliche, gypsum, mudstone, siltstone, sandstone, conglomerate and anhydrite. Discontinuities lateral lenses and interbedded deposits may exist in older units where high-angle faults exist. Groundwater recharge of aquifer units within the lower Salt River Valley occurs primarily as rainfall-induced subsurface influx from the mountain–valley fringe. Rainfall on the valley floor is generally insufficient to contribute to groundwater recharge (U.S. Geological Survey, 1991).

Groundwater is regulated by the Arizona Department of Water Resources (ADWR). The groundwater basin underlying lower Salt River Valley is located within the Phoenix Active Management Area (AMA). The Phoenix AMA comprises two distinct but interconnected alluvial groundwater basins: West Salt River Valley (WSRV) and East Salt River Valley (ESRV). These two units are divided by subsurface geologic outcroppings located near Priest Road in Tempe. Both basins generally comprise three separate hydrogeologic aquifer-layer units. The U.S. Bureau of Reclamation (USBR), U.S. Geological Survey (USGS) and ADWR have independently identified these units, although the descriptions and nomenclature used by these agencies differ slightly. The three units are: (1) Lower Alluvial Unit (LAU), (2) Middle Alluvial Unit (MAU) and (3) Upper Alluvial Unit (UAU). Groundwater within the aquifer units is generally unconfined. The Salt River flows over the UAU and was once the most important source of groundwater recharge for this unit. Composed predominantly of gravel and sand, the UAU ranges from 100 to 400 feet thick under the Salt River. The unit is thinnest near mountain fronts and bedrock outcrops, such as Tempe Butte and lower Papago Park. Water within the UAU is legally referred to as subflow to differentiate it from groundwater in the MAU and LAU. Historically, surface flows from streams and washes provided most of the water that recharges the UAU. Presently, the minor recharge sources, such as seepage from canals and irrigated land, underflow along major streams, and rainfall, have become more important.

Depth to groundwater has fluctuated greatly since development of the Salt River Valley began in the late 1890s. Initially, diversion of water from the river for irrigation led to a rise in the water table. Canal seepage locally raised the water table by as much as 20 feet above the natural water table. As development proceeded, groundwater became an important water source for

agriculture. More than 75% of the pumped groundwater in the Salt River Valley is now used for agriculture. Drought conditions and pumping between 1895 and 1905 caused a decline in the well levels of eight to 20 feet in the Mesa-Tempe area. The water table declined steadily from the 1930s into the 1960s as a result of increased pumping. The magnitude of declines varied spatially, from a few feet in some places to a few hundred feet in others. Where shallow bedrock forces water to the surface, depth to groundwater is only ten to 30 feet greater than in the early 1900s.

During the 1980s, pumping of groundwater declined in the Salt River Valley. Data collected from 1987 to 1992 from seven wells along the Salt River indicate that recent groundwater levels have not exhibited a distinct upward or downward trend, although they have fluctuated considerably. Depth to groundwater decreases downstream, from an average of approximately 260 feet near Granite Reef Dam to less than ten feet near Buckeye. Wells farther downstream on the Gila River show less change and a small range in levels. These areas receive some groundwater recharge from wastewater treatment plants (WWTPs), irrigation seepage, and underflow from the Gila River. Figure 3.3-1 shows the depth to groundwater along the Salt River between 19th Avenue and 83rd Avenue.

The groundwater flow direction is predominantly east to west in both the East Salt River Valley (ESRV) and West Salt River Valley (WSRV). Withdrawals have affected the groundwater flow, and even reversed its direction from historical patterns in some cases. In the ESRV, groundwater flows from the Salt River towards cones of depression located north of the Santan Mountains, east of Mesa, and in the Scottsdale–Paradise Valley area. In the WSRV, groundwater flows from the Salt River toward a major cone of depression near Luke Air Force Base, approximately 15 miles west of Phoenix. Before large scale groundwater pumping began, the movement of water toward the river channel and flow within the channel created a mound of groundwater under the channel, which was accessed by a variety of riparian plants. Deflecting flow away from the river contributes to the water-table decline near the river and reduces the groundwater mound.

3.3 WATER QUALITY

3.3.1 CONTAMINANTS

Surface water and groundwater contaminants include naturally occurring and artificial (manmade) substances that can be introduced into a system from a variety of sources. Federal agencies, primarily the U.S. Environmental Protection Agency (EPA) and state agencies establish water quality standards which vary by water use (e.g., drinking water, irrigation, recreation). Contaminants in the surface waters and groundwater of Arizona fall into seven categories: volatile organic compounds (VOCs), pesticides, metals, nutrients, ions, microorganisms and radiological substances (Table 3.3-1). Similar quality issues exist for all water sources in the lower Salt River; contamination by VOCs and various metals, ions, nutrients, and herbicides. As previously discussed, surface water naturally provides the main source of recharge for groundwater. Shallow groundwater in other reaches of the river often emerges in the channel, creating surface flows. Effluent from wastewater treatment plants (WWTPs) and other industries contribute to both surface and subsurface flows. Thus, contaminants do not remain in one part of the system and may affect all water sources.

Salt River flows maintain high amounts of mineral content and total dissolved solid (TDS). When flood flows do occur, they commonly violate quality standards for fecal coliform bacteria. The Salt River water contains a sodium chloride character both above and below the SRP system dams due to salt springs upstream of the lakes. Verde River water has a lower amount of TDS than found in the Salt River water. The Verde water tends to lower the overall TDS content in flows downstream of their confluence. The quality of water would be sufficient to support native fish species; however elimination of the base flows does not allow it.

Table 3.3-1. Types of Water Contaminants in the Lower Salt River

Contaminant Category	Principal Contaminants	Typical Sources	Potential Health Impacts
Volatile organic compounds (VOCs)	Organic solvents Trichloroethene (TCE) Tetrachloroethylene (PCE) 1,1,1 Trichloroethane (TCA) Chloroform 1,1 Dichloroethylene (DCE) 1,1 Dichloroethane (DCA) Benzene	Landfills Underground storage tanks Airports High technology industry	Carcinogen
Pesticides	Dibromochloropropane (DBCP) Ethylene dibromide (EDB)	Agriculture (soil fumigants) Urban runoff	Toxics Carcinogen
Metals	Arsenic Barium Boron Chromium Copper Iron Lead Manganese Selenium Zinc	Landfills Mines Metal finishing Natural origin	Toxics Carcinogen
Nutrients	Nitrate	Agriculture (fertilizers) Wastewater treatment Septic tanks Industrial manufacturing	Methemoglobinemia (blue-baby disease)
Ions	Total dissolved solids (TDS) Sulfate Chloride Fluoride	Mines Agriculture Natural origin	Taste, hardness Laxative effect Toxics
Micro-Organisms	Fecal coliform	Septic tanks Wastewater treatment	Infectious disease
Radiological		Mines Natural origin	Carcinogen
Source: Graf et al., 1994			

The most prevalent water contaminants in the lower Salt River area are VOCs - organic solvents widely used by both small and large industries and airports and often found in landfills. VOCs are the primary contaminants associated with federal Superfund sites and State of Arizona Water Quality Assurance Revolving Fund (WQARF) sites. They are most frequently present in water as a result of improper disposal of industrial solvents, degreasers, and other compounds. Major disposal practices that have led to groundwater contamination include injection of waste into dry wells, disposal in surface impoundments that leak, dumping into dry washes, unregulated landfills, and leaking underground storage tanks (LUSTs). Water quality violations cited by the Arizona Department of Environmental Quality (ADEQ) show the presence of VOCs in groundwater in areas near every reach of the lower Salt River, especially in the central Phoenix area (Jones & Stokes, 2000). Metals as contaminants are not as extensively distributed as VOCs. Possible sources of metal contamination include landfills, mines, metal finishing and natural origins. The surface waters of both the Salt and Gila Rivers exceed the maximum allowable limit for mercury. Mercury contamination is commonly associated with mining operations and effluent-dominated waters, such as the Salt River below the main Phoenix WWTP, located downstream from the study area near 91st Avenue. When water quality standards are exceeded, it frequently appears to be linked to the remobilization of contaminated sediments during higher-than-normal flows. Although metals appeared in some Salt River Project groundwater wells, concentrations did not exceed the maximum allowable limits. The exact sources and extent of contamination of surface waters by mercury and other metals remains unclear, but it can be assumed that sediments play an important role in their distribution.

Several ions and nutrients also exceed maximum allowable levels in groundwater, surface water and effluent in the study reach. Nitrates are added to the hydrologic system from a variety of sources, including runoff from agricultural fertilizer, animal feed-lot wastes and subsurface domestic septic leachate. Nitrates ranged from 2 to 172 milligrams per liter (mg/1) in SRP-operated wells throughout the valley in 1989 (Jones & Stokes, 2000). Near the Salt River, wells in five out of six reaches exceeded the EPA standard. Historically, nitrate levels have increased as a result of leaching of irrigated soils and sewage seepage.

Wells in all reaches of the river exceeded recommended concentrations of bicarbonate and chloride, 90 mg/1 and 250 mg/1, respectively. Groundwater from an extensive 103 square-mile area of the basin located generally north of Salt River, between Phoenix and Glendale, exceeds EPA's Maximum Contaminant Level drinking water-quality standard of 45 mg/l for nitrate (USGS and ADEQ, 1997). Boron presents another potential danger to plants and is present at problematic levels in wells in the lower four reaches of the river. Boron is found naturally in Salt River waters, but various sources contribute to elevating levels in groundwater: WWTPs; municipal sewer systems, which in some areas employ heavy use of boric acid to control cockroaches; and leaching from irrigated fields that receive wastewater or sludge.

Total dissolved solids (TDS) probably warrant the least concern among all contaminants. Historically, TDS concentrations in surface waters and groundwater exceed the recommended standards for irrigation waters (500 mg/1), ranging between 500 and 5,000 mg/l. The irrigation that has been conducted over a long period in the valley has produced little long-term change in the chemical quality of the groundwater since 1900. TDS concentrations in both the groundwater and surface water of Salt River increased during the first half of this century,

peaking around 1950 at 3,500-4,000 mg/l. More recent data show that TDS concentrations have declined since then, probably as a result of groundwater recharge. Data from the SRP wells suggest that TDS pose the greatest danger to plants in the lower reaches of the river. In 1989, TDS concentrations in SRP wells ranged from 230 to 3,670 mg/l, with a median of 910 mg/1. TDS concentrations are generally lower in the surface waters of the Salt and Verde Rivers and averaged 552 mg/1 and 282 mg/1, respectively, in 1989 above Granite Reef Dam. These concentrations are significantly lower than historical measurements. TDS levels in the Salt River at low flow were 1,850 mg/1 in 1900, 2,490 mg/l in 1912, 2,900 mg/1 in 1930, and 3,500 mg/l in 1943. TDS concentrations on average vary with the amount of flow. For example, during the 1978–80 floods, TDS concentrations in Salt and Verde Rivers ranged between 100 and 900 mg/1 at lower flows and between 200 and 500 mg/1 at higher flows. Although TDS in surface waters and groundwater may cause problems for salt-sensitive crops and other plants, the present concentrations do not significantly differ from more natural conditions along the Salt River.

Urban stormwater runoff also has the potential to generate discharges of contaminants of concern. The USGS, in cooperation with the Flood Control District Maricopa County (FCDMC), have conducted specialized studies of contaminants in urban stormwater runoff in Maricopa County (USGS, 1995a; USGS, 1995b). Based on data collected from 1993 through 1994, stormwater could degrade water quality with oil and grease, pesticides, dissolved trace metals, and ammonia (USGS, 1995a). The highest levels of aquatic toxicity were detected in watersheds that receive drainage from residential and commercial land uses. Streamflow samples from the Salt River were not toxic. Ammonia, lead and zinc loads that were discharged in stormwater were also found to accumulate in channel-bed sediments. Toxicity of bed materials was detected in undeveloped drainage basins and developed basins. Naturally occurring levels of zinc and copper, to a lesser extent, may be responsible for sediment toxicity in undeveloped areas. Recoverable concentrations of zinc and cadmium were most correlated with sediment toxicity from bed material in developed drainage basins. Previous sampling conducted in 1991 and 1992 was evaluated to identify differences in contaminant loading patterns (USGS, 1995b). Data indicated that loading was most directly correlated with the percentage of impervious land area and commercial or industrial land uses. Localized areas in the Cities of Chandler, Mesa, Paradise Valley and Peoria appeared to contribute a large proportion of the total loads evaluated. These areas were typically impervious in excess of 40 percent of the total area and contained high-density commercial, industrial or residential development. A national assessment of stormwater quality from 11 major municipal areas indicated that contaminant-loading stormwater runoff per unit land area was generally better than other areas (USGS, 1994). When compared with other municipalities, contaminant loading in Phoenix, from residential, commercial and industrial drainage basins ranked fourth, second and third lowest, respectively.

3.3.2 POTENTIAL WATER QUALITY STRESSORS

The Water Quality Technical Committee (WQTC), for the first phases of the adjacent Tres Rios Project, identified categories of stressors that could affect the quality of the surface waters and groundwater in the Salt River Valley (Tres Rios River Management Steering Committee–Water Quality Technical Committee, 1998). These stressors are described below.

3.3.2.1 Flood flows

Flood flows are the releases from upstream dams. The flows vary in quantity from minor flows in the channel to the projected 100-year flood flows. The minor flows are the result of controlled releases, while the major floods are caused by uncontrolled releases. Flood flows transport substantial amounts of sediment that originate from tributary flows entering the Salt and Gila Rivers from upstream portions of the river channels and erosion in the study area. Substantial scouring of the Salt River channel occurs during flood flows and is partially related to levee maintenance activities, channelization projects and removal of material for gravel mining operations (USGS, 1995c). Flood flows erode landfills in and adjacent to the river, adding trash and debris to the materials transported by the flow. Much deposition of sediment and landfill materials occurs in the riparian areas in the Tres Rios study area (Jones & Stokes, 2000).

The flood flows can contain pollutants of concern derived from tributary stream inflow, erosion of sediments, and landfills. Large quantities of water in flood flows can dilute the concentration and transport the contaminants through the study area to downstream areas. There is very little information available on the chemical constituents in flood flows.

3.3.2.2 Stormwater Runoff

Stormwater enters the Salt River at numerous locations in the study area and has the potential to degrade the surface quality of water in the system. The quality of water from storm drains varies depending on the length of time between storm events, the amount of flow, and the source of stormwater runoff. Runoff often contains a significant amount of sediment that is washed from undeveloped land and other sources, as well as chemical contaminants or pollutants. The types of chemical pollutants will vary depending on the land uses within the particular drainage area. Potential water quality impacts associated with runoff from industrial sites are projected to be minimal because of the compliance requirements of the Arizona National Pollutant Discharge Elimination System (NPDES) permit program, typically referred to as the AZPDES permits, which require each industrial site to have a Stormwater Pollution Prevention Plan (SWPPP). Runoff from turf areas has the potential to contain pesticide and fertilizer residuals. Runoff from paved areas can contain hydrocarbon products, metals, and anything spilled on the pavement. Detailed description of surface water quality within the study area can be found in Appendices B and D of the Feasibility Report.

There are many areas where stormwater is not collected in a drainage system and runoff flows overland or in streets until it flows into the river channels. This type of stormwater runoff is referred to as unregulated because the quality of runoff is not subject to NPDES stormwater permit program requirements. The pollutants of concern in unregulated stormwater runoff could include sediment and a variety of chemical components, depending on land use of the runoff area.

The City of Phoenix, as part of their citywide Stormwater Management Program (SWMP) for the Municipal Separate Storm Sewer System (MS4), conducts annual monitoring and reporting of selected locations throughout the system. The most recent annual report for the MS4 is for the year ending June 30, 2005. This includes monitoring of storm sewer outfalls located at Elwood

Street and the Salt River (SR03), the south bank of the Salt River at 27th Avenue (SR30), at 67th Avenue and the Salt River (SR49), and at an in-stream monitoring location on the Salt River at 51st Avenue. Monitoring data indicate that on the Salt River conventional pollutant concentrations have decreased with time and trace metals and nutrients have remained fairly constant. It can be assumed that with the continuation of the SWMP and best management practices, the stormwater quality would remain fairly consistent if not improve over time.

3.3.2.3 Agricultural Stormwater Runoff and Irrigation Tailwater

Agricultural land uses can be the source of agricultural stormwater runoff. Most of the agricultural stormwater runoff is from fields, but can also originate from equipment yards. In most cases, agricultural runoff from fields and equipment yards is collected in adjacent irrigation drainage canals and discharged to river channels. In some locations where the farm fields are near river channels, the stormwater runoff can flow directly into river channels. Agricultural stormwater runoff from fields can contain large amounts of sediment because plowing and cultivation break up the soil surface and make soils susceptible to erosion. The field stormwater runoff can contain pollutants of concern associated with agriculture, such as nitrates (from fertilizers), pesticides and herbicides. Past irrigation practices often resulted in the application of excess irrigation water, which was drained from fields into drainage canals and released into the rivers. Discharges of excess irrigation water, or tailwater, are not regulated and their quality is not monitored. Water conservation rules restricting irrigation water use have resulted in a substantial reduction in agricultural drainage, but have not eliminated it.

3.3.2.4 Concentrated Animal-Feeding Operations

Concentrated animal-feeding operations (CAFOs) can produce very poor quality discharges if the site drainage is not controlled. Animal wastes can drain from the site into storm drains or irrigation systems, including both water supply laterals and drainage canals. The principal pollutant of concern from such operations is nitrate. Bacterial pathogens, microbiological pollutants, biochemical oxygen demand (BOD), total suspended solids and nutrient loads can also be generated at a CAFO site. CAFO sites are not located within the Salt River channel. However, uncontrolled runoff from CAFO operations can enter the Salt River through canals and storm drainage systems. Regulations are in place to require control of CAFO discharges by means of an agricultural general permit from the Arizona Aquifer Protection Permit program (Arizona Administrative Code, Title 18, Chapter 9, Article Z [R18-9-201 to 203]). CAFO discharges are also regulated through NPDES permits under the Clean Water Act. The Natural Resources Conservation Service (NRCS) has a pilot program to provide funding to control CAFO discharges at selected sites.

3.3.2.5 Wastewater Treatment Plant Direct Discharge

All WWTPs that discharge to surface waters are required to have NPDES permits that include requirements to monitor the quality of the effluent prior to discharge. There are several WWTPs with discharge permits for the Salt River, including the 23rd Avenue WWTP operated by the City of Phoenix. Reclaimed water produced by this plant is reused by Roosevelt Irrigation District (RID) for irrigation water. When RID is using the reclaimed water, there is no flow discharged

to Salt River. RID diversions are seasonal, following the demand for irrigation water. During winter, the reclaimed water from the WWTP is discharged into Salt River. The discharge percolates into the riverbed, but as the discharge season progresses, the flow extends downstream. When hydrologic conditions permit, the flow from the 23rd Avenue WWTP can continue downstream beyond the study area.

3.3.3 REGULATORY SETTING

This section describes the federal and local agencies that have jurisdiction over water projects on rivers in the study area and that provide for flood protection in the study area. This section also presents information on the federal flood insurance program and pertinent water quality regulations.

3.3.3.1 Agency Jurisdiction

Several governmental agencies have administrative interests in the lower Salt and lower Gila Rivers. Upstream dams were built and/or operated by the USBR, U.S. Bureau of Indian Affairs (BIA), SRP, and the U.S. Army Corps of Engineers (Corps). The Corps built and now operates a major flood control structure (Painted Rock Dam) downstream of the study area. The entire study area for this report is located in Maricopa County. The Flood Control District of Maricopa County (FCDMC) is the primary entity providing for flood protection. These agencies and their jurisdictions are described below.

3.3.3.1.1 U.S. Army Corps of Engineers (Corps)

Since its original legislative mandate in 1927 for flood-related work in the United States, the Corps has acquired significant responsibility for flood damage reduction and related efforts on the lower Salt River. Although the Corps has not built local channel facilities along the lower Salt River, the agency has constructed Painted Rock Dam to protect irrigation works on the lower Gila River from inundation and channel erosion. The dam, begun in 1957 and completed in 1960, can store 2.5 million ac-ft of water, with controlled releases of up to 22,000 cfs. The Corps has several proposed projects related to the lower Salt River. Although it is not known which, if any, of the projects may eventually be completed, they represent an indication of the Corps' interest in the study area.

3.3.3.1.2 U.S. Bureau of Reclamation (USBR)

The USBR has primary responsibility for the development and delivery of water resources. The 1902 Reclamation Act was intended to provide federal investment (with subsequent repayment by users) and expertise in the development of water resources, primarily in the western states. The Reclamation Reform Act of 1982 brought about significant adjustments in USBR's operating methods, recognized leasing, and changed payment procedures.

3.3.3.1.3 Salt River Project (SRP)

Until the mid-20th century, the SRP was primarily a water storage and delivery agency for agricultural users. After World War II, the Phoenix urban area grew rapidly, and the mission of the SRP changed focus. In 1903, the local community included fewer than 20,000 people. By 1967, the population had grown to 800,000 and in 1994, the population approached two million. To accommodate the shift from an agricultural to an urban emphasis, the SRP adjusted to address urban water delivery issues, and it became a major component of the regional electrical power grid. The SRP operates seven major dams upstream of the metropolitan area on the Salt and Verde Rivers, and therefore must be included in any plans for managing river flows and floods through the urban area. The SRP also owns land parcels in and near the river channel.

3.3.3.1.4 Flood Control District of Maricopa County (FCDMC)

FCDMC is a primary agency involved with the management of the lower Salt River and portions of the Gila River. Although Maricopa County had undertaken some flood damage reduction efforts on a relatively small scale before the early 1980s, widespread, coordinated projects became much more common after the Arizona State Legislature mandated the formation of county flood control districts. FCDMC builds various flood control structures, often in cooperation with other agencies, such as Arizona Department of Transportation (ADOT) and NRCS. In addition, FCDMC manages floodplain development by delineating floodplains and administering regulations for floodplain users. The FCDMC coordinates the participation of the county in the National Flood Insurance Program (NFIP), administered by U.S. Department of Housing and Urban Development, as established by congressional action in 1968 and revised in 1973. The availability of federally insured loans and other federal assistance related to floodplains depends on adherence to federal and state rules and regulations as administered by FCDMC. In exercising its responsibilities, FCDMC has completed 32 projects and structures within Maricopa County, including vegetation clearing projects, levee construction, bank stabilization and channel improvements.

3.3.3.2 Water Quality Regulations

3.3.3.2.1 Clean Water Act

Placement of dredged or fill materials into waters of the United States is regulated under Section 404 of the Clean Water Act (CWA) and administered by the Corps of Engineers. Under the act, the state must issue or waive Section 401 water quality certification before a project can receive Section 404 authorization. Water quality certification requires the evaluation of water quality considerations associated with dredging or placement of fill materials into waters of the United States. An evaluation of the potential effects of each action alternative on water quality has been included as the 404(b)(1) Compliance Evaluation (Appendix A).

Section 404(r) of the Clean Water Act waives the requirement to obtain either the State water quality certificate or the 404 permit, provided that the discharge is part of a federal construction project authorized by Congress, and if the following conditions are met: (1) information on the effects of such discharge of dredged or fill material into waters of the United States, including

the application of the Section 404(b)(1) Guidelines, are included in the Environmental Impact Statement (EIS) on the proposed project, and; the EIS is submitted to Congress before the actual discharge takes place and prior to either authorization of the proposed project or appropriation of funds for its construction. The Corps has determined that this project as proposed is consistent with the Section 404(b)(1) guidelines (Appendix A) and is in compliance with the Clean Water Act. The Corps may seek an exemption from the requirement to obtain State water quality certification under Section 404(r) of the Clean Water Act.

The Section 404(r) exemption does not extend to the OMRR&R responsibilities of the non-federal sponsor. The sponsor may be required to obtain a Section 404 permit for discharges of dredge and fill material that are not considered part of the five year adaptive management plan. The Regulatory Branch would determine what type of permit (if any) is needed for these activities. The Corps would assist the non-federal sponsor with preparation of any permit application that may be needed.

The EPA requires states to identify and establish beneficial uses and water quality objectives for surface and groundwater resources. ADEQ is the responsible agency and the water quality standards are established in the Arizona Administrative Code, Title 18, Chapter 11. Numerical and narrative water quality objectives are established to protect designated uses. The Salt River, from the location of the Phoenix 24th Street WWTP extending downstream to the confluence with the Gila River is classified as an effluent-dependent waterbody under Title 18, and ADEQ regulates effluent discharges within this reach on a site-specific basis.

Section 303(d) of the Clean Water Act requires states to identify water resources that are impaired by contaminants and failing to meet ambient surface water quality objectives. The applicable regulations require development of a Total Maximum Daily Load (TMDL) program for 303(d) listed water bodies. TMDL programs identify sources of the contaminants, available assimilative capacity of the water body that would result in water quality objectives being met, and allocates the allowable daily load to dischargers within the watershed. The TMDL implementation plan is then developed to regulate and control the loading of contaminants in the watershed. The Salt River is listed as being impaired by chlordane, DDT metabolites, pH and toxaphene in the lower reach of the channel extending from near Phoenix Sky Harbor Airport to the confluence with the Gila River (ADEQ, 1998). TMDLs for these constituents are proposed to be developed before 2007.

3.3.3.2.2 National Pollutant Discharge Elimination System Discharge Permits

Established by Section 402 of the Clean Water Act, the National Pollution Discharge Elimination System (NPDES) is the primary federal program that regulates point-source discharges to waters of the United States. The NPDES program is administered by the EPA Region 9 office in San Francisco, California. In 1992, EPA promulgated rules for a General Construction Storm Water Permit under NPDES which requires property owners to file a notice of intent to discharge stormwater runoff to U.S. waters from land disturbances of more than one acre. The permit generally requires dischargers to eliminate non-stormwater discharges to stormwater systems, develop and implement a Stormwater Pollution Prevention Plan (SWPPP), and perform inspections of stormwater pollution prevention measures. EPA transferred NPDES permitting

authority to the Arizona Department of Environmental Quality (ADEQ) on December 30, 2002. ADEQ currently operates the program and issues AZPDES permits for water pollution. Grading that would occur as part of this project would be more than one acre and, therefore, would require a SWPPP.

However, on August 22, 2005, the 9th U.S. Circuit Court of Appeals vacated EPA's approval of the AZPDES permit program. *Defenders of Wildlife, et al. v. EPA, et al.*, No. 03-71439, 2005 WL 2001100. On September 9, 2005, EPA sent a letter to the ADEQ Water Quality Division stating that unless and until the court's mandate is issued, Arizona's authorization to issue NPDES (AZPDES) permits and implement the program remains in effect.

3.3.3.2.3 Safe Drinking Water Act

Water quality standards for drinking water are established and regulated by the federal Safe Drinking Water Act of 1986. Maximum contaminant levels, which apply to metals and other toxic compounds in drinking water, are subject to revision. Additional compounds may be added. The Arizona Safe Drinking Water Program is administered by ADEQ, except for Underground Injection Control permits. These are still issued by EPA Region 9.

3.4 BIOLOGICAL RESOURCES

This section contains a summary of biological resources occurring in, or potentially occurring in, the Rio Salado Oeste study area. Information was derived from published and unpublished reports, Jones & Stokes' file information, and information obtained incidental to other activities in the study area. For the purpose of this biological resources discussion, the project study area consists of the eight mile long section of the Salt River between 19th Avenue and 83rd Avenue. The study area extends one mile to either side of the center of the river channel, for a total width of two miles. Ten federally- and/or state-listed wildlife species have the potential to occur in the study area and are evaluated in this study.

3.4.1 GENERAL STUDY AREA SETTING

Historically, the study area supported significant biological resources including extensive riparian and marsh habitats and included a rather diverse native fishery which has been extirpated below Granite Reef Dam. Most of these fish species are now federally listed throughout minimal sites in the State of Arizona. Urban development, diversion of water to support agriculture, and domestic livestock grazing have eliminated or altered most of the natural vegetation communities that occupied the project study area leaving only scattered remnants of the original vegetation communities. Modifications of the river system, such as damming and flow diversion, currently allow no natural flow through the project study area except during flood events. Vegetation communities in the project study area have been highly modified from their original state and currently contain a mosaic of degraded natural communities and man-made artificial communities. A classification system was developed for this study based on several sources, including a list of cover types supplied to Jones & Stokes by the U.S. Army Corps of Engineers, Jones & Stokes file information, and recent publications (Brown,1982;

Szaro, 1989). The classification system categorized habitat types in the project study area by the type of vegetation cover. Table 3.4-1 summarizes the mapped cover types and subtypes in the project study area. This section also includes a description of the important biological communities that occur in the project study area, including characteristics of the vegetation and wildlife in each. The general location of these cover types is shown in Figure 3.4-1.

3.4.2 COVER TYPE DESCRIPTIONS

3.4.2.1 Agricultural Lands

3.4.2.1.1 Vegetation

Agricultural lands are common in the study area, occupying 26% of the total area. Generally, agricultural uses include crops such as cotton, small grains, and assorted vegetables. At the time of the field survey, large areas were being prepared for the year's crops and were dominated by bare soil.

3.4.2.1.2 Wildlife

Agricultural lands in general have low to moderate wildlife value. The composition and structure of commercially produced agricultural croplands lack the diversity of more productive wildlife habitats. Plants important for wildlife food and shelter are often absent or reduced to rows at the edges of the fields. While these fencerows provide corridors for animals to move from place to place, many are isolated and fragmented, greatly reducing the wildlife value. Small mammals such as mice, voles and rats frequent such fencerows and may forage on agronomic crops such as alfalfa and small grains. The abundance of small mammals using these edge habitats attracts medium sized mammals such as coyote, gray fox and bobcat, as well as avian predators (e.g., red-tailed hawk, northern harrier, American kestrel, barn owl, and great horned owl). Bird species favoring open habitats such as killdeer, mountain plover, greater roadrunner, mourning dove, white-winged dove, horned lark, various ground-feeding granivorous sparrows and finches will forage in agricultural fields.

Table 3.4-1. Cover Types Present Within the Rio Salado Oeste Project Study Area

Major Cover Type	Subtype	Description	Extent in Acres	Percentage of Project Study Area
Agricultural Lands	Grains	Croplands used for wheat production	273.1	3%
	Alfalfa	Croplands used for hay production	493.7	5%
	Fallow/Ruderal Field	Plowed fields not used for at least a year.	157.9	2%
	Unclassified Agriculture	Plowed and unplanted at the time of the survey.	1,687.9	16%
Cottonwood-willow Forest	Young cottonwood/willow forest	Dominated by native trees, generally less than 10 years old with salt cedar in the understory.	3.3	<1%
	Mature cottonwood/willow forest	Dominated by native trees, generally more than 10 years old with salt cedar in the understory.	7.2	<1%
	Salt cedar/ cottonwood-willow forest	Dominated by salt cedar with scattered native species.	120.7	1%
Ditch/Canal	None	Aqueducts and major ditches	12.4	<1%
Low Flow Channel	None	Low flow channels in the active channel	32.6	<1%
Mesquite Woodland	None	Dominated by mesquite and other small shrubs	10.4	<1%
Open Water	Small ponds	Ponds not associated with gravel operations	3.6	<1%
	Oxidation ponds	Ponds associated with 91st Avenue WWTP	134.3	1%
	Sand/gravel operation ponds	Permanent ponds associated with active sand/gravel operations	240.2	2%
Parks and Recreation Areas	None	Golf courses and parks	133.3	1%
River Bottom	None	Unvegetated river bottom covered mostly with cobbles.	50.0	<1%
Scrub-Shrublands	None	Dominated by burrobush, rabbitbush, quailbush, and saltbush	1,263.1	12%
Sand-Gravel Operations	None	Operations within the active channel	1,179.9	11%
Upland Buffer Zone	None	Newly established shrubs and scrub dominated by a mixture of native and non-native shrubs	489.2	5%
Urban	None	Residential, industrial, or transportation	3,534.7	34%
Ruderal	None	Disturbed areas not associated with agricultural clearing, mostly weedy herbaceous species.	639.4	6%

3.4.2.2 Cottonwood-Willow Forest

3.4.2.2.1 Vegetation

Cottonwood-willow forest is representative of high-quality riparian habitat in Arizona. Riparian habitats are defined as habitats or ecosystems that are associated with adjacent bodies of water (rivers, lakes, or streams) or are dependent on the existence of perennial or ephemeral surface or subsurface water drainage. They are further characterized by having diverse assemblages of plant and animal species in comparison with adjacent upland areas.

Recruitment of most woody riparian vegetation in the southwest has been shown to correlate with high flows followed by a year or more without high flows. The availability of water in the study area is mainly regulated by upstream irrigation diversion dams. Because of the modification of the Salt River system, groundwater elevations have been lowered and have contributed to the decline in cottonwood and willow species. These same conditions have also favored the establishment and dominance of salt cedar. Structural types of most stands of cottonwood/willow within the study area show evidence of disturbed and early successional conditions consistent with past histories of water diversion, infrequent severe floods and land clearing. These plant species are also found in habitats that are narrow, linear strands of vegetation oriented in the main direction of water flow that may occur in riverine flood channels and along the banks of streams. An example of cottonwood/willow habitat can be found near the City of Phoenix 91st Avenue Wastewater Treatment Plant (WWTP).

Only one percent of the total study area acreage consists of cottonwood/willow habitat. In terms of basal area and density, Fremont's cottonwood, Goodding's willow and salt cedar are the dominant canopy species in these habitats. The cottonwood/willow riparian habitat is patchy in the study area, and much of the original stands of this habitat have been replaced by the invasive and non-native salt cedar.

For the purpose of this report, riparian habitat was separated into three subtypes; young cottonwood/willow forest, mature cottonwood/willow forest, and salt cedar-cottonwood/willow forest based on differences in species dominance and stand age within each subtype. All subtypes support varying combinations of cottonwoods, willows and salt cedar in the canopy.

The most common riparian habitat in the project study area is salt cedar-cottonwood/willow subtype. The salt cedar-cottonwood/willow subtype in the project study area is dominated by dense stands of salt cedar with scattered cottonwoods or willows in the canopy. Salt cedar has been labeled an "extreme" phreatophyte because of its ability to tap and exploit deep water tables (Duncan et al., 1993). Salt cedar is also highly salt tolerant and has been shown to thrive on groundwater with a high concentration of salt (Duncan et al., 1993). This ability to disperse highly concentrated salt excretions provides salt cedar with a competitive advantage over native plants, such as willows and cottonwoods (Duncan et al., 1993). In contrast to the salt cedar/ cottonwood/willow subtype, the young cottonwood/willow forest subtype is characterized by small native trees and shrubs generally less than ten years old, and the mature cottonwood/willow forest subtype is characterized by larger native trees and shrubs generally

more than ten years old. Common understory associates in these types include salt cedar, desert broom, marsh fleabane and desert willow.

3.4.2.2.2 Wildlife

Cottonwood-willow forest, although uncommon in the project study area, stands out as the most important remnant wildlife habitat in the area. Cottonwood-willow supports the densest and most diverse wildlife communities in valleys and deserts. The diversity of plant species and growth forms provides a variety of food sources and microclimate conditions for wildlife. Cottonwoods and willows provide substantial nesting support for large birds, such as the great blue heron, red-tailed hawk, American kestrel, western screech owl, great horned owl and northern flicker.

Although salt cedar has displaced large amounts of riparian and other vegetation along the Salt River, the remaining native riparian habitat still provides high wildlife value, especially for resident and migratory birds. Great blue herons, great egrets, western yellow-billed cuckoos, and black-crowned night-herons also roost in the cottonwood/willow vegetation and forage in nearby habitats.

An active rookery with approximately 25 double-crested cormorants, 30 great blue herons, 25 great egrets, and five snowy egrets was observed at one section of salt cedar-cottonwood/willow habitat in the Rio Salado Oeste study area (Kiewet Materials gravel operations site) during the March 6, 2002 field reconnaissance.

The cottonwood/willow habitats are especially important for resident and migratory songbirds because these and other native riparian habitats have high wildlife value and have substantially declined throughout the western United States. Many bird species use cottonwood/willow habitats in the project study area, including Anna's hummingbird, ash-throated flycatcher, willow flycatcher, black phoebe, dusky flycatcher, western wood pewee, western kingbird, tree swallow, house wren, Bewick's wren, verdin, Lucy's warbler, yellow warbler, yellow-rumped warbler and red-winged blackbird.

The most common mammals in cottonwood/willow habitats in the area are the cactus mouse, deer mouse, and western harvest mouse. White-throated woodrat, cotton rat, coyote, and bobcat are also common in these cottonwood/willow habitats (CH2M HILL et al., 1997).

Some of the common reptiles occurring in the area include the tree lizard, earless lizard, sideblotched lizard, desert spiny lizard, western whiptail, banded gecko, desert blackheaded snake, common kingsnake, banded sand snake, and western diamondback rattlesnake. The tree lizard, which has been characterized as a terrestrial riparian lizard (Omart et al., 1988), is among the most common species observed in the cottonwood/willow and salt cedar trees in the vicinity (CH2M HILL et al., 1997).

Many native wildlife species, especially riparian-dependent or riparian/marsh-dependent birds (e.g., willow flycatchers and the western yellow-billed cuckoo [both discussed in more detail below under "Special-Status Species"], summer tanager, and western yellow-billed cuckoo) require large tracts of native riparian trees and shrubs for cover, nesting and foraging.

3.4.2.3 Ditch/Canal

3.4.2.3.1 Vegetation

Ditches and canals are uncommon in the project study area, occupying less than one percent of the total area. These features are characterized by open, perennially flowing water and typically lack any vegetation.

3.4.2.3.2 Wildlife

Ditches and canals, as they occur in the project study area, offer moderate to low wildlife value. These features are only rarely lined with any vegetation that serves as movement corridors or cover for wildlife. The larger concrete-lined aqueducts serve as marginal foraging and loafing areas for several species of waterfowl including mallard, common merganser, and American coot. Belted kingfishers and black phoebes were observed foraging in the vicinity of the larger aqueducts during the site reconnaissance.

3.4.2.4 Low Flow Channels

3.4.2.4.1 Vegetation

Low flow channels in the Salt River have been almost entirely eliminated, occurring in less than one percent of the project study area downstream of the 23rd Avenue WWTP. These features are characterized by either seasonal or perennial open water and are generally unvegetated. Vegetation, when present, consists of scattered patches of Bermuda grass, salt heliotrope and sedges.

3.4.2.4.2 Wildlife

Due to extensive disturbance from sand and gravel mining, and the lack of perennial flow, low flow channels are uncommon in the study area. The low flow channel that does exist within the Salt River is supported primarily by effluent discharged from the 23rd Avenue WWTP. Depending on the water needs of the Roosevelt Irrigation District, the volume of effluent varies from nothing to nearly 50 mgd on a generally annual cycle. The wide fluctuations in water availability and lack of cover (vegetation) limits the suitability of the low flow channel for wildlife. Despite these limitations, the low flow channel provides feeding opportunities for wading birds and some mammals, and can serve as suitable habitats for amphibian larvae (tadpoles) during dry conditions.

3.4.2.5 Mesquite Woodlands

3.4.2.5.1 Vegetation

Mesquite woodlands historically occurred over large areas within the river floodplain and on higher terraces of the river. These communities have been nearly eliminated from the river

ecosystem by changes to natural processes and occur in less than one percent of the study area. Currently, only small fragmented stands of scattered mesquite woodlands remain along the Salt River. Within the study area, one stand of mesquite woodland was located at the west end of the project near the 91st Avenue WWTP on the south side of the river. This stand had a high level of disturbance including cutting/clearing and vehicular traffic, and appeared to be in poor condition. The mesquite woodland appeared to be dominated by mature trees and did not have evidence of mesquite reproduction, probably due to the factors described above.

3.4.2.5.2 Wildlife

Mesquite is common throughout the region, but has been reduced to remnant patches within the study area. Although no wildlife species are completely dependent on this habitat type, mesquite provides cover, foraging, and breeding habitat for many wildlife species. Most wildlife species that use mesquite habitats also use other similar habitats, including quailbush and salt cedar. This wildlife habitat type is used by many bird species, including mourning dove, white-winged dove, Lucy's warbler, Bell's vireo, Abert's towhee, elf owl, Gila woodpecker, verdin, European starling, and house finch. Mammals that use this habitat include coyotes, gray fox, bobcats, pocket gophers, black-tailed jackrabbit, desert cottontails, and cactus mice. Reptiles that often use mesquite habitat include earless lizards, side-blotched lizards, desert spiny lizards, western whiptails, gopher snakes, common kingsnakes, banded sand snakes, and western diamondback rattlesnakes.

3.4.2.6 Open Water

3.4.2.6.1 Vegetation

Open water habitat is uncommon in the project study area, occupying three percent of the total area. For the purpose of this report, the open water cover type was separated into three subtypes: sand/gravel operation ponds, small ponds not associated with sand/gravel operations, and oxidation ponds associated with the 91st Avenue WWTP. These open water subtypes may contain some narrow bands of vegetation around the edges, but are generally unvegetated.

3.4.2.6.2 Wildlife

Open water habitat along the Salt River has high wildlife value. The open water habitat supports large numbers of water birds that feed or breed in the area. Mallard and cinnamon teal are known to nest near open water habitats of Maricopa County (Witzeman et al., 1997), and may nest within the project study area. Amphibians, turtles and garter snakes are likely to be common in some of the open water habitats.

3.4.2.6.3 Fish

Few quantitative and comprehensive inventories of fish species have been undertaken on the Salt River system (CH2M HILL et al., 1997). Fifteen native fish species and 29 introduced fish species have been recorded in Salt River and Phoenix Canal systems (Marsh and Minckly, 1982). Fish habitat in the region has been altered because of elevated nutrient levels in the WWTP

effluent discharge. This has resulted in abundant growths of algae and emergent and submergent aquatic vegetation. Dissolved oxygen levels in the water column vary widely. If native fish species are still present in the Salt River system, their occurrence would likely be limited by low dissolved oxygen levels (CH2M HILL et al., 1997).

3.4.2.7 Parks and Recreation Areas

3.4.2.7.1 Vegetation

Parks and recreation areas occupy one percent of the study area and include turf-covered lands used for activities such as golf and other recreation activities. These areas generally contain nonnative ornamental trees and shrubs.

3.4.2.7.2 Wildlife

Parks and recreation areas, as they occur in the study area, offer moderate wildlife value. Parks and golf courses planted with non-native ornamental trees and shrubs provide some foraging and roosting habitat for resident and migrating birds, and smaller man-made ponds may support waterfowl. Wildlife species occurring in parks and recreation areas are expected to be similar to those found in urban areas and in close association with human activity. The rock dove, European starling, house finch, and house sparrows are among those species known to be common in parks and recreational areas.

3.4.2.8 River Bottom

3.4.2.8.1 Vegetation

The river bottom cover type was located in less than one percent of the total project study area. This cover type is largely unvegetated, and is characterized by cobble in the active channel of Salt River.

3.4.2.8.2 Wildlife

River bottom habitat provides low wildlife value because the vegetation is sparse or grows in clumps, but the habitat is used by many wildlife species for foraging or sunning. Many species of snakes and lizards use cobble habitats for sunning during the morning and evening. Cobble habitats often trap small fish and amphibian tadpoles as the river flows recede during spring or summer. These small fish and tadpoles are prey for water birds (e.g., herons, egrets, and gulls), raccoons, skunks and aquatic snakes.

Quailbush is found in the river bottom habitat. It is used by many birds, mammals and reptiles, for feeding and cover. Many of the wildlife species that use river bottom habitat are also found in association with habitats of sand/gravel operations.

3.4.2.9 Scrub-Shrublands

3.4.2.9.1 Vegetation

Scrub-shrublands are common and are present within the active channel of the river occupying 12 percent of the project study area. They are dominated by various combinations of burrobush, rabbitbush, quailbush, saltbush, and occasionally by creosote bush. Many of these areas have been highly disturbed from OHV traffic and gravel mining activities, and contain little or no vegetation cover. If the total vegetation cover was less than ten percent, the area was mapped as unvegetated river bottom. If water was present, it was mapped as low flow channel.

3.4.2.9.2 Wildlife

Scrub-shrublands, as they occur in the study area, offer moderate wildlife value. The shrub and scrubland vegetation provides foraging and resting cover for small and medium-sized mammals, snakes and lizards, and various terrestrial birds including Gambel's quail, greater roadrunner, loggerhead shrike, curve-billed thrasher and verdin.

3.4.2.10 Sand/Gravel Operations

3.4.2.10.1 Vegetation

Sand/gravel operations are common in the project study area, occupying 11 percent of the total area. Next to water diversion, these operations appear to be a large factor contributing to habitat alteration within the historic river channel. Because operations are characterized by a large amount of disturbance in the active channel, vegetation is mostly lacking. However, mostly weedy non-native species that tend to colonize quickly after disturbance may be present.

3.4.2.10.2 Wildlife

Sand/gravel operations provide low wildlife value because the areas tend to be characterized by high human activity and disturbance from the operation of heavy equipment. Because the vegetation is sparse, there is little foraging or resting cover for wildlife species. Many of the wildlife species that use sand/gravel operations are also found in association with river bottom habitat.

3.4.2.11 Upland Buffer Zone

3.4.2.11.1 Vegetation

The upland buffer zone is uncommon in the study area, occupying only five percent of the area. It is characterized by a mixture of non-native and native species on the upper terraces and floodplain of the river. The presence of the upland buffer zone is highly variable, depending on the level of disturbance from urban, industrial and agricultural uses. Typical species associated with this zone include mesquite, rabbitbush, acacia, paloverde, creosote, salt cedar and tree tobacco.

3.4.2.11.2 Wildlife

Although the upland buffer zone area supports good plant diversity and structure, it offers only low to moderate wildlife value due to its small area and its proximity to disturbed habitats.

3.4.2.12 Urban Areas

3.4.2.12.1 Vegetation

Urban areas are the most common land use in the project study area, occupying 34 percent of the total area. Major land uses in this type include residential, commercial and industrial developments. Vegetation in urban areas is generally dominated by non-native ornamental plants and small patches of turf.

3.4.2.12.2 Wildlife

Urban areas make up one-third of the available wildlife habitat within the project study area. This habitat has low wildlife value because it provides minimal cover and food sources. Wildlife species often using urban areas include northern mockingbird and mourning dove, in addition to those species known to be common in parks and recreational areas. Urban areas tend to support wildlife species with high tolerances to human activity and disturbance. Medium-sized mammals adapted to take advantage of urban areas include opossum, raccoon, striped skunk and coyote.

3.4.2.13 Ruderal Areas

3.4.2.13.1 Vegetation

Ruderal areas are common in the project study area, occupying six percent of the total area. These areas are characterized by a highly disturbed surface with little or no vegetation cover. Characteristic species found in this habitat include introduced annual plant species, including London rocket and filaree, and scattered native and non-native shrubs including Russian thistle, saltbush, creosote, and burrobush.

3.4.2.13.2 Wildlife

Ruderal areas have low wildlife value because they provide minimal cover for foraging and resting. Because of the open nature of ruderal areas, raptors such as white-tailed kite, red-tailed hawk, and American kestrel are commonly found hunting in these habitats.

One raptor species able to utilize the flatter ruderal habitats is the western burrowing owl. Until the early eighties, the western burrowing owl was common along the north bank of the Salt River. However housing and industrial development, and high OHV use in former western burrowing owl habitat, have made it increasingly uncommon in Maricopa County (Witzeman et al., 1997). No burrowing owls are known to be present within the project implementation area.

3.4.3 SPECIAL-STATUS SPECIES

Species included on federal or state (or, in some cases, county or local) listings for the purpose of regulatory consideration are collectively referred to as special status species. For the Rio Salado Oeste feasibility study, special-status species are those animals in the following categories:

- Animals listed or proposed for listing as Threatened or Endangered under the federal Endangered Species Act (ESA) (50 CFR 17.11 [listed animals] and various notices in the Federal Register [proposed species]);
- Animals that are candidates for possible future listing as Threatened or Endangered under the federal ESA (66 FR 54808, October 30, 2001), and;
- Wildlife of Special Concern (WSC) to the Arizona Game and Fish Department (AGFD, 1996)

The US Fish and Wildlife Service (FWS) defines an Endangered Species as an animal or plant species in danger of extinction throughout all or a significant portion of its range. A Threatened Species is an animal or plant species likely to become Endangered within the foreseeable future throughout all or a significant portion of its range. Finally, a Candidate Species is a plant or animal species for which the USFWS, or the National Oceanic and Atmospheric Administration - Fisheries (NOAA Fisheries, or National Marine Fisheries Service), has on file sufficient information on biological vulnerability and threats to support a proposal to list as Endangered or Threatened. When the Arizona Game and Fish Department (AGFD) formally classifies a species as Wildlife of Special Concern (WSC), known threats and documented population declines are the most important factors considered. Potential threats and perceived declines also receive consideration (AGFD, 1996).

The U.S. Army Corps of Engineers (Corps) has coordinated with the U.S. Fish and Wildlife Service (FWS) and the Arizona Game and Fish Department (AGFD) pursuant to the Fish and Wildlife Coordination Act (FWCA). As part of this coordination, the FWS provided a Planning Aid Letter on June 21, 2002, and a Coordination Act Report on June 20, 2005. These documents provide recommendations for alternative formulation and future OMRR&R activities, and state that the FWS is unaware of any federally listed Threatened or Endangered species within the project area.

The Corps has initiated informal consultation with the FWS in accordance with Section 7 of the Endangered Species Act. The purpose of the Section 7 consultation is to ensure that proposed actions are not likely to jeopardize the continued existence of listed species, or result in destruction or adverse modification of critical habitat. No critical habitat has been designated in the study area. In addition, no special-status plants (other than protected native plants) or fish have been recorded in or are expected to occur in the study area. Protocol surveys for federally Threatened and Endangered species, as well as WSC, would be conducted prior to project construction if they are warranted. The scientific and common names of plants and wildlife discussed in this section are listed in Appendix B.

There are ten special-status species with the potential to occur in the county: the lowland leopard frog, desert tortoise, Mexican garter snake, bald eagle, Yuma clapper rail, southwestern willow flycatcher, western yellow-billed cuckoo, cactus ferruginous pygmy owl, American peregrine falcon, and the lesser long-nosed bat. All ten of these special status species are considered to be WSC by AGFD. The bald eagle, Yuma clapper rail, southwestern willow flycatcher, cactus ferruginous pygmy owl, and lesser long-nosed bat are also federally listed. The federal and state status for each of these species is summarized on Table 3.4-2.

Aside from an occasional visit by a migrating or foraging bald eagle, no special-status species have been recorded in the study area (CH2M HILL et al., 1997). The following discussions and Table 3.4-2 summarize the habitat requirements and distribution of the ten special-status wildlife species that could potentially occur in the study area.

3.4.3.1 Lowland Leopard Frog

The lowland leopard frog has no federal listing, but is included on the draft review list of WSC in Arizona (AGFD, 1996). This amphibian occurs below 5,500 feet in elevation, south and west of the Mogollon Rim (AGFD, 1996). This species is restricted to permanent streams, and it generally avoids ponds or other aquatic habitats. It usually occurs in streams with willows and cottonwoods or emergent vegetation (bulrushes and cattails) (Stebbins, 1954). The central Arizona population appears to be healthy, but the lowland leopard frog has disappeared from the lower Gila River and lower Colorado River system. This species has probably declined for a variety of reasons, including predation and competition from non-native fish and amphibians, and from stream alteration and flow diversion (AGFD, 1988; AGFD, 1996).

3.4.3.2 Desert Tortoise

The Sonoran Desert population of the desert tortoise has no federal listing, but is included on the draft review list of WSC in Arizona (AGFD, 1996). This tortoise inhabits much of southwestern and south central Arizona's Sonoran Desert, principally in rocky foothills and less often on lower bajadas and in semidesert grassland. Sonoran Desert populations in the Tucson and Phoenix areas have declined because of urban and agricultural development, road construction, wildfires, illegal collection, and use of off-road vehicles in unauthorized areas (AGFD, 1996).

3.4.3.3 Mexican Garter Snake

On January 4, 2006, the U.S. Fish and Wildlife Service announced that a petition to list the Mexican garter snake as Threatened or Endangered under the Endangered Species Act may be warranted (FR Vol. 71, No. 2: pp 315 – 324). As a result, the agency is initiating a status review to determine if the Mexican garter snake should be proposed for listing. This review includes a 60-day public comment period to allow all interested parties the opportunity to provide information on the status of this species throughout its range. The Mexican garter snake is already included on the draft review list of WSC in Arizona (AGFD, 1996). This species occurs in permanent marshes in south-central and southeastern Arizona. It is strongly aquatic and feeds on aquatic animals, including fish and amphibians. This garter snake has declined because of the

loss of wetland habitats and competition and predation from non-native fish and bullfrogs (AGFD, 1996).

3.4.3.4 Bald Eagle

The bald eagle was federally listed as Endangered on March 11, 1967, and then reclassified to threatened on July 12, 1995 (60 FR 35999). No critical habitat has been established. The bald eagle has been proposed but not finalized for delisting on July 06, 1999 (50 CFR Section 17). This species is also on the draft review list of wildlife of special concern (WSC) in Arizona (AGFD, 1996). Bald eagles are currently found in all Arizona counties. Bald eagles nest in large trees near lakes and streams, and hunt for waterfowl and fish in wetlands and along rivers and lakes. In Arizona, a small resident population of approximately 40 pairs nests along the Salt, Verde, Gila, Bill Williams, Agua Fria, San Pedro, and San Francisco Rivers, and Tonto and Canyon Creeks. There are at least 200 to 300 individuals that winter throughout the state each year.

Bald eagles have been reported nesting along Salt River east of Phoenix since the 1930s (Witzeman et al., 1997). Bald eagles do not nest in the study area, although they occur in the area as winter visitors and migrants (Benham-Blair Associates, 1980). Bald eagles have been observed foraging along the rivers in the study area (CH2M HILL et al., 1997). The open water marsh in the study area may be suitable foraging habitat for bald eagles.

3.4.3.5 Yuma Clapper Rail

The Yuma clapper rail was federally listed as Endangered on March 11, 1967 (32 FR 4001) without critical habitat designation. The Yuma clapper rail is also on the draft review list of WSC in Arizona (AGFD, 1996). This inland clapper rail requires a wet substrate, such as a mudflat, sandbar, or slough bottom that supports cattail and bulrush stands of moderate to high density adjacent to shorelines (USFWS, 2002). It occurs in cattail, sedge, and bulrush marshes along the Colorado River, the lower Gila and Salt Rivers below the Verde/Salt River confluence, and Pichacho Reservoir (AGFD, 1996; Edelman and Conway, 1998). This species has declined because of the loss and fragmentation of river marshes. Toxic levels of heavy metals, such as selenium, could also have contributed to the species' decline (AGFD, 1996). The Yuma clapper rail is known to occur as a rare and local summer resident in cattail marshes in the Salt River south and west of Phoenix (Witzeman et al., 1997).

3.4.3.6 Southwestern Willow Flycatcher

The southwestern willow flycatcher was federally listed as Endangered on February 27, 1995 (60 FR 10693). Critical habitat designations were made on July 22, 1997 (62 FR 39129), August 20, 1997 (62 FR 44228), and October 19, 2005 (50 CFR 60886). A recovery plan was completed on August 30, 2002. This Neotropical migrant is also on the draft review list of WSC in Arizona (AGFD, 1996). The breeding range for this species includes southern California, Arizona, New Mexico, southern Utah, southern Nevada, far western Texas, perhaps southwestern Colorado, and extreme northwestern Mexico (USFWS, 1995). Wintering grounds are in Central and South America. The willow flycatcher prefers nesting in dense willow riparian habitats, and is also

found in areas of salt cedar in the Sonoran Life Zone (e.g., the lower Big Sandy River, lower Santa Maria River, Bill Williams Delta, upper Gila River, Grand Canyon, and middle Salt River). Historically, the willow flycatcher nested along Salt, Gila, and Agua Fria Rivers (CH2M HILL et al., 1997). Recent statewide surveys indicate that most sites are occupied by fewer than five nesting pairs, which has raised concern over their population status in Arizona. This species has declined for a variety of reasons, including habitat loss and fragmentation resulting from flood damage reduction projects, development, and intensive grazing. Brown-headed cowbird nest parasitism may also have contributed to the species' decline (AGFD, 1996). This species is currently considered an uncommon transient in Maricopa County, with only a few historic summer records (Witzeman et al., 1997).

3.4.3.7 Western Yellow-billed Cuckoo

The western yellow-billed cuckoo is federally listed as a Candidate species for addition to the list of Threatenend and Endangered species (66 FR 38611, July 25, 2001). This bird is also included on the draft review list of WSC in Arizona (AGFD, 1996). In Arizona, the western yellow-billed cuckoo is found locally in streamside cottonwood and willow groves, and prefers to nest in willow or mesquite thickets (AGFD, 2001b). This species has declined due to degradation and loss of mature riparian habitat within its range. The western yellow-billed cuckoo is considered an uncommon local summer resident (Witzeman et al., 1997).

3.4.3.8 Cactus Ferruginous Pygmy Owl

The cactus ferruginous pygmy-owl was federally listed as Endangered on March 10, 1997 (62 FR 10730), and critical habitat was designated on July 12, 1999 (64 FR 37419) and November 27, 2002 (67 FR 7102). This owl is also on the draft review list of WSC in Arizona (AGFD, 1996). Historically, the cactus ferruginous pygmy owl occurred as far north as the confluence of Salt and Verde Rivers. This species occurs in desert scrub, mesquite bosques, and Sonoran riparian deciduous woodland areas with mature cottonwoods and willows. This small owl nests in cavities created by woodpeckers. The species has declined because of urban development, reduction of suitable habitat, and competition from other cavity-nesting birds (AGFD, 1996; AGFD, 2001a). Areas of recent occupancy include xeric riparian washes in Organ Pipe Cactus National Monument, riparian forests of the lower San Pedro River, and saguaro forests near Tucson (AGFD, 1996).

3.4.3.9 American Peregrine Falcon

The American peregrine falcon was federally listed as Endangered or Threatened before being removed from the endangered species list (delisted) on August 25, 1999 (64 FR 46541). This falcon remains on the draft review list of WSC in Arizona (AGFD, 1996). The peregrine falcon occurs in small numbers, and is found nesting on cliffs throughout the state. It is found sparsely in migration, and occasionally winters along the Colorado River. The Arizona population of peregrine falcons declined in the 1950s and 1960s and the rest of the U.S. due to DDT contamination. Additionally, increased development forced the peregrine falcon to nest in sub-optimal habitat (AGFD, 1998b). Since the late 1970s, the peregrine falcon has been increasing

in the Phoenix area, and is known to nest on cliffs along the Salt River east of the study area (Phillips et al., 1964; Witzeman et al., 1997).

3.4.3.10 Lesser Long-Nosed Bat

The lesser long-nosed bat was federally listed as Endangered on September 30, 1988 (53 FR 38456). This bat is a summer resident of central and southeastern Arizona. It roosts colonially in large numbers, occupying mines and caves at the bases of mountains. The lesser long-nosed bat is found in habitats that support agaves, yuccas, saguaros, and organ pipe cacti (Harvey et al., 1999), and feeds mainly on agave and saguaro flower nectar and pollen. The lesser long-nosed bat population has declined because of human disturbance at breeding and roosting sites and habitat loss; however, the population appears stable (AGFD, 1996).

3.5 CULTURAL RESOURCES

3.5.1 REGULATORY SETTING

3.5.1.1 National Historic Preservation Act

For federal undertakings, in compliance with the National Historic Preservation Act, Public Law 89-665, as amended, 16 U.S.C. 470 et seq., cultural resources are located using two principal methods. Before starting a project, a records and literature search is conducted at repositories of archeological site records. The search may show that an archaeological or historical survey has been conducted in the project area and that cultural resources have been identified. That information may be enough to proceed with the significance evaluation stage of the project. If no previous survey has been done, or if a previous survey was either out of date or inadequate, a pedestrian survey of the ground surface within the proposed project boundaries may be conducted. Subsurface testing may also be performed if deemed appropriate by the cultural resources professional.

After a cultural resource(s) has been identified during a survey or record and literature search, the federal agency overseeing the undertaking proceeds to determine whether the cultural resource is eligible for listing in the National Register of Historic Places (National Register). Section 106 of the National Historic Preservation Act mandates this process. The federal regulation that guides the process is located at 36 CFR 800.2(c)-(d). For a cultural resource to be determined eligible for listing in the National Register, it has to meet certain criteria. The resource has to be either minimally 50 years old or exhibit exceptional importance. After meeting the age requirement, cultural resources are evaluated according to four criteria. The National Register criteria for evaluation as defined in 36 CFR 60.4 are:

Table 3.4-2. Special Status Species that may occur in the Rio Salado Oeste project area.

Species	Status* Federal/State	Arizona Distribution	Habitat Requirements	Reasons for Decline	Potential for Occurrence in the Study Area
Lowland leopard frog (*Rana yavapaiensis*)	--/WSC	Occurs below 5,500 feet in elevation, south and west of Mogollon Rim.	Permanent streams, generally avoids ponds; prefers streams with willows and cottonwoods or emergent vegetation.	Predation and competition from non-native fish and amphibians and from stream alteration and flow diversion .	The study area is in the lowland species' geographic range. Areas along the Salt and Rivers appears to be suitable habitat; no recent records.
Desert tortoise (*Gopherus [=Xerobates] agassizii*)	--/WSC	Occurs across much of Arizona's Sonoran Desert, including the Phoenix area.	Desert areas with sandy loam to gravelly soils for digging dens; favors cactus scrub habitats with high densities of annual blooms in spring for feeding.	Loss of habitat from urban development, habitat alteration and direct mortality from off-road vehicle use, cattle grazing, and predators, respiratory disease.	Not likely to occur in the study area due to marginal habitat and presence of factors that have caused its decline.
Mexican garter snake (*Thamnophis eques megalops*)	--/WSC	Occurs in permanent marshes in south-central and southeastern Arizona.	Strongly aquatic, and feeds on aquatic animals, including fish and amphibians.	Loss of wetland habitats and because of competition and predation from non-native fish and bullfrogs.	Suitable wetland habitat is present along the Salt River; not likely to occur in the study area due to presence of factors that have caused its decline.
Bald eagle (*Haliaeetus leucocephalus*)	T/WSC	Nesting occurs along the Verde and Salt Rivers; also nests along the Agua Fria and Gila Rivers; wintering occurs along rivers and lakes where suitable habitat occurs.	Occurs along large rivers and lakes for nesting and wintering; requires large trees, cliffs, or pinnacles for nesting.	Human disturbance at nesting and wintering sites; loss of suitable nesting sites, and pesticides.	Not known to nest in the study area although individuals occur in the area as winter visitors and migrants; observed foraging along the rivers in the project area. Open water, marshes, constructed wetlands, and fields in the study area are suitable foraging habitats.

Species	Status* Federal/State	Arizona Distribution	Habitat Requirements	Reasons for Decline	Potential for Occurrence in the Study Area
Yuma clapper rail (*Rallus longirostris yumanensis*)	E/WSC	Occurs in cattail and bulrush marshes along the Colorado River; the lower Gila and Salt Rivers below the Verde/Salt River confluence; and Picacho Reservoir.	Marsh and riparian habitats.	Loss and fragmentation of river marshes; toxic levels of heavy metals such as selenium, could also have contributed to the species' decline.	The Salt River supports suitable habitat; known to occur in areas of suitable habitat along the Gila River.
Southwestern willow flycatcher (*Empidonax trailii extimus*)	E/WSC	Nests in dense willow riparian habitats along the lower Big Sandy River, lower Santa Maria River, Bill Williams Delta, upper Gila River, Grand Canyon, and middle Salt River; historically nested along the Salt, Gila, and Agua Fria Rivers.	Riparian forest and scrub habitats.	Has declined for variety of reasons, including habitat loss and fragmentation from flood damage reduction projects, development, and intensive grazing; brown-headed cowbird nest parasitism could also have contributed to the species' decline.	Habitat quality along the Salt River is considered marginal, because the cottonwood/willow habitat is narrow and fragmented, although still considered suitable for the species; no nesting southwestern willow flycatchers have been observed, although migrating birds have been observed.
Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	C/WSC	Summer resident only in central and southern Arizona.	Nests in mature cottonwood/willow riparian forests; salt cedar can be a component of their habitat.	Degradation and loss of mature riparian habitat.	Salt and Gila Rivers support suitable habitat; known to occur in areas of suitable habitat along the Gila River.
Cactus ferruginous pygmy owl (*Glaucidium brasilianum cactorum*)	E/WSC	Historically occurred as far north as the confluence of the Salt and Verde Rivers.	Occurs in desert scrub and riparian areas with mature cottonwood and willows; nests in cavities created by woodpeckers.	Loss of habitat from urban development; competition from other cavity-nesting birds.	Once fairly common in south central Arizona; only recent records are from Organ Pipe Cactus National Monument, near Ajo, and suburban Tucson. Not likely to occur in the study area due to disturbance and lack of suitable habitat.

Species	Status* Federal/State	Arizona Distribution	Habitat Requirements	Reasons for Decline	Potential for Occurrence in the Study Area
American Peregrine Falcon (*Falco peregrinus anatum*)	--/WSC	Nearly global distribution; Breeds in Arizona where sufficient prey is available near cliffs, such as the Mogollon Rim and the Grand Canyon.	Optimum habitat consists of cliffs overlooking habitats with abundant bird life, such as woodlands and riparian areas. Suboptimal habitat consists of smaller cliffs in ponderosa pine forest, or large cliffs in xeric areas.	Declined in the 1950s and 1960s and the rest of the U.S. due to DDT contamination. Increased development forced the peregrine falcon to nest in sub-optimal habitat.	Low potential to occur in study area except while migrating. Tall buildings are occasionally used as nesting sites. If this were to occur in downtown Phoenix, it could increase the potential for this species to utilize the study area.
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)	E/WSC	Summer resident of central and southeastern Arizona; a few late-summer records of immature individuals from the Phoenix area.	Roosts colonially in large numbers; feeds on agave and saguaro flower nectar and pollen. Unable to withstand cold weather; migrates to Mexico each fall.	Has declined because of human disturbance at breeding and roosting sites and habitat loss; the population appears stable.	Habitat quality appears to be low in the study area; no systematic surveys have been conducted in the study area; this species was recorded upstream of the Salt River/Gila River confluence, north of the Salt River.

* Status explanations:

Federal

E = listed as Endangered under the federal Endangered Species Act.

T = listed as Threatened under the federal Endangered Species Act.

C = listed as a Candidate species under the federal Endangered Species Act.

-- = no listing.

State

WSC = Wildlife of Special Concern in Arizona (Arizona Game & Fish Department, or AGFD)

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and:

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history.

After a cultural resource has been determined eligible for inclusion in the National Register, it is accorded the same level of protection as a property that is included. It then becomes formally known as a "historic property" regardless of age.

3.5.1.2 American Indian Religious Freedom Act of 1978

The American Indian Religious Freedom Act of 1978, Public Law 95-341, 42 U.S.C. 1996, may also apply to the project. This law makes it policy of the federal government to protect and preserve the inherent rights of American Indians, Eskimos, Aleuts, and Native Hawaiians to believe, express and exercise their traditional religions. This includes, but is not limited to access to religious sites, use and possession of sacred objects, and freedom to worship through ceremonials and traditional rites. It directs federal agencies to evaluate their policies and procedures to determine if changes are needed to ensure that such rights and freedoms are not disrupted by agency practices. The act also requires that the views of Native American leaders are to be obtained and considered where a proposed land use might conflict with traditional Indian religious beliefs or practices.

3.5.1.3 Native American Graves Protection and Repatriation Act of 1990

The Native American Grave Protection and Repatriation Act of 1990, Public Law 101-601, 25 U.S.C. 3001 et seq. addresses the recovery, treatment and repatriation of Native American and Native Hawaiian remains, including human remains, associated funerary objects, sacred objects, and objects of cultural patrimony.

3.5.2 PREHISTORY

3.5.2.1 Paleo-Indian and Archaic

Thus far, there are no known Paleo-Indian sites in the Phoenix Basin or surrounding environs. Little is known of the archaic occupation of the area, but newly acquired excavation data is becoming available. The current construction boom in Scottsdale has required new surveys, which in turn has prompted excavation of previously unknown archaic sites. Presently, much of that information is locked up in unpublished, possibly proprietary reports.

Ongoing archeological and geomorphic surveys on the Gila River Indian Reservation have uncovered discrete Archaic features and occasional diagnostic Archaic projectile points. Site AZ T:11:94(ASM) in the Tres Rios project area may have Archaic components (Onken, 2005). Sufficient knowledge to quantify or characterize the archaic sequence is still quite scarce (Mike Waters and Robert Neily, pers. comm.., 1999). Additional Archaic sites will assuredly be discovered, but in the meantime, they are buried beneath a thick mantle of Gila River alluvium.

3.5.2.2 Hohokam

The principal prehistoric cultural manifestation in the project area is the Hohokam culture. Hohokam is a Pima word that means "those who have gone" (Gladwin and Gladwin, 1933), or more poetically, "those who have vanished" (Wormington, 1973). The name Hohokam has endured and is still the preferred name in spite of some other prehistoric cultures being renamed. The four southern O'odham tribes crafted a policy statement that stated, "We recognized Indian Tribes have mutually agreed to promote and protect the archaeological artifacts and remains of our ancestors, the Hohokam..." (SRPMIC, 1989). The earliest investigations into the Hohokam probably began with Frank Hamilton Cushing's work at Los Muertos in 1887 and 1888, in what was to become the City of Tempe (Gumerman, 1991). The bulk of the effort expended toward defining the Hohokam came from the work of Harold and Winifred Gladwin, and Emil W. Haury of the Gila Pueblo Archaeological Foundation in Globe.

After accumulating five years of knowledge from excavating at Casa Grande, combined with their detailed stratigraphic analyses, the Gladwins formulated the basis for a ceramic sequence and sketchy ideas for a Hohokam culture history. The concept of the Hohokam as a unique southwestern culture was first proposed in the Gladwins' (1933) paper on ceramics. The archeological community finally accepted the Hohokam culture concept after publication of Excavations at Snaketown: Material Culture (Gladwin et al., 1937). Until then, Frank H. H. Roberts (1935) considered the idea of the Hohokam as a separate culture to be a "bunch of hokum."

Throughout the 1940s, Harold Gladwin continued to tinker with the 1937 chronology that had been developed at Snaketown (Doyel, 1986: 202-204; Gumerman and Haury, 1979). Among other issues, Gladwin developed irreconcilable differences with the temporal/cultural placement of the Pioneer Period. Gladwin (1942) was critical of the phase sequence at Snaketown and published a rebuttal of sorts. He posited that Haury's work on chronology was incorrect and he continued to revise the chronology until it was virtually unintelligible (Doyel, 1986).

To clarify the problems surrounding Hohokam origins, Haury decided that a return to Snaketown was in order. In the winter of 1964-1965, Haury revisited Snaketown to verify the accuracy of his original chronology. In addition to fine tuning the chronology, Haury also surmised that the Hohokam were not derived from the Cochise base. Instead, he ended up agreeing with Gladwin, DiPeso, and Schroeder that the Hohokam were migrants from Mexico. However, he stuck to his argument that the Pioneer Period began at about 300 B.C (Doyel, 1986). Later research concluded that the Pioneer period was rooted in the Archaic Period.

As with all chronological systems, there always seems to be dissention. This is usually because various researchers have data suggesting a localized variant on a chronological scheme, or they are advancing their own ideas. Others, however, are content to use Haury's system (Holly Young, pers. comm., 1999). Hohokam research in the 1980s took a different look at the origin, and the temporal placement of the phases within the Pioneer period.

After considerable deliberation, Dean developed a chronology for the Phoenix Basin that has become the basis for the prevailing sequence. He disavowed the viability of the Polvoron phase because its "provisional" place in the sequence was based on one valid date (Dean, 1991:87). Deaver (1997: 459) developed a concordance of chronological sequences showing the geographic and temporal variation for the various centers of the Hohokam culture. He included the Polvoron phase in the sequence for the Phoenix Basin. Deaver's Phoenix Basin sequence is based on Haury's 1976 chronology, refined by Dean (1991), with the Polvoron phase added. Even though the Polvoron phase is still controversial (Deaver, 1997), there appears to be a consensus for the Polvoron phase as a cultural manifestation. However, the disagreement is generally based on the temporal placement of the phase (Owen Lindauer, pers. comm., 1999).

Under Haury's system (1976), the five Hohokam cultural periods (Pioneer, Colonial, Sedentary, Classic, and Post-Classic) were broken down into nine developmental phases. Three problems that persist with the cultural periods involve questions of when and why they began and why they ended. Two phases were added to hopefully address these problems: Red Mountain, which identified the Archaic-Pioneer Transition; and Polvoron, the final Post-Classic phase. As of 1997, the Polvoron was still a controversial phase (Deaver, 1997:463). Dean (1991:62) restates the existing problems with Hohokam chronology. He agrees that there are few problems of concurrence on the sequence of phases and dating of the Colonial-Sedentary and Sedentary-Classic transitions. Dean continues to say that there is still considerable disagreement with phase dates, particularly in Pioneer and Colonial periods, and the beginning and termination of the Hohokam expression. He concluded that, "given these circumstances, it can be seen that a rather uncertain foundation underlies any effort to evaluate the Hohokam chronology." However, since Dean completed his analysis, major advances in refining Hohokam chronology have been made (Richard Ciolek-Torello, pers. comm., 1999).

Rather than a full description of the chronology of the Hohokam; ethnohistory and ethnography; history; and Previous Work in the Area, as part of this report, please see *The Tres Rios Survey: An Archeological Survey of 700 Acres for the Proposed Tres Rios, Arizona Feasibility Study, Maricopa County* (McLean and Perry, 2002) for a complete discussion. A Bibliography is also included for additional information.

3.5.3 ETHNOHISTORY AND ETHNOGRAPHY

The Gila River Indian Community (Reservation) is located immediately south of the Salt River. The Gila River bisects the Reservation before its confluence with the Salt River at its northwest corner. Familiarly known as the Pima, the residents prefer their traditional name, Akimel O'odham, meaning the River People. The suffix O'odham means "we the people" (Fontana, 1983). Akimel refers to their inhabiting a riverine environment. Their cultural counterparts, the Tohono O'odham, are the Desert People. Remove the upper case "O" from "O'odham" and the term odham is singular (Barnaby V. Lewis, pers. comm., 1999). They originated in the Salt River Valley, then moved south into the Gila River Valley (Swanton, 1969 [1953]). The O'odham were called Pimas Altos, or upper Pima Indians, by the Spanish to distinguish them from their southern relatives in lower Sonora. The term Pima was used when Ezell (1983) wrote his history of the O'odham. However, since O'odham is preferred, this term will be used here.

There has been a longstanding, unresolved question regarding the lineal relationship between the O'odham and the Hohokam. The question is not with the contemporary O'odham who clearly see themselves as direct descendents. Archeologically, that is another issue because a link has not been firmly demonstrated. Paul Ezell (1983) offered arguments both ways. Haury (1976) wrote that "to assert that there was no connection between the Pima people and the Hohokam requires the removal of the latter from the area by about A.D. 1450 and the introduction of the Pimas with an impressively similar lifeway almost immediately." Verifying the relationship between the Hohokam and the O'odham is not currently a major research issue. Undoubtedly, someone will find a site that will bridge the gap and finally answer the question archeologically.

The early O'odham were organized around a patrilineal extended family system. Family members included the parents, married sons, and unmarried daughters. Families belonged to clans that were broken down further into moieties. Clans held something of a legitimizing function in the culture. Because they were a patrilineal culture, children of non-O'odham fathers were not accorded clan membership. Marriage was very informal; the couple simply moved in together. Divorces were also subject to the same lack of ceremony. They also had marriage rules that governed incest avoidance. The couple had to be separated by at least five generations.

Even under Spanish colonial rule, the Gila River Indians, known as GileZo's, enjoyed something of a privileged position (Ezell, 1983). This privilege was a result of several factors. They were cultivators as opposed to collectors and were thus considered to be productive. While some of the Gila Pimas took part in the revolt of 1843, the followers of Culo Azul stayed out of the fray and thus were considered loyal to the Spanish. The closest Spanish outpost was in Tucson at San Xavier del Bac, so their presence was very understated. They were able to control their lands because of the assumption that they would easily be incorporated into the Spanish or later Mexican, commonwealth (Ezell, 1983:153). Land titles were issued and following the Gadsden Purchase in 1853, the O'odham demonstrated clear Spanish title to their lands.

Table 3.5-1. Hohokam Chronology for the Phoenix Basin

Hohokam Chronology for the Phoenix Basin

	Conventional Periods and Subdivisions		Ceramic Markers	Phoenix Basin Phase Sequence
A.D. 1450?	Post-Classic			Polvoron
	Classic	Late	Gila Polychrome	Civano
		Early	Casa Grande R/B Smudged Red Wares	Soho
A.D. 1150	Sedentary	Late Middle Early	Sacaton R/B	Sacaton
	Colonial	Late	Santa Cruz R/B	Santa Cruz
A.D. 900		Early	Gila Butte R/B	Gila Butte
	Pioneer	Late	Snaketown R/B	Snaketown
A.D. 700		Middle	Sweetwater R/G	Sweetwater
			Estrella R/G	Estrella
A.D. 400		Early	Red Ware	Vahki
			Plain Ware	Red Mountain
A.D. 1				

Source: Deaver 1997:459

Neighboring Apaches and Yavapai stepped up attacks on the wealthy O'odham villages. This caused the normally peaceful O'odham to develop a militaristic society. The O'odham changed their raiding strategy from vengeance raids to Spanish-styled offensive incursions. Prowess in battle became honored and the further movement toward a war-oriented culture became quite evident.

Due to the requirements of intensified agriculture and increased raiding by the Apaches and Yavapai, the settlement patterns became denser. By necessity, this caused the further coordination and formalization of the society. Village autonomy suffered because the office of hereditary, paramount chief was established. Culo Azul, who claimed the role of governor, forced this change in political power. Pressure from Apaches was the catalyst that caused the push toward complex political organization and irrigation management (Hackenburg, 1983 citing Drucker, 1941). By the end of the Hispanic period, the O'odham were formally considered a "nation." The Spanish, Mexicans, and Anglo-Americans easily acknowledged this designation.

For a brief 15-year period, it appeared that the economic times had changed for the O'odham. A very wet period, "the wettest conditions in many centuries" (Hackenburg, 1983) lasted from 1905 until 1920. However, 40 years of extreme drought followed, wiping out all the gains they had recently made. Unfortunately, problems that arose in this debilitating 40-year period persisted until the 1980s, and only now are close to rectification with a new Bureau of Reclamation sponsored irrigation project. The Pima-Maricopa Irrigation Project is only in the early stages of implementation, with the preliminary archeological surveys now underway (Gila River Indian Community, 1998).

3.5.4 HISTORY

The potential value of the Salt River was realized when, in 1867, John W. "Jack" Swilling first ventured from Wickenburg to John Y. T. Smith's Hay Station, approximately four miles from present day Phoenix (Granger, 1960). Without a doubt, one of the more colorful people in Arizona's history, Swilling had compiled quite an impressive resume after arriving in Yuma in 1858.

In 1867, as a farmer visiting Smith's Hay Station, he observed the long, low earthen ridges radiating out from the Salt River and concluded that these were the remnants of a long forgotten irrigation system (Salt River Project [SRP], 1979; Myers, 1961). This observation prompted him to envision the irrigation potential of the Salt River. Swilling, together with Henry Wickenburg (formerly Heinrich Heintzel), discoverer of the extremely rich Vulture Gold Mine and founder of Wickenburg, and Yuma Ferryman Louis J. F. Jaeger, started the Swilling Irrigating and Canal Company. Jack Swilling's vision resulted in the growth of Phoenix.

One of the workers hired to begin digging the first canal was the well-schooled Englishman and possible British Army deserter, Lord Bryan Philip Darrel Duppa (Granger, 1960). The impetus to actually begin work on the canal probably was with the erudite Duppa's pronouncement that a canal could be created when he commented, "of course it's feasible. I've seen it done in Persia" (Myers, 1961). Swilling's fledgling company was incorporated in Prescott and officially opened for business on December 10, 1867.

The original canal, located in Hayden's Ferry, was Swilling's first effort to reopen a prehistoric Hohokam canal. But, he quit after hitting caliche and bedrock. Undaunted, he shifted his operation four miles downstream to another location just east of modern 40th Street (SRP, 1979). This second attempt was successful and became known as the Salt River Valley Canal. It was completed on April 5, 1868 (Myers, 1961; Carlin, 1981) for the meager sum of $400.00 (Horton, 1941:65).

Other canals followed Swilling's Ditch, developing the agricultural potential of the Salt River Basin. The Maricopa Canal was completed in 1869, the Arizona Canal in 1887, and the Highlands Canal was constructed in 1888. The early canals were beset by their own problems stemming from Salt River floodwaters. Flooding washed out the diversion dams, leaving the head gates high and dry and rendering them useless (Walker and Bufkin, 1986). A number of the historic canals were reconstructed from the old Hohokam canals. The only functional

difference between the Hohokam and modern canals is the lack of drop structures and drainage canals in the Hohokam systems according to Nials and Gregory (1989). Nials and Gregory compiled a list of the prehistoric canals and the historic counterparts (1989:45, Table 3.5-2) based on Turney's research (1929:51-52).

Table 3.5-2. Prehistoric Canals and Their Historic Counterparts

Prehistoric Canal System	Historic Equivalent
One	Tempe
Two	Grand (Swilling's first attempt)
Three	Ditch to Maricopa Reservation
Five	Dutch
Six	Farmers
Seven	Hayden and San Francisco
Twelve	St. John's

Source: Nials and Gregory, 1989, adapted from Turney, 1929

The Swilling Irrigation Canal Company moved its headquarters from Tempe back to Smith's Station. But the necessity to have an address for supply deliveries prompted the group to find a more identifiable name (Granger, 1960). In honor of his confederate heritage, Swilling suggested Stonewall. Another trial name was Salina. That was voted down because of the implications that the area was a salt marsh. The final selection was Duppa's who was mindful of the group's efforts to reopen the Hohokam canal, and had been reverentially impressed with the Hohokam's engineering skills. While clearing the old canal, Duppa expected that the Hohokam were able to set a proper gradient. During construction of the new canal, Duppa had quipped to Swilling, "I'm counting on them, though it's hard to see how they did it without a logarithm in their breech clouts" (Myers, 1961).

Duppa foresaw a new city as a Phoenix rising from the ashes of the old civilization. He is credited with giving the valley its name by declaring..."As the mythical phoenix rose reborn from its ashes, so shall a great civilization rise here in the ashes of a past civilization. I name thee Phoenix." Duppa is also quoted with a different version of his famous proclamation (Horton, 1941:15). Alternatively he may have said "A new city shall spring Phoenix-like upon the ruins of a former civilization." In any event, Phoenix became the new town's name. By 1871, Phoenix was an official town. The number of townspeople had risen to 300, a far cry from the old Smith Hay Station: population 1. All the original lots had been sold and the town was formally mapped. Phoenix was one-mile-long, one-half-mile-wide, and encompassed 96 blocks. Washington Street was the first main street running east west. The Salt River Valley Post Office was moved to Phoenix, and the first County election was held. In 1872, the 320 acre Townsite of Phoenix was officially filed in Prescott.

In 1877, the newly incorporated Sacramento Canal Company (SCC) drew 10,000 miner's inches of water from the north side of the Salt River, 7.5 miles east of the Agua Fria River. The SCC

canal was ten miles long comparable to the Farmers Canal also on the north side of the Salt River and eight miles to the east. Lowendorf (n.d.) noted that the head of the SCC canal was probably between today's 75th and 83rd Avenues. After further analysis, Lowendorf concluded that the SCC canal was probably a reopened Hohokam Canal that was affiliated with the nearby Hohokam site at Cashion. Both Omar Turney and Frank Midvale had identified a prehistoric feature at the site of the head of the SCC canal.

W. H. St. John and three colleagues constructed the 12-mile-long old St. Johns Canal near the present project area in Cashion in 1887. The canal's head was near where 83rd Avenue is located. By 1907, apparently all the other canals had disappeared. Surveyors for the Salt River Project (SRP) had mapped the area and the old St Johns Canal was the only one shown. An article in the Phoenix Herald in 1887 (Lowendorf, n.d.) drew attention to the new canal. An unnamed columnist wrote that four men, A. B. Smallwood, W. H. St. John, H. Warren, and Dan Martin had been working for a month on a new canal on the Salt River. The canal was designed to carry 5,000 miners inches of water and irrigate a 40 square mile area. The canal will be diverted on the Agua Fria near Yuma Road at a point where a "reef of rocks" provided a steady flow of water. According to Lowendorf (n.d.), other canals including the prehistoric Cashion Canal were probably dug in the same area.

Due to changing times, possibly associated with all the dams on the Salt and Verde Rivers drying up its water source, the old St. Johns Canal ceased to exist (Lowendorf, n.d.). In its place is the modern St. Johns Canal, which is fed from a well. The modern canal runs parallel to Southern Avenue for four miles and stops about one-half mile past its intersection with Dysart Road.

3.5.5 PREVIOUS WORK IN STUDY AREA

The earliest known archaeological work in the vicinity of the Rio Salado Oeste project involved Adolph Bandelier's and Frank Cushing's studies in the 1880s of Pueblo Grande approximately 15 miles to the east (Downum and Bostwick, 1993:17-21) and investigations of the prehistoric Hohokam canals (Hodge, 1893; Patrick, 1903).

The eastern portion of Cashion Ruin was recorded by Frank Midvale in 1923. Turney documented the western portion of Cashion Ruin in 1925 with updates in 1929 and 1935. Cashion Ruin was recorded again and trenched in 1939 by Audie R. Kelley as part of the Salt River Valley Stratigraphic Survey financed by the U.S. Works Progress Administration and headquartered at Pueblo Grande Museum under Director Odd Halseth (Downum and Bostwick, 1993:212-220).

Glen Rice (pers. comm., 1999) said that Midvale's Canal Cashion may not have actually been a canal, and that Midvale's site map was south of the site's actual location. During the Museum of Northern Arizona's (MNA) excavation of the Cashion Site, Antieau (1981) noted that he was unable to locate either the Canal Cashion or three Casa Grande type ballcourts, probably due to this locational error. Midvale mapped all the ruins in the Palo Verde project area right-of-way in 1967 and in some cases corrected Turney's locations (cf. Legend on Midvale's' map of the Cashion ruins in Antieau (1981:42). Antieau's excavations verified that Turney was in fact correct and Midvale was incorrect (Antieau, 1978).

Following Turney, Frank Midvale developed an interest in prehistoric irrigation and spent the 1920s, 30s, and 60s investigating every lead he could in an attempt to retrace the flow of irrigation water through the Salt-Gila Basin (Antieau, 1981:8). He had also mapped the five sites that were excavated by the MNA for the Palo Verde Nuclear Generating Station Wastewater Conveyance System (PVNGSWCS).

The Cashion site, NA 14690, was excavated by the MNA in 1977 and 1978 (Antieau, 1981). Midvale originally mapped the Cashion site in 1927 when he called it Los Conejos (Antieau, 1981:144). Estimated to cover approximately 640 acres, the Cashion site was listed on the National Register of Historic Places on December 19, 1978 (reference No. 78000547). It is the largest site excavated near the confluence of the Salt and Gila Rivers, one of the largest and the most complex in the Salt-Gila River Valley (Stein 1977), and equals Snaketown in size (Antieau, 1981). Encompassing dates from A.D. 500 - 1150, the Cashion site was occupied from the Pioneer through the Classic Periods (Stein, 1977; Antieau, 1981). By the end of the Classic Period, Cashion was largely abandoned.

3.5.6 RECORDS AND LITERATURE SEARCH

For the purposes of the record and literature investigation, the following description was used. The study area is approximately eight miles long extending from 19th Avenue on the east to 83rd Avenue on the west and from Lower Buckeye Road on the north to Baseline Road on the south. The project implementation area extends from 19th Avenue on the east to 83rd Avenue on the west, and is the area within the 100-year floodplain of the Salt River. The project Area of Potential Effect (APE) is on average approximately two-thirds of a mile wide and consists of approximately 3,315 acres.

A literature search of the proposed project area was performed through the Arizona State Museum, Arizona State Office of Historic Preservation, the City of Phoenix, and Corps of Engineers files. This search indicated that archeologists had never surveyed the APE.

3.5.7 RECOMMENDATIONS

Geoarchaeological investigations were conducted for the Tres Rios project (Onken et al., 2005), which provide a very good reconstruction of the floodplain history just west (downstream) of the Rio Salado Oeste study area, at the junction of the Salt and Agua Fria Rivers with the Gila River. The results of the Tres Rios geomorphological investigation suggest that 94 percent of that project area has no or low sensitivity for buried prehistoric sites.

Given Rio Salado Oeste's study area location upstream of Tres Rios, it is reasonable to conclude that the alluvial stratigraphy of the lower Salt River might be comparable. The entire length of the Salt River within the Oeste study area boundary appears to have been more disturbed than areas downstream, and has been modified through natural scouring action of periodic flooding, sand and gravel mining, and dumping.

Surveys of selected portions of the river, at all outfalls and adjacent or nearest terrace, were conducted by a Corps of Engineers staff archeologist. No cultural material was observed at any of these areas. The effects of the above mentioned impacts on the river are evident at the outfalls and surrounding areas. Based on the reconnaissance survey, level of disturbance, and data provided by the Tres Rios geological assessment, the Corps believes that the potential for buried archeological resources within the project area is low. Additional surveys would be conducted as necessary during the design phase.

A letter was sent to the Arizona State Historic Preservation Officer (SHPO) on July 6, 2005, with our determinations in accordance with 36 CFR 800.4(d). The SHPO provided a response in a letter dated August 10, 2005. This letter concurred with the APE as described in Section 3.5.6 above. The SHPO requested a written report of the survey conducted by Corps personnel. A Memorandum of Record (MFR) was completed describing the survey conducted in March, 2004. Copies of all these documents can be found in Appendix N of the Feasibility Report. The Rio Salado Oeste project is in compliance with Section 106 (36 CFR 800) of the National Historic Preservation Act (NHPA – Public Law 89-665; 16 USC 470-470m, as amended, 16 USC 460b, 470l-470n).

All supporting documentation required under 36 CFR 800.11(d) will be sent to the SHPO. This includes the draft environmental impact statement (EIS). The archeologist representing the City of Phoenix will receive copies of SHPO communications in addition to a copy of the DEIS.

3.5.8 NATIVE AMERICAN CONCERNS

Section 106 of the National Historic Preservation Act and the American Indian Religious Freedom Act of 1978 require that government agencies consult with Native Americans to determine their interests in federal projects. For the Rio Salado Oeste study, consultation was initiated with the following tribes: Ak-Chin Indian Community; Gila River Indian Community; Hopi Tribe; Pascua Yaqui Tribe; Salt River Pima-Maricopa Indian Community; Tohono O'odham Nation, and; Yavapai-Apache Nation. Letters including project descriptions and requests for comments were sent to these tribes noted below on July 6, 2005. The memorandum for record was transmitted to the tribes on October 6, 2005. The DEIS, including all identification, evaluation, and mitigation studies, will also be sent to the tribes for comment.

3.6 AESTHETICS

3.6.1 INTRODUCTION

This section describes the existing aesthetic resources and conditions in the study area. A description of local governmental organizations with jurisdiction in the area is also provided, along with the regulatory setting guiding aesthetic resources in the area. Please refer to Sections 3.1, "Geology and Topography," 3.2, "Hydrology and Water Resources," and 3.11 "Land Use," for other details on the physical conditions that influence the visual and aesthetic character of the study area.

3.6.2 GENERAL PROJECT SETTING

The study area is located in the eastern portion of Maricopa County, just north of the southern City of Phoenix boundary and South Mountain. The study area is located within a subdivision of the Sonoran Desert referred to as the Lower ColoradoValley, the Lower Sonoran or the *microphyllous* desert. This area is the largest and most arid subdivision of the Sonoran Desert. Low annual precipitation and high temperatures support relatively sparse vegetation. Characteristic species include blue paloverde (*Cercidium floridum*), creosotebush (*Larrea tridentata*) and bursage (*Ambrosia spp.*) (City of Phoenix, 1998).

Terrain ranges from hills and rock outcrops south of the study area to alluvium within the river floodplains to the north. Surrounding land on the western end of the study area is relatively flat and rural (rural residential, agricultural, dairy farms, open space and gravel mining), while the eastern portion of the study area is generally urban in character and land uses (residential, agricultural, light industry, manufacturing, commercial, gravel mining and vacant land). The slopes in the study area range from 0 and 2 percent (Maricopa County, 1992a). The study area includes the floodway and adjacent land uses. The study area stretches through urbanized Phoenix on the east and rural areas to the west, and is essentially a wide dry wash dominated by large expanses of sand, cobbles and sediment (silt and clay). The interior floor of the Salt River Valley is comprised of thick layers of alluvium on nearly level or gently sloping surfaces.

3.6.3 GENERAL DESCRIPTION OF THE PROJECT AREA

Views of the study area are limited due to existing development and lack of public access points along the banks. Views within the wash are characterized by diverse channel widths and include dry cobble/dirt, trash, debris and open water-dominated reaches. Generally, area topography is flat. This lack of topographic features limits long-range viewing opportunities along river channels. Very few vegetative communities exist within or along the sides of the wash. Visible degradation of the streambed in the eastern half of the study area has resulted from illegal dumping of garbage, household trash, commercial waste, used furniture, appliances, abandoned cars, tires, off-road vehicle use, gravel mining, and debris left over from unauthorized/illegal target shooting activities. Prominent features that can be viewed adjacent to Salt River include power lines and towers, scattered rural development on the western half of the study area, and light industrial, manufacturing and commercial auto salvage uses along the eastern half. Most notably, sand and gravel mining operations within and along the banks of the study area have significantly degraded visual resources and aesthetic conditions. Long-distance views include Sierra Estrella and South Mountain to the south, Camelback Mountain and the Phoenix Mountains to the northeast, and the White Tank Mountains to the northwest. Descriptions of the views from various locations along the study corridor are provided below.

35th Avenue: Views of the Salt River from the vicinity of 35th Avenue are wide open, revealing broad, relatively flat areas of cobble and dirt. Surface sediment is mostly fine sand, silt and clay. This portion of Salt River is used as an illegal dumping site for commercial and residential refuse and other materials. Domestic refuse and construction debris is common along this river section. Vegetation is exceedingly sparse in this area. To the north are gravel mining operations, industrial and warehouse uses. To the south are auto salvage and commercial uses.

43rd Avenue: Views of the Salt River from the vicinity of 43rd Avenue are unobstructed. This portion of the Salt River is also used as an illegal dumping site for commercial and residential refuse and other materials. Trash and debris are common along this section of the Salt River. Vegetation on the flat, dry landscape is very sparse in this area. Power lines and buildings can be seen in the distance. To the north are gravel mining operations. To the south are residential and manufacturing uses. Gravel mining continues on both sides of the wash from 43rd Avenue to the western end of the study area.

83rd Avenue: The study area east of 83rd Avenue consists of riparian habitat, including cottonwood/willow and salt cedar growing adjacent to the river channel at the on-grade river crossing. Vegetation on the flat, dry landscape is very sparse to the east of this crossing. Low-density, agriculture-related residential structures and crop fields are present to the north and south.

Broadway Road: The study area between the channel and Broadway Road consists of gravel mining operations in and along the channel and agricultural fields to the north. Vegetation within the channel is very sparse. New residential development is expanding from east to west along Broadway Road, displacing agriculture and dairy farms.

3.6.4 REGULATORY SETTING

Pertinent regulations, plans, goals and policies, related to aesthetic resources of the Rio Salado Oeste study area, are described below.

3.6.4.1 Maricopa County

Portions of the study area are within unincorporated Maricopa County and governed by county planning. The Maricopa County General Plan is divided into a series of land use plans for the area. Plans relative to the Oeste Project include the Maricopa County Comprehensive Plan, the Estrella Planning Area Land Use Plan, the Laveen Planning Area Land Use Plan (Maricopa County, 1997), and the City of Phoenix General Plan.

3.6.4.2 Maricopa County Comprehensive Plan

The Comprehensive Plan seeks to establish a network of protected open spaces that correspond to regionally significant mountains, rivers, washes and upland deserts. The existing and future open space areas are important to the quality of life in the county and are intended to be planned and managed to protect, maintain and enhance their intrinsic value for recreational, aesthetic and biological purposes. Dedicated Open Space areas are those areas that are under public ownership (except state trust land) that have unique environmental and physical qualities. These areas include mountains and foothills, rivers and washes, canals, significant desert vegetation, wildlife habitat and cultural resources. Within Maricopa County, Dedicated Open Space exists in the form of regional parks, wilderness areas, wildlife areas and in Tonto National Forest. Dedicated Open Space currently comprises approximately 2,000 square miles, with another proposed 650 square miles of open space in the unincorporated areas of the county.

According to the Comprehensive Plan, complementing open spaces and parks are visual resources. These are to include scenic corridors and vistas that offer county residents an opportunity to view the natural environment without manmade intrusions. Major rivers and washes thread through the region providing uninterrupted views of mountains, vegetation and wildlife native to the county. Major roads offer motorists scenic vistas as they travel.

3.6.4.3 Estrella Planning Area Land Use Plan

The Estrella Planning Area Land Use Plan (Maricopa County, 1992a) regulates planning and development activities within its jurisdiction of unincorporated Maricopa County. The Estrella Planning Area is currently highly rural in character and is considered an island of farming activity, surrounded by more urban-type development. The Salt River and the areas immediately north of it are designated as "Open Space" by the Estrella Land Use Plan. This category denotes areas that would be best precluded from development for any reasons except as open space or recreation areas, to potentially include parks, drainageways and scenic areas (Maricopa County, 1992a).

3.6.4.4 Laveen Planning Area Land Use Plan

The Laveen Planning Area Land Use Plan (Maricopa County, 1992b) regulates planning and development activities for approximately 30 square miles of unincorporated Maricopa County south of the Salt River. The area is generally characterized by rural ranchettes, cultivated farmland and dairy farms. There is a small urban area within Phoenix in the northeastern portion of the planning area. The portion of the Laveen Planning Area along the south banks of the Salt River is currently vacant. Minor amounts of developed land and agricultural land use are nearby. Industrial development and a considerable number of auto wrecking and salvage operations are located in the northeast quadrant closest to Phoenix (Maricopa County, 1992b).

3.6.4.5 City of Phoenix General Plan

The City of Phoenix General Plan (City of Phoenix, 2001b) regulates planning and development activities within incorporated areas of the city in the study area vicinity. The General Plan's mission is to help achieve the City's vision by preserving the culture, heritage and natural and manmade environment. The General Plan also acknowledges that preserved natural areas provide visual and emotional relief from day-to-day stresses of life in the urban setting, recreation, and habitat for native flora and fauna. Sonoran Desert, mountains, and wash terrain features define these major natural areas (City of Phoenix, 2001b).

3.6.4.6 Gila River Indian Community

The Gila River Indian Community (GRIC) is considered a Sovereign Nation, and is not under the regulatory or political jurisdiction of any local government or the federal government. No GRIC lands are located within the project implementation area, though some project features could be visible from tribal lands. The GRIC does not have any established regulations or plans for visual resources.

3.7 AIR QUALITY

3.7.1 INTRODUCTION

This section describes the existing climate, meteorology, and ambient air quality in the region of the study area, along with the regulatory requirements associated with the management of air pollutants.

3.7.2 CLIMATE AND METEOROLOGY

The proposed Rio Salado Oeste project is located within Salt River Valley (Valley) at an elevation of approximately 335 meters (1,100 feet). The Valley is oval shaped and flat, except for scattered precipitous mountains rising to as much as 460 meters (1,500 feet) above the Valley floor. The study area is characterized as a desert with hot summers, mild winters and low annual rainfall. As described in Table 3.7-1, summer mean high and low temperatures (July) in Phoenix are 41°C (106°F) and 27°C (81°F), respectively. Mean high and low temperatures for winter (January) are 19°C (66°F) and 5°C (41°F), respectively. Precipitation in the study area is approximately seven inches annually.

Precipitation occurs in two distinct seasons of the year; the summer monsoon season (July, August, September, and into October) and winter (December, January, February, and March). Rainfall is unusual in late May and June. There is a transition from generally dry conditions during the spring and early summer associated with the prevailing mid-latitude westerlies, to deep southeasterly or southerly winds that transport moisture from the Gulf of Mexico and the tropical eastern North Pacific. The change in air mass provides conditions favorable for the formation of deep convection that is typical of the summer in the southwest U.S. (ASU, 2005). Summer rains in the form of thunderstorms originate in moist air that flows into Arizona from the Gulf of Mexico and the tropical east Pacific. These storms generally occur in middle to late afternoon, and are usually of local extent. Approximately 80 percent of the thunderstorms over the basin occur in the summer months. Floods can occur from heavy thunderstorms, but are typically of short duration (lasting up to three hours).

Winter precipitation is normally associated with the passage of cyclonic storm centers originating in the Pacific Ocean, which commonly are a result of interaction between polar Pacific and tropical Pacific air masses. Some snow falls at the higher elevations, but the effect on flood flows is negligible. Individual storms usually are of several days' duration and wide aerial extent, with slow and steady intensity. Winter floods from these storms are of longer duration with lower flood crests.

As described in Table 3.7-1, the Valley is characterized by light wind speeds that range from 8.2 kilometers per hour (kph) [5.1 miles per hour (mph)] in December to 11.4 kph (7.1 mph) in July. Less frequently, widespread gusty winds occur over all areas of the Valley.

Table 3.7-1. Monthly Temperature, Precipitation and Wind Speed in Phoenix

Month	Temperature				Precipitation		Wind	
	Maximum		Minimum				Speed	
	°F	°C	°F	°C	inches	cm	mph	Kph
January	65.9	18.8	41.2	5.1	0.67	1.7	5.3	8.5
February	70.7	21.5	44.7	7.1	0.68	1.73	5.8	9.5
March	75.5	24.2	48.8	9.3	0.88	2.24	6.6	10.6
April	84.5	29.2	55.3	12.9	0.22	0.56	6.9	11.1
May	93.6	34.2	63.9	17.7	0.12	0.3	7.0	11.3
June	103.5	39.7	72.9	22.7	0.13	0.33	6.8	10.9
July	105.9	41.1	81	27.2	0.83	2.11	7.1	11.4
August	103.7	39.8	79.2	26.2	0.96	2.44	6.6	10.6
September	98.3	36.8	72.8	22.7	0.86	2.18	6.3	10.1
October	88.1	31.2	60.8	16	0.65	1.65	5.8	9.3
November	74.9	23.8	48.9	9.4	0.66	1.68	5.3	8.5
December	66.2	19	41.8	5.4	1.0	2.54	5.1	8.2
Source: National Climatic Data Center, Phoenix Annual Summary of the Local Climatological Data								

3.7.3 EXISTING AIR QUALITY

3.7.3.1 Criteria Pollutants

The quality of the surface air (air quality) is evaluated by measuring ambient concentrations of pollutants that are known to have deleterious effects. The degree of air quality degradation is then compared to the ambient air quality standards (AAQS). A summary of the air quality status in the study area (i.e., generally the urban area of Maricopa County) relative to the AAQS, is provided in Table 3.7-2.

Table 3.7-2. Attainment Status and Conformity Thresholds

December 2005 Maricopa County Area, Arizona			
Pollutant	Attainment Status	Federal Register Citation	Conformity Threshold
Carbon Monoxide	Maintenance Area	70 FR 11553 March 9, 2005	100 tons/yr
Ozone: VOC & NOx	**8-hr Standard** Basic Nonattainment Area **1-hr Standard** Maintenance Area	69 FR 23858 April 30, 2004 70 FR 34362 June 14, 2005	VOC: 100 tons/yr. NOx: 100 tons/yr
PM-10	Nonattainment Area- (Serious Classification) -	June 10, 1996 (61 FR 21372)	70 tons/yr
PM-2.5	Attainment Area	70 FR 944 January 5, 2005	N/A

Non-attainment is a term used to indicate the violation of a particular AAQS. Both the Arizona Department of Environmental Quality (ADEQ) and Maricopa County have adopted the federal AAQS, and do not enforce a separate set of standards. Air quality in the vicinity of the study area has experienced exceedances of the AAQS for fine particulate matter (PM-10) on several days each year. As a result, the U.S. Environmental Protection Agency (EPA) and ADEQ have classified Maricopa County as a serious non-attainment area for federal AAQS for PM-10.

ADEQ and Maricopa County Air Quality Department operate a countywide network of air pollution monitoring stations, including several in the study area. The air quality monitoring station nearest the study area is the West Forth Third Station (43rd Avenue and Broadway Road), located at a Maricopa County Department of Transportation storage lot. The second closest station is the Durango Complex (27th Avenue and Durango Street), located one mile northwest from the former Salt River site in the Maricopa County Flood Control District storage yard. Data from these sites provide a general profile of air quality within the study area. Table 3.7-3 lists the monitoring stations and presents ambient air quality concentrations recorded for PM-10 in 2002 through 2005, as well as the number of days the ambient concentrations exceeded federal/state AAQS. Ozone (O_3), nitrogen dioxide (NO_2), and carbon monoxide (CO) are not monitored at these stations. This is because the EPA guidance on siting monitors requires that monitors for ozone, nitrogen dioxide and carbon monoxide levels be located where levels of these pollutants are higher. PM-10 monitors are located in the study area because of the PM-10 sources in the vicinity.

Table 3.7-3. Air Quality Monitoring Stations

Pollutant Standards	Monitoring Station							
	27th Ave. & Durango Street				43rd Ave. & Broadway Road			
	2002	2003	2004	2005	2002	2003	2004	2005
Ozone (O_3)								
Maximum Concentration (ppm)	NM	NM	NM	NM	NM	NM	NM	NM
Days > NAAQS (0.08 ppm)	NM	NM	NM	NM	NM	NM	NM	NM
Nitrogen Dioxide (NO_2)								
Maximum Concentration ($\mu g/m^3$)	NM	NM	NM	NM	NM	NM	NM	NM
Days > NAAQS (100 $\mu g/m^3$)	NM	NM	NM	NM	NM	NM	NM	NM
Particulates (PM-10)								
Maximum Concentration	232	195	209		172	157	251	
Days > NAAQS (150 $\mu g/m^3$)	2	1	0	13*	1	1	1	13*
Carbon Monoxide (CO)								
Maximum Concentration (ppm)	NM	NM	NM	NM	NM	NM	NM	NM
Days > NAAQS (9.0 ppm)	NM	NM	NM	NM	NM	NM	NM	NM

Notes: ppm = parts per million; $\mu g/m^3$ = micrograms per cubic meter; NM = not monitored.
Source: Maricopa County Website. www.maricopa.gov/aq/AIRDAY/docs/REVIEW04.pdf pages 27&43.
*2005 exceedances for PM-10 are based on preliminary data that has not been quality assured.

3.7.3.2 Toxic Air Contaminants

Hazardous Air Pollutants: In addition to criteria pollutants, other regulated pollutants include hazardous air pollutants (HAPs) which are suspected or known to cause cancer, genetic mutations, birth defects or other serious illnesses in exposed people. HAPs are not regulated by federal AAQS, but are addressed by National Emissions Standards for Hazardous Air Pollutants (NESHAPs) and Title III of 1990 Clean Air Act Amendments.

The concentrations of toxic pollutants are determined by the level of emissions, at the source, and the meteorological conditions encountered as these pollutants are transported away from the source. Impacts from toxic pollutant emissions tend to be site specific and their intensity is subject to constantly changing meteorological conditions.

3.7.4 REGULATORY SETTING

3.7.4.1 Federal, State, and County Regulations

Federal, state and regional agencies have established standards and regulations addressing air pollutant emissions that affect proposed projects. The following federal and state regulatory considerations may apply to the project and to the alternatives.

- The federal Clean Air Act of 1970 directs the attainment and maintenance of National AAQS for six "criteria" pollutants (e.g., ozone, carbon monoxide, etc.).

- The 1997 Clean Air Act enacted legislation to control seven air toxic pollutants. EPA adopted the National Emission Standards for Hazardous Air Pollutants (NESHAP),

which was designed to control Hazardous Air Pollutants (HAP) emissions to prevent adverse health effects in humans.

- The 1990 Amendments to this Act determine attainment and maintenance of NAAQS (Title I), motor vehicles and reformulation (Title II), hazardous air pollutants (Title III), acid deposition (Title IV), operating permits (Title V), stratospheric ozone protection (Title VI), and enforcement (Title VII).

- Clean Air Act implements the New Source Review (NSR) and Prevention of Significant Deterioration (PSD) regulations.

- Maricopa Air Pollution Control Regulations Rule 310

- Arizona State revised Statute Title 49

3.7.4.2 Federal Conformity Requirements

Federal projects are subject to either the Transportation Conformity Rule (40 Code of Federal Regulations [CFR], Part 51, Subpart T), which applies to federal highway or transit projects, or the General Conformity Rule (40 CFR Part 51, Subpart W), which applies to all other federal projects. Because the proposed action is not a federal highway or transit project, it is subject to the General Conformity Rule. The purpose of the General Conformity Rule is to ensure that federal projects conform to applicable State Implementation Plans (SIP) so that they do not interfere with strategies employed to attain the NAAQSs. The rule applies to federal projects in areas designated as non-attainment areas for any of the six criteria pollutants for which the EPA has established NAAQSs and, in some areas, designated as maintenance areas. Maintenance areas are former non-attainment areas which have subsequently met the NAAQSs, and that have submitted an approved Maintenance Plan to demonstrate continued attainment. The General Conformity Rule applies to all federal projects except:

- programs specifically included in a transportation plan or program that is found to conform under the federal transportation conformity rule,

- projects with associated emissions below specified *de minimus* threshold levels, and;

- certain other projects that are exempt or presumed to conform.

The study area is in a serious non-attainment area for federal PM-10 standards. The area is also designated as a maintenance area for carbon monoxide and 1-hour ozone, and a basic non-attainment area for 8-hour ozone. The applicable *de minimus* thresholds are provided in Table 3.7-2. If the Rio Salado Oeste project would result in total direct and indirect emissions in excess of the *de minimus* emission rates, it must be demonstrated that the emissions conform with the applicable SIP for each affected pollutant. If emissions would not exceed the *de minimus* levels, the project is presumed to conform and no further analysis or determination is required.

3.7.4.3 Regional and Local Regulations

The proposed project would be located entirely within Maricopa County, and is under the jurisdiction of the Maricopa County Air Quality Department (AQD). Therefore, emissions that would result from the construction and maintenance of the project are subject to rules and regulations of the Maricopa County AQD. The rules and regulations of this agency help achieve defined air quality standards that are protective of public health by specifying emission controls and control technologies for each type of emitting source.

3.8 NOISE

3.8.1 INTRODUCTION

This section describes the existing noise setting in the vicinity of the Rio Salado Oeste study area, including noise sources and the regulatory setting for noise. General information about noise is also provided.

3.8.2 GENERAL NOISE SETTING

A noise environment consists of a base of steady background noise derived from many distant and indistinguishable noise sources combined with sound from individual local sources. In the study area, these local sources include frequent aircraft flyovers, traffic noise from area streets, and sand and gravel mining operations along the study area.

3.8.2.1 Description of Noise Characteristics

Noise is measured on the decibel (dB) scale, which quantifies sound intensity. Because the human ear is not equally sensitive to all frequencies within the entire spectrum, noise measurements are weighted more heavily within those frequencies of maximum human sensitivity (a process called "A-weighting"). The human ear can detect changes in sound levels of approximately 3 A-weighted decibels (dBA) under normal conditions. Changes of 1 to 3 dBA are typically noticeable under controlled conditions, whereas changes of less than 1 dBA are only discernable under controlled, extremely quiet conditions. A change of 5 dBA is typically noticeable by the general public in an outdoor environment. Noise may be generated from a point source, such as a piece of construction equipment, or from a line source, such as a road containing moving vehicles. Noise attenuates (decreases) with distance at a rate of 6 dB per doubling of distance for a point source and 3 dB per doubling of distance from a line source.

The rate at which noise attenuates can also be affected by the type of terrain over which the noise passes. For an acoustically soft site, such as undeveloped areas, open space, and vegetated areas, noise from a line source attenuates at a rate of 4.5 dBA per doubling of the distance. These rates represent the extremes, and most areas contain a combination of hard and soft elements, with the noise attenuation falling somewhere between these two attenuation factors. Objects that block the line of sight attenuate the noise source if the receptor is located within the "shadow" of the blockage, such as behind a sound wall. If a receptor is located behind the wall but has a view of

the source, the wall will do little to attenuate the noise. Additionally, a receptor located on the same side of the wall as the noise source may experience an increase in the perceived noise level because the wall will reflect noise back to the receptor, possibly compounding the noise. Time variation in noise exposure is typically expressed in terms of the average energy over time (called L_{eq}), or alternatively, as a statistical description of the sound level that is exceeded over some fraction of a given observation period.

3.8.2.2 Effects of Noise

High noise levels can interfere with a broad range of human activities in a way that degrades public health and welfare. Such activities may include;

- speech communication in conversation and teaching,
- telephone communication,
- listening to television and radio,
- listening to music,
- concentration during mental and physical activities,
- relaxation, and
- sleep.

Interference with listening situations can be determined in terms of the level of environmental noise and its characteristics. The amount of interference in non-listening situations often depends on factors other than the physical characteristics of the noise. These may include attitude toward the source of an identifiable noise, familiarity with the noise, characteristics of the exposed individual, and the intrusiveness of the noise.

3.8.2.3 Noise Sources

The study area is located in a mixed setting containing both urbanized areas and semi-rural areas. The study area has a moderate activity level and few sources of adverse noise. Sand and gravel mining operations are the largest contributors to ambient noise levels in the area. Vehicular traffic on streets that cross the study area (across the Salt River in a north-south direction) is another contributor of ambient noise. Study area traffic noise may be characterized as light and not considered to be significant. Aircraft departing from and entering Phoenix Sky Harbor Airport also contribute to the ambient noise in the study area. This airport is not within the immediate vicinity of the study area, though the study area runs generally parallel to the airport's takeoff and approach zone. Because aircraft produce intense noise and pass over the area at relatively low altitudes, these aircraft are considered to be moderate noise sources.

3.8.2.4 Sensitive Receptors

The study area contains residential, agricultural, industrial, and commercial land uses. Sensitive receptors for noise in the study area consist of residential uses located to the north of the river channel and a few scattered houses on the south side of the river channel.

3.8.3 REGULATORY SETTING

3.8.3.1 Federal and State Standards and Regulations

The Department of Housing and Urban Development (HUD) has identified the relationship between noise levels and human response. HUD has determined that over a 24-hour period, an L_{eq} of 70 dBA will result in some hearing loss. Interference with activity and annoyance will not occur if exterior levels are maintained at an L_{eq} of 55 dBA and interior levels at or below 45 dBA. Although these levels are relevant for planning and design and are useful for informational purposes, they are not land use planning criteria because they do not consider economic cost, technical feasibility, or the needs of the community. In addition to the L_{eq} limitations discussed above, in accordance with 24 CFR 51, Subpart B, "Noise Abatement and Control," HUD set 55-dBA day-night average sound level (L_{dn}) as the basic goal for residential noise intrusion. Other federal agencies, in consideration of their own program requirements and goals, as well as the difficulty of actually achieving a goal of 55-dBA L_{dn}, have settled on the 65-dBA L_{dn} level as their standard. At 65-dBA L_{dn}, activity interference is kept to a minimum, and annoyance levels are still low. It is also a level that can realistically be achieved.

The federal government regulates occupational noise exposure common in the workplace through the Occupational Health and Safety Administration (OSHA). Noise exposure of this type is dependent on work conditions and is addressed through a facility's or construction contractor's health and safety plan. With the exception of construction workers involved in facility construction, occupational noise is irrelevant to this study and is not further addressed in this document.

3.8.3.2 Regional and Local Standards and Regulations

Local governmental jurisdictions are responsible for regulating noise within their respective political boundaries. Specific noise regulations are discussed in the respective zoning ordinances for each of the local jurisdictions, where applicable.

3.8.3.2.1 Maricopa County

Maricopa County does not have a noise ordinance. Noise-producing aspects of new projects and existing development fall under the jurisdiction of individual cites in which a given development is located. On October 20, 1997, the County adopted the Maricopa County Comprehensive Plan, which contains a noise element. The Comprehensive Plan states that due to increased highway traffic, air traffic, construction, industrial and commercial activities brought about by growth and development, noise has become an increasing concern to both the public and governmental agencies. The Comprehensive Plan sets forth Objectives and Policies to reduce or eliminate sources of noise, including unnecessary traffic (Maricopa County Planning and Development Department, 1997).

3.8.3.2.2 City of Phoenix

The Phoenix Zoning Ordinance specifies the average noise levels for various land use categories. The City Code includes specific hours for construction operations (Section 23-14, h). During weekdays, construction hours include the period between 6:00 a.m. and 7:00 p.m. from the first day of May to and including the 30th day of September, and between the hours of 7:00 a.m. and 7:00 p.m. beginning the first day of October to and including the 30th day of April. Extended construction work hour permits would be required for Saturdays, Sundays, and hours that are beyond the construction periods described above.

3.9 SOCIAL AND ECONOMIC RESOURCES

3.9.1 INTRODUCTION

This section presents information regarding the social and economic resources that exist in the vicinity of the study area. A description of the population characteristics, including population, ethnicity, housing trends, local industries and employment rates is provided below. In addition, environmental justice issues are presented. The data and associated tables and figures presented in this section are based on information obtained from 1990 and 2000 U.S. Census Bureau surveys for Maricopa County, Maricopa Association of Governments (1997) and Arizona Department of Economic Security (1997 and 2000) web sites. These sites provided information regrading population- and housing-growth forecasts and other demographic projections for the County and local municipalities. In this socioeconomic report section, the term *study area* refers to the group of census tracts that exist within or extend into the study area. Whenever possible, the 1990 census information has been supplemented by the most current information available from the aforementioned sources and from the online database of the City of Phoenix (2002).

3.9.2 GENERAL SOCIOECONOMIC SETTING

3.9.2.1 Population

The southern portion of the study area lies in the southwest portion of the City of Phoenix, Arizona (City), which has a total population of 1,321,045 (U.S. Census Bureau, 2000). Table 3.9-1, "Population and Household Characteristics in the Vicinity of the Study Area," shows the 2000 population and household and family structure for the County and study area. In 2000, the population in the County totaled 3,072,149 people (U.S. Census Bureau, 2000). The Maricopa Association of Governments (MAG) projects that the County's population will grow to approximately 3,709,566 by 2010, and to approximately 4,516,090 by 2020, increases of 637,417 and 1,443,941 people, respectively (MAG, 2002). The study area includes only 1.6% of the total County population (U.S. Census Bureau, 2000).

Table 3.9-1. Population and Household Characteristics in the Vicinity of the Study Area

Jurisdiction	Population	Number of Households	Persons per Household	Number of Families	Persons per Family
Maricopa County	3,072,149	3,027,366	2.67	763,110	3.21
Study Area	48,854	11,504	3.93	9,362	4.20
Source: U.S. Census Bureau, 2000					

3.9.2.2 Ethnicity

Table 3.9-2, "Ethnic Population Characteristics in the Vicinity of the Study Area," shows the ethnic makeup of the County and the study area in 2000. The approximate population breakdown of the County by ethnicity is: 66.2% white, 24.8% Hispanic, 3.5% African American, 1.4% American Indian and Alaskan Native, 2.1% Asian, 0.05 % Native Hawaiian or other Pacific Islander, 0.1% other races, and 1.5% two or more races (U.S. Census Bureau, 2000).

Table 3.9-2. Ethnic Population Characteristics in the Vicinity of the Study Area

Jurisdiction	White	Black or African American	American Indian or Alaskan Native	Asian	Native Hawaiian or other Pacific Islander	Other	Hispanic or Lation	Two or more Races
Maricopa County	2,034,530	108,521	45,703	64,562	3,725	4,086	763,341	47,681
Percent of County Total	66.2%	3.5%	1.5%	2.1%	0.1%	0.1%	24.8%	1.6%
Rio Salado Oeste Study Area	11,714	2,918	3,019	166	31	47	30,543	416
Percent of Study Area Total	24.0%	6.0%	6.2%	0.3%	0.1%	0.1%	62.5%	0.9
Source: U.S. Census Bureau, 2000								

The ethnic composition of the study area differs from that of the County as a whole, most notably in the proportions of white and Hispanic residents. The proportions of the other races do differ as well, although not as much. The approximate population breakdown in the study area is: 24.3% white, 62.0% Hispanic, 5.9% African American, 6.2% American Indian and Alaskan

Native, 0.3% Asian, 0.06% Native Hawaiian or other Pacific Islander, 0.09% other races, and 0.85% more than two races.

3.9.2.3 Housing

The housing within the study area is characterized by urban, rural residential, and rural farming. Table 3.9-3, "Occupancy Rates in the Vicinity of the Study Area," shows the housing data for the County and study area for 2000. The County had a total of 1,250,231 housing units, of which 1,123,866 (89.8%) were occupied. MAG projects that the County will have approximately 1,490,212 housing units by the year 2010, and approximately 1,824,979 by 2020. On the local level, MAG predicts that the City will have approximately 604,938 housing units by 2010, and approximately 701,091 housing units by 2020 (MAG, 1997).

Table 3.9-3. Occupancy Rates in the Vicinity of the Study Area

Jurisdiction	Housing Units	Households	Occupancy
Maricopa County	1,250,231	1,123,866	89.8%
Study Area	12,448	11,504	92.4%
Percent of County Total	1.0%	1.0%	
Source: U.S. Census Bureau, 2000			

Table 3.9-4, "Housing-Unit Type and Housing-Unit Median Value in the Vicinity of the Study Area," shows that in 1990, 7,620 people (40.8% of the total population of the study area) resided in urban areas in the study area, while 3,417 people (31%) lived in rural areas (185 residing on farms and 3,232 on non-farmland). In the County, approximately 921,947 people (96.8% of the total population of the County) lived in urban areas, and approximately 30,352 people (3.2%) lived in rural areas. The housing units within the study area had a median value of $50,055.

Table 3.9-4. Housing-Unit Type and Median Value in the Vicinity of the Study Area

Urban	Rural		Urban		Median Unit Value
	Farm	Non-Farm	Inside	Outside	
Maricopa County	750	29,603	896,344	25,603	$85,300
Study Area	185	3,232	7,620	0	$50,055
Source: U.S. Census Bureau, 1990					

3.9.2.4 Employment

According to the Arizona Department of Economic Security, approximately 1,553,900 people were employed in Maricopa County in 2000, with employment expected to continue to grow in the region. Employment opportunities in the Phoenix-Mesa metropolitan area are expected to expand to 2,086,543 jobs by 2008. This would represent an 8-year increase of 532,643 jobs (2000–2008). In January 2002, the total civilian labor force in the County was 1,586,600, of which 1,501,000 were employed.

Table 3.9-5, "Industry Employment in Maricopa County, January 2002," shows 1,528,500 people are currently employed in the County (Arizona Department of Economic Security, 2002), a slight decrease from two years before.

Table 3.9-5. Industry Employment in Maricopa County, January 2002

Employment	Jobs
Total Civilian Labor Force	1,586,600
Total Unemployment	85,600
Total Employment	1,501,000
Non-Farm Employment	1,528,500
Goods Producing	258,900
Mining and Quarrying	1,000
Construction	112,500
Manufacturing	145,400
Service Producing	1,269,600
Transportation, Communication, and Public Utilities	82,200
Trade	374,400
Financial, Insurance, and Real Estate	125,300
Government	
Federal	19,700
State and Local	171,300
Source: Arizona Department of Economic Security, 2002 * Adjusted to the Current Population Survey (CPS 2002) to reflect place of residence. BENCHMARK YEAR 2001 QUARTER 1	

In Maricopa County, 1,877,045 people are expected to be employed by the year 2010, and 2,212,889 people are expected to be employed by 2020. Although employment predictions are not available specifically for the study area, the City of Phoenix is expected to have 821,325 persons employed by 2010 and 873,975 people employed by 2020 (MAG, 1997).

3.9.2.5 Income

Table 3.9-6, "Median Household Income in the Vicinity of the Study Area," shows median household income for residents within Maricopa County and the study area for the year 1990. In 1990, the median household income for the County was $30,797, whereas for the median household income for the study area was substantially less, averaging $19,493 (U.S. Census Bureau, 1990).

Table 3.9-6. Median Household Income in the Vicinity of the Study Area

Jurisdiction	Median Income Amount
Maricopa County	$45,358
Study Area	$27,847
Source: U.S. Census Bureau, 2000	

3.9.3 ENVIRONMENTAL JUSTICE

In 1994, the President of the United States issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. The objectives of the executive order include developing federal agency implementation strategies, identifying minority and low-income populations where proposed federal actions could have disproportionately high and adverse human health and environmental effects, and encouraging the participation of minority and low-income populations in the NEPA process. There are two types of data that must be reviewed to evaluate environmental justice effects: minority populations and income levels. Minority data for census tracts located within the study area were obtained from the recent 2000 census. Countywide statistics were reviewed to determine the percentage of the population not classified as Caucasian and the percentage classified as Hispanic. Using the county average for comparison, each of the census tracts in the study area was evaluated to determine whether the minority and/or Hispanic population percentages were greater than the county average. If a census tract percentage exceeded the county average, the tract was evaluated for environmental justice effects based on its minority population.

3.10 TRANSPORTATION

3.10.1 REGIONAL PLANNING

As the designated Metropolitan Planning Organization for the Maricopa region, the Maricopa Association of Governments plans and finances the regional transportation system. The Regional Transportation Plan (RTP) provides a broad vision for the regional transportation system for the next two decades, addressing freeways and other highways, streets, transit, airports, bicycle, and pedestrian facilities.

3.10.2 FREEWAYS AND SURFACE STREETS

The dominant mode of transportation in the Rio Salado Oeste study area is the automobile. Interstate Highway 10 (I-10) services Phoenix from the east and west, while Interstate 17 (I-17) brings travelers to and from Flagstaff, 130 miles to the north. These interstate highways are connected by an extensive network of limited access freeways, including State Routes 51, 101, 202 and 303. In addition to the interstate highways, State Highways 60, 85 and 87 are major transportation routes.

The Arizona Department of Transportation (ADOT) is currently conducting the South Mountain Corridor Study (http://www.dot.state.az.us/ROADS/SouthMtn). The South Mountain Freeway was included in the Regional Freeway System Plan that was approved by Maricopa County voters in 1985. Currently, several alternatives have been advanced for further study. Several remaining alternatives include crossing the river and project area somewhere between 59th and 91st Avenues. It is assumed that there is potential for a future freeway to cross the project area at some point in the future but that crossing should not adversely affect the Rio Salado Oeste Project. Construction funding for the project is included in the Regional Transportation Plan for 2009-2015.

Major surface streets are generally laid out in north-south and east-west directions at one mile intervals, though this pattern is interrupted by topography and restrictive land uses (such as airports) in some areas. Nearly all local streets and arterials near the Rio Salado Oeste study area are part of this north-south, east-west grid roadway network. Four local roadways cross the Salt River in the study area: 19th, 35th, and 51st Avenues (bridges) and 67th Avenue (at-grade crossing). All of these major surface arterials streets have interchanges with interstate 10 three to four miles north of the Salt River.

3.10.3 MASS TRANSIT

Valley Metro provides transportation services for the greater metropolitan area, including rideshare services and a large fleet of public transit buses. The area's first light rail line is expected to begin providing service between Phoenix, Tempe, and Mesa in 2008, with future extensions scheduled through 2025 (MAG, 2006)

3.10.4 AIRPORTS

Phoenix owns and operates three airports, Phoenix Sky Harbor International Airport (Sky Harbor), Phoenix Deer Valley Airport and Phoenix Goodyear Airport. Sky Harbor is served by 23 airlines which provide nonstop service from Phoenix to 89 cities in the United States and 17 cities in Canada, Mexico, and Europe (City of Phoenix, 2006). With more than 1,700 daily arrivals and departures, and 36 million passengers annually, Sky Harbor is the fifth busiest airport in the word (Sky Harbor Coalition, 2006). The Rio Salado Oeste study area is located approximately five miles west of Sky Harbor. Deer Valley Airport and Goodyear Airport are general aviation reliever airports for Phoenix Sky Harbor. Luke Air Force Base, while not a public airport, is a major consideration in airspace planning in the Phoenix area.

3.10.5 RAILROADS

The Phoenix area is serviced by two major railroads, Union Pacific and the Burlington Northern Santa Fe Railway. These rail lines are currently used for freight. The Maricopa Association of Governments is studying the feasibility of using these freight lines as the basis for a regional commuter network (MAG, 2006). No rail lines cross the Salt River in the study area.

3.10.6 REGULATORY SETTING

The Rio Salado Oeste project could potentially affect local roadway conditions, access, and through traffic flow. It may be necessary to obtain encroachment permits or similar legal agreements from the respective public agencies responsible for the numerous roadways through the study area. Such permits would be needed for any location where an activity would occur physically within the right-of-way of a public road. The regulatory setting of the transportation network in the area is guided by numerous governmental and political jurisdictions, which would be responsible for issuing such permits. Throughout the study area, these agencies include the City of Phoenix, the Maricopa County Department of Transportation, and the Federal Aviation Administration. ADOT has jurisdiction over activities occurring on or affecting I-10 and I-17 near the study area.

3.11 LAND USE

3.11.1 INTRODUCTION

This section describes the existing land uses and recreational opportunities in the vicinity of the Rio Salado Oeste study area. A discussion of the various planning organizations with jurisdiction in the area is provided, along with information on the regulatory setting for future development projects in the area.

3.11.2 LAND USE IN THE PROJECT STUDY AREA

Based upon the City of Phoenix General Plan (revised February, 2001), most of the land area on the north side of the Salt River between 19th Avenue and 59th Avenue is zoned as industrial, with some high-density residential between 43rd Avenue and 60th Avenue. From 60th Avenue to 83rd Avenue, the primary land use is low-density residential. South of the Salt River, there is some land between 19th Avenue and 35th Avenue zoned as commercial. Otherwise, the prevailing land use designation is low- to medium-density residential.

Estrella Village and Laveen Village are the two primary planning areas that lie adjacent to the Salt River between 19th Avenue and 83rd Avenue. Estrella Village is characterized by an ample supply of undeveloped land, large parcels, natural and scenic amenities, and excellent transportation access. As noted on the City of Phoenix web site, the village also poses unique challenges, given the isolation of its existing residential neighborhoods and the extensive industrial activities that have developed over the years. Approximately 62 percent of the Village

is undeveloped, either vacant or with agricultural uses. However, there are 21 residential developments in various phases of approval and development. Over 8,000 new single-family housing units were approved in this area in 1999 alone.

The Laveen Village contains largely undeveloped and agricultural properties. Primary agricultural crops grown in the area include cotton, citrus, and corn. The area has been valued by farmers, equestrians, and those looking for solitude and mountain access. However, development pressures have increased in this area due to its proximity (about seven miles) to downtown. This pressure is expected to increase along with access to the future South Mountain Loop transportation corridor. There are 12 residential developments in various phases of approval and development in the Laveen Village area, which is anticipated to result in a doubling of population over the next decade.

The South Mountain planning area is also primarily composed of vacant land, agriculture, and low-density residential uses. These categories, along with open space, represent over 85 percent of the space in this planning area (see Figure 3.11-1).

3.11.3 REAL ESTATE

The majority of the land within the project area is privately owned. Within the floodplain, or the area where restoration measures would be proposed, this ownership includes sand and gravel companies, the State of Arizona, Maricopa County, and the City of Phoenix. The City of Phoenix currently owns approximately 511 acres in the project area and has a Recreation and Public Purposes Lease on an additional 159 acres of Bureau of Land Management property. A general summary of land ownership within the 100-year floodplain is presented in Table 3.11-1. Refer to the Feasibility Report, Appendix G, Economic Evaluation, for more details.

Table 3.11-1. Property Ownership within the Study Area (100-Year Floodplain)

Ownership	Acres
City of Phoenix	511
Maricopa County	118
State of Arizona	261
Federal	190
Private	2094
Total	3174

3.11.4 NEARBY RECREATION RESOURCES

Arizonans place high importance on the State's outdoor recreation resources. In the 1994 Statewide Comprehensive Outdoor Recreation Plan survey, 94 percent of respondents stated that parks and recreation areas are important to their everyday lifestyles. With the exception of the

recently opened Rio Salado Phoenix project (Section 5.1.5), the greater Phoenix area does not have any significant riparian habitat areas with supporting recreation facilities. The major existing parks in the area consist primarily of desert mountain preserves, which do not contain the types of habitat that could be supported in the study area. For purposes of this analysis, the market area will be defined as the greater Phoenix metropolitan area, which would include Maricopa and Pinal Counties. However, it is likely that many visitors would be drawn from even greater distances.

3.11.5 REGULATORY SETTING

Although the proposed project is being undertaken by U.S. Army Corps of Engineers (Corps), the State, County, City and the Gila River Indian Community have jurisdiction over respective planning and development decisions in the study area. Regulatory requirements and future growth policies for these organizations are identified in several different planning documents. The regulatory setting for these organizations is presented below.

3.11.5.1 State of Arizona

In recent years, the State of Arizona adopted growth management legislation, known as "Growing Smarter" and "Growing Smarter Plus," in response to concerns about the rates of population growth in communities throughout the state. This legislation requires all cities in Arizona to update their General Plans. These laws were enacted to improve the way cities plan for future growth, expansion, and redevelopment by reforming local planning and zoning procedures, increasing citizen participation in growth and planning issues, and adjusting State Land Trust policies to preserve open space and enhance conservation.

City and county plans are required to include new elements and/or modify existing elements. Each municipality must coordinate their plan with other plans in the region. The Growing Smarter Act mandates five new elements to be added to municipal plans: open space, growth areas, environmental planning, cost of development, and water resources.

The State Land Department is also required to prepare a conceptual land use plan, with an annual five-year disposition or development plan for all trust lands located in urban areas. It must identify lands projected for sale, lease, reclassification, or rezoning over each period. The 2000 legislation requires that voters ratify new community plans at least once every ten years. If a proposed new plan fails to receive a sufficient number of votes, the existing plan remains in effect. Minor amendments to an existing plan must be approved by the City Council. During the 2002 legislative session, HB 2601 was introduced to address issues with the Growing Smarter legislation that were identified by stakeholders statewide through the efforts of the Growing Smarter Oversight Council. As proposed, the bill includes the following provisions, among others:

- extends the deadline for the adoption of updated General or Comprehensive Plans,
- clarifies language regarding the water resources element, and
- revises the requirements for the 60-day review period.

3.11.5.2 Maricopa County

Portions of the study area are within unincorporated areas of the County and are governed by county planning and development activities. The vast size of the County has dictated a sub-regional approach to comprehensive planning in the County during the last 20 years (Maricopa County, 1997). A series of land use plans for the area have been developed in a program to plan for unincorporated areas. Within the study area, these plans include the Maricopa County Comprehensive Plan, Estrella Planning Area land use plan, and the Laveen Planning Area land use plan. Each of these plans is briefly discussed below.

3.11.5.2.1 Maricopa County Comprehensive Plan

As required by state law, Maricopa County prepared a comprehensive plan "to conserve the natural resources of the County, to ensure efficient expenditure of public funds, and to promote the health, safety, convenience, and general welfare of the public" (Maricopa County, 1997). The plan provides a guide for decisions made by the planning and zoning commission and the board of supervisors concerning growth and development. The County lands within the study area are designated as a "General Plan Development Area" on the County's land use map. These areas are defined as unincorporated areas that are likely to be annexed by a city or town in the future and are included in an adopted municipal general plan. As is the case within the study area, these areas often include many of the unincorporated lands that are either surrounded by a jurisdiction or surrounded by a strip of annexation. The County will take into consideration the general plans of municipalities within these areas to guide decision making under the following circumstances: 1) the municipal plan has been updated in the previous five years; and 2) the municipality can demonstrate that residents, property owners, and improvement districts from the unincorporated areas in the specific planning area have been involved in the planning process (Maricopa County, 1997). The City of Phoenix General Plan meets these criteria and is discussed later in this chapter.

The Salt River is identified as "Proposed Open Space" on the land use map. This designation recognizes that natural resources and open spaces are important to the quality of life in the county and, if acquired, are intended to be planned and managed to protect, maintain, and enhance their intrinsic value for recreational, aesthetic, and biological purposes. Additionally, the General Plan provides that public access should be protected and preservation shall be encouraged. When combined with Dedicated Open Space lands, the Proposed Open Spaces are intended to establish an interconnected system of protected natural open spaces, corresponding to regionally significant mountains, rivers, washes, upland desert, and cultural resources in unincorporated areas of the County (Maricopa County, 1997).

The County's size and environmental diversity is greater than some U.S. states, and it provides a complex natural ecosystem. As part of the overriding vision for the County, protection of the unique desert environments is among the top priorities. The Maricopa County Comprehensive Plan focuses on maintaining and improving the physical environment, natural resource conservation, and other environmental considerations. Additionally, the plan recognizes the importance of creating, improving, and conserving natural habitat and open space to increase

biological diversity. River and wash policies include discouraging development within 100-year floodplains, maximizing wildlife habitat and native vegetation along waterways, and developing management principles to protect the natural riparian habitat of the region (Maricopa County, 1997).

3.11.5.2.2 City of Phoenix

The City of Phoenix General Plan (City of Phoenix, 2001b) regulates planning and development activities within incorporated areas of the city in the vicinity of the study area. The General Plan considers areas currently outside the jurisdictional political boundaries (unincorporated county lands) for potential future annexation. Through goals, policies and recommendations, the General Plan provides a short- (within the next 10 years) and long-range (10 to 20 years) comprehensive direction for the growth, conservation, and redevelopment of all physical aspects of the city. The mission of the General Plan is to help achieve the City's vision by preserving the culture, heritage, and natural and human-made environment. The General Plan also acknowledges that preserved natural areas provide visual and emotional relief from day-to-day stresses of life in the urban setting, recreation, and habitat for native flora and fauna. Mountains and wash terrain features define these major natural areas (City of Phoenix, 2001b). As part of the strategic growth concepts adopted by the City, the Estrella and Laveen areas are two of the major target growth areas identified in the General Plan, and are within the study area. The Rio Montana Plan (2000), prepared for the eastern portion of Laveen, identifies "encouraging development and redevelopment along the Rio Salado that will be compatible with the Rio Salado Habitat Restoration Project" as one of the major issues that is unique to the area. The Estrella Plan (1999) identifies "encouraging development along Rio Salado that will be compatible with the new residential character village" as one of the major issues that is unique within the area (City of Phoenix, 2001b).

3.12 RECREATION

3.12.1 INTRODUCTION

This section presents the existing recreational opportunities in the vicinity of the Rio Salado Oeste study area. A discussion of the planning organizations with jurisdiction in the area is provided, along with information on the regulatory environment guiding recreational facilities in the area. Several local government agencies have jurisdiction over recreational facilities in the area. Although the majority of the study area lies within the City of Phoenix, a substantial portion lies within unincorporated Maricopa County. The Gila River Indian Community (GRIC) has jurisdiction over the far southwestern corner of the study area.

South Mountain Park is the largest nearby recreation area. South Mountain Park is located about three miles south of the Salt River and extends from about 48th Street on the east to 43rd Avenue on the west - a distance of over ten miles. The park is bounded on the north by Baseline Road and on the south by Chandler Boulevard, and is over three miles wide in some places. It encompasses about 17,000 acres of desert mountain landscape and is the largest municipal park

in the United States. It contains an activity complex, hiking and riding trails (extending over 40 miles), an interpretive center, lookouts, ramadas, picnic areas, and restrooms.

The Estrella Mountains Regional Park is located southwest of the study area within the Cities of Avondale and Goodyear. The 19,840-acre park features 65 acres of grass with ten covered ramadas, picnic tables, grills, restrooms, playground equipment, two lighted ballfields, a rodeo arena, and an 18-hole privately operated golf course. In addition to the developed recreational facilities, the park offers an extensive natural desert landscape for passive recreation. More than 33 miles of trails for hiking, mountain biking, and horseback riding are available for use.

Maricopa County provides a countywide system of trails, the primary component of which is the Sun Circle Trail. The Sun Circle Trail, when completed, will encircle the Phoenix metropolitan area (Maricopa County, 1992). This trail will provide opportunities for hiking, horseback riding, and bicycling. The existing recreational environment is provided for the respective government jurisdictions below.

3.12.2 CITY OF PHOENIX

The Phoenix Parks, Recreation, and Library Department operates more than 200 parks throughout the City, including six desert-mountain parks and 132 urban parks. The Department also administers almost 26,000 acres of desert parks and preserves within the city limits and more than 100 miles of Sonoran Desert trails (City of Phoenix, 2001a). In addition to facilities and programs offered on city-owned land, the recreation needs of the community are met in part by joint use of school facilities, such as lighted fields and school buildings. Recreational facilities within the City also include swimming pools, special facilities (such as historic sites, stadiums, and gardens), urban parks (small, pedestrian-oriented green open spaces within dense urban areas), and the West Valley Recreation Corridor (the longest recreation corridor in the Valley, extending from Lake Pleasant to Avondale along Agua Fria River and New River). In the study area, the existing streambed consists primarily of a dry wash with no recreational facilities or public access for recreation. The only improved recreation area adjacent to the Salt River in the Phoenix area is the 14-acre Rio Salado Park, which is located outside the study area at 12th Street and Elwood.

3.12.2.1 Rio Salado Phoenix Project

The Rio Salado Project is a planned recreational and habitat restoration project that is in the process of restoring the Salt River to a more natural state. It includes construction of a low-flow channel in the river bottom, and establishment of open water, wetland marsh, cottonwood/willow, open edges, and mesquite habitat on the river bottom and over banks. The project includes approximately 595-acres of restoration and 10-miles of a recreation multi-use path. Additional recreational elements include scenic overlooks, interpretive centers, gathering areas, parking, restrooms, and shade structures. Activities along the project area include bird watching, hiking, biking, and equestrian uses, wildlife observation, and fishing. The project is located immediately upstream from the project study area, and opened for public use in November, 2005.

3.12.2.3 Tres Rios Project

The Tres Rios project extends west from the 91st Avenue wastewater treatment plant to the confluence of Gila and Agua Fria Rivers. The selected plan includes a 6-mile flood control levee, a 184-acre regulating wetland that would equalize diurnal variations in discharges from the 91st Avenue treatment plant, a 300-million gallon per day pump station to convey the flow from the treatment plant to the regulating wetland, 128-acres of wetland along the north bank of the Salt River, a pipeline in the overbank wetland that would lead to 38-acres of riparian corridor, 134-acres of open water marsh, grading the Salt River to convey surface water to supply 69-acres of riparian habitat, and a dewatering well from the treatment plant that will deliver enough water to support about 206 acres of open water marsh and about 16 acres of riparian corridor on the south bank of the Salt River. In all, approximately 775 acres of habitat will be restored and an 11-mile recreation path will be created. Construction on the levee began in 2005 and scheduled for completion in 2008.

3.12.3 GILA RIVER INDIAN COMMUNITY (GRIC)

No recreational facilities or parks that fall within the jurisdiction of GRIC were observed within the study area.

3.12.4 REGULATORY ENVIRONMENT

Although the proposed project is being undertaken by the Corps and the City of Phoenix, Maricopa County has jurisdiction over respective planning and development decisions in some portions of the study area. Because three separate jurisdictions have authority over planning and development in the study area, there are a multitude of regulations within the various planning documents.

3.12.4.1 Maricopa County

Portions of the study area are within unincorporated Maricopa County. The Maricopa County Comprehensive Plan is divided into a series of land use plans for the area. Plans relative to the Oeste Project include the Maricopa County Comprehensive Plan, the Estrella Planning Area Land Use Plan, and the Laveen Planning Area Land Use Plan. Goals and policies related to recreation facilities are discussed for each plan below (Maricopa County, 1997).

3.12.4.2 Maricopa County Comprehensive Plan

The Comprehensive Plan seeks to establish a network of protected open spaces that correspond to regionally significant mountains, rivers, washes, and upland deserts. Parks and recreation facilities are a form of secured open space that provide the foundation of a coordinated outdoor recreation system and contribute to the County's quality of life. Existing publicly owned recreation areas include neighborhood and community parks, Maricopa County regional parks (the largest county park system in the country), State Game and Fish lands, and a municipal mountain preserve. These lands provide recreational opportunities within or near urbanized areas.

The Comprehensive Plan recommends acquisition of open space to meet the passive and active recreation needs of the region's population. Dedicated open space areas are those areas that are under public ownership (except state trust land) that have unique environmental and physical qualities. These areas include mountains and foothills, rivers and washes, canals, significant desert vegetation, wildlife habitat, and cultural resources. Within Maricopa County, dedicated open space exists in the form of regional parks, wilderness areas, wildlife areas, and the Tonto National Forest. This dedicated open space currently comprises approximately 2,000 square miles, with another 650 square miles of proposed open space in the unincorporated areas of the county. Open space provides recreation and visual resources for the residents of Maricopa County.

3.13 PUBLIC HEALTH AND SAFETY

3.13.1 INTRODUCTION

This section describes the existing environmental conditions in the vicinity of the Rio Salado Oeste study area relating to public health and safety.

3.13.2 GENERAL PROJECT SETTING

The Salt River is a terraced, low-gradient river. Historically, its flow has been directed by development, dating back to Native American use of the river for irrigation. Presently, the Salt River is a mostly dry riverbed whose flow is dependent on large storm events, treatment plant releases, or upstream dam releases. Depth to groundwater ranges from 70 feet below land surface near 19th Avenue to 40 feet below land surface near 83rd Avenue. The direction of flow is highly variable; however, groundwater flow is generally to the west (Arizona Department of Water Resources, 1992). Soil types in the Salt River are porous sands, gravel, and rounded cobbles.

The primary modern use of the Salt River is for extreme event flood damage reduction. The land uses in the vicinity of the Salt River between 19th Avenue and 83rd Avenue are sand and gravel quarries, automotive scrap yards, commercial developments, and residential developments on the south side of the river, and residential developments, sand and gravel quarries, and landfills on the north side of the river. The soils and water in the riverbeds are potentially subject to contamination from several sources, including discharge from stormwater systems that may carry metals, grease, and oils of minimal toxicity; overland flows that may transmit sediment and fertilizers; leachate from landfills within the riverbed; and point-source dumping by the general public. The City of Phoenix collects and discharges untreated stormwater from its streets and gutters into Salt River. The Salt River Project (SRP) releases water into storm drains and farmers release irrigation return into Salt River (Salisbury, pers. comm.). City ordinances do not allow gutters and storm sewers to be used for any purpose other than stormwater. EPA issued a permit to the City for this activity. According to City of Phoenix staff, stormwater is tested by the Flood Control District of Maricopa County, while dry weather runoff is tested by the City. Phoenix has cameras installed in storm drains to monitor for illegal sources of runoff.

The 23rd Avenue Phoenix wastewater treatment plant is located just south of Lower Buckeye Road. Phoenix treats and releases this municipal wastewater into Salt River under a National Pollutant Discharge Elimination System (NPDES) permit issued by the EPA and an Aquifer Protection Permit issued by ADEQ. Under the NPDES permit, Phoenix must submit an annual report with analytical results of sampling (Karnes, pers. comm.). The 2001 annual report indicates that the plant had no discharges that violated applicable EPA or local standards (Hollender, pers. comm.).

3.13.3 REGULATORY SETTING

The principal federal regulatory agency for hazardous waste is the EPA. In Arizona, the Arizona Department of Environmental Quality (ADEQ) is responsible for implementing federal regulations throughout the state. Federal law requires state regulations to be at least as stringent as federal regulations.

The Occupational Safety and Health Administration (OSHA) is the primary federal agency responsible for worker safety in the handling and use of chemicals in the workplace. The employer is required to monitor worker exposure to listed hazardous substances and notify workers of exposure. OSHA regulations specify requirements for employee training, availability of safety equipment, accident-prevention programs and hazardous substance exposure warnings.

3.13.4 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE (HTRW)

The presence of Hazardous, Toxic, and Radioactive Wastes (HTRW) within the study area was evaluated for the study. Because of the size of the study area, approximately 23.5 square miles total, a typical Phase I Environmental Site Assessment (ESA) was not feasible. Consequently, a Modified Phase I ESA was determined to be most appropriate for the project. The basic difference is that a site reconnaissance of every property within the project area was not conducted. The Modified Phase I ESA was conducted to review past and current land use practices along the site corridor to identify areas of known or suspected contamination that may environmentally impact the subject property.

The site corridor is defined as the neighboring properties and facilities along the Salt River within an approximate distance of one mile north and south of the river's centerline, the nature of which may adversely affect or have affected environmental conditions at the site due to the presence and/or release of hazardous substances or petroleum products to the environment. URS completed the assessment under contract to the City of Phoenix (URS, 2002).

The Modified Phase I ESA was accomplished by, and limited to, a visual reconnaissance of the site from existing rights-of-way and public areas, a drive-by survey of the site corridor (or vicinity), a review of publicly available records (including aerial photographs), and a review of pertinent documentation presently and readily available from the client and/or through URS' standard resources. The following activities were conducted in accomplishing the Modified Phase I ESA:

- Review of aerial photographs.
- Review and interpretation of available archival topographic maps, historical land use maps of the site for information regarding historical site land use that could have involved the manufacture, generation, use, storage and/or disposal of hazardous substances.
- Review of the following state and federal agency lists of known or potential hazardous waste sites, and sites currently under investigation for potential environmental violations as prescribed by the American Society for Testing and Materials. All databases were searched for areas approximately one mile from the Salt River centerline to include the project implementation area (or buffer area):

  Federal National Priorities List (NPL) site list
  Federal Comprehensive Environmental Response, Compensation, and Information System (CERCLIS) list
  Federal Resource Conservation and Recovery Act (RCRA) CORRACTS TSD facilities list
  Federal RCRA non-Corrective Action Report (CORRACTS) Treatment, Storage, and Disposal (TSD) facilities list
  Federal RCRA generators list
  Federal Emergency Response Notification System (ERNS) list

  State lists of hazardous waste sites identified for investigation or remediation:
  State-equivalent NPL
  State-equivalent CERCLIS
  State landfill and/or solid waste disposal site lists
  State Leaking Underground Storage Tank (LUST) lists
  State-registered Underground Storage Tank (UST) lists

- Review of previous environmental reports conducted within or relating to the Rio Salado Oeste study area.

- Performance of an onsite visual reconnaissance of the subject property and the area within 1-mile of the Salt River centerline in each direction to make visual observations of existing site conditions, activities, and types of land use and businesses within the project corridor area.

Sites having possible HTRW concerns include Arizona Water Quality Assurance Revolving Fund (WQARF)/National Priority List (NPL, or Superfund) sites, landfills, LUSTs, other sites included on lists of known or potential hazardous waste sites, and sites currently under investigation for potential environmental violations. Areas of groundwater quality concern are summarized in the Modified Phase I ESA prepared by URS (2002), and are depicted on Figure 3.3-2. The entire assessment is included as Appendix F to the Feasibility Report. Groundwater quality concerns are also addressed in Appendix D: Groundwater Quality and Hydrogeology Report attached to the Feasibility Report.

Sites identified with possible HTRW concerns are, for the most part, located outside the 100-year floodplain (Figure 3.3-2). Project features would be located almost entirely within the 100-year floodplain, and would be designed to avoid the known HTRW sites. In accordance with Engineer Regulation 1165-2-132, the Corps would not participate in clean up of materials regulated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or by the Resource Conservation and Recovery Act (RCRA).

3.13.5 WQARF/NPL SITES

There are two Arizona Water Quality Assurance Revolving Fund (WQARF)/National Priority List (NPL, or superfund) sites adjacent to or near study area. These sites are the 19th Avenue Landfill, and the West Van Buren WQARF Site. The 19th Avenue Landfill is located adjacent to the east side of the study area on 19th Avenue between Lower Buckeye Road and the Salt River. The landfill was used for disposal of municipal and local industrial waste. Historically very low concentrations of VOCs, heavy metals, and beta radiation have been detected in groundwater at the site. Remediation activities at this site have been completed and the site is currently in the operations and maintenance phase (ADEQ, 2001).

In 2001, moderate concentrations of 1,1-Dichloroethylene (1,1-DCE) were detected in two wells located in the study area and associated with the 19th Avenue Landfill NPL Site. One of these wells had a concentration exceeding the ADEQ Aquifer Water Quality Standard (AWQS) of 7 micrograms per liter (µg/L). Based on these data and data from wells east of the study area, the likely extent of groundwater with high concentrations of 1,1-DCE was estimated as shown on Figure 3.3-2.

The West Van Buren WQARF Site is located between Buckeye Road on the south and Van Buren Street on the north and between 7th Avenue on the east and 83rd Avenue on the west. Part of the study area falls within the one-mile buffer zone of the West Van Buren site. This site has elevated concentrations of tetrachloroethene (PCE) and trichloroethene (TCE) (ADEQ, 2001).

The portion of the study area north of the Salt River and east of 51st Avenue is most likely to be impacted by poor groundwater quality from these sites. However, the study area is located up-gradient, so encroachment of poor quality groundwater from these sites is not anticipated.

3.13.6 SOLID WASTE LANDFILLS

There are three closed landfills within the study area. These include the 27th Avenue Landfill which was closed in 1995, and the SRP landfill, closed in 2000. The 19th Avenue landfill, located east of 19th Avenue, has been closed and a remediation plan has been implemented. Groundwater monitoring is conducted at the landfills. Although these landfills are within the study area, they are outside the project implementation area and would not have any impact on the project.

3.13.7 LEAKING UNDERGROUND STORAGE TANKS (LUSTS)

Thirteen LUST sites with monitoring wells on record with ADWR were identified within the study area. Description of the sites can be found within Appendix D, Groundwater Quality and Hydrogeology Report attached to the Feasibility Report. These sites may have impacts on local soil and water conditions, but are not considered likely to affect the project to be implemented within the floodplain.

3.13.8 WASTEWATER TREATMENT PLANTS

The 27th Avenue wastewater treatment plant (WWTP) is located near the upstream end of the study area, while the 91st Avenue WWTP is located just downstream of the study area. The 27th Avenue WWTP is currently active, and effluent water is discharged at the outfall point on the north side of the Salt River near 35th Avenue. There are currently eight monitoring wells surrounding the sludge drying beds and a monitoring well near the outfall point. Groundwater from these wells is sampled and analyzed periodically. The well near the 35th Avenue outfall point is monitored as part of the Aquifer Protection Permit (APP) for the site.

The 91st Avenue WWTP is currently active and effluent water is discharged to the Salt River. This effluent will be used as a water source for the Tres Rios Project, a riparian habitat restoration project that is located west of 83rd Avenue. Part of the WWTP's field of sludge drying beds is located within the study area boundary. Since the WWTP's effluent outfalls are west of the study area, and groundwater flow is to the west in the vicinity, the WWTP will likely have little influence on groundwater quality within the study area.

3.13.9 "WILDCAT" DUMPING

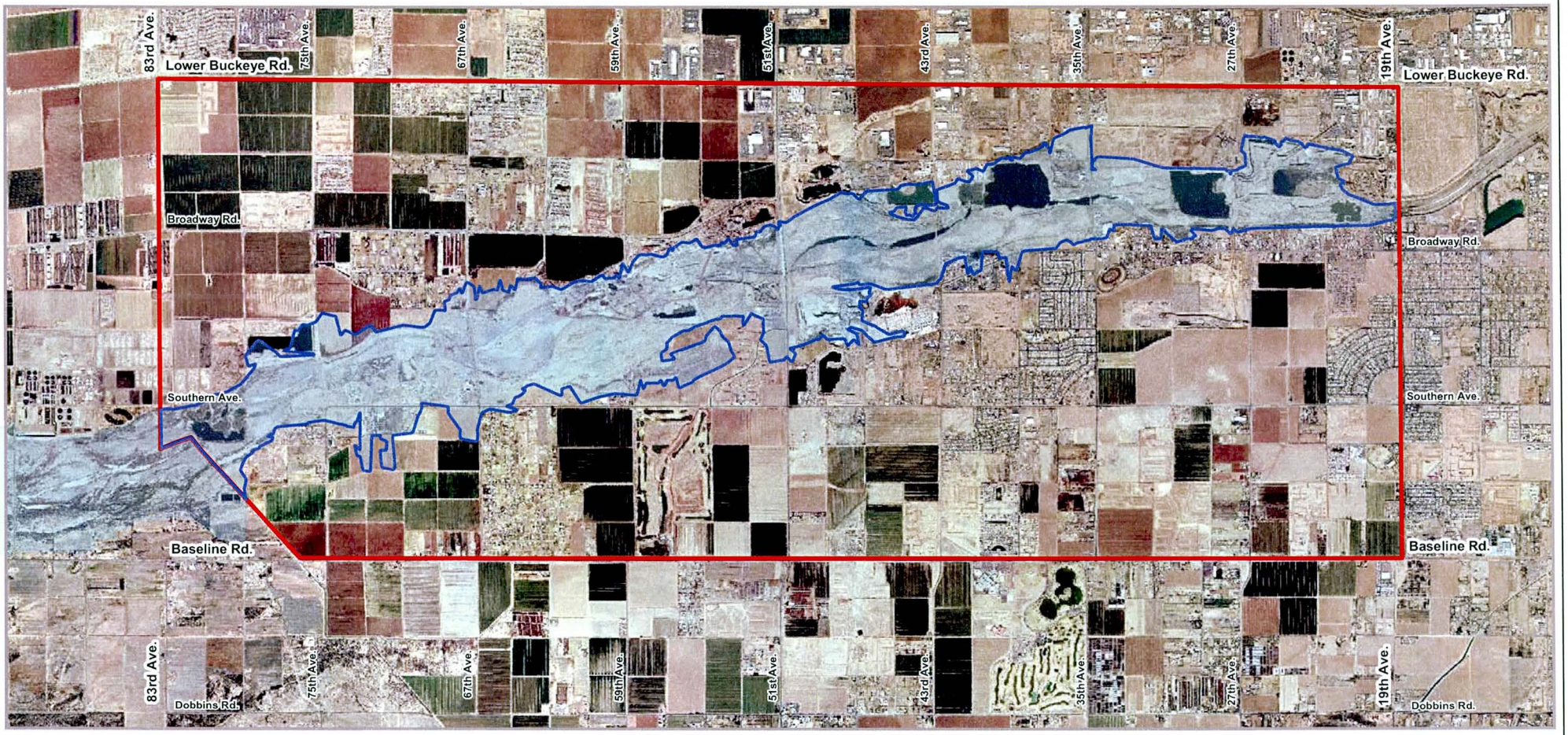
"Wildcat" or uncontrolled, illegal random dumping of materials has occurred and continues to occur along the river and study area. This dumping includes soils, concrete, asphalt, construction debris, commercial refuse, household and landscape waste, etc. The reach between 35th and 51st Avenues was at one time littered with such waste materials. However, the City of Phoenix has implemented changes that significantly reduced the amount of dumping in this through barricades and increased policing. It should be assumed that some waste is still present within the study area. Dumping could result in potential sources of contamination.

3.13.10 VECTOR CONTROL

Maricopa County Department of Environmental Services, Vector Control Division and Arizona State Department of Health Services, Office of Infectious Disease Services, Vector-Borne and Zoonotic Disease Section are the agencies primarily responsible for control of mosquitoes and other animal vectors in the project area.

The ecological characteristics in the study area provide a potential environment for mosquito infestation. Mosquitoes are a public health concern because of their potential to spread disease. Mosquito-borne viruses, such as St. Louis encephalitis virus, western equine encephalitis, and West Nile virus, are found every year in Arizona. Public health agencies in the state have been

monitoring mosquito borne viruses for many years and added West Nile monitoring in 2003. Maricopa County Vector Control has a routine monitoring program county wide and a vector control program to help reduce the risk of mosquito-borne disease. Maricopa County monitors mosquitoes along the Salt River, primarily during the summer. Monitoring methods include carbon dioxide traps set twice each month (Ramirez, pers. comm.).



Legend

- Project Study Area
- Project Implementation Area
- 100-Year Floodplain

March 2006

100-YEAR FLOODPLAIN

Rio Salado Oeste

N
W E
S

0 5,000 10,000
Feet

Figure 3.2-1

US Army Corps of Engineers.

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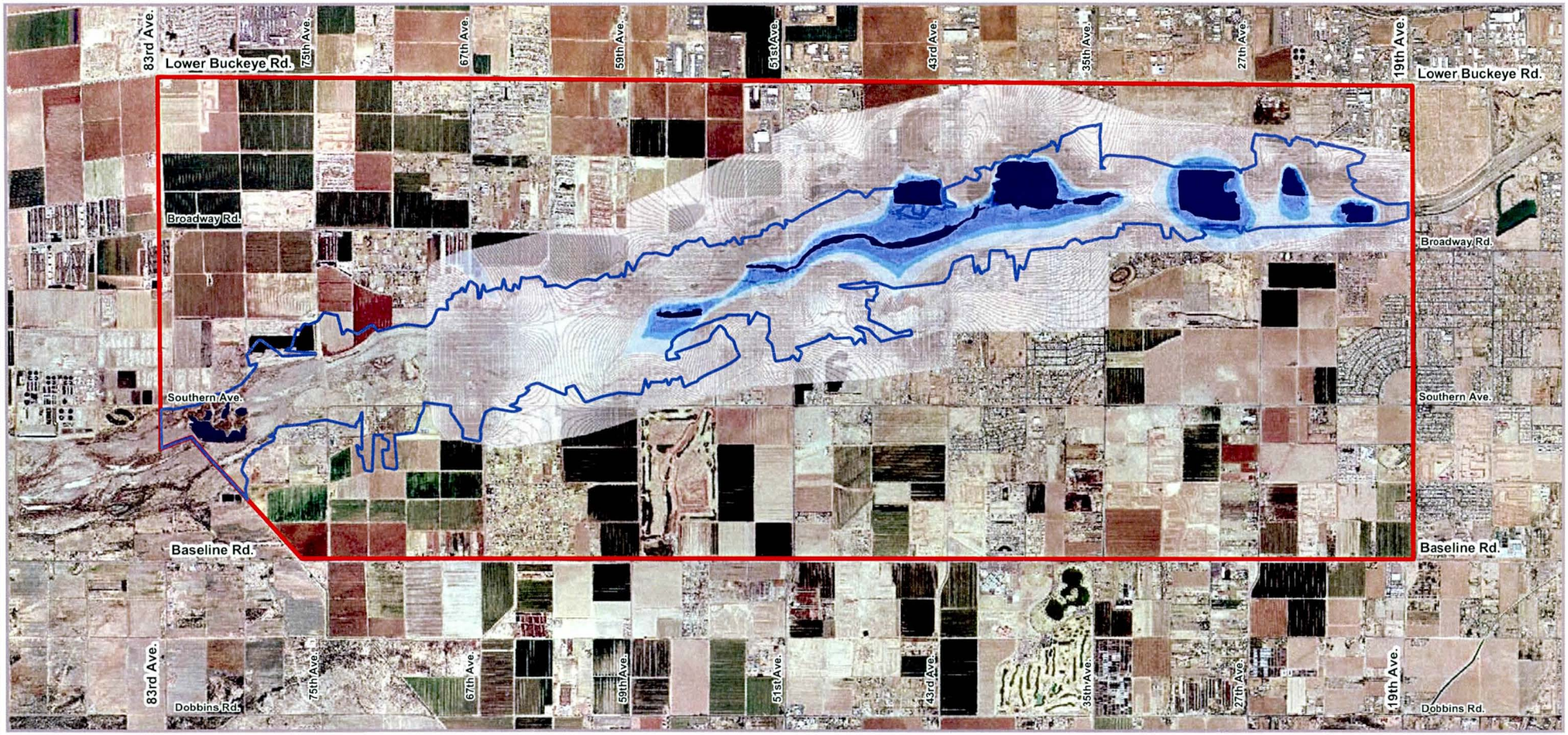
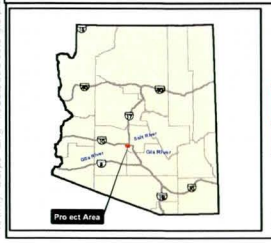




Legend

- Project Study Area
- Project Implementation Area

Depth to Groundwater

- Surface Water
- 0 - 3 Feet
- 4 - 5 Feet
- 6 - 10 Feet
- 11 - 112 Feet

March 2005

DEPTH TO GROUNDWATER

Rio Salado Oeste

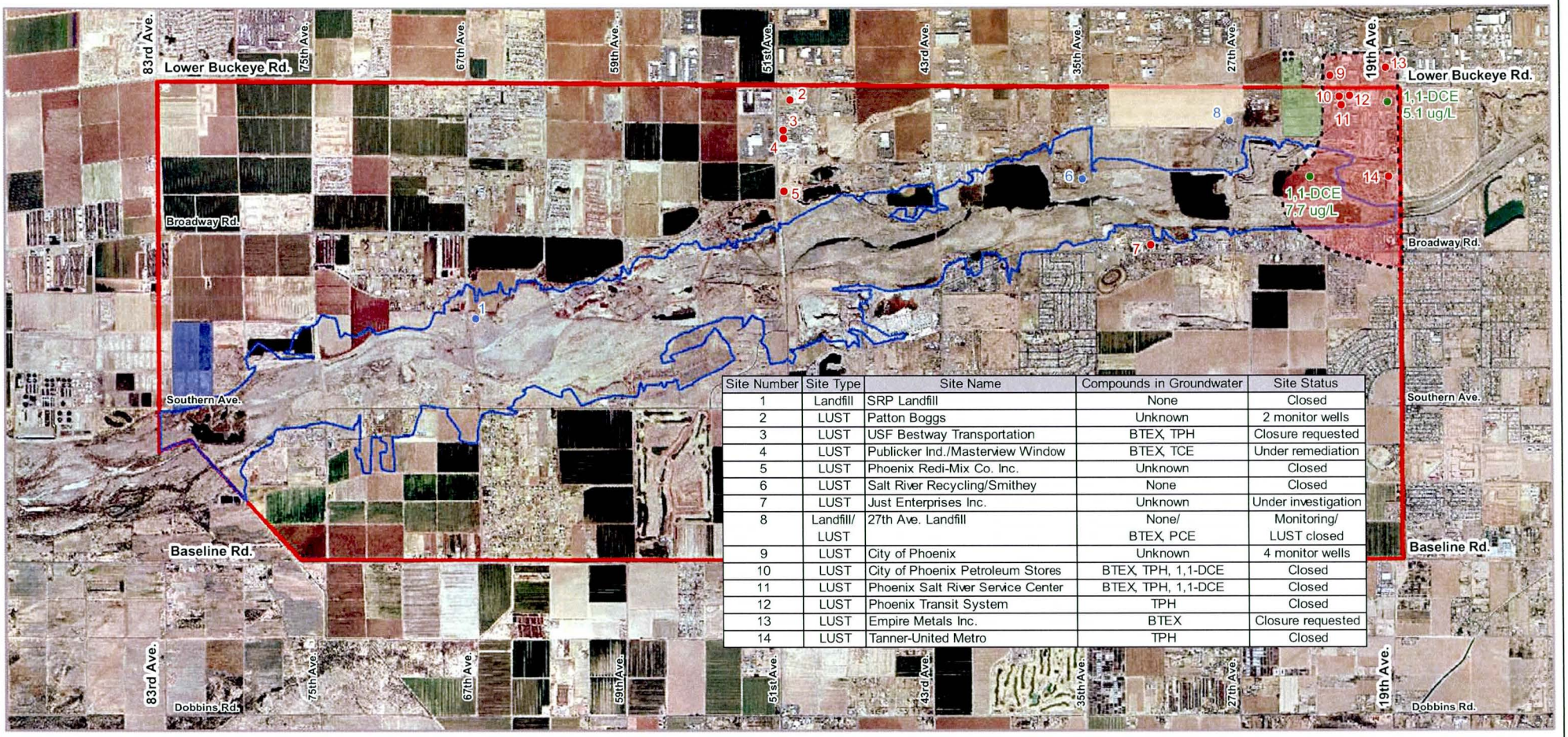
Figure 3.3-1

N W E S

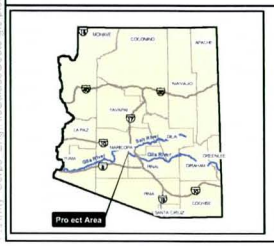
0 5,000 10,000

Feet

US Army Corps of Engineers



Site Number	Site Type	Site Name	Compounds in Groundwater	Site Status
1	Landfill	SRP Landfill	None	Closed
2	LUST	Patton Boggs	Unknown	2 monitor wells
3	LUST	USF Bestway Transportation	BTEX, TPH	Closure requested
4	LUST	Publicker Ind./Masterview Window	BTEX, TCE	Under remediation
5	LUST	Phoenix Redi-Mix Co. Inc.	Unknown	Closed
6	LUST	Salt River Recycling/Smithey	None	Closed
7	LUST	Just Enterprises Inc.	Unknown	Under investigation
8	Landfill/ LUST	27th Ave. Landfill	None/ BTEX, PCE	Monitoring/ LUST closed
9	LUST	City of Phoenix	Unknown	4 monitor wells
10	LUST	City of Phoenix Petroleum Stores	BTEX, TPH, 1,1-DCE	Closed
11	LUST	Phoenix Salt River Service Center	BTEX, TPH, 1,1-DCE	Closed
12	LUST	Phoenix Transit System	TPH	Closed
13	LUST	Empire Metals Inc.	BTEX	Closure requested
14	LUST	Tanner-United Metro	TPH	Closed



Legend

- Project Study Area
- Project Implementation Area
- 27th Ave. Landfill
- Possible extent of 1,1-DCE plume
- 23rd Ave. Wastewater Treatment Plant
- 91st Ave. Wastewater Treatment Plant
- Wells with elevated concentrations of 1,1-DCE
- Sites with known or probable groundwater contamination
- Groundwater investigation sites with no known impacts

AREAS OF GROUNDWATER QUALITY CONCERN

Figure 3.3-2

N W E S

0 5,000 10,000

Feet

March 2005

Source:
Groundwater Quality and Hydrogeology Report, (URS 2002a)

Rio Salado Oeste

US Army Corps of Engineers

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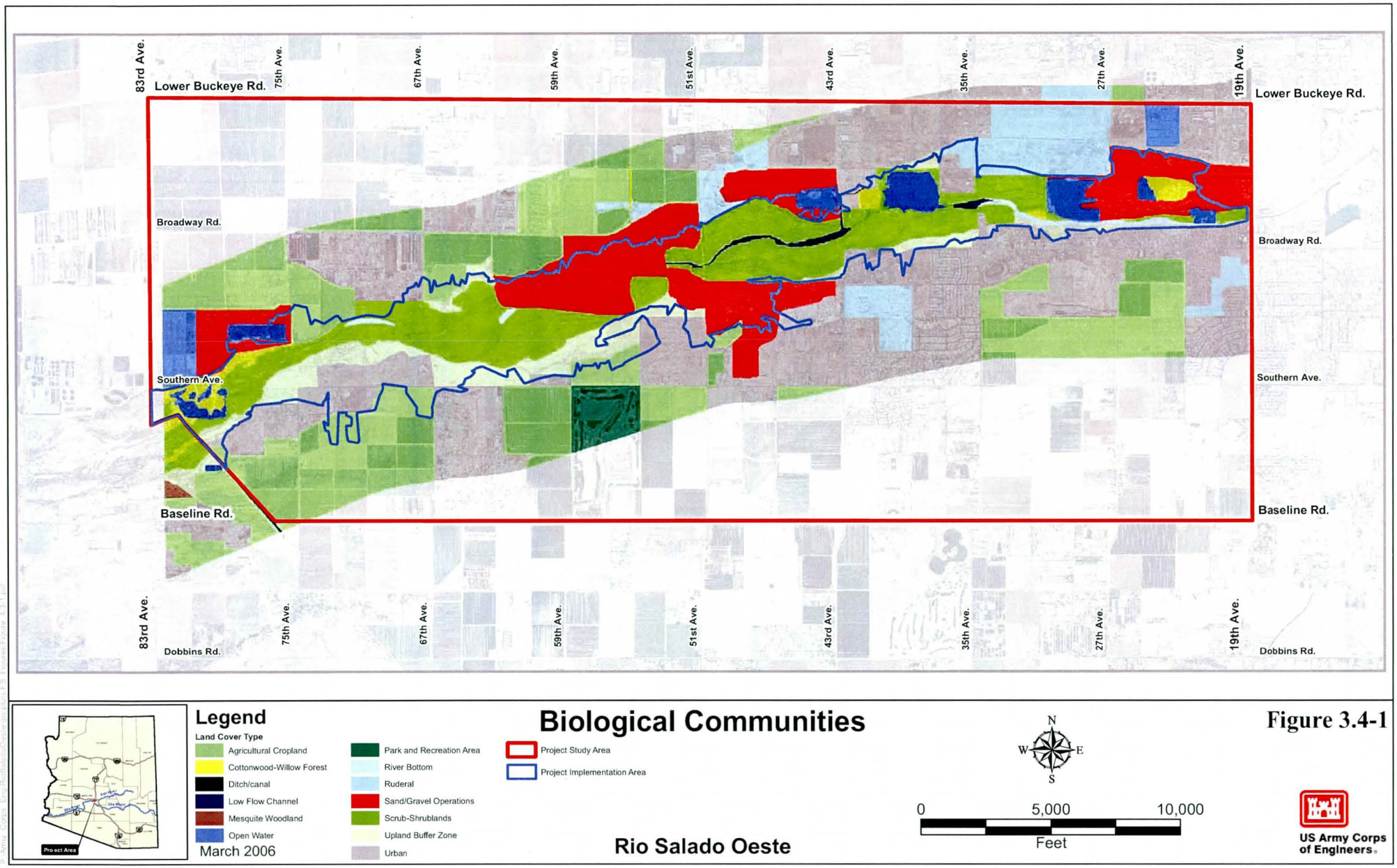

Legend

Land Cover Type

- Agricultural Cropland
- Cottonwood-Willow Forest
- Ditch/canal
- Low Flow Channel
- Mesquite Woodland
- Open Water
- Park and Recreation Area
- River Bottom
- Ruderal
- Sand/Gravel Operations
- Scrub-Shrublands
- Upland Buffer Zone
- Urban
- Project Study Area
- Project Implementation Area

March 2006

Biological Communities

Rio Salado Oeste

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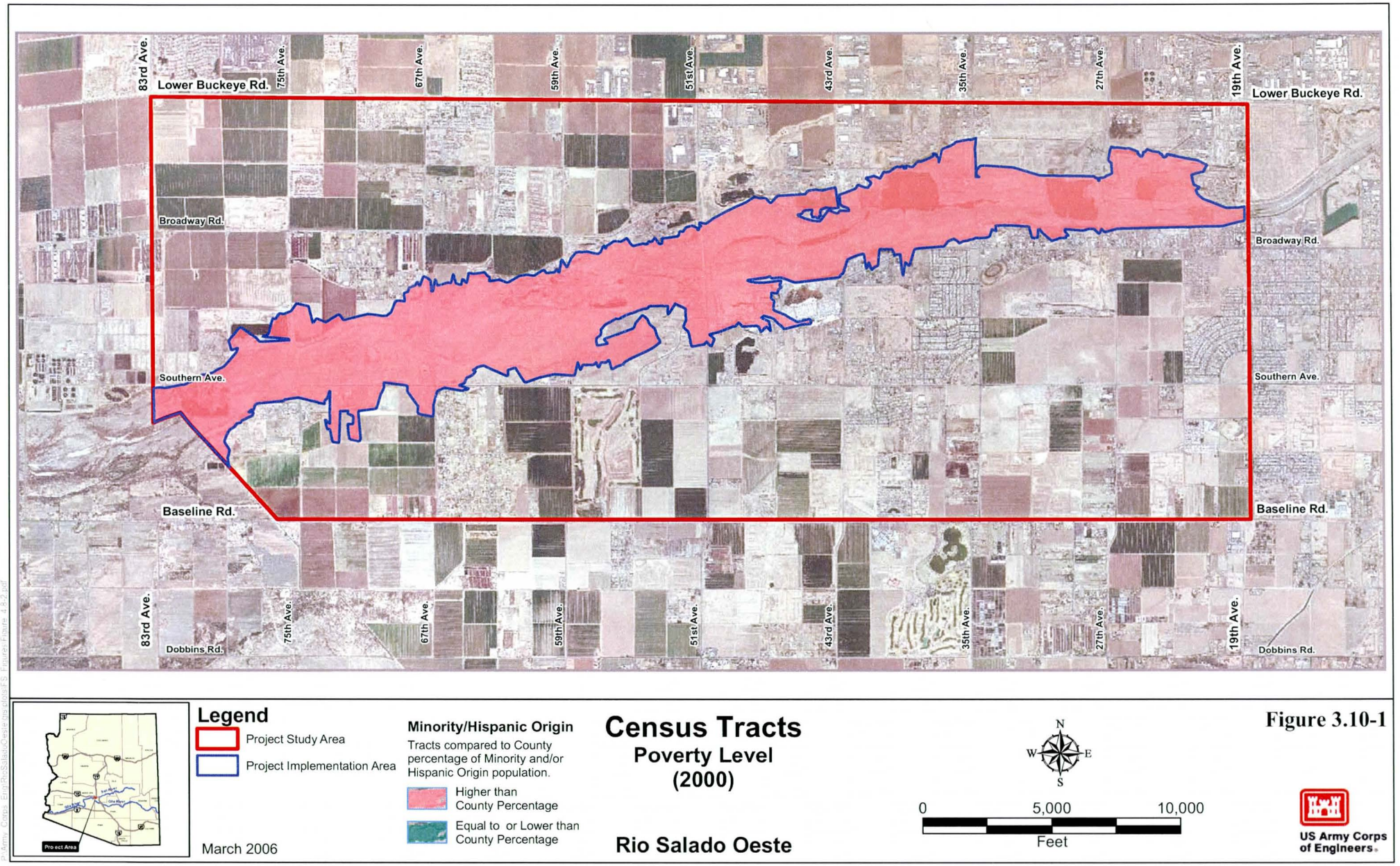
Feet

US Army Corps of Engineers

Figure 3.4-1



Legend

- Project Study Area
- Project Implementation Area

Minority/Hispanic Origin

Tracts compared to County percentage of Minority and/or Hispanic Origin population.

- Higher than County Percentage
- Equal to or Lower than County Percentage

March 2006

Census Tracts

Poverty Level (2000)

Rio Salado Oeste

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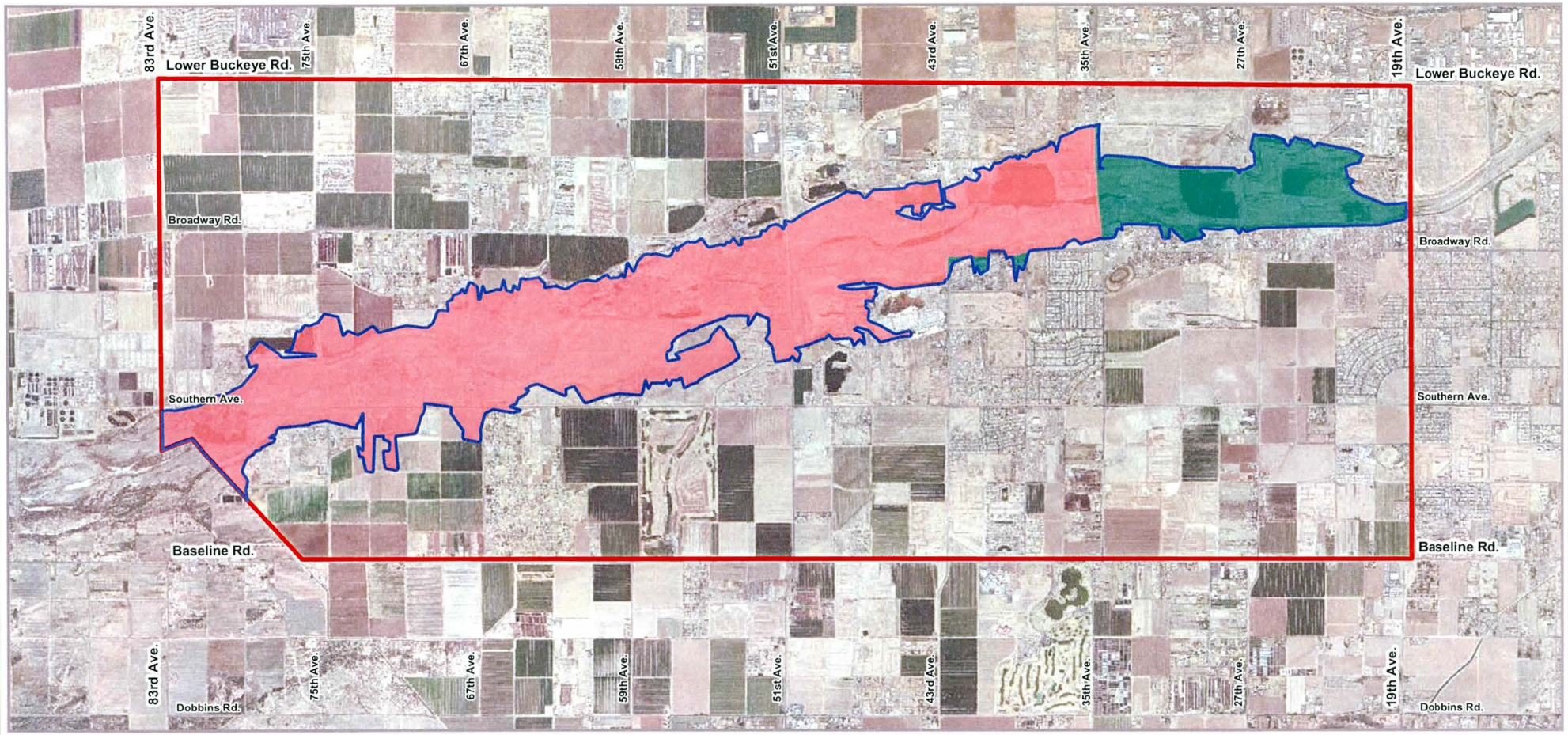
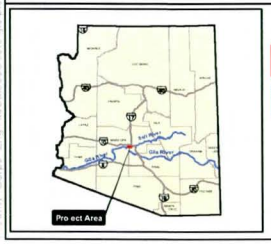
Feet

Figure 3.10-1

US Army Corps of Engineers





Legend

- Project Study Area
- Project Implementation Area

Minority/Hispanic Origin

Tracts compared to County percentage of Minority and/or Hispanic Origin population.

- Higher than County Percentage
- Lower than County Percentage

March 2006

Census Tracts

Minority/Hispanic Origin (2000)

Rio Salado Oeste

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Figure 3.10-2

US Army Corps of Engineers

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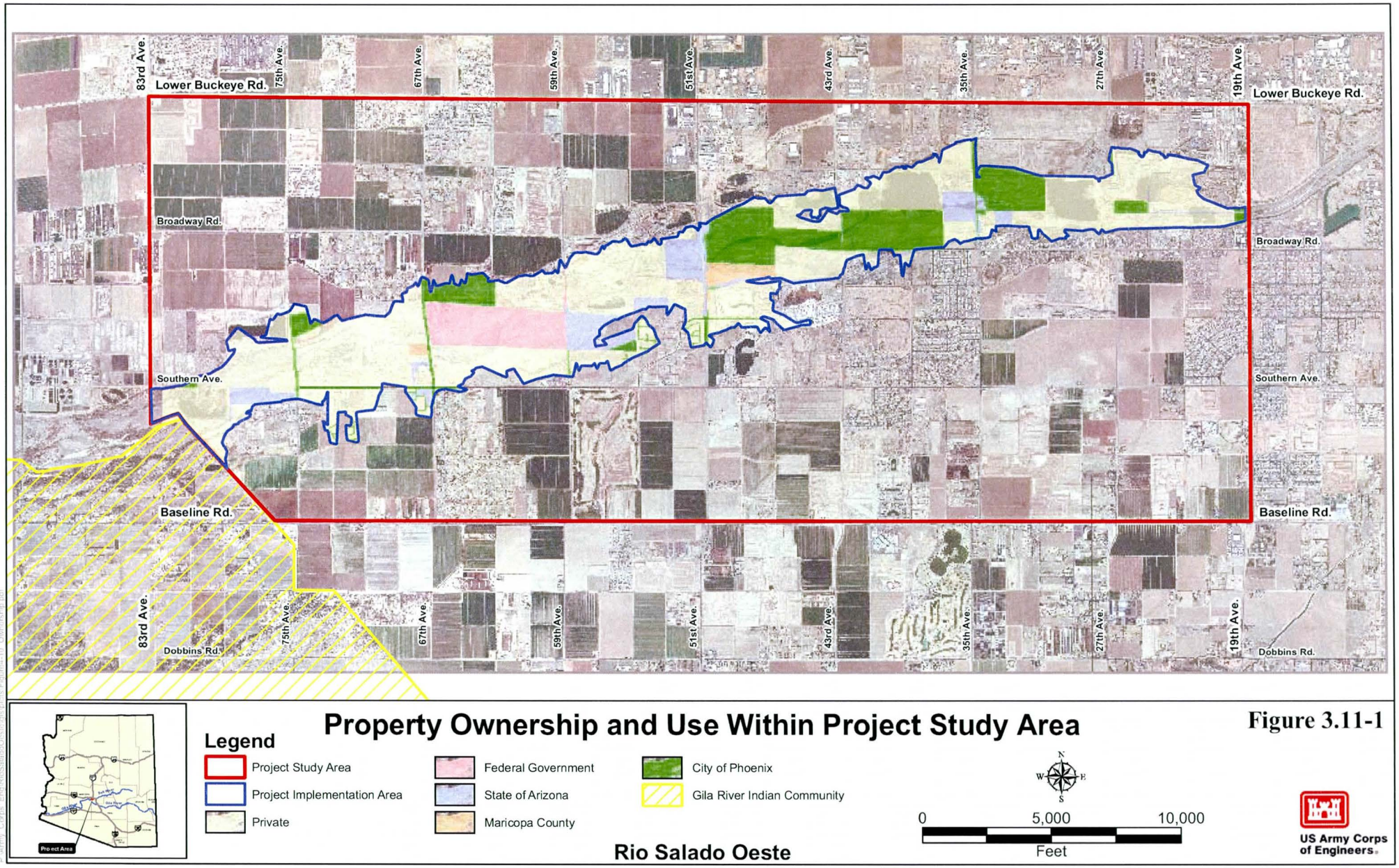
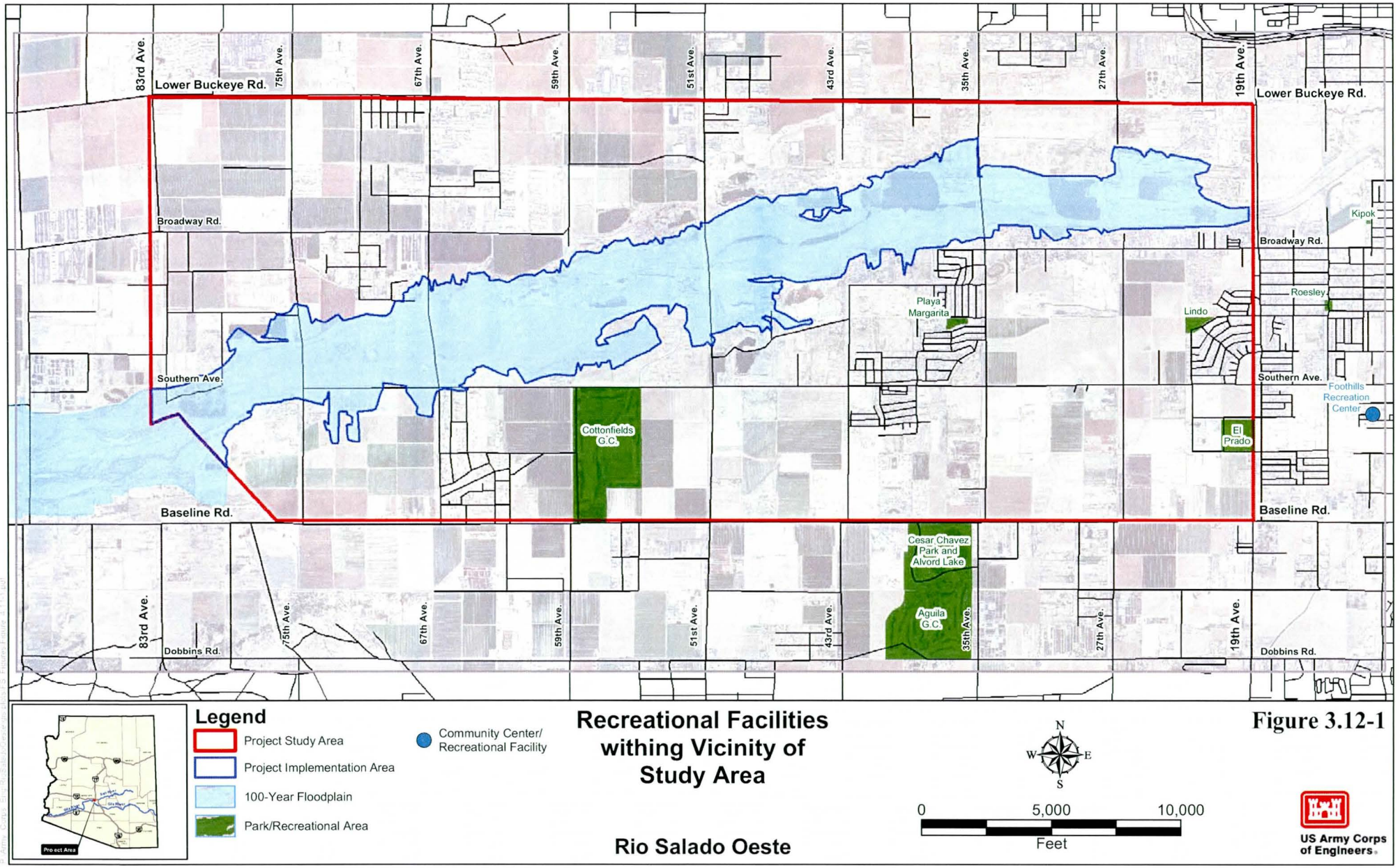


Property Ownership and Use Within Project Study Area

Figure 3.11-1

Rio Salado Oeste

US Army Corps of Engineers


83rd Ave.
Lower Buckeye Rd.
75th Ave.
67th Ave.
59th Ave.
51st Ave.
43rd Ave.
35th Ave.
27th Ave.
19th Ave.
Lower Buckeye Rd.
Broadway Rd.
Kipok
Broadway Rd.
Roesley
Playa Margarita
Lindo
Southern Ave.
Southern Ave.
Foothills Recreation Center
Cottonfields G.C.
El Prado
Baseline Rd.
Baseline Rd.
Cesar Chavez Park and Alvord Lake
Aguila G.C.
83rd Ave.
75th Ave.
67th Ave.
59th Ave.
51st Ave.
43rd Ave.
35th Ave.
27th Ave.
19th Ave.
Dobbins Rd.
Dobbins Rd.
Project Area
Legend
Project Study Area
Project Implementation Area
100-Year Floodplain
Park/Recreational Area
Community Center/ Recreational Facility
Recreational Facilities withing Vicinity of Study Area
Rio Salado Oeste
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US Army Corps of Engineers

Figure 3.12-1

CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

This section forms the scientific and analytic basis for the comparisons of alternatives. It describes the environmental effects associated with the No-Action alternative and each of the action alternatives. It explains the approach and methodology used to perform the analysis and the results of the analysis, both indirect and direct. The environmental effects are described separately for each resource area and alternative. Mitigation measures are provided for impacts that are substantial and adverse. While some short-term impacts would occur as a result of project construction and temporary site disturbance, the long-term impacts are expected to be beneficial.

4.1 TOPOGRAPHY AND GEOLOGY

4.1.1 APPROACH AND METHODOLOGY

Impacts involving topography and geology in or near the project area focus on how project-related construction activities and proposed site improvements may impact the soil and erosion potential. The study area is characterized by a group of soils that are often sandy to gravelly, may include lenses of finer particles, and are often redistributed by water flows associated with nearby active channels. Borrow materials are abundant and currently being utilized in the local area. Two stone borrow sites have been identified as sources of construction material and may be available for potential use by a contractor.

Other evaluated impacts include changes to the surface and/or groundwater hydrogeology. The evaluation classified the hydrogeologic units, depths, and materials composition. The potential significance for impacts was based on past field experience with similar restoration projects.

As discussed in Section 7.1 of the Geotechnical Evaluation, Appendix E of the Feasibility Report, no known active faults are known to occur on or near the project site therefore no direct impacts, related to surface rupture, are anticipated. Seismic activity is very low in the region of the proposed project. Seismic impacts related to ground motion are not anticipated. In addition, subsidence in the project area has not occurred in the past and there is very little potential for subsidence to occur in the future. Therefore, subsidence is not projected to influence design or operation of the Rio Salado Oeste project

4.1.2 ENVIRONMENTAL IMPACTS

4.1.2.1 No-Action Alternative

Under the No-Action Alternative, no impacts would occur related to topography and geology. Conditions along the river channel are expected to remain essentially the same as current conditions. Landforms would remain approximately the same though large-scale flood events

will continue to change the floodplain. Areas within the channel that are currently subject to erosion will continue to erode at current rates. The minor recharge sources-such as seepage from canals and irrigated land, underflow along major streams, and rainfall will most likely remain the most significant source for subflow replenishment. Additionally, ongoing human encroachment and gravel mining will continue to adversely affect the river channel profile and planform. In the short-term, on-going gravel mining within the project are will cause upstream headcutting and sediment trapping within the gravel pits Sediment trapping would lead to a reduction in downstream sediment transport would lead to associated downstream channel bed and bank erosion. Long-term impacts could include an increase in the potential for wind-related soil erosion from continued decreased water availability. This could result in a substantial decrease in vegetative cover over time.

4.1.2.2 Alternatives 2, 4, 5, 5A, and 5B

4.1.2.2.1 Impact: Minor Geomorphologic Changes in River Channel

Activities related to topography and geology under these alternatives include the modification of existing stormwater outfall areas to improve retention and water spreading and modification and/or restructuring of the primary conveyance channel to a more natural state by grading and terracing the river corridor from 19th Avenue to 83rd Avenue. These procedures would involve several forms of reshaping, including excavation and grading. All Alternatives, with the exception of Alternative 2, would add supplemental effluent and clay fill material, which would be used to restore increasing amounts of habitat, including in-channel wetlands. Moreover, Alternatives 5A and 5B would add significant amounts of fill material to the gravel pits at 27th and 37th Avenues to restore them to the floodplain.

Under all of the Alternatives, the geomorphologic character of the existing landscape would be permanently altered due to the many reshaping procedures planned for the project. River bottom areas would undergo surface reshaping, which includes moving soil to fill depressions or removing unwanted mounds. In addition, soils would be imported to various areas to provide the necessary substrate for new vegetation. Clay, mixed gravel, and cobble layers would be placed in areas of proposed wetland habitats in Alternatives 4, 5, 5A, and 5B.

Implementation of the project would no doubt require moving a significant amount of earth, regrading of large areas, and addition of new materials. However, the impact to the hydrogeology would be less than significant because the structure and function of the existing alluvial materials and stratification described in the Geotechnical Evaluation, Appendix E, would remain intact, with the possible exception of higher than existing levels of clay where new emergent wetlands are proposed. The soil erosion loss potential would likely be reduced with terracing and regrading, except for the initial construction-related effects.

Mitigation Measure: No mitigation required.

4.1.2.2.2 Impact: Beneficial Changes to River Channel

All of the Alternatives would decrease the potential for soil loss through regrading and terracing of the primary conveyance channel to a more natural state, and through planting new vegetation.

Alternatives 4, 5, 5A, and 5B have the potential to restore historically present surface flow in some areas through the addition of supplemental effluent and added clay fill material, both of which would be used to restore increasing amounts of habitat, including in-channel wetlands.

Alternatives 5A and 5B would add significant amounts of fill material to the gravel pits at 27th and 37th Avenues to restore them to the floodplain. This would decrease the potential for those gravel pits to trap sediments that would otherwise flow downstream.

These are all considered beneficial effects.

Mitigation Measure: No mitigation required.

4.2 HYDROLOGY AND WATER RESOURCES

4.2.1 APPROACH AND METHODOLOGY

This section describes the impacts of the various alternatives to hydrology and water resources within the study area. These impacts were determined through inspection of the plans for each alternative and a review of the construction and restoration aspects of each alternative.

Impacts on surface hydrology were evaluated to determine whether the implementation of the alternative would result in substantial alteration of watercourses and in stream channels. Additionally, impacts were analyzed to determine if the alternative would exacerbate flooding in currently flood-prone areas or create new potential for flooding or flood damage. A sedimentation analysis was completed to determine the impacts of the potential changes in the shape and grading of the streambed. Groundwater hydrological impacts were analyzed to determine whether an alternative would result in a substantial loss or change in groundwater resources within the area.

4.2.2 ENVIRONMENTAL IMPACTS

4.2.2.1 No-Action Alternative

Under the No-Action Alternative, existing flooding and flood damage will continue at approximately the same level of magnitude and frequency. Water quality is expected to decline slightly as the watershed continues to urbanize. Erosion and sedimentation processes would continue at current rates and degrees of magnitude.

4.2.2.2 Alternatives 2, 4, 5, 5A, and 5B

4.2.2.2.1 Impact: Changes in the 100-year Water Surface Elevations

Channel reshaping and vegetation planting activities proposed under all of the alternatives has the potential to increase 100-year surface elevations and to increase the potential for flooding in the project area. As a part of the project planning process, the Corps conducted modeling (HEC-RAS) to analyze changes in hydraulic conditions associated with implementation of the project alternatives, beginning with the alternative that had the most potential to increase the 100-year surface elevation, Alternative 5A. This alternative did not significantly increase the flood damages in the project area. Thus, the remaining Alternatives, 2, 4, 5, and 5B would not significantly increase flood damages either.

Mitigation Measures: No mitigation required.

4.2.2.2.2 Impact: Potential Changes in Groundwater Depths

Sediments within the Salt River are divided into four units. Rio Salado Oeste construction will occur only at the upper most unit of the basin, the Upper Alluvial Unit (UAU). This unit runs 300-400 feet deep. In the past, the UAU was the primary source of groundwater in the valley, but because of lower water levels (decreased groundwater elevations) and large areas of poor quality water, only about one fourth of groundwater pumped in the valley is from the UAU. Important sources of recharges to groundwater in the valley include infiltration of Salt River flows, mountain recharge along the McDowell and Superstition Mountains, percolation of excess irrigation water, and canal seepage.

Within project implementation area, static water level is relatively shallow, ranging from 20 to 50 feet below ground surface within the Salt River channel to 60 to 80 feet below ground surface north and south of the river. Fluctuations in static water level can be as much as 20 to 30 feet on an annual basis due to agriculture pumping demands, and have declined as much as 25 feet in the last five years (Dames & Moore, 1991; Parsons Engineering Science, 2001). Contributing factors that may cause the fluctuations are water discharge from the 35th Avenue water treatment plant outfall during winter months that produces groundwater mounding, and related radial flow during periods of discharge and basin-wide groundwater pumping and stormwater runoff into the Salt River. . In general the selected wells show a consistent water level decline without radical changes in gradient direction. Therefore, while the groundwater elevation has declined approximately 10 to 20 feet since 1997, the current contours are likely to be similar to the 1997 contours (URS, 2002).

Alternative 2 should not have any impacts on changes in groundwater elevation since it does not add water sources to the project implementation area. Alternatives 4, 5, 5A and 5B, however, add effluent to the project area in order to create additional riparian habitat. The additional water resources have the potential to increase groundwater elevation, but to insignificant levels.

Mitigation Measures: No mitigation required.

4.2.2.2.3 Impact: Beneficial Changes in Sedimentation

Based on HEC-RAS modeling, the No-Action alternative would result in a scour hole downstream of the 35th Avenue Bridge within 10-years time. Implementation of all of the alternatives would include a grade control structure in the area to prevent the development of this scour hole. Also, all of the alternatives would create a more homogenous riverbed slope that would transport sediment more effectively and efficiently than the No-Action alternative.

Mitigation Measures: No mitigation required.

4.3 WATER QUALITY

4.3.1 APPROACH AND METHODOLOGY

This section describes the impacts of the various alternatives to water quality within the study area. These impacts were determined through inspection of the plans for each alternative and a review of the construction and restoration aspects of each alternative. The impacts were evaluated to determine whether construction or operation of an alternative would result in degradation of existing or future water quality, resulting in the potential for violations of existing water quality standards. The analysis focuses on turbidity and sedimentation associated with construction and restoration activities and the potential for water quality impacts caused by accidental spills of fuels or solvents during construction. A Stormwater Pollution Prevention Plan (SWPPP) would be prepared for the preferred alternative, and additional water quality compliance permits for project construction would be obtained in coordination and consultation with the Arizona Department of Environmental Quality (ADEQ).

The project alternatives must also comply with Section 404(b)(1) Guidelines of the Clean Water Act of 1977 which state, "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have significant adverse environmental considerations."

4.3.2 ENVIRONMENTAL IMPACTS

4.3.2.1 No-Action Alternative

Under the No-Action Alternative no construction would take place and thus, would not create any adverse temporary effects to water quality. Water quality is expected to decline slightly as the watershed continues to urbanize. Erosion and sedimentation processes would continue at current rates and degrees of magnitude.

4.3.2.2 Alternatives 2, 4, 5, 5A and 5B

4.3.2.2.1 Impact: Temporary Adverse Effects on Water Quality during Project Construction

Project construction and restoration activities proposed under this alternative include grading, site preparation for vegetation planting, irrigation system establishment, channel excavation and reshaping, and channel terracing. These activities, as well as operations and maintenance (OMRR&R) activities such as sediment removal, would result in soil disturbance and have the potential to cause temporary discharges of soil and sediment into the river channel. Soil that is discharged into the river channel can increase turbidity, stimulate algal growth, increase sediment deposition, and adversely affect aquatic organisms. This would be a potentially significant impact but can be mitigated through the implementation of Best Management Practices.

Mitigation Measure WQ-1: Implement Erosion Control Best Management Practices (BMPs)

The Corps and its contractors shall implement erosion control measures throughout the construction period and during implementation of OMRR&R activities to minimize erosion and sediment input into the river. The Corps would oversee implementation of erosion control measures during construction. The contractor selected for the project shall:

- Conduct construction and OMRR&R activities during the dry season;
- Conduct all construction work in accordance with site-specific construction plans that minimize the potential for increased sediment inputs to the river;
- Divert concentrated runoff away from channel banks;
- Minimize vegetation removal;
- Identify with construction fencing all areas that required clearing, grading, revegetation, or reshaping in a way that minimizes areas to be cleared, graded, reshaped or otherwise disturbed;
- Grade and stabilize spoils and stockpile sites to minimize erosion and sediment input to the river;
- Implement erosion control measures as appropriate to prevent sediment from entering the river channel or other watercourses to the extent feasible, including the use of silt fencing or fiber rolls to trap sediments and erosion control blankets to protect channel banks;
- Apply water to unpaved haul roads at a frequency adequate to maintain visible surface moisture;
- Mulch disturbed areas as appropriate and plant with appropriate species as soon as practicable after disturbance, and;
- Avoid operating equipment in flowing water by using temporary cofferdams or other suitable structures to diver flow around the channel and bank construction areas.
- If hay bales are used for erosion control during construction they must be sterile and weed-free.

4.3.2.2.2 Impact: Potential Adverse Effects on Water Quality Associated with Accidental Spills of Fuels or Other Toxic Materials during Project Construction

Project construction and restoration activated could result in accidental spills of fuel or other toxic materials associated with the operation of construction equipment (e.g., gasoline, oils, lubricants, solvents). Hazardous substances that enter the river channel could have temporary adverse effects on water quality and aquatic organisms. This impact is considered potentially significant, but can be mitigated through the implementation of BMPs.

Mitigation Measure WQ-2: Implement Spill Prevention Measures

The Corps and its contractors would prepare a spill prevention and response plan that regulates the use of hazardous and toxic materials, such as petroleum-based fuels and lubricants for construction equipment. The Corps would oversee development and implementation of a stormwater pollution prevention plan. Elements of that plan would ensure that:

- workers are trained to avoid and manage spills;
- construction and maintenance materials are prevented from entering the river channel;
- all spills are cleaned up immediately and appropriate agencies are notified of any spills and of the clean-up procedures employed;
- staging and storage areas for equipment, materials, fuels, lubricants, solvents, and other possible contaminants are located at least 100-feet a way from the river's normal high-water area;
- vehicles are removed from the river's normal high-water area before refueling or lubricating;
- vehicles are immediately removed from the work area if they are leaking, and;
- equipment is not operated in flowing water (if necessary, suitable temporary structures can be installed to divert water around in-channel work areas).

4.3.2.2.3 Impact: Potential Beneficial Effects on Water Quality Associated with Stormwater

All of the alternatives include the creation of additional In-Channel Wetlands. The addition of In-Channel Wetlands has the potential to increase the retention of nutrients carried in by fine sediments, which would improve water quality. The wetland plants would also act as filters by taking up nutrients (such as nitrogen and phosphorus), which can cause algal blooms and fish kills in streams and lakes. Wetland vegetation would provide additional water quality benefits, such as removing additional nitrogen through the action of soil bacteria, binding to metal pollutants such as lead, zinc and cadmium, removing some kinds of pesticides bound to sediments, retaining other pesticides long enough for them to break down into less harmful components, and preventing stormwater runoff from causing destructive downstream soil erosion by holding water after a storm and releasing it slowly (Ohio EPA Fact Sheets and Publications, 2006).

Mitigation Measures: No mitigation required.

4.3.2.3 Alternatives 4, 5, 5A, and 5B

4.3.2.3.1 Impact: Potential Adverse Effects on Water Quality Associated with Effluent

Alternatives 4, 5, 5A, and 5B add supplemental water supply in the form of effluent from the 23rd Avenue Wastewater Treatment Plant. Wastewater from this plant undergoes tertiary treatment and is released at wastewater class A+. Arizona Administrative Code, Title 18, Environmental Quality defines the classification of A+ as: "...wastewater that has undergone secondary treatment, filtration, nitrogen removal treatment, and disinfection..." In addition, A+ wastewater turbidity must be kept below five Nephelometric Turbidity Units (NTUs), a measure of water clarity, at all times, and strict regulations minimize fecal coliform organisms and enteric viruses. In summary, no adverse effects on water quality associated with effluent use are anticipated.

Mitigation Measures: No mitigation required.

4.3.2.3.2 Impact: Potential Adverse Effects on Groundwater Quality associated with Introduction of Effluent Water Source

While the water quality of the 23rd Avenue WWTP would not adversely impact overall water quality within the project, there is a chance that portions of the additional water source may enter the groundwater within the Upper Alluvial Unit (UAU) above and beyond current conditions. If such recharging occurs, the potential for it to leach contaminants that may be present in the project implementation area exists. Appendix D of the Feasibility Report, Groundwater Quality Hydrogeology Report analyzed this potential with a modified Phase I Environmental Site Assessment. The report investigated four areas of potential groundwater concern: Water Quality Assurance Revolving Fund (WQARF) or National Priority List (NPL) sites, also known as Superfund sites, Landfills, WWTPs, and Leaking Underground Storage Tank sites (LUSTs).

The report concluded that potential adverse effects would not occur due to WQARF/NPL sites because the sites of concern are located upgradient of project features. The landfills are for the most part under the OMRR&R phase of remediation and are located outside the possible locations for project features. Therefore, potential adverse effects from landfills are considered not to be significant. Only the 23rd Avenue WWTP impacts groundwater in the project implementation area and lies within the potential project features areas. This WWTP is currently at A+ standards and is monitored regularly. No potential adverse effects are expected to occur to groundwater sources due to WWTPs. Thirteen LUST sites with monitoring wells on record with ADWR were identified within the study area. These sites may have impacts to local soil and water conditions but are not considered likely to affect the project to be implemented within the floodplain.

In conclusion, a possibility remains that additional groundwater recharge may occur due to the supplemental effluent in Alternatives 4, 5, 5A and 5B. The four investigation areas of potential concern are determined to have a less than significant impact on groundwater quality.

Mitigation Measures: No mitigation required.

4.4 BIOLOGICAL RESOURCES

This section analyzes the impact of each alternative on the biological resources of the Rio Salado Oeste study area. The impacts analysis focuses on short-term effects that project construction, implementation, and operation may have on existing vegetation and wildlife. The long-term biological impacts are expected to be beneficial because the major focus of the action alternatives is ecosystem restoration, which would increase wildlife habitat in the study area.

4.4.1 APPROACH AND METHODOLOGY

In June 2002, a team of biologists and other specialists in related fields conducted the habitat evaluation analysis for baseline and future without-project conditions using the Hydrogeomorphic (HGM) approach. The HGM team consisted of Corps (Los Angeles District [LAD] and Engineer Research and Development Center [ERDC]) personnel, representatives from the non-federal sponsor (City of Phoenix), and federal and state resource agency personnel. In May 2004, the HGM team conducted the HGM analysis for the action alternatives. The HGM analysis provides quantitative estimates of projected habitat benefits over the period of analysis for the alternatives, and also provides a means of comparing the benefits of the different alternatives, including the No-Action alternative. HGM benefits are expressed as Functional Capacity Units (FCUs). Members of the HGM team develop Functional Capacity Indices, which are the indices within the ecosystem that can be quantified to present a range of how the ecosystem is functioning and how it would function with different alternatives. Indices include such functions as: floodwater detention, internal nutrient cycling, organic carbon export, removal and sequestration of elements and compounds, maintenance of characteristic plant communities, and wildlife habitat maintenance. These FCIs can then be multiplied by acreages to derive Functional Capacity Units, or the unit that provides a means of assessing the gains or losses in functional value for a single target year of interest. For all alternatives, a baseline condition of 583 FCUs is used. The FCUs are averaged over the period of analysis for the project (51 years for this study) to determine Average Annual FCUs (AAFCUs) for each alternative. This analysis includes the AAFCUs for each of the alternatives for purposes of comparison. The detailed HGM analysis is included as Appendix I of the Feasibility Report.

Biological baseline studies were used as the basis to evaluate project impacts for each alternative. Plans for each alternative were reviewed and the potential changes in habitat communities were determined. In general, the following criteria were considered in determining significant impacts on biological resources:

- Loss of individuals or populations of a Special Status species or critical habitat for listed species
- Loss of critical habitat or sensitive plant communities
- Substantial loss of species or community diversity in natural vegetation and wildlife habitat
- Substantial loss of populations or habitat of Special Status that would jeopardize the continued existence of the species within the region
- Adverse effects on special aquatic sites (e.g., wetlands)

- Substantial loss of natural vegetation
- Loss or long-term disruption of a major wildlife movement corridor
- Take or harassment of any listed threatened or endangered species

4.4.2 ENVIRONMENTAL IMPACTS

4.4.2.1 No-Action Alternative

The No-Action Alternative would occur if no federal action is conducted. The Rio Salado Oeste study area has already been highly degraded due to construction of upstream dams, disconnection of the riparian ecosystem from groundwater sources, sand and gravel mining, and development associated with the Phoenix metropolitan area. Future characteristics along the Salt River channel are expected to remain similar to current conditions, though the location of active sand and gravel mining activities would change. The addition of increased impervious surfaces along portions of the floodplain upstream would likely result in increased flow rates for the river following rain events, particularly for those smaller events that mostly infiltrate under current conditions. Existing cottonwood/willow areas are highly fragmented and are being replaced by salt cedar. The small remnant habitat that remains is supported by stormwater outfalls and wastewater effluent discharges, which are expected to continue in theWithout-Project condition. Due to the lack of suitable habitat and the proximity of the Phoenix metropolitan area, riparian wildlife species are already largely absent from the area.

4.4.2.1.1 Impact: Long-Term Decrease in Vegetation

In the HGM functional assessment, many assumptions are proposed. The study area is quickly urbanizing with industrial and medium-density residential development. The study estimated that all 133 acres of agricultural land in the study area would be converted to urban (residential) uses within six years. As this development occurs, impervious ground cover would increase, thereby reducing both available land for native habitat and infiltration of runoff. The already rare cottonwood/willow forest is forecast to decrease in area from 112 acres to 25 acres over the next 50 years, primarily due to decreasing water availability and competition from the invasive salt cedar. The lost cottonwood/willow area is expected to slowly convert to less desirable scrub-shrub lands, which already dominate the study area. An additional five acres of wet river bottom habitat would convert to dry river bottom in the same period due to an assumed reduction in wastewater discharge at the 23rd Avenue wastewater treatment plant. While a reduction in wetland area from 30 acres to 25 acres seems inconsequential, nearly all of this habitat type has already been lost. The small amount of wetlands that would remain would be supported by wastewater effluents that are expected to continue. Ecologically important mesquite bosques have already been completely eliminated from the area and would remain absent. An additional 160 acres of desert/bare earth is expected to be created in the same period, primarily due to loss of open water areas remaining from inactive sand and gravel operations. Due to pending permit applications for new sand and gravel mining operations, it was assumed that the acreage of sand and gravel pits would remain approximately the same (671 acres), but would move to new sites at the west end of the study area. Together with the noted loss in other natural settings such as

desert and open water habitats, the overall loss of wetland and terrestrial communities that serve as habitat for a myriad of wildlife species is significant.

The issue of groundwater overdraft is an extremely important one in the Salt River watershed. Despite the obvious evidence of water within the channel through many portions of the study area, the watershed throughout the area remains in a state of moderate to severe groundwater depletion. Historic groundwater levels (that may have actually or nearly reached the surface in some reaches of the channel) now range from approximately 30 to 100 feet below the surface. This issue impacts a number of resources in the study area, notably riparian habitats and associated wildlife. All existing native riparian vegetation within the study area is completely dependent on the availability of water. Were it not for effluent flows in the channel, nothing would remain of these diverse and critical riparian resources. Without this source, the vegetation would gradually give way to xeric species more suited to desert upland settings. Current effluent flow supports a limited but significant growth of vegetation in those reaches in which water remains on the surface, or flows as shallow subsurface flow. The contribution of effluent to this shallow groundwater zone cannot be underestimated. Despite its importance, a reduction in the volume of this effluent is anticipated within the next 6 years.

4.4.2.1.2 Impact: Long-Term Changes in Fish and Wildlife Populations

The already rare cottonwood/willow forest is forecast to decrease in area from 112 acres to 25 acres over the next 50 years, primarily due to decreasing water availability and competition from the invasive salt cedar. Cottonwood-willow forest stands out as the most important remnant wildlife habitat in the area. Cottonwood-willow supports the densest and most diverse wildlife communities in valleys and deserts. The diversity of plant species and growth forms provides a variety of foods and microclimate conditions for wildlife. Cottonwood-willow habitat provides substantial nesting support for large birds, such as Great Blue Heron, Red-Tailed Hawk, American Kestrel, Western Screech Owl, Great Horned Owl and the Northern Flicker. Due to the changes in vegetation, it is anticipated that wildlife that utilizes cottonwood/willow, or that requires ponded water would significantly decrease in the area.

The lost cottonwood/willow area is expected to slowly convert to less desirable scrub-shrub lands, which already dominate the study area. Thus, species that are able to survive in scrub-shrublands would likely remain and perhaps increase in number.

4.4.2.1.3 Impact: Long-Term Effects of Recreational Use to Wildlife and Vegetation

The disturbance from unregulated recreation, off-highway vehicle traffic and "wildcat" dumping is expected to continue and potentially increase in some areas, further degrading the riparian system.

4.4.2.1.4 Impact: Long-Term Decrease in Potential for Threatened and Endangered Species

Ten special-status species have the potential to occur in the study area: the lowland leopard frog, desert tortoise, Mexican garter snake, cactus ferruginous pygmy owl, Yuma clapper rail,

southwestern willow flycatcher, western yellow-billed cuckoo, American peregrine falcon, bald eagle and the lesser long-nosed bat. All of these species are considered to be Wildlife of Special Concern by Arizona Game and Fish Department and six of them are considered to be a Candidate Species, Threatened or Endangered by the U.S. Fish and Wildlife Service (Table 3.4-2). Under the No-Action Alternative, these species would experience a continual degradation of their requisite habitats.

The decrease of cottonwood/willow forests from 112 acres to 25 acres effectively removes the potential for the Yuma clapper rail and southwestern willow flycatcher to return to breed within the project area. Conversion of agricultural land to urban uses, through time, would eliminate potential for recovery of the cactus ferruginous pygmy owl and lesser long-nosed bat due to lighting, noise, and loss of habitat within the urban areas.

4.4.2.1.5 Impact: No Change in Functional Capacity Units.

The average functional capacity index (FCI) score across the ten functions listed in Table IV-8 of the Feasibility Report, was 0.33, which indicates a fair to moderately low functioning wetland ecosystem at best. Over the 50-year planning horizon, the Without-Project FCUs are predicted to decline from 583 at target year (TY) 0, the year baseline conditions are established, to 579 FCUs at TY 51, the end of the period of analysis. Therefore, the without-project AACFU output is forecast to remain essentially unchanged (the slight decline from 583 AAFCU to 579 AAFCU is due to rounding error).

4.4.2.2 Alternatives 2, 4, 5, 5A and 5B

4.4.2.2.1 Impact: Potential Short-Term Decrease in Vegetation due to Construction

Clearing, grading, and other construction-related activities would eliminate a minimum of 137 acres of disturbed scrub-shrubland, sparsely vegetated river bottom habitat, and other disturbed habitat in the vicinity of the stormwater outfall areas. Alternatives 4, 5, 5A and 5B would eliminate and additional 324 acres of mostly disturbed shrub-scrublands for the creation of additional cottonwood/willow and mesquite habitats. While the quality of the vegetation is less than desirable, the temporary loss in amount of vegetation is significant. These effects can be minimized with mitigation.

Mitigation Measure BR-1: Re-vegetation Construction Management Practices.

The Corps would remove salt cedar (*Tamarix spp.*) and giant reed (*Arundo donax*) from the restoration areas as part of the restoration process (Alternatives 4, 5, 5A, and 5B). The City of Phoenix, the non-federal sponsor, would be responsible for maintaining the restored habitat areas free of invasive plants, especially salt cedar and giant reed, throughout the life of the project (Alternatives 4, 5, 5A, and 5B).

The cleared areas would be re-vegetated with habitat of higher quality and permanence than the habitat removed. Implementation of good construction management practices, especially dust suppression with water and/or non-toxic dust-suppressing chemicals or soil binders, would

minimize potential impacts from fugitive dust. Also, decreases in the vegetation population can be minimized through careful phasing of the project construction. Areas of desirable vegetation can be delineated on construction plans as areas that are not to be disturbed. Additionally, vegetation removal would occur outside of the spring breeding season to ensure adequate time for a majority of the avian offspring to disperse prior to construction activities.

Mitigation Measure BR-2: Use Clean and Certified Foreign Soils

If any imported topsoil is used in the restoration project, it shall be clean and certified free of weeds, including seeds (Alternatives 2, 4, 5, 5A, and 5B). Feral or free-ranging cats and dogs shall be reported to the local of Animal Control office, and signs shall be posted prohibiting the release of pets of any kind and the use of the restoration area by unrestrained pets (Alternatives 2, 4, 5, 5A, and 5B).

4.4.2.2.2 Impact: Long-Term Increase in Vegetation

Restoration of the disturbed and sparsely vegetated habitat in the channel and outfall areas would result in long-term beneficial effects. All of the alternatives would restore approximately 66 acres of cottonwood/willow habitat, 43 acres of mesquite habitat and 28 acres of wetland habitat in the vicinity of the stormwater outfalls. Alternatives 4, 5, 5A and 5B would restore significantly more acres of habitat; see Table ES-1 for further detail.

Approximately 773 acres of disturbed scrub-shrublands and disturbed river bottom habitat along the channel corridor would be restored to potentially support higher quality Sonoran Desert riparian habitat. Table 2.5-1 summarizes the restored acreage of various vegetative communities for each alternative.

Mitigation Measures: No Mitigation Required.

4.4.2.2.3 Impact: Short-Term Decrease in Fish and Wildlife Populations due to Construction and OMRR&R Activities

Channel clearing and reconfiguration activities in the channel and in the vicinity of the outfalls would temporarily displace onsite wildlife. Some mortality of slower-moving ground-dwelling wildlife on site may occur with vehicular traffic during construction and OMRR&R. Noise and other disturbance associated with the operation of large construction equipment may displace additional wildlife in adjacent areas. Vector control may have slight affects to fish and wildlife populations depending on the type of control. Due to the generally low existing habitat values in the project area and the temporary nature of the disturbance, short-term impacts to wildlife would be adverse but not significant.

Mitigation Measures: No Mitigation Required.

4.4.2.2.4 Long-Term Benefits to Fish and Wildlife Populations

Restoration of the disturbed and sparsely vegetated habitat in the channel and outfall areas would result in a long-term beneficial effect. This alternative would restore approximately 137 acres of disturbed scrub-shrublands and disturbed river bottom to native habitat cover types that once naturally occurred in the area. Restored habitats would increase the quantity and quality of cover, forage, and breeding areas for existing wildlife populations in the Rio Salado Oeste reach. Alternative 2 would also provide opportunities for a higher diversity of native wildlife than under existing conditions. In the vicinity of the outfalls, project features would especially benefit amphibians and birds associated with wetlands and riparian habitats. Channel restoration would greatly increase the value of the Rio Salado Oeste reach as a wildlife corridor. Channel restoration would provide habitat connectivity between the authorized Rio Salado project, immediately upstream from the Rio Salado Oeste study area, and the downstream Tres Rios Environmental Restoration project. The Tres Rios project, currently under construction, extends downstream from the Rio Salado Oeste study area for nine miles to the confluence of the Gila and Agua Fria Rivers. This wildlife corridor connection would increase the values of the upstream and downstream projects to extend beyond the benefits gained on site.

Mitigation Measures: No Mitigation Required.

4.4.2.2.5 Impact: Potential Adverse Effects of Recreation to Wildlife and Vegetation

The recreation component is broken down into three primary areas for easier analysis: the channel, the ban and the terrace. No significant adverse effects of recreation to wildlife and vegetation are expected to occur because of increases in recreational users and park rangers within the area.

The channel would provide equestrian opportunities. The channel would be accessible by the trail system from the bank at select locations along the terrace. At each transition point to the terrace, appropriate signage would inform visitors of the new habitat they are entering, and any user restrictions and expectations. The channel would provide opportunities for environmental education and developing an understanding of how the habitat has been restored.

The banks would provide recreational experiences including hiking, biking, and horseback riding to scenic overlooks, and leisure walking. Features constructed to interpret cultural and biological components would provide educational opportunities, as well as ecological themes related to the restored desert riparian habitat.

The terrace is the area where the habitat has a permanent water source to create a self- sustaining ecosystem. This area would provide more limited and controlled recreational and educational experiences, such as bird watching and guided nature walks. Some areas of the channel may be designated as "sensitive" habitat, and would be protected from public impacts. The increase in regulated use would have less than significant impacts to the wildlife and vegetation.

Mitigation Measures: No Mitigation Required.

4.4.2.2.6 Impact: Short-Term Decrease in Potential for Special Status Species and Migratory Birds due to Construction

The cottonwood/willow habitats are especially important for resident and migratory songbirds because these and other native riparian habitats have high wildlife value and have substantially declined throughout the western United States. Many bird species use cottonwood/willow habitats in the project study area, including Anna's hummingbird, ash-throated flycatcher, willow flycatcher, black phoebe, dusky flycatcher, western wood pewee, western kingbird, tree swallow, house wren, Bewick's wren, verdin, Lucy's warbler, yellow warbler, yellow-rumped warbler and red-winged blackbird. Great blue herons, double-crested cormorants, snowy egrets, great egrets, western yellow-billed cuckoos, and black-crowned night-herons also roost in the cottonwood/willow vegetation and forage in nearby habitats. No special status species are known to roost in the study area.

Channel clearing and reconfiguration activities in the channel and in the vicinity of the outfalls would temporarily decrease potential to provide suitable habitat for Wildlife of Special Concern (WSC), federally Threatened, Endangered and Candidate (T, E, & C) Species, and resident and migratory avian species. Noise and other disturbance associated with construction may decrease the potential for suitable habitat outside the study area temporarily. Due to the generally low existing habitat values in the project area and the temporary nature of the disturbance, short-term impacts to the potential for special status species, resident and migratory birds would be adverse but not significant.

Mitigation Measure BR-3: Consult with USFWS and AGFD prior to Ground-Disturbing Activities

Prior to ground-disturbing activities in existing riparian or wetland areas, the Corps would consult with U.S. Fish and Wildlife Service and Arizona Game and Fish Department to determine the potential for the occurrence of any sensitive wildlife species. If sensitive species are determined to be present or to have potential to occur, the schedule for invasive removal shall be revised to avoid breeding seasons of any sensitive species on site (Alternatives 4, 5, 5A, and 5B).

Mitigation Measure BR-4: Conduct Operation & Maintenance Activities on a Rotating Basis and Only During Non-Nesting Periods

Sediment removal and other activities would only be conducted during non-nesting periods of the above listed Threatened, Endangered, Wildlife of Special Concern and migratory birds. Sediment removal would be conducted on a rotating basis so that no more than 25% of the marsh area would be affected in any one year.

4.4.2.2.7 Impact: Long-Term Increase in Potential for Special Status Species

Restoration may eventually result in establishment of habitats suitable for a number of native species including those that are threatened or endangered, especially birds. Coordination with the US Fish and Wildlife Service to consider development of Safe Harbor Agreements,

Candidate Conservation Agreement, or Habitat Conservation Plan, will be completed as appropriate.

Mitigation Measures: As described above.

4.4.2.2.8 Impact: Increase in Functional Capacity Units.

The functional output associated with Alternative 2 at the end of the 50-year study period, or TY 51 would be 633 FCUs and an increase of 51 Average Annual FCUs over without project conditions. The function output associated with Alternative 4 at TY 51 would be 775 FCUs with an increase of 165 AAFCUs over without-project conditions and 114 AAFCUs over Alternative 2. The functional output associated with Alternative 5 at TY 51 would be 851 FCUs with an increase of 240 AAFCUs over without-project conditions, and an increase of 75 AAFCUs over Alternative 4. The functional output associated with Alternative 5A at TY 51 would be 879 FCU with an increase of AAFCUs over without-project conditions, and an increase of 27 AAFCUs over Alternative 5. The functional output associated with Alternative 5B at TY 51 would be 865 FCUs, with an increase of 253 AAFCUs over without-project conditions, an increase of 13 AAFCUs over Alternative 5, but a decrease of 14 AAFCUs compared to Alternative 5A. This is summarized in Table 4.4-1 below.

Table 4.4-1. With-Project Average Annual Functional Capacity Units

	No-Action	Alt 2	Alt 4	Alt 5	Alt 5A	Alt 5B
TY0	583	583	583	583	583	583
TY51	579	633	775	851	879	865
AAFCUs (TY0-TY51)	0*	631	745	820	847	833
Increase in AAFCUs from No-Action Alt	-	51	165	240	267	253
Change in AAFCUs Between Alternatives	-	51	114	75	27	-14

* The slight decline from 583 AAFCU to 579 AAFCU is due to rounding error.

Mitigation Measures: No Mitigation Required.

4.4.2.3 Alternatives 4, 5, 5A and 5B

4.4.2.3.1 Impact: Potential Short-Term Adverse Effects on Vegetation

Short-term impacts of providing the additional water supply system would involve minor construction activities in disturbed areas. Impacts would be adverse but not significant.

Short-term impacts of cottonwood/willow and mesquite establishment include grading and re-contouring over 300 acres (exact number depends on alternative) of mostly disturbed scrub-shrub land habitats (in addition to the 137 acres at the stormwater outfalls). Impacts of ground-

disturbing activities would be adverse but not significant. Newly planted cottonwood, willow, and mesquite trees would begin to provide habitat benefits once the vegetation matures.

Invasive control involves the removal of undesirable non-native vegetation mechanically and/or with EPA-approved herbicides. Although a small percentage of native plants are invariably removed with the invasive species, the net short-term effect of invasive control is beneficial to native vegetation.

Short-term impacts of emergent wetland establishment would involve grading and recontouring up to five acres of mostly disturbed scrub-shrubland habitats (in addition to approximately 28 acres at the stormwater outfalls). Short-term impacts of ground-disturbing activities would be similar to the impacts associated with establishing the cottonwood/willow and mesquite habitats. These impacts would be adverse but not significant. In order to reduce the intensity of the adverse impacts, the following mitigation measures would be implemented.

Mitigation Measure BR-1: Re-vegetation Construction Management Practices.

The Corps would remove salt cedar (*Tamarax* spp.) and giant reed (*Arundo donax*) from the restoration areas as part of the restoration process (Alternatives 4, 5, 5A, and 5B). The City of Phoenix, the non-federal sponsor, would be responsible for maintaining the restored habitat areas free of invasive plants, especially salt cedar and giant reed, throughout the life of the project (Alternatives 4, 5, 5A, and 5B).

The cleared areas would be re-vegetated with habitat of higher quality and permanence than the habitat removed. Implementation of good construction management practices, especially dust suppression with water and/or non-toxic dust-suppressing chemicals or soil binders, would minimize potential impacts from fugitive dust. Also, decreases in the vegetation population can be minimized through careful phasing of the project construction. Areas of desirable vegetation can be delineated on construction plans as areas that are not to be disturbed. Additionally, vegetation removal would occur outside of the spring breeding season to ensure adequate time for a majority of the avian offspring to disperse prior to construction activities.

Mitigation Measure BR-2: Use Clean and Certified Foreign Soils

If any imported topsoil is used in the restoration project, it shall be clean and certified free of weeds, including seeds (Alternatives 2, 4, 5, 5A, and 5B). Feral or free-ranging cats and dogs shall be reported to the local of Animal Control office, and signs shall be posted prohibiting the release of pets of any kind and the use of the restoration area by unrestrained pets (Alternatives 2, 4, 5, 5A, and 5B).

4.4.2.3.2 Impact: Long-Term Effects on Vegetation

Long-term effects of providing additional water would include increased productivity (i.e., biomass, wildlife forage and seed production) of native vegetation, increased vegetation diversity, and a potential to restore and maintain additional acres of cottonwood/willow and mesquite habitat. In addition, wetland habitat would likely become established without human

intervention where conditions are favorable along the restored channel. Increased water would also support the spread of undesirable and invasive plant species, especially salt cedar (*Tamarix* spp.) and giant reed (*Arundo donax*). The impact of increased invasives would be adverse but not significant. With the inclusion of invasive control as part of this project, the long-term effects of additional water would be beneficial.

Long-term effects of cottonwood/willow and mesquite establishment include increased productivity, increased habitat structure and diversity, increased shade and cooling of the ground surface, and reduced water temperature where tree canopy overhangs the flowing channel and the edges of lakes or ponds.

Long-term invasive control involves the periodic removal of undesirable non-native vegetation mechanically and/or with EPA-approved herbicides. Periodic removal of invasives is especially beneficial during the early years following restoration, allowing the native plants to gain a competitive advantage over the invasives. The long-term effect of invasive control is highly beneficial to native vegetation.

Long-term effects of emergent wetland establishment would be beneficial. Emergent wetlands would add another element of diversity to the habitat and provide other benefits including removal of pollutants from water, substrate stabilization, and slowing flood flows. Wetlands would replace some scrub-shrublands and other disturbed habitats.

Mitigation Measures: No Mitigation Required.

4.4.2.3.3 Impact: Short-Term Effects on Fish & Wildlife

Short-term impacts of minor construction activities to provide additional water to the habitat would temporarily displace some wildlife. Because construction-related disturbance would be minor, little or no wildlife mortality is anticipated. Impacts would be adverse but not significant.

Short-term impacts of cottonwood/willow and mesquite establishment would include grading and recontouring activities in mostly disturbed scrub-shrubland and disturbed river bottom habitats (in addition to the stormwater outfalls as described in Alternative 2). Due to the additional project features of Alternative 4, a larger wildlife population would be temporarily displaced. As with Alternative 2, impacts of ground-disturbing activities would be adverse but not significant. Newly planted cottonwood, willow, and mesquite trees would begin to provide habitat benefits almost immediately.

Invasive control, either mechanically and/or with EPA-approved herbicides, may have an adverse but not significant short-term impact on wildlife. Mechanical removal of invasives would temporarily displace some native wildlife adapted to living in salt cedar or other non-native vegetation. Herbicide application, if used, would have little or no adverse impact on wildlife because only EPA-approved herbicides would be authorized.

Short-term impacts of emergent wetland establishment would be similar to the impacts associated with establishing the cottonwood/willow and mesquite habitats. Grading,

recontouring, and establishing the necessary hydrology to support wetlands would displace or eliminate a small percentage of the existing wildlife in the study area. Due to this additional project feature in Alternatives 4, 5, 5A and 5B, an incrementally larger wildlife population would be temporarily displaced than with Alternative 2. These impacts would be adverse but not significant.

Mitigation Measures: No Mitigation Required.

4.4.2.3.4 Impact: Long-Term Effects on Fish and Wildlife

Long-term effects of providing additional water to the habitat would be beneficial. The additional water would support an increase in the quantity and quality of cover, forage, and breeding areas for existing wildlife populations in the Rio Salado Oeste reach. Benefits would be similar to those described for the outfall areas under Alternative 2, but Alternatives 4, 5, 5A and 5B would provide additional acres of restored habitat, including cottonwood/willow and mesquite habitat. This additional riparian habitat would sustain considerably larger wildlife populations than the riparian habitats at the stormwater outfalls alone. Due to additional water supplies, additional wetlands would likely become established without further human intervention where conditions are favorable.

Although total habitat acreage restored would be more than triple that restored under Alternative 2, the wildlife benefits may be more than proportional to the increase in area due to the increased connectivity of habitat. The larger, more contiguous areas of habitat would potentially support a higher diversity of wildlife in addition to larger populations than the smaller, more isolated patches of habitat. In the HGM analysis for the alternatives, the team determined that for Function 10, "Maintain Interspersion and Connectivity," the increase in habitat values would be more than proportionate to the increase in acreage for that habitat type.

Long-term effects of invasive control would include long-term benefits to wildlife in the project area due to the overall improvement of habitat quality. Long-term benefits of emergent wetland establishment include a greater diversity of habitats in the study area than with Alternative 2. This additional emergent wetland habitat would sustain considerably larger wildlife populations than the emergent wetland habitats at the stormwater outfalls alone. Wildlife groups that would benefit from emergent wetland establishment include amphibians, waterfowl, and wading birds.

Mitigation Measures: No Mitigation Required.

4.4.2.4 Alternatives 5, 5A and 5B

4.4.2.4.1 Impact: Short-Term Effects on Vegetation.

Short-term impacts of lake (gravel pit) restoration would include the loss of minimal areas of vegetation. Focus sites for restoration are the two larger gravel pits in the vicinity of 27th Avenue and 37th Avenue. Gravel pit lake restoration would include both riparian and wetland restoration, combined with control of water levels. Additional measures may include substrate modification to reduce permeability and an increased water supply. The majority of vegetation

that would be disturbed is not native. Due to the low quality of existing vegetation, impacts would be adverse but not be significant. In order to reduce the intensity of the adverse impacts, the following mitigation measures would be implemented.

Mitigation Measure BR-1: Re-vegetation Construction Management Practices.

The Corps would remove salt cedar (*Tamarax* spp.) and giant reed (*Arundo donax*) from the restoration areas as part of the restoration process (Alternatives 4, 5, 5A, and 5B). The City of Phoenix, the non-federal sponsor, would be responsible for maintaining the restored habitat areas free of invasive plants, especially salt cedar and giant reed, throughout the life of the project (Alternatives 4, 5, 5A, and 5B).

The cleared areas would be re-vegetated with habitat of higher quality and permanence than the habitat removed. Implementation of good construction management practices, especially dust suppression with water and/or non-toxic dust-suppressing chemicals or soil binders, would minimize potential impacts from fugitive dust. Also, decreases in the vegetation population can be minimized through careful phasing of the project construction. Areas of desirable vegetation can be delineated on construction plans as areas that are not to be disturbed. Additionally, vegetation removal would occur outside of the spring breeding season to ensure adequate time for a majority of the avian offspring to disperse prior to construction activities.

Mitigation Measure BR-2: Use Clean and Certified Foreign Soils

If any imported topsoil is used in the restoration project, it shall be clean and certified free of weeds, including seeds (Alternatives 2, 4, 5, 5A, and 5B). Feral or free-ranging cats and dogs shall be reported to the local of Animal Control office, and signs shall be posted prohibiting the release of pets of any kind and the use of the restoration area by unrestrained pets (Alternatives 2, 4, 5, 5A, and 5B).

4.4.2.4.2 Impact: Long-Term Effects on Vegetation

Long-term benefits of gravel pit lake restoration would potentially include increased native emergent wetland, cottonwood/willow riparian forest, and possibly mesquite woodland. These long-term effects would be beneficial.

Mitigation Measures: No Mitigation Required.

4.4.2.4.3 Impact: Short-Term Effects on Fish and Wildlife

Gravel pit lake restoration construction activities would temporarily disturb fish, amphibians, and aquatic wildlife habitat. Reconfiguration of the gravel pits is likely to eliminate some game fish and possibly a limited number of native fish. Some amphibians may also be eliminated, depending on the timing and extent of reconfiguration work. In the absence of a major draw-down of the water level, fish would tend to avoid disturbance. In this case, impacts would be adverse, but not significant. If it becomes necessary to drain or substantially lower the water level of the lakes during construction, short term localized impacts to fish could be significant.

Construction activities would also displace aquatic birds that roost around the edges of the lakes and/or feed upon the fish, invertebrates, and aquatic vegetation found in the gravel pit lakes. The temporary loss of fish and aquatic wildlife is considered a less than significant adverse impact because fish populations can be restored relatively quickly and other wildlife would return when the habitat is restored and improved.

Construction activities would also disturb terrestrial wildlife habitat adjacent to the lakes and would potentially displace or eliminate some common native wildlife including reptiles such as side-blotched lizard and western whiptail and small mammals such as deer mouse and desert cottontail. Due to the relatively low quality and small quantity of terrestrial habitat disturbed, impacts to terrestrial wildlife would be adverse but less than significant.

Mitigation Measure BR-5: Trap and Relocate Native Fish

If it becomes necessary to drain or substantially lower the water level of the lakes during construction, short term localized impacts to fish could be significant. To mitigate this impact, it is recommended that native fish be trapped and relocated prior to any major water draw-down.

4.4.2.4.4 Impact: Long-term Effects on Fish and Wildlife

Gravel pit lake restoration would reduce open water habitat and would increase native emergent wetland, cottonwood willow riparian forest, and possibly mesquite woodland. These restored habitats would attract and support populations of native amphibians, reptiles, aquatic birds, riparian birds, and mammals, and could be stocked with native fishes. These long-term effects are beneficial. The loss of open water habitat would reduce the capacity of the lakes to support fish populations. This impact would be adverse but not significant because the displaced fish would be primarily common, non-native species. Although the quantity of open water would be reduced, the quality of open water habitat would be improved due to slope modification, shading, and diversity of topography.

Mitigation Measures: No Mitigation Required.

4.5 CULTURAL RESOURCES

4.5.1 APPROACH AND METHODOLOGY

4.5.1.1 Significance Criteria

Adverse effects to sites and properties listed on, or eligible for, inclusion in the National Register of Historic Places are evaluated based on the Criteria of Adverse Effect as outlined in 36 Code of Federal Regulations (CFR) 800.5 of the regulations implementing Section 106 of the National Historic Preservation Act (NHPA).

4.5.1.1.2 Coordination and Preliminary Archaeological Surveys

Given the study area's location upstream of the Tres Rios project, it is reasonable to conclude that the alluvial stratigraphy of the Salt River might be comparable. The entire length of the Salt River within the Rio Salado Oeste project boundary appears to have been more disturbed than areas further downstream, and has been modified through natural scouring action of periodic flooding, sand and gravel mining, and dumping.

Surveys of selected portions of the river, at all outfalls and adjacent or nearest terraces, were conducted by a Corps of Engineers staff archeologist. No cultural material was observed at any of these areas. The effects of the above mentioned impacts on the river are evident at the outfalls and surrounding areas. Based on the reconnaissance survey, level of disturbance, and data provided by the Tres Rios geological assessment, the Corps believes that the potential for buried archeological resources within the project area is low. Additional surveys may be conducted as alternatives are refined.

If upon further investigation, any resources are determined to be NRHP eligible and avoidance is not feasible, mitigation measures would be detailed in a Memorandum of Agreement (MOA) between the affected tribes, Corps, the City of Phoenix and the Arizona State Historic Preservation Officer (SHPO).

4.5.2 ENVIRONMENTAL IMPACTS

4.5.2.1 No-Action Alternative

Implementation of the No-Action Alternative would not result in any direct impacts on cultural resources. However, it is probable that the disturbance from unregulated recreation, off-highway vehicle traffic and "wildcat" dumping will continue and potentially increase in some areas, further disturbing properties listed or eligible for listing on the National Register. Likewise, it is probable that sites may be disturbed or lost through natural processes such as flooding and erosion.

4.5.2.2 Alternatives 2, 4, 5, 5A and 5B

4.5.2.2.1 Impact: Potential Disturbance or Loss of Properties Listed or Eligible for Listing on the National Register

Preliminary project designs indicate low potential for adverse effects to resources eligible for listing in the National Register of Historic Places (NRHP). Once design begins for the preferred project alternative, additional inventory and evaluation efforts may be required. After consideration of potential for buried cultural resources within the refined project Area of Potential Effect (APE), a determination of effect would be made in consultation with SHPO, the tribes, and the City of Phoenix.

Surface examination of this area revealed no cultural material. The potential for sub-surface resources is low. The Corps has determined that the alternatives would have low potential to

adversely affect sites either listed on or eligible for listing on the National Register of Historic Places. Should artifacts be discovered upon project construction, Section 106 of the NHPA (described below) would be adhered to.

Mitigation Measures CR-1: Conclude MOA to Complete Field Surveys and Conduct Testing and Data Recovery Activities as Appropriate

Pursuant to Section 106 of the National Historic Preservation Act, 36 CFR 800.13(2)(b), any discoveries of either human remains or archeological deposits shall result in the following process:

- Contractor shall stop work.
- Corps of Engineers Archeology Staff shall be notified of discovery.
- Corps Archeology Staff shall determine if discovered cultural mater is an isolated find, or consists of a deposit of some extent. If needed, hand excavations shall be conducted to determine if the deposit is of sufficient content and integrity to be eligibly for listing on the National Register of Historic Places.
- The Corps shall determine eligibility, and effect in consultation with the State Historic Preservation Officer pursuant to 36 CFR 800(a)-(d).

4.6 AESTHETIC RESOURCES

4.6.1 APPROACH AND METHODOLOGY

Impacts to aesthetic resources are evaluated based on the potential for permanent degradation to the scenic beauty of the project area. Long-term degradation, either as a direct or an indirect impact of the proposed project, would be considered a significant impact. Each action alternative includes features that would restore and enhance the river corridor. Incidental to the objectives of the project are the aesthetic improvements associated with restoration. Potential impacts are described by qualitatively evaluating the project components for each of the alternatives against the existing aesthetic conditions within the project area.

4.6.2 ENVIRONMENTAL IMPACTS

4.6.2.1 No-Action Alternative

Under the No-Action Alternative, the existing aesthetic environment would continue to slowly degrade over time, with localized improvements along the banks as developers sporadically change the local area with new construction. With the No-Action Alternative, there would be no short-term impacts on aesthetic resources that are associated with construction activities. However, long-term aesthetic improvements would not be realized with this alternative.

4.6.2.2 Alternatives 2, 4, 5, 5A and 5B

4.6.2.2.1 Impact: Potential Short-Term Adverse Aesthetic Effects due to Construction

The alternatives involve excavation and grading in the river corridor, construction of a grade control structure, installation of constructed wetlands, and development of cottonwood/willow, mesquite and Sonoran Scrub-shrub habitat. These temporary activities could result in impacts on the aesthetic quality of the area. Passers-by on adjacent streets may experience temporary views of construction activities and construction equipment in the river corridor and nearby areas. However, there are relatively limited viewing/access points from adjacent roadways and construction activities would not appear to be much different to the casual observer than the current sand and gravel mining activities. The potential impacts from these construction-related activities would be less than significant.

Mitigation Measures: No mitigation required.

4.6.2.2.2 Impact: Potential Long-Term Adverse Aesthetic Effects

The alternatives include a grade control structure west of 35th Avenue. The structure would be similar to those installed in the upstream Rio Salado project and would consist of roller-compacted concrete and grouted stone. The structure should not be highly visible from nearby areas and the view of the structure should be reduced as vegetation matures in the adjacent areas. Thus, the installation of the grade control structure is not considered a significant aesthetic impact.

Mitigation Measures: No mitigation required.

4.6.2.2.3 Impact: Potential Long-Term Aesthetic Benefits

The alternatives would include significant increases in wetland, cottonwood/willow, mesquite, and Sonoran Scrub-shrub communities. Additionally, removal of salt cedar and other invasive vegetation species that signify habitat disturbance and degradation would improve habitat values and increase biodiversity in the project implementation area.

The alternatives also include opportunities for passive and active recreation along the Salt River in regulated areas. Thus, the increases to habitat and biodiversity would provide improved aesthetic quality in the corridor while recreation features would guide users to these areas. This is considered a beneficial effect.

Mitigation Measures: No mitigation required.

4.7 AIR QUALITY

4.7.1 APPROACH AND METHODOLOGY

Implementation of any of the proposed alternatives would generate emissions from both the construction phase, and later Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) activities. The construction-related emissions would consist of fugitive dust from exposed disturbed soil, exhaust and dust emissions produced by the use of heavy construction equipment, and exhaust and dust emissions from construction worker commute trips. OMRR&R for any alternative other than the No-Action Alternative would also generate exhaust and dust emissions from vehicles driven by workers and recreational visitors, as well as routine maintenance. OMRR&R would be conducted by the non-federal sponsor, and would be subject to dust control under Maricopa County Rule 310.

As discussed in Section 3.7.4.2, federal projects must be evaluated to determine whether their emissions would exceed specified *de minimus* thresholds for six criteria pollutants. If the *de minimus* threshold is exceeded for a criteria pollutant, it must be demonstrated that these emissions conform with the applicable State Implementation Plan (SIP). Total project emissions of ozone precursors (Volatile Organic Compounds [VOC] and Oxides of Nitrogen [NOx]), carbon monoxide (CO), and fugitive dust (PM-10) associated with each alternative are thus compared to *de minimus* thresholds. Air quality impacts would be considered significant if the proposed action causes any of these emission thresholds to be exceeded.

Detailed information on the methods and assumptions used to estimate air pollutant emissions is provided in Appendix C. To calculate construction and OMRR&R emissions, emission factors developed by EPA's AP-42, *Compilation of Air Pollutant Emission Factors*, have been used to calculate exhaust and fugitive dust emissions. Calculations are also based on construction information provided in this DEIS. The following types of air pollutant emission sources prior to mitigation are included in the calculations. All levels of emissions were under the threshold limits, and the mitigation measures would further reduce these emissions. The following mitigation measures were included:

- Fugitive dust emissions from haul trucks, off road equipment and passenger vehicles on unpaved roads within the construction site were estimated based on the assumed number of vehicle trips and travel distance, using AP-42 emission factors applicable for the western United States. For the construction phases, it was assumed unpaved haul roads would be aggressively watered to reduce dust emissions.
- Fugitive dust emissions from excavating, loading, dumping, and spreading of bulk materials during channel excavation and bank stabilization were estimated based on the assumed earthwork volumes, using the EPA's AP-42, *Compilation of Air Pollutant Emission Factors.*
- Emissions from construction equipment tailpipes were estimated based on the type and number of equipment, using recent emission factors for off-road equipment the EPA's AP-42, *Compilation of Air Pollutant Emission Factors.*

Emissions from passenger vehicle traffic associated with the project were based upon the EPA's AP-42, Compilation of Air Pollutant Emission Factors.

4.7.2 ENVIRONMENTAL IMPACTS

4.7.2.1 No-action

Under the No-Action Alternative, no project-related construction activities would take place and no new construction-related commute trips would occur. Thus, no construction-related emissions would be generated. Recreational use of the site would likely remain about the same, with no increases in criteria emissions resulting from new recreational use of the Rio Salado Oeste project.

4.7.2.2 Alternatives 2, 4, 5, 5A and 5B

Air quality impact mechanisms associated with construction of Alternatives 4, 5, 5A and 5B would be similar to those occurring under Alternative 2. However, the total quantities of emissions from channel excavation, habitat restoration and recreation facility installation would be higher for Alternative 4, 5, 5A and 5B, respectively, than they would be under Alternative 2. However, they would still be under the *de minimus* threshold.

4.7.2.2.1 Impact: Generation of Construction-Related and Tailpipe Emissions (CO, VOC, NO_X)

Construction and OMRR&R activities would generate emissions of ozone precursors, carbon monoxide (CO) and PM in the form of tailpipe emissions. Construction tailpipe emissions would originate from a combination of construction equipment activities, and construction worker commute trips. OMRR&R activities would generate tailpipe emissions from recreational vehicle trips, employee trips, and a variety of maintenance activities.

Table 4.7-1 summarizes the estimated emissions associated with implementation of Alternatives 2, 4, 5, 5A and 5B. Annual emissions of CO, VOC, NO_X, SO_X and PM-10 would be below federal conformity *de minimus* levels during each year of project construction and operation; thus, impacts from these emissions is considered less than significant. SO_X has been included in the analysis even though Maricopa County does not violate that standard and does not have a SIP for this pollutant.

Mitigation Measure: No mitigation is required.

4.7.2.2.2 Impact: Generation of Construction-Related and Operational Fugitive Dust (PM-10) Emissions

Channel excavation and bank stabilization activities would generate fugitive dust emissions at the construction site. Table 4.7-1 summarizes the estimated emissions that are associated with implementation of Alternative 2. Annual fugitive PM-10 emissions during the year of maximum construction activity would be less than federal *de minimus* thresholds for General Conformity.

As described by the detailed emission calculations provided in Appendix C, most of the PM-10 emissions would be caused by the daily use of equipment generated by excavation of and spreading of riverbed material, and from haul trucks on unpaved roads.

The construction contractor would be required to obtain appropriate air pollution permits for stationary processing equipment (e.g., rock crushers and screens) and earthmoving activities as required under Maricopa County Air Quality Rules. The dust control plan under those permits includes stringent fugitive dust controls. Implementation of this mitigation measure would reduce dust emissions (and potential nuisance effects) to levels below the *de minimus* threshold.

Mitigation Measure AQ-1: Implement PM-10 - Reducing Measures during Channel Excavation and Bank Stabilization

All construction, restoration and routine maintenance activities would be required to include fugitive dust control measures in accordance with Maricopa County Air Quality Rule 310. The Corps would implement an appropriate combination of the following PM-10 - reducing construction practices in compliance with Maricopa County Rule 310 throughout the construction period.

- Apply water to unpaved haul roads at a frequency adequate to maintain visible surface moisture. Alternatively, apply nontoxic binders (e.g., latex acrylic copolymer) to supplement road watering in accordance with Maricopa County Rule 310.
- Minimize vehicle speed on unpaved roads.
- Water active storage piles at least with a frequency consistent with Maricopa County Rule 310.
- Cover or otherwise stabilize inactive storage piles where feasible.
- Cover haul trucks securely when transporting materials.
- Water all active construction areas with a frequency consistent with Maricopa County Rule 310. Frequency should be increased if wind speeds exceed 15 mph.
- Prohibit all grading activities during periods of high wind (i.e., winds greater than 30 mph).

Compliance with Maricopa County rules would be made a condition of the construction contract and would be enforced through weekly inspection by the Corps.

Table 4.7-1. Estimated Annual Air Pollutant Emissions (tpy) Associated with Alternatives 2, 4, 5, 5A, and 5B

Summary of Total and Average Daily Emissions from All Sources					
	Emissions for entire job, lbs				
Alternative	CO	VOC	NO_X	SO_X	PM-10
2	43904	5806	92561	9372	6396
4	92678	10432	165404	16601	11591
5	189074	16741	260676	25549	18820
5A	136916	13489	212686	21075	15128
5B	136916	13489	212686	21075	15128
	Average Daily, lbs/day				
Alternative	CO	VOC	NO_X	SO_X	PM-10
2 (1200 days)	37	5	77	8	5
Exceedance	No	No	No	No	No
4 (2000 days)	46	5	83	8	6
Exceedance	No	No	No	No	No
5 (2800 days)	68	6	93	9	7
Exceedance	No	No	No	No	No
5A (2400 days)	57	6	89	9	6
Exceedance	No	No	No	No	No
5B (2400 days)	57	6	89	9	6
Exceedance (lbs/day)	No	No	No	No	No
Significance Thresholds (lbs/day)	550	75	100	N/A	150
	Average Yearly, tons/year				
Alternative	CO	VOC	NO_X	SO_X	PM-10
2	3.66	0.48	7.71	0.78	0.53
Exceedance	No	No	No	No	No
4	4.63	0.52	8.27	0.83	0.58
Exceedance	No	No	No	No	No
5	6.75	0.60	9.31	0.91	0.67
Exceedance	No	No	No	No	No
5A	5.70	0.56	8.86	0.88	0.63
Exceedance	No	No	No	No	No
5B	5.70	0.56	8.86	0.88	0.63
Exceedance (lbs/day)	No	No	No	No	No
De Minimus Threshold for General Conformity	100 tons/yr	100 tons/yr	100 tons/yr	N/A	70 tons/yr
200 work days per year. 2000 lbs = 1 ton.					

4.7.2.2.3 Impact: Determination of Conformity

Based on the air quality analysis described in Appendix C, the proposed project would not have a significant impact on air quality. The total emissions of each criteria pollutant is below *de minimus* levels as prescribed in 40 CFR 93.153(b). Therefore, this proposed project conforms to the federal Clean Air Act as amended in 1990 and, as required, a Record of Non-Applicability has been prepared instead of a Conformity Determination (Appendix C).

Mitigation Measures: No mitigation required.

4.7.2.2.4 Impact: Long-Term Effects on Air Quality due to Recreational Use

Due to the location of the project and the intimacy of the expected recreation and education experience, it is projected that most visitors would arrive by private vehicle. Based on historical data maintained by the City of Phoenix for resource-based recreational sites, it is estimated that 2.75 visitors arrive in each vehicle. Additionally, an estimated one visitor per four vehicles arrives at a site by an alternate mode of transportation including bicycle, foot traffic and public transportation. It would be a legitimate goal of the Recreation/Education component to increase the ratio of visitors arriving by alternate means such as buses.

Mitigation Measure AQ-2: Promotion of Alternative Transportation and Energy Efficiency.

In order to mitigate potential environmental impacts from increased traffic, recreational facilities (e.g., multipurpose trails, walk-in access points, access control, continuity with other projects) would be developed that promote alternative transportation and energy efficiency. Initial capacity of the parking facilities would be designed for not more than 500 vehicles in order to limit the potential impact of human activities upon the restoration project.

4.8 NOISE

4.8.1 APPROACH AND METHODOLOGY

Noise impacts are analyzed using standard noise modeling methods. First, potential sources of noise are identified. Then, noise levels for each source are identified from standard references or monitoring data for similar sources. The distance from sources to noise-sensitive receptors is determined, and the projected sound level of sources at the receptor is calculated, taking into account attenuation factors, such as distance and atmospheric effects. Resulting sound levels at receptors are compared to relevant sound level criteria, if criteria exist for a project, to determine the relative magnitude of a noise effect. For each of the project alternatives except for the No-Action Alternative, noise effects would occur during the construction phase of the alternatives and during post-construction use of the site by recreationists. These effects would be in the form of increased traffic noise in the project study area.

4.8.2 ENVIRONMENTAL IMPACTS

4.8.2.1 No-Action Alternative

Under the No-Action Alternative, no changes to ambient noise conditions in the project study area would occur. No construction-related noise would be generated, and no new project-related traffic would use area roadways. For these reasons, there would be no adverse noise effects associated with this alternative.

4.8.2.2 Alternatives 2, 4, 5, 5A and 5B

4.8.2.2.1 Impact: Short-Term Effects Upon Ambient Noise Conditions due to Construction and OMRR&R Activities

Residents living adjacent to or near the project area would be exposed to noise from construction or OMRR&R activities. Typical equipment used would include graders, loaders, rollers, bulldozers, trucks, scrapers, pumps, and generators.

The study area already has moderate activity levels and several sources of adverse noise. The principle sources of noise in the study area are sand and gravel mining operations. These would remain the largest and most significant contributor to ambient noise in the study area. Most of the construction operations would occur within the river bottom. Any increase in noise levels observed by sensitive receptors along the project area is expected to be insignificant with implementation of a few noise-reducing construction measures.

Mitigation Measure N-1: Employ Noise-Reducing Construction Measures.

Construction within 1,000-feet of residences or other noise-sensitive uses shall be restricted to daytime hours. No construction shall be performed within 1,000-feet of an occupied dwelling on Sundays, on legal holidays, or between the hours of 7pm and 7am on other days.

All construction equipment shall have sound-control devices that are at least as effective as those devices provided on the original equipment. No equipment shall have a muffled exhaust.

As directed by the Corps, the contractor shall implement appropriate additional noise mitigation, including, but not limited to, changing the location of stationary construction equipment, shutting off idling equipment, notifying adjacent residents in advance of construction work, and installing acoustic barriers around stationary construction noise sources.

4.8.2.2.2 Impact: Long-Term Effects on Ambient Noise Conditions

The restored ecosystem has the potential to increase visitation and use. The most significant possible noise increase would come from increased traffic noise. The additional traffic would be distributed throughout a typical day and would not be concentrated during peak hours. Since expected recreation-related traffic represents a very small fraction of total traffic volume in the

area, the contribution of project traffic to local noise conditions would not be considered significant.

Mitigation Measures: No mitigation required.

4.9 SOCIAL AND ECONOMIC RESOURCES

4.9.1 APPROACH AND METHODOLOGY

Impacts to social and economic resources are assessed by estimating potential changes to socioeconomic conditions (i.e., population, ethnicity, housing, employment and income) as a result of the alternatives. Potential indirect and direct impacts were determined by qualitatively evaluating the project components for each of the alternatives against the existing social and economic conditions within the study area. A discussion on environmental justice is contained in this section identifying the potential social equity concerns relating to impacts from the project.

4.9.2 ENVIRONMENTAL IMPACTS

4.9.2.1 No-Action Alternative

Existing socioeconomic conditions would remain relatively unaffected as a result of the project. Under the No-Action Alternative, normal fluctuations in socioeconomic conditions would continue. No substantial impacts are anticipated. No impacts involving environmental justice would result.

4.9.2.2 Alternatives 2, 4, 5, 5A and 5B

4.9.2.2.1 Impact: Detectable Increases or Decreases to Population, Housing, Employment or Income due to the Project

None of the alternatives would cause significant direct or indirect impacts on social or economic resources, such as population, housing, employment, or income in the study area. The minimal construction-related employment during the project and park ranger-related employment during the life of the project would not have the capacity to affect local or regional income levels or to increase employment to any significant levels locally or regionally. Normal fluctuations in socioeconomic conditions would naturally occur over time with or without the project. No substantial impacts are anticipated.

Mitigation Measures: No mitigation required.

4.9.2.2.2 Impact: Potential Beneficial Effects on Quality of Life Adjacent to Project

The existing streambed consists primarily of a dry wash with no recreational facilities or public access for recreation. The project would include trails, scenic overlooks, interpretive centers,

gathering areas, parking facilities, restrooms and shade structures. Activities along the project corridor would include bird watching, hiking, biking, equestrian uses, wildlife observation and fishing. The addition of this parks system in place of the existing environment has the potential to increase the quality of life adjacent to the project area.

Mitigation Measures: No mitigation required.

4.9.2.2.3 Impact: Effects on Environmental Justice

Project impacts were reviewed to determine whether low-income or minority neighborhoods would be disproportionately affected by the alternatives. None of the alternatives would generate environmental justice impacts. Although low-income and minority neighborhoods are located in proximity to the project area, impacts would not be inequitably distributed to affect these neighborhoods to a greater degree than other neighborhoods. No impacts associated with social equity or environmental justices are anticipated.

Mitigation Measures: No mitigation required.

4.10 TRANSPORTATION

4.10.1 APPROACH AND METHODOLOGY

The Oeste project consists of restoration of an eight mile reach of Salt River extending from 19th Avenue to 83rd Avenue. The dominant mode of transportation for this area is the automobile. Along this reach of the Salt River, there are three bridged crossings and one at-grade crossing. Nearly all local streets and arterials near the Salt River form a north-south, east-west grid roadway network. Impacts on transportation were assessed based on how project-related construction and post-construction traffic would benefit or adversely affect existing traffic and roadway infrastructure. For this analysis, it was assumed that there would be no permanent or temporary road closures associated with any of the alternatives, with the exception of occasional closures related to high flows in the main channel. Traffic and circulation effects related to the number of vehicle trips associated with construction workers commuting to the project site were based on estimates of labor hours. Estimates of daily vehicle trips were developed using the following assumptions:

- Eight labor hours generate one person-round-trip.
- Vehicle occupancy rates are 1.1 people per vehicle.
- Construction activities occur year-round on approximately 200 days per year.
- An adequate supply of construction workers resides within a reasonable distance from the proposed project sites. Because Sky Harbor Airport would not be affected by this project, no detailed analysis related to this facility was performed. Haul routes were assumed to be either within the river channel or via local primary streets to I-17.

4.10.2 ENVIRONMENTAL IMPACTS

4.10.2.1 No-Action Alternative

Under the No-Action Alternative, traffic volume would continue to increase as the surrounding areas became more developed. This is especially true in the western part of the project area where new housing developments are being constructed. In addition, to accommodate the increase in traffic volumes, the roadways would continue to be widened, typically up to six lanes with a median. There would be no short-term increases in traffic from construction, no accelerated damage to roadways from heavy vehicles, and no disruption of traffic from construction activities. No adverse effects on transportation would result under this alternative.

4.10.2.2 Alternatives 2, 4, 5, 5A and 5B

4.10.2.2.1 Impact: Temporary Increase in Traffic on Existing Roadways during Project Construction and OMRR&R Activities

The alternatives would create a less than significant increase in vehicle volume around the study area. The arterial streets have adequate capacity to accommodate this temporary, short-term increase in project-related traffic. However, should construction or OMRR&R activities cause lane or road or sidewalk closures or detours, the following mitigation measure would be implemented to reduce impacts.

Mitigation Measure T-1: Implement Traffic Control Plan

This work shall consist of traffic control, and use of devices and flagmen or pilot cars in accordance with Section 401 of the City of Phoenix Supplements and the City of Phoenix Traffic Barricade Manual, dated 1998.

All traffic and/or traffic control devices on this project shall be provided, maintained and/or controlled as specified in the City of Phoenix Traffic Barricade Manual, dated 1998.

Permission to restrict city streets, sidewalks and alleys (street closure permits) shall be requested as specified in Section III of the City of Phoenix Traffic Barricade Manual.

Unless otherwise provided for in the following General Traffic Regulations, all traffic on this project shall be regulated as specified in Section IV of the City of Phoenix Traffic Barricade Manual.

4.10.2.2.2 Impact: Potential Damage to Roadway Surfaces during Project Construction

Increased truck traffic associated with construction activities could result in damage to the roadway surface on roadways used as haul routes. This is a potentially significant impact that is avoidable with mitigation.

Mitigation Measure T-2: Repair Damaged Roadways

The Corps or its contractors shall repair any damage to existing roadways caused as a result of construction activities for this project. Repair work shall be coordinated with the agencies having jurisdiction over each roadway and with the intent to return the roadways to the conditions existing immediately prior to the commencement of the project.

4.10.2.2.3 Impact: Generation of Additional Vehicle Trips by Recreationists

Due to the location of the project and the intimacy of the expected recreation and education experience, it is projected that most visitors would arrive by private vehicle. Based on historical data maintained by the City of Phoenix for resource-based recreational sites, it is estimated that 2.75 visitors arrive in each private vehicle. Additionally, an estimated one visitor per four vehicles arrives at a site by an alternate mode of transportation including bicycle, foot traffic and public transportation. Prime recreation time is defined as weekends and holidays, while non-primetime is weekdays. Therefore, the greater number of recreationist trips would occur during off-peak hours outside of the weekday commute times. Therefore, no significant impacts are anticipated on traffic and circulation.

Mitigation Measures: No mitigation required.

4.11 LAND USE

4.11.1 APPROACH AND METHODOLOGY

Each of the alternatives includes a range of approaches to provide ecological restoration and recreation within the project implementation area. Potential impacts are identified by evaluating each alternative against existing land use patterns within the project area. The alternatives are also analyzed regarding their compatibility with existing plans and policies that are relevant to the project area. Impacts that would result in inconsistencies with existing land use patterns or result in land being degraded so that it cannot be used for current or planned use are considered significant.

4.11.2 ENVIRONMENTAL IMPACTS

4.11.2.1 No-Action Alternative

Under the No-Action Alternative, land use conditions would stay continue to change at rapid rates. There would be no short-term impacts from construction to affect adjacent land. Land use and planning policies to enhance and restore biological habitat and riparian areas and provide flood damage reduction and recreation opportunities in open space areas would not be fully realized.

4.11.2.2 Alternatives 2, 4, 5, 5A and 5B

4.11.2.2.1 Impact: Temporary Adverse Effects on Land Use during Project Construction

The environmental restoration is expected to be beneficial and not have any substantial adverse effects. However, the nearby land uses in the study area could experience temporary adverse effects associated with construction activities. There is on-going low- to medium-density residential construction in the study area. Construction and later OMRR&R activities could disturb that development with brief road blocks or partial closures, but the effects would be too short-term to significantly impact other construction. Most of the impacts on land use are within the 100-year floodplain. This land all ready has large restrictions on use. Converting the area into an ecosystem restoration site would not have any adverse effects on land use.

Mitigation Measures: No mitigation required.

4.11.2.2.2 Impact: Long-Term Beneficial Impact on Land Use Experience

Rapid population growth is anticipated for the City of Phoenix and Maricopa County as a whole. Significant development of residential and non-residential land will be required to accommodate the projected growth. In the study area, existing land uses are primarily comprised of agriculture, industrial and low-density residential. It is anticipated that additional low- to medium-density residential development will take place due to the close proximity of the area to the City core. Existing vacant lots and agricultural land will likely be converted to residential uses. All five action alternatives would develop the river corridor in a manner that does not contribute significant traffic, noise, limited vistas or other effects of development. Therefore, the river corridor's transformation into a low-use restoration area would make it easier for the area to absorb the adjacent higher-use development.

In addition, the project provides opportunities for current City of Phoenix land use and planning policies to be realized. Such policies call for enhancement and restoration of biological habitat and riparian areas and to provide flood damage reduction and recreation opportunities.

Mitigation Measures: No mitigation required.

4.11.2.2.3 Impact: Compatibility with Land Use Plans and Policies of Local Government Jurisdictions

Jurisdictional plans impacting the study are the Maricopa County Comprehensive Plan, Estrella Planning Area Land Use Plan and the Laveen Planning Area Land Use Plan. The Salt River is identified as a "Proposed Open Space" within these plans. Proposed Open Spaces are intended to establish an interconnected system of protected natural open spaces, corresponding to regionally significant mountains, rivers, washes, upland desert, and cultural resources in unincorporated areas of the County (Maricopa County, 1997). In addition, the City of Phoenix Land Use Plan calls for enhancement and restoration of biological habitat and riparian areas and to provide flood damage reduction and recreation opportunities. Implementation of the project would be compatible with local government jurisdictional plans.

Mitigation Measures: No mitigation required.

4.12 RECREATION

4.12.1 APPROACH AND METHODOLOGY

Each of the action alternatives utilizes a variety of components to provide ecological restoration, recreation, and incidental flood damage reduction within the project area. Potential impacts to recreation resources are identified by evaluating each of the alternatives against the existing recreation features within the project area. Alternatives are also analyzed regarding their compatibility with existing recreation plans and policies that are relevant to the project area. Impacts to recreation resources within the project implementation area would be significant if the proposed project is found to be inconsistent with current recreation plans and/or policies.

4.12.2 ENVIRONMENTAL IMPACTS

4.12.2.1 No-Action Alternative

Under the No-Action Alternative, recreation conditions would stay substantially the same. There would be no short-term impacts from construction that would affect adjacent recreation activities. Recreational experiences would also not be enhanced. Land use and planning policies to enhance and restore biological habitat and riparian areas and provide flood damage reduction and recreation opportunities in open space areas would not be fully realized.

4.12.2.2 Alternatives 2, 4, 5, 5A and 5B

4.12.2.2.1 Impact: Temporary Adverse Effects on Recreation during Project Construction and OMRR&R Activities

The existing streambed consists primarily of a dry wash with no recreational facilities or public access for recreation. Therefore, project construction would have no impact on current recreation. OMRR&R activities may briefly affect recreational use. However, impacts would occur in small, localized areas in a way that would have little impact on use.

Mitigation Measures: No mitigation required.

4.12.2.2.2 Impact: Long-Term Beneficial Effect on Recreational Experience

The project would include trails, scenic overlooks, interpretive centers, gathering areas, parking facilities, restrooms and shade structures. Activities along the project would include bird watching, hiking, biking, equestrian uses, wildlife observation and fishing. Completion of this project would also facilitate connectivity between two other restoration projects on the Salt River: Tres Rios and Rio Salado Phoenix. Given that no current regulated or designated recreational uses exist on this reach of the Salt River, implementation of this project would bring significant beneficial effects to the recreational experience.

Mitigation Measures: No mitigation required.

4.13 PUBLIC HEALTH AND SAFETY

4.13.1 APPROACH AND METHODOLOGY

The proposed project is intended to enhance the ecological health of Salt River and its related habitats. As a result of the project, there may be potential impacts associated with public health and safety. Impacts are evaluated by estimating the potential effects of each alternative against existing environmental conditions and reviewing potential public health and safety issues in the project study area.

4.13.2 ENVIRONMENTAL IMPACTS

4.13.2.1 No-Action Alternative

Under the No-Action Alternative, the potential health and safety benefits associated with the other alternatives would not be realized. Safety threats associated with flood hazards would continue to exist for properties within the floodplain. Benefits to soil and water quality would not occur. Mosquitoes are currently a potential problem in the area. Implementation of the No-Action Alternative would not provide vector control beyond existing levels and, thus, existing vector problems would persist.

4.13.2.2 Alternatives 2, 4, 5, 5A and 5B

4.13.2.2.1 Impact: Temporary Construction-Related Water Quality Impacts

Project-related construction activities in the river channel could cause temporary water quality impacts because disturbed and eroded soil, petroleum products, and miscellaneous construction wastes or unearthed waste debris may be discharged into receiving surface waters and leached into subsurface waters. Soil and associated contaminants that enter stream channels can increase turbidity, stimulate the growth of algae, increase sedimentation of aquatic habitat, and introduce compounds that are toxic to aquatic organisms. If released into water sources, construction materials such as fuels, oils, paints, and concrete are potentially harmful to fish and other aquatic life. The extent of potential environmental effects depends on several factors. Some examples of factors that would lead to adverse environmental effects are: highly erodible soil types; poor construction practices; large disturbed area under construction for a long period of time; precipitation during large excavations or soil transport periods, and; construction proximal to drainage channels. Implementation of Best Management Practices would reduce construction impacts to water quality to a less-than-significant level.

Mitigation Measure PHS-1: Implement HTRW Management Measures

Best Management Practices (BMPs) would be implemented during construction. Some examples of these BMPs follow. Construction activities should be conducted in the dry weather

season to the extent possible to minimize exposure of disturbed construction sites to rainfall and stormwater runoff. The general contractor for the project would prepare and implement standard grading and erosion control measures (e.g., management, structural, and vegetative controls) to minimize exposure of soil that may contribute to contaminated runoff. BMPs must be implemented before predicted rain events. In addition, the construction contractor would implement standard hazardous materials management practices to reduce the possibility of chemical spills or releases of contaminants in runoff.

4.13.2.2.2 Impact: Temporary Construction and OMRR&R-Related Area Safety Issues

Project construction and restoration activities proposed under this alternative include grading, site preparation for vegetation planting, irrigation system establishment, channel excavation and reshaping, and channel terracing. These activities, as well as operations and maintenance (OMRR&R) activities such as sediment removal, would result in potential safety hazards. These hazards would be minimized with the implementation of the following mitigation measure.

Mitigation Measure PHS-2: Implement Construction and OMRR&R Management Measures

The Contractor shall provide temporary fencing, barricades, and/or guards, as required, to provide protection in the interest of public safety. Whenever the Contractor's operations create a condition hazardous to the public, he shall furnish at his own expense and without cost to the Government, such flagmen and guards as are necessary to give adequate warning to the public of any dangerous conditions to be encountered and he shall furnish, erect, or maintain such fences, barricades, lights, signs and other devices as are necessary to prevent accidents and avoid damage or injury to the public. Flagmen and guards, while on duty and assigned to give warning and safety devices shall conform to applicable city, county, and state requirements.

Should the Contractor appear to be neglectful or negligent in furnishing adequate warning and protection measures, the Contracting Officer may direct attention to the existence of a hazard and the necessary warning and protective measures shall be furnished and installed by the Contractor without additional cost to the Government. Should the Contracting Officer point out the inadequacy of warning and protective measures, such action of the Contracting Officer shall not relieve the Contractor from any responsibility for public safety or abrogate his obligation to furnish and pay for those devices. The installation of any general illumination shall not relieve the Contractor of his responsibility for furnishing and maintaining any protective facility.

4.13.2.2.3 Impact: Potential Increases in Mosquito Breeding

Increased standing water would potentially attract mosquitoes that may be carriers of serious diseases including West Nile virus and various strains of encephalitis. The outfall wetlands would be designed to maintain flowing water under most conditions, and other areas with increased water supply would be designed to minimize standing water. Under some conditions, standing or slow-moving water may be unavoidable, for example, in the borrow pit lakes during drought periods when inflow is minimum or absent. A vector control program for these area would probably be necessary to protect public health.

Mitigation Measure PHS-3: Monitoring Plan, Natural Controls and Chemical Pesticides

Chemical pesticides would be avoided in favor of natural controls because chemical pesticides often adversely affect desirable fish and wildlife species, as well as humans. Restored habitat would attract some natural predators of mosquitoes, including insects such as water striders, giant water bugs, common backswimmers, dragonflies, and water boatman. Vertebrate predators, including barn swallows, black phoebes, song sparrows, and several species of bats would also potentially populate the habitat following restoration. Native insect and vertebrate predators of mosquitoes could be introduced to the habitat, but unless conditions are optimum, populations may not remain adequate for long-term mosquito control.

Large populations of mosquitoes often occur even in relatively undisturbed habitats where water is present. The Gila topminnow (*Poeciliopsis occidentalis occidentalis*), a small native fish that is federally listed as Endangered, may effectively control mosquitoes. Special protocols would be required to introduce this species to the project area due to its endangered status, but Gila topminnow may be a good option in areas where non-native predators (including mosquito fish) are not present. Western mosquito fish (*Gambusia affinis*), a species of small fish native to the United States from eastern Mississippi to eastern Texas that feeds on mosquito larvae, are commonly stocked in ponds as an efficient and economical biological method of mosquito abatement. Mosquito fish also consume eggs and fry of native fish, as well as desirable insect species, which would be detrimental to native fish populations. In the borrow pit lakes, where fish populations consist primarily of introduced game species, mosquito fish may be an acceptable biological control, provided that they are confined to the lakes. A bacterium, *Bacillus thuringensis* var *israeliensis*, which is specific to mosquito larvae but harmless to most other organisms, is another effective biological control that may be compatible with ecological restoration.

In addition to the above possible measures, Maricopa County has a routine monitoring program county wide and a vector control program to help reduce the risk of mosquito-borne disease. Maricopa County Vector Control monitors mosquitoes along the Salt River primarily during the summer months. Maricopa County Department of Environmental Services, Vector Control Division and the Arizona State Department of Health Services, Office of Infectious Disease Services, Vector-Borne and Zoonotic Disease Section are the agencies primarily responsible for control of mosquitoes and other animal vectors in the project area.

4.13.2.2.4 Impact: Beneficial Decrease in Illegal/Unauthorized Activities in the Project Area

The existing streambed consists primarily of a dry wash with no recreational facilities or public access for recreation. Currently, a number of illegal or unauthorized activities occur in the project study area, primarily dumping of refuse, unauthorized firearm discharges, and short-term habitation of certain portions of the project implementation area by transient persons. After this project is completed, increased use of the area by recreationists and maintenance staff would tend to decrease illegal activities in the area because of increased patrolling of the area by the city and use by the public. Project lands will be acquired by local jurisdictions who will become

responsible for policing these areas and protecting recreationists from illegal activities. This is a beneficial impact.

Mitigation Measures: No mitigation required.

4.13.3 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE (HTRW)

As discussed in Section 3.13.4, there are a number of HTRW concerns both in and near the study area. Sites identified with possible HTRW concerns are, for the most part, located outside the 100-year floodplain (Figure 3.3-2). Project features would be located almost entirely within the 100-year floodplain, and would be designed to avoid the known HTRW sites. The Corps would not participate in clean up of materials regulated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or by the Resource Conservation and Recovery Act (RCRA).

Groundwater underlying the 19th Avenue gravel pit may be contaminated with 1,1-DCE (Figure 3.3-2). Alternatives 2, 4, 5, 5A and 5B would include grading and restoration of the river channel in the vicinity of the 1,1,-DCE plume. Each of these alternatives also includes some action to restore the 19th Avenue gravel pit to wetlands and associated riparian habitats. Due to the likely presence of 1,1-DCE in the groundwater at this location, restoration features would be designed to avoid the groundwater table in the vicinity of the 1,1-DCE plume.

CHAPTER 5
CUMULATIVE IMPACT ANALYSIS

This section is included in the EIS to address the cumulative impacts associated with the proposed project. Cumulative effects result from the proposed action's incremental impacts when these impacts are added to the impacts of other past, present, and reasonably foreseeable future actions, regardless of the agency or person who undertakes them. Cumulative effects can result from individually minor, but collectively significant actions that take place over time (Bass, Herson & Bogdan, 2001). A cumulative impact, then, is the additive effect of all projects in the same geographic area. In addition, federal regulations implementing NEPA (40 CFR 1500-1508) require that the cumulative impacts of a proposed action be assessed.

5.1 PROJECTS WITHIN POTENTIAL CUMULATIVE IMPACT ZONE

For the purpose of this analysis, the Rio Salado Oeste cumulative impact zone is identified as the Salt River corridor stretching from Granite Reef Dam to the confluence of the Agua Fria and Salt Rivers. Five projects, four upstream and one downstream, are located along the Salt River in Maricopa County. Upstream of the proposed Rio Salado Oeste Project on the Salt River are Va Shly'ay Akimel, Rio Salado Tempe, Tempe Town Lake, and Rio Salado Phoenix. Directly downstream of Rio Salado Oeste is the Tres Rios project. The Rio Salado Pathway project also plays a key role in the recreation corridor that is developing along the river. Information on these projects is provided below. These projects are expected to span nineteen years (1998-2017).

5.1.1 VA SHLY'AY AKIMEL

Va Shly'ay Akimel (Vash) is a primary purpose ecosystem restoration project with proposed incidental benefits of passive and active recreation and aesthetics improvements. The project is in the pre-engineering design (PED) phase, with construction estimated to occur from 2009 to 2017. The project is a collaborative effort of the U.S. Army Corps of Engineers, the Salt River Pima Maricopa Indian Community (SRPMIC), and the City of Mesa. The study area includes portions of the SRPMIC and the City of Mesa. The study area is approximately 14 miles long, extending along the Salt River between the Pima Freeway (SR 101) and Granite Reef Dam. The area is approximately two miles wide and encompasses approximately 17,345 acres. The alternative to be constructed includes channelization, installation of a grade control structure, removal of invasive plant species, irrigation via a surface braided irrigation network, irrigation from a new groundwater well and from effluent, the creation of wetlands features, the establishment of new cottonwood, mesquite and Sonoran Desert habitats. A total of 1,712 new habitat acres are expected to be created, in addition to approximately five miles of multi-use recreation paths.

5.1.2 RIO SALADO TEMPE

Another primary purpose ecosystem restoration plan, Rio Salado Tempe, also includes incidental benefits of passive and active recreation. This Corps of Engineers/City of Tempe project is divided into three sections around Tempe Town Lake: Indian Bend Wash, a tributary of the Salt River located between Rural Rd and McClintock Rd, and the portions of the Salt River streambed directly upstream and downstream of the Tempe Town Lake Dams. In total, this 1.2-river mile project planned to restore 169 acres of habitat. To date, construction has been completed on the Indian Bend Wash section, which provides about 41 restored acres. The upstream segment includes roughly 0.5 miles of recreational path. The downstream section is currently in construction and expected to be complete by mid 2007. The upstream section is scheduled to complete construction about a year later in mid 2008.

5.1.3 TEMPE TOWN LAKE

Tempe Town Lake is entirely a City of Tempe project having two primary purposes – economic development and recreation. Incidental benefits include aesthetic improvements and passive restoration both upstream and downstream of the dams. The 220-acre lake was completed in 1999, though construction of resorts, restaurants, retail shops, business parks and condos still continues around the lake. The primary recreation components, which have all ready been constructed, include the 25-acre Tempe Beach Park on the south bank, five miles of paved multi-use paths along the north and south banks, and a marina on the north bank.

5.1.4 RIO SALADO PATHWAY

The Rio Salado Pathway (Tempe to Phoenix) is an accessible, shared-use path proposed along the south bank of the Rio Salado beginning at Priest Drive in Tempe and ending at approximately 28th Street in Phoenix. Through support of both the City Councils of Tempe and Phoenix, and the Regional Council of Maricopa Association of Governments, $150,000 was approved to conduct a feasibility study on the shared-use trail and public amenities for the nearly four mile gap between Rio Salado Tempe and Rio Salado Phoenix. Now that the study is completed, the cities of Tempe and Phoenix are currently seeking a combination of private and public funding to construct Rio Salado Pathway (City of Tempe, Tempe Town Lake website, 2006). No estimate for construction completion currently exists.

5.1.5 RIO SALADO PHOENIX

Rio Salado Phoenix extends from 28th Street west to 19th Avenue, which is the upstream end of the Rio Salado Oeste study area. This Corps of Engineers/City of Phoenix collaboration has the primary purpose of ecosystem restoration with incidental benefits of recreation and aesthetic improvements. The project includes approximately 595 acres of restoration, and ten miles of recreational multi-use paths. It includes construction of a low-flow channel in the river bottom, and establishment of open water, wetland marsh, cottonwood/willow, open edges, and mesquite habitat on the river bottom and overbanks. The recreational elements associated with this project would include trails, scenic overlooks, interpretive centers, gathering areas, parking, restrooms, and shade structures. Construction was completed in 2005 along the riverbed from 16th Street to

19th Avenue. The final phase of this project, 16th Street to 28th Street, is scheduled to be completed in 2007.

5.1.6 TRES RIOS

Tres Rios is one of the more important projects when analyzing cumulative impacts for Rio Salado Oeste. This is because the two projects are contiguous, and construction is expected to occur consecutively. Tres Rios is estimated to finish construction in 2010 and Rio Salado Oeste is not expected to begin construction until 2010. However, there is a slight chance that the construction phases of the two projects may overlap due to the uncertainty of future appropriations. Therefore, a slightly more in-depth analysis of Tres Rios is included below.

Tres Rios is a U.S. Army Corps of Engineers/City of Phoenix ecosystem restoration project that extends along the Salt River from the west end of Rio Salado Oeste at 83rd Avenue downstream to the Agua Fria River. The study efforts were directed toward improving and increasing fish and wildlife habitat values and diversity for Threatened and Endangered species, as well as providing flood damage reduction, and recreation. Potential incidental benefits are associated with water quality and supply.

The selected plan includes a six mile long flood control levee, a 184-acre regulating wetland that would equalize diurnal variations in discharges from the 91st Avenue treatment plant, a 300-million gallon per day pump station to convey the flow from the treatment plant to the regulating wetland, 128 acres of wetland along the north bank of the Salt River, a pipeline in the overbank wetland that would lead to 38 acres of riparian corridor, 134 acres of open water marsh, grading the Salt River to convey surface water to supply 69 acres of riparian habitat, and a dewatering well from the treatment plant that will deliver enough water to support about 206 acres of open water marsh and about 16 acres of riparian corridor on the south bank of the Salt River. In all, approximately 775 acres of habitat will be restored and an 11 mile long recreation path will be created. Construction on the levee began in 2005, and is scheduled for completion in 2008. The final phase: "Pump Stations and Piping to Wetlands" is estimated to begin late 2007 and finish in 2010. However, as with all projects, construction continuation is always subject to the availability of future appropriations.

Table 5.1-1. Summary of Projects within the Potential Cumulative Impact Zone

Project Name	Location	Salt River-Approx. River Miles	Approx. Acres to be Restored	Approx. Recreation Path Miles	Estimated Years in Construction
Va Shly'ay Akimel	Granite Reef Dam to SR-101	14	1,712	5	2009 - 2017
Rio Salado Tempe	Indian Bend Wash, W. of McClintock Dr. to Town Lake East Dam, and West Dam to Priest Dr.	1	169	0.5	2003 - 2007
Tempe Town Lake	W. of McClintock Dr to East of Priest Dr.	3	-	5	1998 - 2004
Rio Salado Pathway	Priest Dr. to 28th Street	3	-	3	TBD
Rio Salado Phoenix	28th St. to 19th Ave.	5	595	10	2001 - 2007
Rio Salado Oeste	19th Ave. to 83rd Ave.	8	1,528	24	2010 - 2017
Tres Rios	83rd Ave to W. of Agua Fria Confluence	8	775	11	2005 - 2010
TOTALS	Granite Reef Dam to W. of Agua Fria Confluence	42	4,734	58.5	1998 - 2017

5.2 SUMMARY OF CUMULATIVE IMPACTS BY RESOURCE AREA

Thresholds and criteria used to determine the significance of effects vary depending on the type of resource being analyzed. An analysis of cumulative impacts to each of the resource areas is presented below.

5.2.1 GEOLOGY AND TOPOGRAPHY

The projects that would impact the topography and soils within the Salt River stream bed are Va Shly'ay Akimel, Tempe Town Lake, Rio Salado (Tempe and Phoenix reaches), and Tres Rios. With the exception of the Tempe Town Lake dams, the projects involve reshaping the channel in a way that prevents erosion and sedimentation problems. Several of the projects include active bank stabilization measures, such as gabion walls and soil cement and protection for potentially disturbed roads and bridges through levees and grade control structures. The measures within the projects that would increase soil stabilization and address known sedimentation problem areas would create beneficial effects for the cumulative impact zone.

5.2.2 HYDROLOGY AND WATER RESOURCES

The cumulative impacts of the proposed project, in combination with the other projects along the Salt River, are not expected to produce any adverse impact to surrounding water uses or the local environment. The proposed project would not cause raised surface water elevations during flooding, or depletion of water on the project site. Cumulatively, the Corps ecosystem restoration projects will not raise the 100-year flood levels, and will slightly lower them overall. In addition, the projects have each been determined to not adversely impact groundwater levels. When examined cumulatively, the projects would not collectively result in significant adverse impacts to groundwater.

5.2.3 WATER QUALITY

The Phoenix area is serviced by a regional WWTP located at 91st Avenue and the Salt River. The plant discharges approximately 154 mgd of effluent to the Salt River. In 1995, a Tres Rios Demonstration Project was placed within the floodway of the Salt River below the 91st Avenue plant. The project provides final treatment of approximately 2 mgd of effluent within ten acres of constructed wetlands. This project is immediately downstream of the Rio Salado Oeste Study area.

Surface water from storm drains is of poor quality and is only sporadically available. The poor quality of stormwater results from land uses in the watershed, and the usually long duration between rainfall events. Neither of these factors would be affected by the ecosystem restoration projects, either individually, or considered cumulatively. Groundwater has somewhat better quality, though there are still concerns with some contaminants. The cumulative effect of the Salt River ecosystem restoration projects on groundwater quantity or quality is expected to be negligible.

In all of the ecosystem restoration projects, incidental water quality improvement would be obtained through incorporation of wetlands into the restoration plan. Effluent that would be used for these projects is of excellent water quality. Tempe Town Lake is constantly monitored and adaptively managed for water quality issues. The projects have the potential to collectively benefit water quality along the Salt River.

5.2.4 BIOLOGICAL RESOURCES

The ecosystem restoration projects have the potential to create a biologically diverse and highly functional riparian more closely resembling what once existed in the Salt River. Three conditions prevent project continuity from Granite Reef Dam to the Salt-Agua Fria River confluence: the area spanning approximately one-mile from SR101 to west of McClintock is not part of a restoration project; the Tempe Town Lake is not consistent with riparian habitat and allows for large amounts of recreation to constantly disrupt wildlife activities, and; the area from Priest Drive to 28th Street in Phoenix will not be restored to reduce the possibility of bird strikes with turbine engine aircraft using Sky Harbor International Airport (Federal Aviation

Administration Advisory Circular 150/5200-33A, Hazardous Wildlife Attractants On or Near Airports, Dated July 27, 2004).

Despite these three interruptions in habitat contiguity, the Salt River would have a total of approximately 4,734 restored acres. Restoration would be continuous for approximately 21 river miles, from 28th Street to the Salt-Agua Fria River confluence with the implementation of Rio Salado Oeste. These ecosystem restoration projects would have significantly beneficial effects on biological resources. These benefits include providing biologically diverse and desirable vegetative communities, and new fish and wildlife habitat. Restored areas may include habitats with potential to support federally Threatened and Endangered species, and wildlife of special concern to the AGFD. The functional capacity of the Salt River as defined by the HGM model would also be greatly increased. Finally, newly restored riparian habitat would help to offset potentially significant adverse impacts from construction and other substantial OMRR&R measures by providing proximal habitat for mobile wildlife species to temporarily relocate.

5.2.5 CULTURAL RESOURCES

It is likely that the construction of these projects would have unavoidable significant impacts on prehistoric and historic cultural resources. Unavoidable significant impacts are impacts that remain following the implementation of mitigation measures or impacts for which there are no mitigation measures. Compliance with Section 106 of the National Historic Preservation Act would be executed and Memorandums of Agreement among all stakeholders would be completed for any NRHP-eligible cultural resources that cannot be avoided.

5.2.6 AESTHETIC RESOURCES

The Salt River has become an illegal dumping ground, home to squatters, and is also an unregulated fishing/recreation area. The streambed has been littered with construction waste, old tires, vehicles and other waste. Habitat has been of low quality and poor biodiversity. The stream banks have shown signs of erosion and degradation. These projects have already started to provide, and would continue to provide, beneficial cumulative impacts on the Salt River. Tempe Town Lake was able to make the area aesthetically pleasing enough to draw large amounts of developmental economic resources. The City of Phoenix concurrently planned the "Beyond the Banks" project, which aimed at redeveloping the area outside Rio Salado Phoenix to a more aesthetically pleasing commercial and residential zone to better coincide with the improvements to the Salt River.

5.2.7 AIR QUALITY

Based on the air quality analysis described in Appendix C, and the discussion presented in Section 4.7.2 above, it has already been shown that the Rio Salado Oeste project would not have a significant impact on air quality. Most air quality impacts would result from project construction, with far more minor contributions from recreation and OMRR&R activities. The most critical cumulative impact consists of PM-10 emissions, because Maricopa County is in a serious non-attainment area for PM-10. For this reason, the potential for additive emissions resulting from concurrent construction phases was examined.

As shown in Table 5.1-1, the Rio Salado Oeste and Va Shly'ay Akimel are expected to be under construction concurrently. The period of concurrent construction would run from 2010 to 2017. It is also possible that the Tres Rios project would not be completed before construction work on Rio Salado Oeste and Va Shly'ay Akimel commences in 2010. The final year of construction for Tres Rios will consist mostly of completing "punch-list" items and light construction. Nevertheless, there is a short period of time around 2010 during which all three of these projects may be under construction at the same time.

In response to this possibility, the projected VOC, NO_X, CO and PM-10 emissions for all three projects need to be considered. Table 5.1-2 summarizes the emissions for the pollutants of concern using average ton-per-year data. Assuming that all three projects are under concurrent construction and generating the average annual emissions, the cumulative impacts still remain below *de minimus* thresholds. Table 5.1-2 provides a good cumulative impact summary based on the "worst-case" scenario for construction timing.

Table 5.2-1. Summary Table of Estimate Emissions

Project Name	POLLUTANTS OF CONCERN			
	VOC	NO_x	CO	PM-10
DE MINIMUS THRESHOLDS (tpy)				
DE MINIMUS	100	100	100	70
DURING CONSTRUCTION (tpy)				
Va Shly'ay Akimel	5	39	44	23
Tres Rios	2	24	18	10
Rio Salado Oeste	0.56	8.86	5.70	0.63
Totals	7.56	71.86	67.7	33.63

In summary, the Rio Salado Oeste project would not have a significant long term effect on air quality, nor would it contribute to a significant cumulative impact on air quality. It would be important for all construction activities to abide by Maricopa County Rule 310 to ensure that *de minimus* thresholds are not exceeded. Compliance with Maricopa County Rule 310 would be made a condition of the construction contracts, and would be enforced through weekly inspection by the Corps.

5.2.8 NOISE

Residents living adjacent to or near the Salt River in the Phoenix area are likely to be exposed to some level of noise from construction, OMRR&R, and recreational activities associated with one of the Salt River projects. The highly urbanized Salt River corridor already has moderate activity levels and many sources of ambient noise. These include highway noise, widespread construction activities not associated with ecosystem restoration, sand and gravel mining operations, and aircraft approaching and departing Sky Harbor International Airport. The principle sources of noise in the immediate vicinity of the Salt River are sand and gravel mining operations. These would remain the largest and most significant contributor to ambient noise along the river.

Unlike air pollution that can accumulate throughout a large area, noise attenuates as the distance from its source increases. The Salt River projects most likely to have concurrent construction periods would be Rio Salado Oeste and Va Shly 'ay Akimel. Since these projects are located 12 river miles apart, sensitive receptors would not be exposed to ambient noise from both projects at the same time. As discussed above, there is a small chance that Tres Rios would be completing construction as Rio Salado Oeste begins construction. The final construction work on Tres Rios (improvements to the pump stations and piping water to wetlands) would be located some distance from the western end of Rio Salado Oeste. Therefore, noise generated by construction equipment on the two projects would be unlikely to have a cumulative effect.

While construction at any single location along the Salt River would occur during a relatively short period of time, OMRR&R and recreational activities would continue in perpetuity. However, these noise sources would be minor contributors to ambient noise levels along the Salt River. OMRR&R work would occur on an infrequent basis at any one location along the river. Thus, no significant cumulative impacts to noise levels would occur within the cumulative impact zone along the Salt River.

5.2.9 SOCIAL AND ECONOMIC RESOURCES

The presence of Tempe Town Lake has created a highly desirable waterfront area that has spurred residential and commercial development along its banks. The City of Phoenix, through its "Beyond the Banks" program, is actively pursuing redevelopment along the Salt River corridor. These effects would be considered positive and beneficial by most people, but have a limited area of effect. In the context of Maricopa County, the Salt River ecosystem restoration projects would not have significant cumulative effects on population, housing, employment, or income.

5.2.10 TRANSPORTATION

Construction activities for the Salt River projects would cause local, temporary inconveniences for motorists utilizing roads along or crossing the Salt River. Since most of these impacts would be on surface streets, motorists would be unlikely to encounter delays associated with more than one project during their everyday activities. With the exception of additional commuter trips for construction workers, and delivery of construction materials and equipment to and from the work sites, there would be little cumulative impact on the local network of limited access highways. In the context of the traffic volume already present in Maricopa County, any cumulative impact would be inconsequential.

Long-term recreational use would generate additional vehicle trips within the cumulative impact zone. However, recreation would occur in higher volume during non-peak traffic times (i.e., week nights and weekends). Interstate highways and state routes provide limited access service throughout the zone of cumulative impacts. These freeways have numerous exits so that the accumulation of any additional vehicle trips by recreationists would not adversely impact any single area.

5.2.11 LAND USE

The Salt River is identified as "Proposed Open Space" on local land use maps. This designation recognizes that natural resources and open spaces are important to the quality of life in the county and, if acquired, are intended to be planned and managed to protect, maintain, and enhance their intrinsic value for recreational, aesthetic, and biological purposes. Additionally, the City of Phoenix General Plan provides that public access should be protected and preservation shall be encouraged. When combined with Dedicated Open Space lands, the Proposed Open Spaces are intended to establish an interconnected system of protected natural open spaces, corresponding to regionally significant mountains, rivers, washes, upland desert, and cultural resources in unincorporated areas of the County (Maricopa County, 1997).

The County's size and environmental diversity is greater than some U.S. states, and it provides a complex natural ecosystem. As part of the overriding vision for the County, protection of the unique desert environments is among the top priorities. The Maricopa County Comprehensive Plan focuses on maintaining and improving the physical environment, natural resource conservation, and other environmental considerations. Additionally, the plan recognizes the importance of creating, improving, and conserving natural habitat and open space to increase biological diversity. River and wash policies include discouraging development within 100-year floodplains, maximizing wildlife habitat and native vegetation along waterways, and developing management principles to protect the natural riparian habitat of the region (Maricopa County, 1997). Rio Salado Oeste, when combined with the other restoration and recreation projects, collectively achieves the Proposed Open Space land use designation.

5.2.12 RECREATION

Cumulatively, the Salt River ecosystem restoration projects would create approximately 58.5-miles of recreational paths along the Salt River. Moreover, the sections from Rio Salado Tempe to Tres Rios are part of a larger 100-mile Regional Loop, a non-vehicular transportation corridor that will encircle the Phoenix metropolitan area. Therefore, the addition of Rio Salado Oeste to the other projects along the Salt River would have cumulative beneficial impacts.

5.2.13 PUBLIC HEALTH AND SAFETY

The Salt River corridor has become an illegal dumping ground, home to squatters, and is an unregulated fishing/recreation area. Implementation of the Salt River ecosystem restoration projects would eliminate wildcat dumping, and would create a more regulated environment for recreationists. The presence of park rangers and maintenance staff would also create a river corridor that is safer for public use. Fishing opportunities in sand and gravel pits converted to riparian habitats would be lost. Addressing problems with squatters is a sensitive issue that would be more difficult to address.

Vector issues have the potential to occur wherever standing water lingers. Maricopa County has a routine monitoring program county wide, and a vector control program to help reduce the risk of mosquito-borne disease. Maricopa County Vector Control monitors mosquitoes along the Salt River primarily during the summer months. Maricopa County Department of Environmental

Services, Vector Control Division and the Arizona State Department of Health Services, Office of Infectious Disease Services, Vector-Borne and Zoonotic Disease Section are the agencies primarily responsible for control of mosquitoes and other animal vectors in the project area.

The increase in wetlands and other riparian habitats would aid in removing potentially harmful pollutants from stormwater. Pollutants that are not removed or broken down have the potential to infiltrate into the groundwater supply. The Salt River projects would also ensure a hydraulically designed river channel for conveyance of flood flows, with incidental flood damage reduction benefits. The cumulative impact of the Salt River ecosystem restoration projects would be a net beneficial effect on public health and safety.

5.3 CONCLUSIONS

The Rio Salado Oeste project, in concert with the five other projects along the Salt River, would be expected to bring desirable, positive increases in desirable native vegetation, wildlife habitat, and an extended riparian corridor for the local area. Other beneficial impacts would include a decrease in erosion and sedimentation problems, potentially improved water quality through the creation of new wetlands, improved aesthetic resources, a land use that fulfills the Maricopa County Comprehensive Plan, a continuous recreation corridor, incidental flood damage reduction benefits, and increased public health and safety along the Salt River.

The only significant adverse cumulative impact would be to cultural resources. These potential impacts may be unavoidable and significant. Compliance with all federal and local statutes and regulations would be implemented whenever potential artifacts are found.

CHAPTER 6
IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES AND UNAVOIDABLE SIGNIFICANT IMPACTS

The Council on Environmental Quality (CEQ) NEPA regulations (42 U.S.C. 4332; 40 CFR 1502.16) require analysis of significant irreversible and irretrievable commitments. Irreversible commitments are damages to the environment that cannot be reversed, even after the life of a project. Irretrievable commitments are those that are lost for a long period of time. This includes the use of nonrenewable resources, such as metal, wood, fuel, paper, and other natural or cultural resources. These resources are considered committed because they would be used for the proposed action when they could have been conserved or used for other purposes. Another impact that is discussed in this chapter is the unavoidable impacts of the proposed action and alternatives where no mitigation is available to offset the environmental consequences.

Long term implications of the project are to enhance the degraded riparian habitat that has diminished as a viable support system for wildlife. A commitment to an efficient utilization of natural resources would allow the historically productive habitat to be restored.

6.1 IRREVERSIBLE COMMITMENTS

A defined above, irreversible commitments made during the construction of the Rio Salado Oeste project would include air pollutant emissions. The project construction would not reach *de minimus* threshold levels. However, Maricopa County is a PM-10 non-attainment area. The construction of this project would add to other emissions and create an irreversible commitment to the environment.

6.2 IRRETRIEVABLE COMMITMENTS

All of the alternatives would result in the irretrievable commitment of resources such as fuel for construction vehicles and concrete for the grade control structure. Additionally, clay and stone needed to construct some project features may be imported from offsite. All of these materials are both readily available and easily generated.

Another resource this project commits that is currently available is stormwater and effluent. Stormwater currently has no other use than to be directed into the river, though effluent is also used to irrigate agricultural lands as needed. The project would commit both of these water sources to newly constructed cottonwood/willow, mesquite, scrub-shrub and wetland habitats. These resources are both readily available and easily generated, but could realistically be needed for other uses in the future if current drought conditions and population expansion continue. Dedication of this water to the Rio Salado Oeste project would create an irretrievable commitment of this nonrenewable resource.

Finally, the proposed action would commit workforce time for construction, engineering, environmental review and compliance, and for project operation, maintenance, repair, replacement and rehabilitation.

6.3 UNAVOIDABLE SIGNIFICANT IMPACTS

As stated previously throughout this document, construction of Rio Salado Oeste may result in unavoidable significant impacts to cultural resources. Unavoidable significant impacts are impacts that remain following the implementation of mitigation measures or impacts for which there are no mitigation measures. Compliance with Section 106 of the National Historic Preservation Act would be executed and Memorandums of Agreement amongst all stakeholders would be concluded for any NRHP-eligible cultural resources that cannot be avoided.

CHAPTER 7
ENVIRONMENTAL COMPLIANCE

The Rio Salado Oeste project would comply with several major state and federal laws, as described below:

7.1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1969, as amended

NEPA requires that environmental consequences and project alternatives be considered before a decision is made to implement a federal project. NEPA establishes requirements for preparation of an EIS for projects potentially having significant environmental impacts. This EIS has been prepared in accordance with the requirements set forth in Section 102 of NEPA, the CEQ Regulations for implementing the procedural provisions of NEPA (40 CFR 1500 et seq.), and the U.S. Army Corps of Engineers Regulation 200-2-2, *Procedures for Implementing NEPA*, (33 CFR, parts 230 and 325). Reasonable alternatives have been considered during the planning process. Potential environmental effects have been included in the evaluation of the proposed project actions, and all procedural review requirements of the aforementioned rules and regulations would have been met as part of the EIS process.

7.2 CLEAN AIR ACT, as amended, 1990

The US Environmental Protection Agency (EPA) is involved in local air quality planning through the federal Clean Air Act, as amended, 1990. Air quality impacts of each alternative considered at Rio Salado Oeste project fall under both federal and state conformity regulation. In Arizona, the federal conformity regulation in 40 CFR Part 93, Subpart B has been adopted by reference in the Arizona Administrative Code, Section R18-2-1438. Based on the air quality analysis described in the DEIS, the total emissions of each applicable criteria pollutant are below *de minimus* levels as prescribed in 40 CFR 93.153(b). As a result, the General Conformity Rule does not apply and no further analysis or determination is required. This project is expected to comply with the Clean Air Act, as amended, 1990.

7.3 CLEAN WATER ACT OF 1977

The Clean Water Act is the principal law governing pollution control and water quality of the Nation's waterways. The objective of the Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (33 U.S.C 1251). Each action alternative would require the discharge of fill material into Waters of the United States. A jurisdictional delineation of Waters of the U.S. has been performed for the project implementation area. A 404(b)(1) evaluation has been prepared and is included in Appendix A of the EIS. Compliance

from the Water Quality Division, State of Arizona Department of Environment Quality would be obtained prior to start of construction. The District Commander may plan to seek exemption under Section 404(r) if the requirements for this exemption are met.

7.4 ENDANGERED SPECIES ACT (ESA) OF 1973, as amended

In accordance with Section 7(a)(2) and 7(c) of the ESA, the Corps requested information on threatened and endangered species in the study area in a letter to the U.S. Fish and Wildlife Service (FWS) in December 2004. FWS responded in a March 22, 2004 letter with a reference to the Internet web page http://arizonaes.fws.gov where the Arizona Ecological Field Services Office has posted lists for state of Arizona by County. FWS assigned consultation number 02-21-04-I-0137 to this project. Copies of correspondence and the Maricopa County species information (downloaded from the Internet) are included in Appendix B. As FWS noted in their letter, the species on the county list do not necessarily occur in the study area. A federal agency is required to consult with FWS pursuant to Section 7 of the Act if it determines that an action may affect a listed species. Results of Section 7 Consultation will be included in the Final EIS.

7.5 BALD AND GOLDEN EAGLE PROTECTION ACT OF 1940, as amended (16 U.S.C. 668)

This DEIS addresses the potential for this project to affect the bald eagle. No take of bald or golden eagles, alive or dead, or any part, nest, or egg thereof, is anticipated, regardless of which alternative is selected. All five action alternatives are expected to comply with the Bald and Golden Eagle Protection Act.

7.6 FISH AND WILDLIFE COORDINATION ACT OF 1958, as amended (16 U.S.C. 661)

The project alternatives are in compliance with the Fish and Wildlife Coordination Act. In response to the requirements of the Act, the Corps has and will continue to coordinate with both the U.S. Fish and Wildlife Service (USFWS) and the Arizona Game and Fish Department (AGFD). As part of this coordination, the USFWS provided a Planning Aid Letter on June 21, 2002, and a Coordination Act Report on June 20, 2005. These documents provide recommendations for alternative formulation and future OMRR&R activities, and state that the USFWS is unaware of any federally listed Threatened or Endangered species within the project area.

Both agencies participated as members of the HGM team, and the USFWS also conducted soil, water, and fish tissue analyses. The DEIS will be sent to the USFWS and the AGFD during the public review period.

7.7 MIGRATORY BIRD TREATY ACT OF 1994, as amended

This project complies with the Migratory Bird Treaty Act, which provides legal protection for almost all breeding bird species occurring in the United States. The intent of the Act is to eliminate any commercial market for migratory birds, feathers, or bird parts. This document addresses the potential of the alternatives of the project components to affect migratory birds. The alternatives would not include the taking, killing, or possession of any migratory birds. In addition, the project would not facilitate the commercial market for any bird species.

7.8 NATIONAL HISTORIC PRESERVATION ACT

An archeological field survey of the Area of Potential Effect (APE) would need to be conducted in accordance with Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800). If cultural resources were to be discovered during construction and could not be avoided, work would be suspended in that area until the finds are evaluated for eligibility for listing in the National Register of Historic Places (NRHP) in consultation with the State Historic Preservation Officer (SHPO). If resources were determined to be NRHP-eligible and avoidance is not feasible, further mitigation measures would be detailed in a Memorandum of Agreement (MOA) between all necessary parties, including the SHPO, the City of Phoenix, and the tribes. These mitigation measures would include field surveys, testing, and data recovery. The Advisory Council on Historic Preservation would be provided the opportunity to comment in accordance with 36 CFR 800.11.

7.9 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT, MAY 24, 1977, as amended

Under this Executive Order, the Corps must take action to avoid development in the base floodplain (100-year) unless it is the only practicable alternative to reduce hazards and risks associated with floods; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial value of the base floodplain. The project area is located entirely within the Salt River floodplain. The hydrologic and hydraulic analyses included as Appendix A to the Feasibility Report show that implementation of Alternative 5A would not cause a rise in water surface elevations during the 100-year flood. Incidental flood damage reduction benefits would occur if Alternative 5A was constructed. The project is in compliance with this Executive Order.

7.10 EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS, 1977

In developing alternatives, the Corps considered the effects of the project on the survival and quality of wetlands. Projects are to "...avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative...."

Since it is necessary to reconstruct the entire Salt River channel to implement any one of the action alternatives, avoidance of wetlands is not practicable. Essentially all wetlands within the project implementation area would be impacted by construction of Alternative 5A. However, a much larger acreage of higher quality, more sustainable wetlands would be created. There would be a short term adverse effect on wetlands until the benefits associated with the project begin to accrue. The overall effect of this project on wetlands would be beneficial.

7.11 EXECUTIVE ORDER 12898, ENVIRONMENTAL JUSTICE

On February 11, 1994, President Clinton signed an "Executive Order on Federal Action to address Environmental Justice in Minority Population and Low-Income Populations. This Order is designed to focus federal attention on actions that affect environmental and human health conditions in minority and low-income communities. The proposed project would not adversely affect minority populations or low income populations. This project would provide a geographic benefit to the area surrounding the Salt River.

7.12 ARIZONA GROUNDWATER MANAGEMENT ACT

The Arizona Groundwater Management Act was passed by the Arizona Legislature in 1980. This Act created Active Management Areas (AMAs) overseen by Arizona Department of Water Resources (ADWR). ADWR has identified the groundwater basin underlying lower Salt River Valley as the Phoenix Active Management Area. The Phoenix AMA comprises two distinct but interconnected alluvial groundwater basins: West Salt River Valley and East Salt River Valley (Section 3.2.2). The management goal of the Phoenix AMA is to attain "safe yield" by 2025. "Safe yield" means that ground-water withdrawals are balanced with natural and artificial recharge within the AMA. This is to be achieved by implementing water conservation, utilizing renewable water resources such as Colorado River water and effluent, retiring agriculture with advancing urbanization, and by purchasing and extinguishing private groundwater rights. Regardless of the water sources utilized, any alternative implemented would be expected to comply with the Arizona Groundwater Management Act.

7.13 AQUIFER PROTECTION PERMITS

The Arizona Department of Environmental Quality (ADEQ) administers an Aquifer Protection Permit (APP) program to safeguard the groundwater supply from pollutants that come from an identifiable source. Organizations or individuals may be required to obtain an APP if they own or operate a facility that discharges a pollutant directly to an aquifer, to the land surface, or to the area between an aquifer and the land surface (the vadose zone) when it is likely that the pollutant will reach an aquifer (ADEQ, 2006). The APP program includes provisions for exemptions or non-applicability. An APP may be needed from ADEQ prior to project implementation.

7.14 ARIZONA NATIVE PLANT LAW

The Arizona Department of Agriculture enforces the Arizona Native Plant Law. The law provides varying levels of protection for most of the plants native to the state. Landowners have the right to destroy or remove native plants growing on their land, but 20 to 60 days prior to the removal of any protected native plants, landowners are required to notify the Arizona Department of Agriculture and to obtain permits or tags where applicable. The proposed alternatives would increase the number and diversity of native plants within the project while greatly reducing the number of non-native plants.

7.15 ARIZONA EXECUTIVE ORDER 91-6, PROTECTION OF RIPARIAN AREAS

Under this executive order, the Governor of Arizona has established state policy:

- To recognize that the protection and restoration of riparian areas are of critical importance to the state;
- To actively encourage and develop management practices that will result in maintenance of existing riparian areas and restoration of degraded riparian areas;
- To promote public awareness through the development of educational programs of the benefits and values of riparian areas and the need for their protection and careful management;
- To seek and support cooperative efforts and local group and citizen involvement in the protection, maintenance and restoration of riparian areas;
- To actively encourage the preservation, maintenance, and restoration of instream flows throughout the state; and that any loss or degradation of riparian areas will be balanced by restoration or enhancement of other riparian areas of equal values and functions.

The proposed project is in compliance with this Executive Order.

CHAPTER 8
MITIGATION MEASURES

Chapters 4 through 7 address impacts related to the proposed project implementation and future maintenance. Mitigation measures are developed for each resource to minimize project-related impacts. The following explanation details required mitigation measures for Alternative 5A, the preferred alternative. For a complete comparison of mitigation measures for each alternative, please refer to Table ES-2.

8.1 GEOLOGY AND TOPOGRAPHY

No mitigation required.

8.2 HYDROLOGY AND WATER RESOURCES

No mitigation required.

8.3 WATER QUALITY

In terms of water quality, the awarded contractor would need to prepare a project-specific Notice of Intent (NOI) and a Stormwater Pollution Prevention Plan (SWPP) for construction activities. In addition, it should be noted that on November 16, 1990, EPA published regulations under the NPDES program that defined one facet of the phrase "stormwater discharges associated with industrial activity" as being discharges from construction activities (including clearing, grading and excavation activities) that result in the disturbance of five or more acres of total land area, including smaller areas that are part of a larger common plan of development or sale (40 CFR 122.26(b)(14)(x)). These are commonly referred to as Phase I construction activities. ADEQ is issuing the construction general permit that authorizes the discharge of pollutants in stormwater discharges associated with construction activity. The AZPDES rules found in the Arizona Administrative Code (A.A.C.) R18-9-A905 incorporate these and other NPDES federal regulations, by reference.

The regulation entitled "National Pollutant Discharge Elimination System – Regulation for Revision of the Water Pollution Control Program Addressing Stormwater Discharges" (64 FR 68722) was published by EPA on December 8, 1999. This regulation, which is considered Phase II of the stormwater program, expands the existing NPDES stormwater program to address discharges that result in land disturbance of equal to or greater than one and less than five acres or less than one acre if part of a larger common plan of development or sale. The Stormwater Phase II Rule automatically designates these small sites; however, this rule allows for the exclusion of certain sources from the national program based on a demonstration of the lack of impact on water quality, as well as the inclusion of others based on a higher likelihood of localized adverse impact on water quality. Exclusion from the program is available through waivers to operators of small construction activity who certify for one of the available waivers.

There may be confusion about permitting requirements for sites that are part of a larger common plan of development or sale. All large construction activity, regulated under 40 CFR 122.26(b)(14)(x), is required to obtain coverage under a stormwater permit including sites disturbing less than five acres that are part of a larger common plan of development or sale that has the potential to disturb five or more acres collectively. A similar permit requirement exists for small construction activity, regulated under 40 CFR 122.26(b)(15)(i), that disturbs less than one acre but is part of a larger common plan of development or sale having the potential to disturb at lease one, but less than five acres collectively. Examples of these would be lots in a subdivision or industrial park. Construction projects that disturb less than one acre not meeting these requirements may still be designated to be covered under this permit based on the potential for contribution to a violation of a water quality standard or for significant contribution of pollutants to waters of the U.S. (40 CFR 122.26(b)(15)(ii)).

The mitigation measures/environmental commitments are summarized in the following paragraphs.

Mitigation Measure WQ-1: Implement Erosion Control Best Management Practices (BMPs)

The Corps and its contractors shall implement erosion control measures throughout the construction period and during implementation of OMRR&R activities to minimize erosion and sediment input into the river. The Corps would oversee implementation of erosion control measures during construction. The contractor selected for the project shall:

- Conduct construction and OMRR&R activities during the dry season;
- Conduct all construction work in accordance with site-specific construction plans that minimize the potential for increased sediment inputs to the river;
- Divert concentrated runoff away from channel banks;
- Minimize vegetation removal;
- Identify with construction fencing all areas that required clearing, grading, revegetation, or reshaping in a way that minimizes areas to be cleared, graded, reshaped or otherwise disturbed;
- Grade and stabilize spoils and stockpile sites to minimize erosion and sediment input to the river;
- Implement erosion control measures as appropriate to prevent sediment from entering the river channel or other watercourses to the extent feasible, including the use of silt fencing or fiber rolls to trap sediments and erosion control blankets to protect channel banks;
- Apply water to unpaved haul roads at a frequency adequate to maintain visible surface moisture;
- Mulch disturbed areas as appropriate and plant with appropriate species as soon as practicable after disturbance;

- Avoid operating equipment in flowing water by using temporary cofferdams or other suitable structures to diver flow around the channel and bank construction areas, and;
- If hay bales are used for erosion control during construction they must be sterile and weed-free.

Mitigation Measure WQ-2: Implement Spill Prevention BMPs

The Corps and its contractors would prepare a spill prevention and response plan that regulates the use of hazardous and toxic materials, such as petroleum-based fuels and lubricants for construction equipment. The Corps would oversee development and implementation of a stormwater pollution prevention plan. Elements of that plan would ensure that:

- Workers are trained to avoid and manage spills;
- Construction and maintenance materials are prevented from entering the river channel;
- All spills are cleaned up immediately and appropriate agencies are notified of any spills and of the clean-up procedures employed;
- Staging and storage areas for equipment, materials, fuels, lubricants, solvents, and other possible contaminants are located at least 100-feet a way from the river's normal high-water area;
- Vehicles are immediately removed from the work area if they are leaking, and;
- Equipment is not operated in flowing water (if necessary, suitable temporary structures can be installed to divert water around in-channel work areas).

8.4 BIOLOGICAL RESOURCES

Mitigation Measure BR-1: Re-vegetation Construction Management Practices

The Corps would remove salt cedar (*Tamarix* spp.) and giant reed (*Arundo donax*) from the restoration areas as part of the restoration process (Alternatives 4, 5, 5A, and 5B). The City of Phoenix, the non-federal sponsor, would be responsible for maintaining the restored habitat areas free of invasive plants, especially salt cedar and giant reed, throughout the life of the project (Alternatives 4, 5, 5A, and 5B).

The cleared areas would be re-vegetated with habitat of higher quality and permanence than the habitat removed. Implementation of good construction management practices, especially dust suppression with water and/or non-toxic dust-suppressing chemicals or soil binders, would minimize potential impacts from fugitive dust. Also, decreases in the vegetation population can be minimized through careful phasing of the project construction. Areas of desirable vegetation can be delineated on construction plans as areas that are not to be disturbed. Additionally, vegetation removal would occur outside of the spring breeding season to ensure adequate time for a majority of the avian offspring to disperse prior to construction activities.

Mitigation Measure BR-2: Use Clean and Certified Foreign Soils

If any imported topsoil is used in the restoration project, it shall be clean and certified free of weeds, including seeds (Alternatives 2, 4, 5, 5A, and 5B). Feral or free-ranging cats and dogs shall be reported to the local of Animal Control office, and signs shall be posted prohibiting the release of pets of any kind and the use of the restoration area by unrestrained pets (Alternatives 2, 4, 5, 5A, and 5B).

Mitigation Measure BR-3: Consult with USFWS and AGFD prior to Ground-Disturbing Activities

Prior to ground-disturbing activities in existing riparian or wetland areas, the Corps would consult with U.S. Fish and Wildlife Service and Arizona Game and Fish Department to determine the potential for the occurrence of any sensitive wildlife species. If sensitive species are determined to be present or to have potential to occur, the schedule for invasive removal shall be revised to avoid breeding seasons of any sensitive species on site (Alternatives 4, 5, 5A, and 5B).

Mitigation Measure BR-4: Conduct Operation & Maintenance Activities on a Rotating Basis and Only During Non-Nesting Periods

Sediment removal and other activities would only be conducted during non-nesting periods of the above listed Threatened and Endangered species, and Wildlife of Special Concern. Sediment removal would be conducted on a rotating basis so that no more than 25 percent of the marsh area would be affected in any one year.

Mitigation Measure BR-5: Trap and Relocate Native Fish

It would be necessary to drain the lakes in the project implementation area during construction, and impacts to fish could be significant. To mitigate this impact, it is recommended that native fish be trapped and relocated prior to any major water draw-down.

8.5 CULTURAL RESOURCES

Mitigation Measures CR-1: Conclude MOA to Complete Field Surveys and Conduct Testing and Data Recovery Activities as Appropriate

Pursuant to Section 106 of the National Historic Preservation Act, 36 CFR 800.13(2), any discoveries of either human remains or archeological deposits shall result in the following process:

- Contractor shall stop work;
- Corps of Engineers Archeology Staff shall be notified of discovery;
- Corps Archeology Staff shall determine if discovered cultural mater is an isolated find, or

consists of a deposit of some extent. If needed, hand excavations shall be conducted to determine if the deposit is of sufficient content and integrity to be eligibly for listing on the National Register of Historic Places, and;

- The Corps shall determine eligibility, and effect in consultation with the State Historic Preservation Officer pursuant to 36 CFR 800.

8.6 AESTHETICS

No mitigation required.

8.7 AIR QUALITY

Mitigation Measure AQ-1: Implement PM-10 - Reducing Measures during Channel Excavation and Bank Stabilization

All construction, restoration and routine maintenance activities would be required to include fugitive dust control measures in accordance with Maricopa County Air Quality Rule 310. The Corps would implement an appropriate combination of the following PM-10 - reducing construction practices in compliance with Maricopa County Rule 310 throughout the construction period:

- Apply water to unpaved haul roads at a frequency adequate to maintain visible surface moisture. Alternatively, apply nontoxic binders (e.g., latex acrylic copolymer) to supplement road watering in accordance with Maricopa County Rule 310;
- Minimize vehicle speed on unpaved roads;
- Water active storage piles at least with a frequency consistent with Maricopa County Rule 310;
- Cover or otherwise stabilize inactive storage piles where feasible;
- Cover haul trucks securely when transporting materials;
- Water all active construction areas with a frequency consistent with Maricopa County Rule 310. Frequency should be increased if wind speeds exceed 15 mph, and;
- Prohibit all grading activities during periods of high wind (i.e., winds greater than 30 mph).

Compliance with Maricopa County rules would be made a condition of the construction contract and would be enforced through weekly inspection by the Corps.

Mitigation Measure AQ-2: Promotion of Alternative Transportation and Energy Efficiency

In order to mitigate potential environmental impacts from increased traffic, recreational facilities (e.g., multipurpose trails, walk-in access points, access control, continuity with other projects) would be developed that promote alternative transportation and energy efficiency. Initial capacity of the parking facilities would be designed for not more than 500 vehicles in order to limit the potential impact of human activities upon the restoration project.

8.8 NOISE

Mitigation Measure N-1: Employ Noise-Reducing Construction Measures

Construction within 1,000-feet of residences or other noise-sensitive uses shall be restricted to daytime hours. No construction shall be performed within 1,000 feet of an occupied dwelling on Sundays, on legal holidays, or between the hours of 7pm and 7am on other days.

All construction equipment shall have sound-control devices that are at least as effective as those devices provided on the original equipment. No equipment shall have a muffled exhaust.

As directed by the Corps, the contractor shall implement appropriate additional noise mitigation, including, but not limited to, changing the location of stationary construction equipment, shutting off idling equipment, notifying adjacent residents in advance of construction work, and installing acoustic barriers around stationary construction noise sources.

8.9 SOCIAL AND ECONOMOIC RESOURCES

No mitigation required.

8.10 TRANSPORTATION

Mitigation Measure T-1: Implement Traffic Control Plan

This work shall consist of traffic control, and use of devices and flagmen or pilot cars in accordance with Section 401 of the COP Supplements and the City of Phoenix Traffic Barricade Manual, dated 1998.

All traffic and/or traffic control devices on this project shall be provided, maintained and/or controlled as specified in the City of Phoenix Traffic Barricade Manual, dated 1998.

Permission to restrict city streets, sidewalks and alleys (street closure permits) shall be requested as specified in Section III of the City of Phoenix Traffic Barricade Manual.

Unless otherwise provided for in the following General Traffic Regulations, all traffic on this project shall be regulated as specified in Section IV of the City of Phoenix Traffic Barricade Manual.

Mitigation Measure T-2: Repair Damaged Roadways

The Corps or its contractors shall repair any damage to existing roadways caused as a result of construction activities for this project. Repair work shall be coordinated with the agencies having jurisdiction over each roadway and with the intent to return the roadways to the conditions existing immediately prior to the commencement of the project.

8.11 LAND USE

No mitigation required.

8.12 RECREATION

No mitigation required.

8.13 PUBLIC HEALTH AND SAFETY

Mitigation Measure PHS-1: Implement HTRW Management Measures

Best Management Practices (BMPs) would be implemented during construction. Some examples of these BMPs follow. Construction activities should be conducted in the dry weather season to the extent possible to minimize exposure of disturbed construction sites to rainfall and stormwater runoff. The general contractor for the project would prepare and implement standard grading and erosion control measures (e.g., management, structural, and vegetative controls) to minimize exposure of soil that may contribute to contaminated runoff. BMPs must be implemented before predicted rain events. In addition, the construction contractor would implement standard hazardous materials management practices to reduce the possibility of chemical spills or releases of contaminants in runoff.

Mitigation Measure PHS-2: Implement Construction and OMRR&R Management Measures

The Contractor shall provide temporary fencing, barricades, and/or guards, as required, to provide protection in the interest of public safety. Whenever the Contractor's operations create a condition hazardous to the public, he shall furnish at his own expense and without cost to the Government, such flagmen and guards as are necessary to give adequate warning to the public of any dangerous conditions to be encountered and he shall furnish, erect, or maintain such fences, barricades, lights, signs and other devices as are necessary to prevent accidents and avoid damage or injury to the public. Flagmen and guards, while on duty and assigned to give warning and safety devices shall conform to applicable city, county, and state requirements.

Should the Contractor appear to be neglectful or negligent in furnishing adequate warning and protection measures, the Contracting Officer may direct attention to the existence of a hazard and the necessary warning and protective measures shall be furnished and installed by the Contractor without additional cost to the Government. Should the Contracting Officer point out the inadequacy of warning and protective measures, such action of the Contracting Officer shall not relieve the Contractor from any responsibility for public safety or abrogate his obligation to furnish and pay for those devices. The installation of any general illumination shall not relieve the Contractor of his responsibility for furnishing and maintaining any protective facility.

Mitigation Measure PHS-3: Monitoring Plan, Natural Controls and Chemical Pesticides

Chemical pesticides would be avoided in favor of natural controls because chemical pesticides often adversely affect desirable fish and wildlife species, as well as humans. Restored habitat would attract some natural predators of mosquitoes, including insects such as water striders, giant water bugs, common backswimmers, dragonflies, and water boatman. Vertebrate predators, including barn swallows, black phoebes, song sparrows, and several species of bats would also potentially populate the habitat following restoration. Native insect and vertebrate predators of mosquitoes could be introduced to the habitat, but unless conditions are optimum, populations may not remain adequate for long-term mosquito control.

Large populations of mosquitoes often occur even in relatively undisturbed habitats where water is present. The Gila topminnow (*Poeciliopsis occidentalis occidentalis*), a small native fish that is federally listed as Endangered, may effectively control mosquitoes. Special protocols would be required to introduce this species to the project area due to its endangered status, but Gila topminnow may be a good option in areas where non-native predators (including mosquito fish) are not present. Western mosquito fish (*Gambusia affinis*), a species of small fish native to the United States from eastern Mississippi to eastern Texas that feeds on mosquito larvae, are commonly stocked in ponds as an efficient and economical biological method of mosquito abatement. Mosquito fish also consume eggs and fry of native fish, as well as desirable insect species, which would be detrimental to native fish populations. In the borrow pit lakes, where fish populations consist primarily of introduced game species, mosquito fish may be an acceptable biological control, provided that they are confined to the lakes. A bacterium, *Bacillus thuringensis* var *israeliensis*, which is specific to mosquito larvae but harmless to most other organisms, is another effective biological control that may be compatible with ecological restoration.

In addition to the above possible measures, Maricopa County has a routine monitoring program county wide and a vector control program to help reduce the risk of mosquito-borne disease. Maricopa County Vector Control monitors mosquitoes along the Salt River primarily during the summer months. Maricopa County Department of Environmental Services, Vector Control Division and the Arizona State Department of Health Services, Office of Infectious Disease Services, Vector-Borne and Zoonotic Disease Section are the agencies primarily responsible for control of mosquitoes and other animal vectors in the project area.

CHAPTER 9
PUBLIC INVOLVEMENT

9.1 SCOPING

The City of Phoenix formally requested assistance from the Corps to explore possible remedies for several problems recognized along the Salt River. Many of these problems have long-standing and regionally widespread roots, but are evident in the immediate region of the study area. In brief, they can be attributed to land use changes in the past 150 years. The Salt River no longer runs as a perennial stream and the average depth to groundwater is far greater than was true in the past. Without previously available water sources and modifications that have been made to the floodplain, most of the native vegetation and wildlife cannot survive, and the Salt River is biologically quite impoverished. The objectives of the study are as follow:

- Restore native riparian, wetland and floodplain habitat and manage undesirable plan, fish and wildlife species.
- Reduce flood damages to infrastructure and structures.
- Improve passive recreation and environmental-education opportunities.

The non-federal views and preferences regarding ecosystem restoration, with some recreation, were generally obtained through coordination with the non-federal sponsor and with various local and regional agencies and organizations, neighborhood associations, and the general public. Announcements for public meetings, including the date, time, location, and subject matter, were made in local newspapers. A formal public scoping meeting was held with the sponsor on September 13, 2001. The purpose of the meeting was to introduce the project to the public, give individuals and agencies an opportunity to identify issues for consideration in this DEIS, and to solicit input on the project. The Corps received no written public comments during the scoping period. The Corps, in conjunction with the local sponsors, held or made presentations at the following locations:

- Tres Rios Project Stakeholder Meeting at Flood Control District of Maricopa County- November 14, 2001, and;
- Rio Salado Advisory Committee Meetings - January 2004, May 2005;

Concerns expressed at the public meetings included the following:

- Vector control is an important component;
- Flood conveyance needs to be maintained;

- Utilize existing open water bodies (public fishing), and;

- Natural water course should be maintained.

9.2 HGM MODEL PREPARATION

The hydrogeomorphic modeling (HGM) approach to assessing wetland functions has been developed by scientists and the Engineering Research and Development Center (ERDC) Environmental Laboratory (EL) under its wetlands research program. Under this assessment procedure, the focus is narrowed to 1) the functions a particular type of wetland will perform and 2) the characteristics of the ecosystem and landscape controls of those functions. Wetlands are classified by their geomorphic setting, water source, and hydrodynamics.

From March 26–28, 2002, the Corps sponsored a workshop in Tucson, Arizona, to modify the HGM models that would be used for this project. In addition to the Corps and its consultants, participants included: representatives of federal, state and local agencies; technical experts in hydrology, soils, wildlife, and riparian vegetation, and; representatives from the non-federal cost-sharing sponsors. A subset of workshop participants gathered the base field data for the HGM model during the week of April 22, 2002. In June, 2002, representatives of federal, state, and local agencies with an interest in the Rio Salado Oeste project met to discuss baseline project area conditions and without-project results. In April, 2004, a similar group met to project future without-project conditions for the HGM models.

9.3 AGENCY COORDINATION

This DEIS has been prepared in compliance with NEPA to meet the needs of federal, state, and local permitting agencies in considering the proposed restoration of this reach of the Salt River. The lead agency responsible for preparing this DEIS for the proposed action is the U.S. Army Corps of Engineers, Los Angeles District. The City of Phoenix is the non-federal sponsor for the project. The Corps is responsible for ensuring that this EIS has been prepared in compliance with the provisions of NEPA. The Corps will determine the adequacy and completeness of the final EIS (FEIS) prior to rendering any decisions on the proposed action. A decision for the proposed action will be issued by the Corps in the form of a Record of Decision (ROD). The Corps will rely upon this EIS when considering whether to move forward with any of the restoration projects described in the proposed action. This EIS will also be utilized by other federal and state agencies to evaluate the project for permitting decisions. Thus far, the Corps has coordinated with the following agencies during the completion of this EIS: U.S. Fish & Wildlife Service, Flood Control District of Maricopa County, Arizona Game and Fish Department, and the City of Phoenix.

CHAPTER 10
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CHAPTER 11
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City of Phoenix. Personal contact with Gaye Knight, Air Quality Specialist. November 2005 and February 2006.

Merriott, Susan. City of Phoenix, Streets Department. March 12, 2002 – telephone conversation regarding a transportation plan for the City of Phoenix.

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CHAPTER 13
ACRONYMS AND ABBREVIATIONS

AAC	Arizona Administrative Code
AAC	Average Annual Cost
AAFCU	Average Annual Functional Capacity Unit
AAQS	Ambient Air Quality Standards
ac-ft	acre-foot
ADEQ	Arizona Department of Environmental Quality
ADES	Arizona Department of Economic Security
ADOT	Arizona Department of Transportation
ADT	Average Daily Traffic
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game and Fish Department
AMA	Active Management Area (Arizona Department of Water Resources designation for particular groundwater basins throughout the state)
APE	Area of Potential Effect
APP	Aquifer Protection Permit
AQD	Air Quality Department
ASLD	Arizona State Land Department
AWQS	Aquifer Water Quality Standard
AZPDES	Arizona Pollution Discharge Elimination System
AZ-WIPWG	Arizona Wildlands Invasive Plant Working Group
BIA	Bureau of Indian Affairs
BMP	Best Management Plan
BOD	Biochemical Oxygen Demand
CAA	Clean Air Act
CAFO	Concentrated Animal-Feeding Operation
CEA	Cost Effectiveness Analysis
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (commonly referred to as the "Superfund" Act)
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
CNEL	Community noise equivalent level
CO	carbon monoxide
COP	City of Phoenix
Corps	U.S. Army Corps of Engineers
CORRACTS	Corrective Action Reports

CWA	Clean Water Act
dB	decibel
dBA	A-weighted decibel
DBCP	Dibromochloropropane
DCA	1,2 Dichloroethane
DCE	1,1 Dichloroethane
DDT	Dichlorodiphenyltrichloroethane
DEIS	Draft Environmental Impact Statement
EDB	Ethylene Dibromide
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERDC	Engineer Research and Development Center
ERNS	Emergency Response Notification System
ES	Executive Summary
ESA	Endangered Species Act/Environmental Site Assessment
ESRV	East Salt River Valley, one of two Phoenix AMA alluvial groundwater basins
FAA	Federal Aviation Administration
FCDMC	Flood Control District of Maricopa County
FCI	Functional Capacity Index
FCU	Functional Capacity Unit
FEIS	Final Environmental Impact Statement
FR	Federal Register
FWCA	Federal Wildlife Coordination Act
FWS	(U.S.) Fish and Wildlife Service
GRIC	Gila River Indian Community
HAP	Hazardous Air Pollutant
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HGM	Hydrogeomorphic Assessment
HR	House Resolution
HTRW	Hazardous, Toxic and Radioactive Waste
HUD	U.S. Department of Housing and Urban Development
ICA	Incremental Cost Analysis
kph	kilometers per hour
LAU	Lower Alluvial Unit
L_{dn}	day-night average sound level
L_{eq}	equivalent sound level
LUST	Leaking underground storage tank

µg/m3	micrograms per cubic meter
MAG	Maricopa Association of Governments
MFR	Memorandum for the Record
MAU	Middle Alluvial Unit
Mgd	millions of gallons per day
mg/l	milligrams per liter
MM	Mitigation Measure
MM	Modified Mercalli (Intensity Scale)
MNA	Museum of Northern Arizona
MOA	Memorandum of Agreement
mph	miles per hour
MS4	Municipal Separate Storm Sewer System
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List (EPA list of Superfund sites)
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSR	New Source Review
NTU	Nephelometric Turbidity Unit
O_3	ozone
OHV	Off-Highway Vehicle
OMRR&R	Operation, Maintenance, Repair, Replacement and Rehabilitation
OSHA	Occupational Safety and Health Administration
PCE	Tetrachloroethylene (Perchloroethylene)
PM-10	Particulate Matter 10 microns or less in diameter
ppm	Parts per million
PSD	Prevention of Significant Deterioration
PVNGSWCS	Palo Verde Nuclear Generating Station Wastewater Conveyance System
RCRA	Resource Conservation and Recovery Act
RID	Roosevelt Irrigation District
ROD	Record of Decision
ROG	Reactive Organic Gases

RTP	Regional Transportation Plan
SCC	Sacramento Canal Company
sf	Square Foot
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO_2	Sulfur dioxide
SR	State Route
SRP	Salt River Project
SRPMIC	Salt River Pima Maricopa Indian Community
SWMP	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
sy	Square Yard
TAC	Toxic air contaminant
TCA	1,1,1 Trichloroethane
TCE	Trichloroethene
TDS	Total dissolved solids
thalweg	Centerline of drainage flow within a watercourse
TMDL	Total Maximum Daily Load
tpy	Tons per year
TSD	RCRA-approved treatment, storage, and disposal facilities
TY	Target Year
UAU	Upper Alluvial Unit
USBR	U.S. Bureau of Reclamation
UST	Underground Storage Tank
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile organic compound
WQARF	Arizona Water Quality Assurance Revolving Fund
WQTC	Water Quality Technical Committee
WSC	Wildlife of Special Concern
WSRV	West Salt River Valley, one of two Phoenix AMA alluvial groundwater basins
WWTP	Wastewater treatment plant

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DRAFT ENVIRONMENTAL IMPACT STATEMENT

APPENDIX A
CLEAN WATER ACT, SECTION 404 (B)(1)
COMPLIANCE EVALUATION

Rio Salado Oeste

Salt River- Phoenix, Arizona

APPENDIX A.

CLEAN WATER ACT, SECTION 404 (B)(1) COMPLIANCE EVALUATION

I. INTRODUCTION

This appendix evaluates compliance of the recommended plan, Alternative 5A, with the guidelines established under the Federal Pollution Control Act (Clean Water Act) Amendments of 1972 (Public Law 92-500), as amended by the Clean Water Act of 1977 (Public Law 95-217), legislation collectively referred to as the Clean Water Act, 33 U.S.C. 1251 et seq.

The Clean Water Act sets national goals and policies to eliminate the discharge of water pollutants into waters of the U.S. Any discharge of dredged or fill material into waters of the U.S. by the Corps requires a written evaluation that demonstrates that a proposed action complies with the guidelines published at 40 CFR § 230. These guidelines, referred to as the Section 404(b)(1) Guidelines (the "Guidelines") are the substantive criteria used in evaluating discharges of dredged or fill material under Section 404 of the Clean Water Act.

The Rio Salado Oeste project would require the discharge of dredged and fill material into the Salt River and its tributaries. These waterways are considered to be Waters of the U.S. as defined in 33 CFR § 328.3 and, as such, are subject to regulation under Section 404. The lateral limit of jurisdiction in non-tidal waters such as the Salt River is defined in 33 CFR § 328.4(c)(1) as the ordinary high water mark (OHWM), provided the jurisdiction is not extended by the presence of wetlands (see below). Title 33 CFR § 328.3(e) defines the OHWM as that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Wetlands are one of the Special Aquatic Sites identified in 40 CFR § 230 Subpart E. The list of special aquatic sites also includes sanctuaries and refuges, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes. Special aquatic sites are geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. These areas are generally recognized as significantly influencing or positively contributing to the general overall environmental health or vitality of the entire ecosystem of a region (40 CFR § 230.3[q-1]).

The Regulatory Branch, US Army Corps of Engineers, Los Angeles District completed a Clean Water Act Section 404 jurisdictional determination for the project implementation area on February 22, 2006, attached. The total area within the jurisdiction of Section 404 is defined primarily by the location of the OHWM, and consists of 1,700 acres. The only type of special

aquatic located in the project area is wetlands. Wetlands are defined as, "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR § 328.3). These wetlands consist of small areas dependent upon stormwater, effluent and irrigation discharges, and a few larger areas associated with abandoned aggregate mining activities. These wetlands are transitional in nature, changing with fluctuations in the volume of stormwater flows, delivery of effluent, flood events, and management of active and abandoned aggregate mining operations.

With the exception of the "No-Action" Alternative, all alternatives receiving final consideration include restoration of the Salt River channel through the entire length of the study area. This work would include modifications to the river channel, banks and terraces, installation of water harvesting features and irrigation infrastructure, planting of vegetation, and soil amendment/ restoration activities. Three of the five action alternatives under consideration would also entail modifications to aggregate mining (sand/gravel) pits located along the river. All five action alternatives would have a similar range of impacts to Waters of the U.S., both for initial construction work, and during future operation, maintenance, repair, replacement and rehabilitation (OMRR&R) activities completed by the non-federal sponsor (City of Phoenix).

Fundamental to the Guidelines is the precept that "dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." The procedures for documenting compliance with the Guidelines include the following:

- Examining practicable alternatives to the proposed discharge that might have fewer adverse environmental impacts, including not discharging into a Water of the U.S. or discharging into an alternative aquatic site;

- Evaluating the potential short- and long-term effects, including cumulative effects, of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment;

- Identifying appropriate and practicable measures to mitigate the unavoidable adverse environmental impacts of the proposed discharge, and;

- Making and documenting the Findings of Compliance required by §230.12 of the Guidelines.

This Clean Water Act, Section 404(b)(1) evaluation of compliance with the Guidelines is not intended to be a "stand alone" document. It relies heavily on information provided in the Draft Environmental Impact Statement (DEIS) to which this Appendix is attached.

II. PROJECT DESCRIPTION

A. Study Authority

The study was conducted under two separate authorities provided by Congress. The first authority is given by Public Law 761, Seventy-fifth Congress, dated June 28, 1938, known as Section 6 of the Flood Control Act of 1938, which reads in part as follows:

> *"the Secretary of War(now Secretary of the Army) is hereby authorized and directed to cause preliminary examinations and surveys...at the following localities...Gila River and tributaries, Arizona."*

The second and most recent authority is provided by House Resolution 2425 (HR 2425), dated May 17, 1994, which states:

> *"...the Secretary of the Army is requested to review the reports of the Chief of Engineers on the State of Arizona...in the interest of flood damage reduction, environmental protection and restoration, and related purposes."*

B. Project Purpose and Need

The Salt River was once a perennial watercourse in the project area, characterized by meandering flows throughout the river system. The river once supported substantial growth of cottonwoods, willows, and mesquites. The river channel carried abundant water that supported early irrigation projects. Increasing appropriation of surface and groundwater to support expansion of agriculture and growing urban populations, coupled with construction of dams upstream, transformed the Salt River to a dry river that flows only ephemerally in response to storm runoff and effluent discharge.

Scour-and-fill events have degraded the river bed in some areas and caused elevations to increase in other areas. The scour-and-fill transportation of sediment has produced numerous thick deposits within the fluvial system: cobble lag surfaces, sand sheets (macro-forms), channel sidebars, mid-channel bars, point bars, and overbank deposits. Channel shifts have distributed alluvial material across the entire width of the floodplain. Many of these deposits have been disturbed by intensive sand and gravel mining.

Flood control, in-river mining, and water supply projects (dams and groundwater withdrawal) within the Gila River watershed have resulted in substantial alteration of the hydrological and sediment transport regimes. This alteration, as well as increased agricultural development and urbanization of the metropolitan Phoenix area, have eliminated most of the native cottonwood/ willow, mesquite bosque, and freshwater marsh habitat types. Destruction of native riparian habitat facilitates an increase in invasive plant species that are more tolerant of disturbed conditions. Invasive plants consume more water than native vegetation because of their ability to occupy a greater areal extent on the landscape, placing additional strains on the already limited water supply. Within the study area, the river is now a highly disturbed riverbed with minimal native vegetation.

The purpose of the project is to restore ecosystem functions and processes to improve overall ecological health and return the project area to a less degraded, more natural condition. Implementation of the proposed action would increase the diversity of native plants and animals, enhance the ability of the area to sustain larger populations of key indicator species or more biologically desirable species, and produce a viable, self-sustaining ecosystem that would require only minimal ongoing human intervention.

This project is also needed to provide an ecological connection between other riparian restoration projects that are currently underway along the Salt River. Additionally, there is a substantial need for additional recreation areas within the Phoenix metropolitan area. Restoration of the area may provide new passive recreational opportunities by increasing the area of open space that is available to recreationists.

Without restoration, habitat values in the project implementation area (see below) are expected to remain essentially unchanged from their highly degraded condition over the next 50 years. This would not allow establishment of habitat for the endangered Yuma clapper rail, southwestern willow flycatcher, or other sensitive wildlife species. There would also be no opportunity to provide recreation, or an ecological connection between the Rio Salado Phoenix and Tres Rios projects.

C. Study Area Location

The study area for the project consists of an eight mile reach of the Salt River and adjacent lands in and near southwestern Phoenix, Maricopa County, Arizona. More specifically, the study area consists of the Salt River corridor from 19th Avenue downstream (west) to 83rd Avenue, between Lower Buckeye Road and Baseline Road. This study area is three miles wide and encompasses approximately 23.5 square miles. The riparian zone averages 300 feet in width and runs the entire length of the study area (DEIS, Figure 1.6-2). The study area lies between two other U.S. Army Corps of Engineers ecosystem restoration projects; Rio Salado Phoenix upstream, and Tres Rios downstream.

While this is a large study area extending beyond the riverbanks, any implementation of project features would be associated with the river floodplain in an area referred to as the project implementation area. The project implementation area extends from 19th Avenue on the east to 83rd Avenue on the west, and is the area within the 100-year floodplain of the Salt River. The project implementation area averages two-thirds of a mile in width, and consists of approximately 3,315 acres.

D. General Description

An initial array of 20 alternatives (including the No-Action Alternative) was formulated by the Corps and the City of Phoenix during the alternative formulation process. These alternatives represented varying combinations of restoration treatments (e.g., vegetation types, channel and sand/gravel pit modification, water source, infrastructure). Alternatives were initially developed based on the Corps' federal planning objectives for water resource projects, specific planning objectives developed for the Rio Salado Oeste project, and project-specific opportunities and

constraints for implementing restoration activities. The specific planning objectives listed below reflect the problems and opportunities and represent desired positive changes along the Rio Salado Oeste reach:

- Restore native riparian, wetland and floodplain habitats, and manage undesirable plant, fish, and wildlife species;
- Reduce flood damages to infrastructure and structures, and;
- Improve passive recreation and environmental-education opportunities.

The initial array of alternatives was ranked and screened based on associated habitat benefits and implementation costs. The Hydrogeomorphic (HGM) wetland assessment method was used by the Corps' planning team to identify and quantify the anticipated habitat benefits associated with the proposed restoration alternatives. The HGM method assesses and quantifies the functional values of existing wetland habitat types (e.g., water storage and plant community characteristics), and evaluates and quantifies future changes in these characteristics and associated habitat benefits resulting from implementation of the restoration alternatives (refer to the Feasibility Report, Appendix I for a discussion of the HGM methodology). Results of the HGM assessment were incorporated into the Corps' standard cost evaluation analysis (ICA) to identify the alternatives that provided the highest habitat benefits per unit cost.

The construction alternatives are Alternative 2, Alternative 4, Alternative 5, Alternative 5A and Alternative 5B. The following ecosystem restoration features are common to all construction alternatives:

- river channel restoration;
- construction of vegetated habitat, and;
- ground reshaping to alter significant features, install irrigation systems, or create topographic and soil conditions needed to establish plantings (e.g., stormwater harvesting basins).

Alternative 4 adds the following ecosystem restoration measures:

- use of supplemental water sources, such as effluent from the City of Phoenix 23rd Avenue wastewater treatment plant (WWTP), and/or groundwater;
- water distribution systems to irrigate new vegetation (canals, diversion structures, etc.), and;
- eradication of salt cedar (*Tamarix spp.*).

In addition, Alternatives 5, 5A and 5B add the following:

- modifications to the 27th and 37th Avenue sand/gravel pits to maintain open water, create new riparian habitat, or both.

Project alternatives differ primarily in the types and amounts of vegetation that would be established, treatment of the 27th and 37th Avenue sand/gravel pits, the extent of structural components, and the amount of water that would be required. Project features would be constructed both in and adjacent to the river channel.

Operation, maintenance, repair, replacement and rehabilitation (OMRR&R) activities would be needed for all alternatives after the project is constructed in order to keep project features functioning as designed. These activities may include:

- periodic dredging to remove sediment deposited by floods, surface reshaping, or replanting of project features damaged by flood events;
- maintenance and replacement of pumps, pipelines, and other water delivery and irrigation infrastructure features;
- vector control, and;
- environmental monitoring.

III. PROJECT ALTERNATIVES

A. Regulatory Considerations

Section 230.10 of the Guidelines dictates that, except as provided under §404(b)(2), "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have significant adverse environmental considerations." A "practicable alternative" is defined as "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." The project purpose is to restore this reach of the Salt River. While the NEPA process, through the EIS, extensively examines alternatives and discloses all of their environmental impacts, the 404(b)(1) Evaluation focuses on the impacts of alternatives to the aquatic ecosystem.

The Guidelines also require that "where the activity associated with a discharge which is proposed for a special aquatic site does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water dependent"), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise." The basic purpose of this project – ecosystem restoration- is water dependent, since the project purpose cannot be fulfilled without utilizing the river. The Guidelines further specify that where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge that do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise.

For the purpose of a 404(b)(1) alternatives analysis, practicable alternatives include:

- Offsite alternatives - i.e., discharges of dredged or fill material at other locations in waters of the United States, and;

- On-site alternatives - these include project designs that do not involve a discharge of dredged or fill material into Waters of the U.S., as well as project designs that have different impacts to Waters of the U.S.

B. Off-Site Alternatives

The location of this project was chosen based upon the availability of a large, contiguous segment of the river corridor, the support of a non-federal sponsor, the proximity and contiguity of other restoration projects on the Salt River, and the technical feasibility of constructing a project at this location. The Rio Salado Oeste project is one of four ecosystem restoration projects that are at various stages of development by the Corps and non-federal sponsors along the Salt River downstream from Granite Reef Dam. The Rio Salado Phoenix project, just upstream from Rio Salado Oeste, is currently under construction. The Va Shly'ay Akimel project is upstream of the Rio Salado project, and is entering the design phase. The Tres Rios project, just downstream from Rio Salado Oeste, is also in the design stage. The proposed project location would provide an almost continuous series of habitat restoration projects from Granite Reef Dam to the confluence of the Salt River with the Gila River (DEIS, Figure 1.7-1). The nearest other potential location for a Salt River restoration project would be upstream of Granite Reef Dam. Such a location would not be near or contiguous with the other restoration projects, and does not currently have the support of a non-federal sponsor. In addition, because of the series of upstream dams and associated legal constraints to project design, it would be much more difficult to design a functioning habitat restoration project upstream of the Granite Reef Dam. Off-site alternatives, therefore, are not practicable at this time.

C. On-Site Alternatives

Each of the five construction alternatives analyzed in detail through the NEPA process would accomplish the identified project purpose. However, they would accomplish this purpose to varying extents, with varying levels of benefits and a range of impacts to the aquatic ecosystem. The impacts would be both adverse (short term) and beneficial (long term). The types of OMRR&R activities would be similar for each alternative, although the level of effort and cost for OMRR&R activities would generally be proportional to the amount of new habitat created.

Additional discussion of the measures combined to formulate the action alternatives is provided in Chapter 2 of the DEIS, and a complete discussion of alternative can be found in Chapter V of the Feasibility Report. The following is a summary of those measures that would require the discharge of dredged or fill material into Waters of the U.S:

Channel Restoration: This measure restores the river channel to a more natural state based on hydraulics and geomorphology. It would be accomplished by grading and terracing to help restore an active channel through the entire reach. Average depth of grading is assumed to be

five feet, with a width varying from 200 to 400 feet. The average width of the river channel, including the adjacent river terrace, throughout the study area will be approximately 500 feet. The channel design passes a five-year event (~22,000 cfs) with occasional flooding on the terrace two to four feet in depth at 1-7 cfs. An estimated 660,000 cubic yards (cy) of material would be removed from the channel to implement this measure. Material removed would be native riverbed material, and would be utilized on site for terracing and construction of other project components, such as lake restoration.

Lake Restoration: There are existing features created from sand/gravel mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. These modifications are recommended to better utilize the existing water and improve the functionality of these features. The existing banks would need to be reshaped for restoration and public safety. Depending on the alternative, from 3,000,000 cy to 5,384,000 cy of material would be moved to implement this measure. Due to the porous soils found in this project area, lining the site would be required for restoration. This would be accomplished through excavation and layering of a silt-clay soil substrate overlain by a mixed gravel and cobble layer. Between 64,000 and 213,000 cy of liner material would be required for this work, depending on the alternative.

Stormwater Wetlands: Existing stormwater outfalls within the project area have been identified and possible discharges from them quantified. There are eight different outfalls from which an estimated average of 2,863 ac-ft was estimated to discharge based upon a seven-inch annual rainfall. While not a reliable, constant source of project water, there are opportunities for future use of this water with proper design at the outfall locations. Various forms of habitat are currently being supported by stormwater runoff. Design of a restoration plan would include site-specific measures maximizing use of that runoff. Grading and excavation, as well as installation of a silt-clay soil substrate overlain by a mixed gravel and cobble layer, is recommended for the wetlands.

In-channel Wetlands: In addition to restoration of stormwater wetlands, several alternatives would restore emergent wetlands in the channel immediately downstream of 19th Avenue. This effort would include regrading and installation of similar substrate described above to allow restoration of emergent wetland vegetation. Depending on the alternative, the volume of material regarded to implement this measure would range from approximately 8,059 to 21,000 cy. In each case, a volume of liner material equal to the amount of material regraded would be installed to support newly planted vegetation.

Operation, Maintenance, Repair, Replacement and Rehabilitation: OMRR&R activities would occur after the project is constructed in order to keep project features functioning as designed. These activities may include: periodic removal of sediment, surface reshaping, or replanting of project features damaged by flood events; maintenance and replacement of pumps, pipelines, and other water delivery and irrigation infrastructure features; vector control, and; environmental monitoring. The types of OMRR&R activities necessary would generally be the same for each construction alternative, although the level of effort would be proportional to the amount of new habitat created and the extent of structural features built for that alternative.

Sediment Removal: During high flows, substantial quantities of sediment may be deposited in channelized portions of the Salt River or in newly established habitat areas. To maintain the flow conveyance capacity of the river, channelized portions would need to be excavated and reshaped to restore design specifications if conveyance is significantly affected. Sediment removal would occur on an as-needed basis. For features within the floodplain, regrading and excavation was assumed to be needed once every ten years. It was assumed that for the stormwater outfalls, 50 percent of the construction quantity would need to be regraded in this period. The restored wetlands at existing lakes (gravel pits) would require regrading and excavation once every 20 years of up to one foot of material over the wetlands. The active channel would require regrading up to once every 20 years for up to 50 percent of the estimated construction quantity, or 330,000 cubic yards.

D. Description of the Project Alternatives

Although numerous other alternatives were considered in the study, the following alternatives have been carried though to the final array:

No Action: No federal action would be conducted and no habitat restored. This is the future Without-Project condition.

Alternative 2. Storm Water and Channel: This alternative includes the modification of existing stormwater outfall areas to improve retention and water spreading, as well as increase the existing habitat currently supported by these outfalls. It also includes modification and/or restructuring of the primary conveyance channel to a more natural state by grading and terracing the river corridor from 19th Avenue to 83rd Avenue. No additional water source is included in this alternative other than temporary irrigation to establish vegetation.

Alternative 4. Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent: This alternative includes the features described in Alternative 2, and adds supplemental water supply in the form of effluent. It also includes restoration of emergent wetlands at the existing lake in the channel immediately downstream of 19th Avenue. At locations identified as suitable throughout the project area, cottonwood/willow and mesquite cover types would be restored. This alternative would also address the management, control, and removal of invasive species within the study area.

Alternative 5. Storm Water, Channel, Water Supply, Cottonwood, Mesquite, Invasive, Emergent, Lake: This alternative includes the features described in Alternative 4, and adds lake restoration at the 27th and 37th Avenue sand/gravel pits.

Alternative 5A. Wetland restoration in lieu of permanent open water and lakes: In lieu of lake restoration, this alternative includes regrading both of the sand/gravel pits to restore them to the floodplain. Emergent wetland and riparian habitats would be created in both of these areas.

Alternative 5B. Hybrid of Alternatives 5 and 5A with one sand/gravel pit restored to a lake and the other a wetland/ riparian complex: This alternative includes restoration of one sand/gravel pit to a wetland/riparian complex, and the other to a lake.

E. Comparison of Alternatives

The No-Action Alternative is not considered practicable because it does not meet the primary project objective to restore degraded habitat. The No-Action alternative does not provide a permanent gain in the ecosystem benefit within the project area, specifically, to increase the amount (area) of native riparian habitat. Whereas there would be no disturbance of existing vegetation under this alternative, it provides no impetus to prevent further environmental degradation of existing riparian and wetland habitat. As such, the No-Action alternative is not the least damaging practicable alternative.

All five action alternatives would include restoration of the Salt River channel through the entire length of the project implementation area. This work is necessary to ensure hydraulic continuity for conveyance of flood flows, and for habitat connectivity with the adjacent Rio Salado Phoenix and Tres Rios ecosystem restoration projects. Channel restoration would require removal of 660,000 cy of material from the existing riverbed and terraces. This work would result in creation of 170 acres of low flow channel, in addition to associated terraces. The excavated material would be used as necessary to construct other project features. Every action alternative would include modifications to eight existing stormwater outfalls to utilize runoff as a water source for riparian habitats. These modifications would entail excavation of an additional 149,890 cy of material, followed by discharge of 45,128 cy of material to form an impermeable liner at each outfall. A total area of 28 acres would be directly impacted by this measure for all action alternatives.

Alternative 2 would be limited to the channel restoration and construction at each stormwater outfall discussed above, with no supplemental source of water. This alternative would require the least impacts to Waters of the U.S., but also produces the smallest amount of desirable riparian habitats and functional lift. A total of 737 acres of riparian habitats would be restored. However, only 154 acres of the highly desirable cottonwood/willow, mesquite and wetland habitats (including existing habitat) would result from this alternative. Alternative 2 has a functional output, expressed in terms of Average Annual Functional Capacity Units (AAFCUs), of 51 (a complete discussion of the functional assessment methodology can be found in Appendix I to the Feasibility Report). The single greatest impact to Waters of the U.S. for the five action alternatives consists of the river channel restoration. For this reason, Alternative 2 would require almost as much impacts to Waters of the U.S. as Alternatives 4, 5, 5A and 5B, despite its much lower outputs.

Alternative 4 would incorporate the features described in Alternative 2, and add supplemental water supply in the form of effluent. It would also include restoration of emergent wetlands at the existing lake in the channel immediately downstream of 19th Avenue. This measure would require regrading of approximately 8,059 cy, and installation of the same volume of clay liner material to create five acres of in-channel wetlands. At locations identified as suitable throughout the project area, cottonwood/willow and mesquite cover types would be restored. This alternative would also address the management, control, and removal of invasive species within the study area. Direct impacts to Waters of the U.S. for Alternative 4 would be greater than those associated with Alternative 2. However, Alternative 4 would establish 1,356 acres of riparian habitats, including 824 acres of the highly desirable cottonwood/willow, mesquite and

wetland habitats. The functional output of 165 AAFCUs would also far exceed those of Alternative 2.

Alternatives 5, 5A and 5B would augment the area of wetland creation at the existing lake downstream of 19th Avenue. The larger wetland area would require regrading of 20,952 cy of material, followed by installation of the same volume of clay liner. Alternatives 2 and 4 would not utilize the existing sand/gravel pits located at 27th and 37th Avenues. However, Alternatives 5, 5A and 5B include combinations of additional measures to reconnect these pits to the floodplain while creating permanent lakes, riparian habitats, or both. Alternative 5 would require 5,384,072 cy of cut and fill, followed by discharge of 212,747 cy of lining material to convert both of these pits into two 20-acre lakes. Alternative 5A would require 3,000,000 cy of cut and fill, followed by discharge of 64,469 cy of lining material to convert both of these sand/gravel pits to emergent wetlands with associated riparian habitats. Finally, Alternative 5B would require 2,692,036 cy of cut and fill, followed by discharge of 106,373 cy of lining material to convert one of the sand/gravel pits to a lake. Conversion of the remaining sand/gravel pit to emergent wetland and riparian habitat for Alternative 5B would require 1,500,000 cy of cut and fill, and discharge of 64,469 cy of lining material.

By incorporating the 27th and 37th Avenue sand/gravel pits, direct impacts to Waters of the U.S. for Alternatives 5, 5A and 5B would be greater than for Alternative 4. In return for these increased impacts, Alternatives 5, 5A, and 5B would each provide 1,466 acres of riparian habitat. A total of 902 acres, 982 acres, and 962 acres of the desirable cottonwood/willow, mesquite, and wetland habitats would be restored by Alternatives 5, 5A and 5B, respectively. The functional outputs for Alternatives 5, 5A and 5B would be 240, 267 and 253 AAFCUs, respectively. The primary difference between these three alternatives is whether or not one or both of the 27th and 37th Avenue sand/gravel pits would be converted to a permanent lake, riparian habitat, or a combination of both.

The sand/gravel pits would need to be drained for lining installation, regardless of whether or not they were filled with water to create a lake, or partially filled with soil to create emergent wetland and other riparian habitats. For this reason, Alternatives 5, 5A and 5B would all have nearly identical temporary impacts to Waters of the U.S. These alternatives would also have the greatest impact on wetlands. Since the project would increase the long-term functional value of the wetlands and other riparian areas of this ecosystem, and these elements are physically adjacent as well as functionally interrelated, alternatives that do not impact the existing wetlands would provide fewer long-term improvements in wetland and riparian habitat function.

Alternative 5A produces the greatest area of desirable riparian habitats and the highest functional output in return for the temporary impacts noted above. This alternative also provides the best combination of habitat restoration and cost, and creates ecosystem benefits that far exceed the short-term adverse effects to jurisdictional waters. With appropriate mitigation measures, this alternative would have insignificant adverse environmental impacts to the surrounding ecosystem. Furthermore, Alternative 5A does not place an excessive burden on water resources, and can also be reasonably managed by the non-federal sponsor to ensure long-term success. Alternative 5A has been selected as the tentatively Recommended Plan because it is considered

the least environmentally damaging practicable alternative that fulfills the planning objectives, and it adequately addresses the purpose and need for the project.

Table A-1. Alternative measures and associated quantities of dredged/fill material.

Alt.	Measure	Quantity (cy)	Area (acres)[1]
2	Channel Restoration	660,000	300
	Storm water outfall wetland grading	149,890	28
	Storm water outfall wetland liner	45,128	28
4	Channel Restoration	660,000	300
	Storm water outfall wetland grading	149,890	28
	Storm water outfall wetland liner	45,128	28
	Emergent wetlands (in channel)	8,059	5
	Emergent wetlands liner	8,059	5
5	Channel Restoration	660,000	300
	Storm water outfall wetland grading	149,890	28
	Storm water outfall wetland liner	45,128	28
	Emergent wetlands (in channel)	20,952	13
	Emergent wetlands liner	20,952	13
	Lake restoration cut and fill (permanent water)	5,384,072	200
	Lake liner materials	212,747	20
5A	Channel Restoration	660,000	300
	Storm water outfall wetland grading	149,890	28
	Storm water outfall wetland liner	45,128	28
	Emergent wetlands (in channel)	20,952	13
	Emergent wetlands liner	20,952	13
	Lake restoration (wetland/riparian) cut and fill	3,000,000	200
	Lake restoration liner	64,469	40
5B	Channel Restoration	660,000	300
	Storm water outfall wetland grading	149,890	28
	Storm water outfall wetland liner	45,128	28
	Emergent wetlands (in channel)	20,952	13
	Emergent wetlands liner	20,952	13
	Lake restoration cut and fill (permanent water)	2,692,036	100
	Lake restoration liner	106,373	20
	Lake restoration (wetland/riparian) cut and fill	1,500,000	100
	Lake restoration liner	64,469	20

[1] Acreages noted are not additive. They relate to the potential area affected by implementation of that measure.

Table A-2: Acres of habitat associated with each action alternative.

Alternative	Channel[2]			Cotton-wood/ Willow	Mesquite	Open Water	Scrub-Shrub[3]	Other Wetlands	TOTALS
	Low-Flow Channel	In-Channel Wetlands[4]	Riparian Scrub						
2. Stormwater and Channel	170	17	125	66	43	0	305	28	737
4. Stormwater, Channel, Water Supply, Cottowood, Mesquite, Invasive and Emergent	170	34	165	348	409	0	63	33	1188
5. Stormwater, Channel, Water Supply, Cottowood, Mesquite, Invasive and Emergent, Lake	170	34	296	375	417	40	92	76	1466
5A. Wetland/riparian restoration in lieu of permanent open water and lakes	170	34	296	375	417	0	52	156	1466
5B. Hybrid of 5 & 5A with one sand/gravel pit restored to a lake and the other a wetland/ riparian complex	170	34	296	375	417	20	52	136	1466

[2] River channel consists of low flow, wetland or riparian scrub.
[3] Scrub shrub acres are dispersed among and between the other restored cover types within the floodplain.
[4] Alternative 2 assumes that 10% of the low-flow channel would consist of wetlands; the remaining alternatives assume that 20% of the low-flow channel would consist of wetlands.

IV. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

1. Substrate Elevation and Slope: The study area is located within the Salt River Valley at an elevation of approximately 335 meters (1,100 feet). The project implementation area includes the river channel and overbank areas within the 100-year floodplain. The channel topographic relief is generally very low to flat (less than 1% gradient), ranging from an elevation of ~1,000 feet elevation in the Salt River bed at 19th Avenue to ~960 feet at 83rd Avenue.

The usually dry, sandy Salt River bottom is highly disturbed by both natural processes and human activities. Substrate materials include water-rounded gravel, cobble, and principally fine sand. Since these materials are unconsolidated and easily transported by water, the channel is reconfigured by high flows during flood events. The channel substrate is also continuously altered by aggregate (sand/gravel) mining, and uncontrolled motorcycle and all-terrain-vehicle travel. Alteration of the river bottom and terraces by construction equipment would occur during project implementation. This work would be necessary to construct a low flow channel, create stable side slopes and terraces, and to transport excess excavated materials to locations where needed. Mostly minor changes in topography would occur along the length of the project area. These changes in topography would be more significant in areas where sand/gravel pits are being restored and reconnected to the floodplain. For instance, the sand/gravel pits at 27th and 37th Avenues would be reshaped and partially filled with native material for riparian restoration. However, the overall elevations of the channel bottom and the historic flood plain would not be significantly altered.

Substantial quantities of material would be discharged into the jurisdictional limits of Waters of the U.S. (in this instance, a typically dry condition) during reconstruction of the river channel, regrading of channel banks and terraces, construction of water harvesting basins, installation of water distribution and irrigation systems, and preparing the ground surface for planting. Construction material would consist of native alluvial soils from the project area, as well as clay, rock from nearby quarries, and possibly soil amendments. In terms of volume, the vast majority of dredged and fill material would originate on site. No significant quantities of inadvertently discharged earth materials would remain above existing channel bottom elevations. However, in some locations affected by aggregate mining, increased ground elevation would be part of the project design. The approximate pre-construction channel bottom contour would be reestablished to eliminate any potential changes in flooding characteristics. Excess excavated materials would be incorporated into final grades for the project. The disposal of excavated materials outside the project area is thus not anticipated.

2. Sediment Type: The soils in the vicinity of the river channel in the study area belong to the Hyperthermic Torrifluvents association, a group of well-drained to excessively well-drained soils that are found on nearly level or gently sloping surfaces. The area soils are often sandy to gravelly, may include lenses of finer particles, and are often redistributed by water flows associated with active channels. The material beneath the surface layer is very gravelly sand to very fine sandy loam or loam. Terraces above the river channel consist of thick, well cemented

to non-cemented sand and gravel. The terraces form gently sloping (0-2%), undulatory surfaces having low relief. No exposed bedrock is present in the project area.

Reshaping would include restoration of a low flow channel and adjacent terraces for the entire length of the project area. On site soils would be redistributed to fill depressions or remove unwanted mounds, reconnect the 27th and 37th Avenue sand/gravel pits to the floodplain, and to create new riparian habitats. Where existing sediments are used, sediment types would not be changed by the project. However, materials other than existing sediment types would be used in various areas to provide the necessary environment for new vegetation. Clay, mixed gravel, and cobble layers would be used to line areas of proposed wetland/riparian habitats at eight stormwater outfalls, and at the active and abandoned sand/gravel pits at 19th, 27th, and 37th Avenues. This work would serve to make these basins impermeable, and would armor the surface against anticipated high flows. Most of the materials needed for this work would be imported to the site. Soil amendments may also be necessary to create conditions suitable for the establishment of native vegetation.

3. <u>Dredged/Fill Material Movement</u>: With the exception of pits excavated for aggregate mining, and areas affected by effluent discharges from the 23rd Avenue WWTP, the Salt River is typically dry. Construction activities (e.g., river channel restoration, creation of stormwater detention basins and vegetated areas, removal of invasive species) would result in incidental movement of local soils and sediments into downstream areas during runoff events. The channel substrates are generally unconsolidated, natural embankments are highly unstable, and human-induced perturbations have been both extensive and continuous. Therefore, it is unlikely that construction of the selected restoration alternative would significantly increase erosion in or along the Salt River channel. The potential for increases in erosion would be further minimized by limiting the area of exposed soils during construction, completing earth-disturbing activities during the dry season, rapid revegetation of exposed soil areas, and implementation of an erosion and sedimentation control plan that identifies best management practices (BMPs) appropriate for the study area. Adherence to an erosion and sedimentation control plan, as required by the storm water pollution prevention plan (SWPPP) mandated by the National Pollutant Discharge Elimination System (NPDES) permit, would control storm water discharges associated with construction activities.

Following construction, substantial movement of fill material placed for this project would be expected to occur only under high flow conditions. OMRR&R activities have been incorporated into the project to allow the removal or replacement of sediments to restore project features damaged by the transport of sediment. These activities would include repair work after major flooding events. Dredging and reconstruction may be required in the restoration areas. This would temporarily change substrate elevations and compaction as the substrate is restored to design configurations. Implementation of mitigation measure WQ-1 would minimize unintended movement of fill material. Discharges of dredged or fill material into Waters of the U.S. for future OMRR&R activities by the non-federal sponsor would require separate authorization pursuant to the Clean Water Act.

4. Physical Effects on Benthic Macroinvertebrate Communities: Benthic organisms (organisms that live at the bottom of a water body) may occur in the project area where there is permanent or semi-permanent standing water - presently at the 19th, 27th and 37th Avenue sand/gravel pits. Although effluent is discharged into the river at two locations (near 35th and 41st Avenues), the volume of this effluent is dependent on agricultural needs by the Roosevelt Irrigation District. Daily effluent discharge varies on a generally annual cycle from nothing to nearly 50 mgd. This fluctuation in water availability, coupled with rapid infiltration rates, greatly limits the suitability of the Salt River channel for benthic organisms. Construction work for the project would directly affect the sand/gravel pits, as well as the effluent-supplied portions of the river bottom. The potential of these habitats to support viable benthic communities is low, though some species are probably present in the sand/gravel pits. Undesirable, non-native fish species are known to be present when hydrologic conditions allow.

Site preparation for channel restoration, establishment of riparian habitat, etc., is likely to result in temporary discharges of soil and sediment into the river channel. Due to the usual lack of a water column, soil discharged into the river channel would be unlikely to increase turbidity, stimulate algal growth, increase sediment deposition, or adversely affect benthic organisms. This would be a potentially significant impact in the event of heavy rainfall, but few (if any) benthic organisms are present to be affected. In addition, this impact can be mitigated through the implementation of Mitigation Measure WQ-1.

The sand/gravel pits would need to be pumped dry for reshaping prior to installation of clay lining overlain with gravel and cobble. This short term adverse effect would be expected to result in the complete loss of all aquatic organisms present, with the possible exception of some amphibians. If native fish are found to be present, the Arizona Game and Fish Department may elect to trap and relocate any desirable species. Water pumped from the sand/gravel pits would infiltrate into the bed of the Salt River downstream. Over the long term, these pits would be reconnected to the floodplain and restored with riparian habitat more appropriate for the area.

Construction of the selected restoration alternative would not result in perennial channel flow. With the exception of newly constructed emergent wetland areas, no new habitat for benthic organisms would be created. New benthic communities consisting of more desirable species would likely become established in these wetland areas, with a long term net benefit. Future OMRR&R activities such as sediment removal would have the potential to affect any newly established benthic organisms. Since the purpose of these activities would be to maintain habitat values, including water column depth in emergent wetlands, their effect would be temporary and minor.

5. Other Effects: OMRR&R activities to ensure adequate flood flow would require periodic inspections, removal of sediments and invasive vegetation, gabion replacement and repair, and channel side slope repair to maintain structural integrity and to preserve newly vegetated areas. These effects would be similar to those expected during construction, but on a substantially reduced level because they would be limited in both areal extent and duration.

Project construction and restoration activities could result in accidental spills of fuel or other toxic materials associated with the operation of construction equipment (e.g., gasoline, oils,

lubricants, solvents). Hazardous substances that enter the river channel could have temporary adverse effects on water quality and aquatic organisms. This impact is considered potentially significant, but can be mitigated through the implementation of Mitigation Measure WQ-2.

6. <u>Actions Taken to Minimize Impacts</u>: An Erosion and Sedimentation Control Plan would be prepared for project construction. The plan would also address BMPs for operation and maintenance activities. The BMPs identified in the Erosion and Sedimentation Control Plan would incorporate measures to minimize erosion. With implementation of the plan and the mitigation measures listed below, potential impacts to water resources are presumed to be insignificant.

Mitigation Measure WQ-1: Implement Erosion Control Best Management Practices (BMPs)

The Corps and its contractors shall implement erosion control measures throughout the construction period and during implementation of OMRR&R activities to minimize erosion and sediment input into the river. The Corps would oversee implementation of erosion control measures during construction. The contractor selected for the project shall:

- Conduct construction and OMRR&R activities during the dry season;
- Conduct all construction work in accordance with site-specific construction plans that minimize the potential for increased sediment inputs to the river;
- Divert concentrated runoff away from channel banks;
- Minimize vegetation removal;
- Identify with construction fencing all areas that required clearing, grading, revegetation, or reshaping in a way that minimizes areas to be cleared, graded, reshaped or otherwise disturbed;
- Grade and stabilize spoils and stockpile sites to minimize erosion and sediment input to the river;
- Implement erosion control measures as appropriate to prevent sediment from entering the river channel or other watercourses to the extent feasible, including the use of silt fencing or fiber rolls to trap sediments and erosion control blankets to protect channel banks;
- Apply water to unpaved haul roads at a frequency adequate to maintain visible surface moisture;
- Mulch disturbed areas as appropriate and plant with appropriate species as soon as practicable after disturbance;
- Avoid operating equipment in flowing water by using temporary cofferdams or other suitable structures to diver flow around the channel and bank construction areas, and;
- If hay bales are used for erosion control during construction, they must be sterile and weed-free.

Mitigation Measure WQ-2: Implement Spill Prevention BMPs

The Corps and its contractors would prepare a spill prevention and response plan that regulates the use of hazardous and toxic materials, such as petroleum-based fuels and lubricants for construction equipment. The Corps would oversee development and implementation of a stormwater pollution prevention plan. Elements of that plan will ensure that:

- Workers are trained to avoid and manage spills;
- Construction and maintenance materials are prevented from entering the river channel;
- All spills are cleaned up immediately and appropriate agencies are notified of any spills and of the clean-up procedures employed;
- Staging and storage areas for equipment, materials, fuels, lubricants, solvents, and other possible contaminants are located at least 100 feet away from the river's normal high-water area;
- Vehicles are immediately removed from the work area if they are leaking, and;
- Equipment is not operated in flowing water (if necessary, suitable temporary structures can be installed to divert water around in-channel work areas).

Mitigation Measure BR-1: Re-vegetation Construction Management Practices

The Corps would remove salt cedar (*Tamarix* spp.) and giant reed (*Arundo donax*) from the restoration areas as part of the restoration process (Alternatives 4, 5, 5A, and 5B). The City of Phoenix would be responsible for maintaining the restored habitat areas free of invasive plants, especially salt cedar and giant reed, throughout the life of the project (Alternatives 4, 5, 5A, and 5B).

The cleared areas would be re-vegetated with habitat of higher quality and permanence than the habitat removed. Implementation of good construction management practices, especially dust suppression with water and/or non-toxic dust-suppressing chemicals or soil binders, would minimize potential impacts from fugitive dust. Also, decreases in the cover of desirable vegetation can be minimized through careful phasing of the project construction. Areas of desirable vegetation can be delineated on construction plans as areas that are not to be disturbed. Additionally, vegetation removal would occur outside of the spring breeding season to ensure adequate time for a majority of the avian offspring to disperse prior to construction activities.

B. Water Circulation, Fluctuation, and Salinity Determinations

1. <u>Effects on Water Quality</u>: Potential water sources for the project include stormwater, Salt River flood flows, irrigation return flows (tailwater and surplus water), irrigation drains, effluent from the 23rd Avenue WWTP, groundwater (in situ and pumped), releases from sand/gravel mining operations, and residual water from the Rio Salado Phoenix project. With the possible exception of sediment loads, most of the surface water sources listed above are suitable for ecosystem restoration. However, only effluent and groundwater (both in situ and pumped) are considered to be dependable.

The 23rd Avenue WWTP effluent undergoes tertiary treatment and is released at wastewater class A+. Arizona Administrative Code, Title 18, Environmental Quality defines the classification of A+ as, "...wastewater that has undergone secondary treatment, filtration, nitrogen removal treatment, and disinfection..." This reliable water source is considered to be suitable for ecosystem restoration.

Groundwater and stormwater have potential water quality issues requiring further consideration. Groundwater testing in the vicinity of the project area has indicated the presence of nitrates, volatile organic compounds (VOCs), metals, and pesticides. With few exceptions, these contaminants have been below detection levels or detected at concentrations below numeric groundwater quality standards. Both in situ and pumped groundwater is generally suitable for agricultural purposes, and is expected to be adequate for ecosystem restoration.

Due to infrequent rainfall, stormwater is considered a supplemental water source for the restoration effort. Because stormwater discharges represent runoff from residential, commercial, industrial and agricultural areas, water quality varies greatly based on land use and the magnitude, duration, and timing of storm events. Stormwater quality data are very limited for this reach of the Salt River due to the lack of precipitation. Between rainstorms, sediment and pollutants tend to accumulate, and the highest concentrations of pollutants are often washed into rivers, creeks, and streams during "first flush" events. Despite the limited water quality data, a total of 21 parameters are known to have exceeded numeric surface water quality criteria in the study area (URS, 2002). These parameters include pesticides, metals, chlorinated hydrocarbons, the water quality parameters pH and turbidity, and bacteriological parameters. In general, based on analysis of available data versus the numeric water quality standards, stormwater is a vehicle by which surface water quality appears to degrade within the Salt River (URS, 2002).

The water quality issues already present in the project area will exist regardless of whether or not a project is constructed. Although the project would affect land uses in the immediate environs of the Salt River, overall land use in the watershed is not expected to be affected. Thus, this project would not change the quantity or quality of groundwater or stormwater available for the restoration. Alternative 5A would not be expected to cause or contribute to violations of water quality standards unless a spill occurs during construction.

An AZPDES permit, administered by the Arizona Department of Environmental Quality, would be required for any proposed construction activity, and Storm water Pollution Prevention Plan (SWPPP) would be required, developed, and implemented as part of the permit. The SWPPP, along with other measures discussed in the DEIS, would reduce construction-related water quality impacts to a less than significant level. A separate AZPDES permit may be required for the removal and/or control of invasive vegetation as part of long-term maintenance of the project. The need for this additional permit would be determined through consultation with the Arizona Department of Environmental Quality before construction. [5]

As stated above, the potential exists for impacts to surface and groundwater from minor, chronic, or large scale spills of hazardous and toxic materials during construction from both equipment and storage areas established for the project. The aforementioned SWPPP would also contain provisions for spill prevention that properly identifies storage location, spill containment, and remediation measures for clean up. Mitigation measures WQ-1 and WQ-2 would be employed during construction to minimize the potential for significant impacts to water quality.

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[5] There is currently litigation pending that challenged the authority of the State of Arizona to issue these permits. Should that litigation be resolved in a manner adverse to the State's authority, a permit may have to be issued by the EPA.

The addition of wetlands and other riparian habitats to the Salt River has the potential to increase the retention of nutrients carried in by fine sediments, which would improve water quality. The wetland plants would also act as filters by taking up nutrients (such as nitrogen and phosphorus), which can cause algal blooms and fish kills in streams and lakes. Wetland vegetation would provide additional water quality benefits, such as removing additional nitrogen through the action of soil bacteria, binding to metal pollutants such as lead, zinc and cadmium, removing some kinds of pesticides bound to sediments, retaining other pesticides long enough for them to break down into less harmful components, and preventing stormwater runoff from causing destructive downstream soil erosion by holding water after a storm and releasing it slowly (Ohio EPA Fact Sheets and Publications, 2006).

2. Effects on Current Drainage Patterns and Circulation: The proposed project would not substantially alter the surface water hydraulics or drainage patterns within or into the Salt River. Proposed restoration measures would more closely mimic historical conditions and promote establishment of native vegetation. Stormwater outfalls would be modified to utilize stormwater flows as a supplemental water source for some of this vegetation. The location of stormwater outfalls and irrigation drains would not be changed by the project. Hydraulic modeling (see Appendix A of the Feasibility Report) for the with-project conditions shows that the conveyance capacity of the channel and affected tributaries would not be significantly affected. Utilization of effluent for planted vegetation would likely reduce the amount of water in the low flow channel between 35th and 51st Avenues. Since the availability of this effluent varies widely depending on irrigation needs and distance from the discharge points, it is not a perennial water source supporting high value plant and animal communities.

3. Effects on Normal Water Level Fluctuations: The frequency and duration of flooding along the Salt River would not be altered by construction of an ecosystem restoration project. Hydraulic modeling for Alternative 5A indicates that water surface elevations for the 100-year flood would not increase from the present condition, and would decrease slightly in some areas. Establishment of vegetation within the active area of conveyance would be compensated for by a hydraulically designed channel and reduced surface roughness.

Implementation of Alternative 5A would require reliable sources providing up to 9,293 ac-ft of water per year (8.3 mgd). For this reason, a water supply and distribution system is essential for the success of the project. Providing water to newly established riparian communities at the times and locations needed would require redistribution and reallocation of existing water supplies in the project area.

The primary water sources identified for the project are effluent from the 23rd Avenue WWTP, and both in situ and pumped groundwater. Pumped groundwater would consist of effluent that has infiltrated into the Upper Alluvial Unit (UAU). Effluent not used for other purposes is currently discharged to the Salt River at 35th and 43rd Avenues. Effluent is also available at the 27th Avenue discharge structure, though it is not discharged to the river at this location. Water requirements for the project would likely affect the volume and duration of effluent discharges to the Salt River. This effluent would be distributed to locations as needed using the reclaimed

water system, the distribution system for agricultural water, or indirectly used as groundwater pumped from the UAU.

With the exception of flood flows, construction work proposed for the Salt River channel, stormwater outfalls, and the sand/gravel pits would permanently alter existing water level fluctuations. This is especially true for the 19th, 27th, and 37th Avenue sand/gravel pits, where the existing water column and associated habitats would be adversely affected by draining, reshaping, and installation of clay liners. When combined with the anticipated changes in effluent distribution and availability, project construction would have an adverse effect on water level fluctuations.

Following completion of construction, there would be a long term stabilization of water fluctuations in the project area. The volume of stormwater and flood water entering the Salt River along the project area would not be changed. However, water from these less reliable sources would be retained on site for longer periods by the installation of clay liners at outfall structures, and beneath some restored riparian habitats (former sand/gravel pits). Construction of a continuous low flow channel would also stabilize water availability along the Salt River as flood flows attenuate, and for conveyance of excess water applied for irrigation.

The temporary adverse impacts on plants caused by changes in water level fluctuations would be ameliorated because much of the affected vegetation consists of invasive species that would be removed. The project design incorporates water supplies for existing desirable vegetation that would be retained. The Rio Salado Phoenix and Tres Rios projects would provide refuge for some wildlife disturbed by construction activity and changes in water availability in the Rio Salado Oeste reach. Over the long term, wildlife would find more stable conditions in restored habitats and their associated water supplies.

4. Action Taken to Minimize Impacts: An erosion and sedimentation control plan would be prepared for project activities. This plan would also address Best management Practices (BMPs) for OMRR&R activities.

C. Suspended Particulate/Turbidity Determinations at the Disposal Site

1. Expected Change in Suspended Particulate and Turbidity Levels in the Vicinity of the Disposal Site: Short-term increases in suspended particulate and turbidity levels may occur during construction, if water is flowing. Water pumped from the 27th and 37th Avenue sand/gravel pits while they are drained would increase suspended particulate and turbidity levels in the Salt River until this water infiltrates into the riverbed. Following construction, vegetation establishment would be expected to reduce suspended particulate and turbidity levels during the smaller flow events, but would have little effect during major floods. No long-term effects are anticipated.

2. Effects on Chemical and Physical Properties of the Water Column: The Salt River is typically dry except while effluent is being discharged from the 23rd Avenue WWTP. The existing water column in the sand/gravel pits would be eliminated, then replaced with emergent wetlands. This effect would be adverse but temporary. Project construction and restoration

activities could result in accidental spills of fuel or other toxic materials associated with the operation of construction equipment (e.g., gasoline, oils, lubricants, solvents). Hazardous substances that enter the river channel could have temporary adverse effects on water quality and aquatic organisms. The SWPPP developed for this project would contain a spill prevention, control, and clean-up plan that would specify proper storage, handling, containment, and clean-up techniques and measures for potentially hazardous materials during construction. These measures are designed to minimize the probability of a spill and any resulting impacts. This impact is considered potentially significant, but can be mitigated through the implementation of Mitigation Measure WQ-2.

3. Effects of Turbidity on Biota: The Salt River rarely flows, and construction activities would generally be carried out during dry conditions. Soil discharged into the river channel due to project construction is unlikely to significantly increase turbidity. The ephemeral and highly turbid flows in the Salt River are generally of short duration and do not, during flow periods, support aquatic biota. With implementation of BMPs for sediment and erosion control, no adverse impacts are expected.

4. Actions Taken to Minimize Impacts: Refer to the three previous subsections for mitigation measures.

D. Contamination Determination

The project study area was evaluated to determine the potential for encountering hazardous materials and wastes in areas that would be disturbed during construction (Sections 3.13, 4.13 and 8.13 of the DEIS, and Appendix F of the Feasibility Report). Buried materials found during construction would be evaluated and disposed of in accordance with local, state and federal regulations.

E. Effect on Aquatic Ecosystem and Organism Determination

Alternative 5A would result in a substantial increase in the cottonwood/willow, mesquite bosque, new river bottom (including freshwater marsh), wetland, and associated riparian communities compared to future conditions without the project. It would result in the creation of 375 acres of cottonwood/willow, 417 acres of mesquite, 170 acres of river bottom (including 34 acres of wetlands), 156 acres of additional wetlands, 296 acres of riparian scrub, and 52 acres of Sonoran desert scrub-shrub, for a total of 1,466 acres. It would also entail the physical removal of non-native salt cedar habitat in areas where the new habitat cells would be created.

The only special aquatic site type in the project area consists of wetlands. These wetlands are transitional in nature, changing with fluctuations in the delivery of effluent, volume of stormwater flows, flood events, and management of active and abandoned aggregate mining operations. Most of the area within the jurisdiction of Section 404, including these wetland areas, would be disturbed during project construction. However, a much larger acreage of higher quality, more sustainable wetlands would be created. With implementation of erosion control measures and other measures identified in the DEIS, no significant long-term adverse effects on the aquatic ecosystem or aquatic organisms are anticipated. There would be a short term adverse

effect on wetlands until the benefits associated with the project begin to accrue. The overall effect of this project on special aquatic sites would be beneficial.

Implementation of Alternative 5A would also result in substantial short-term impacts on vegetation. The major disruption would be to salt cedar habitat, which would be removed in some areas. There is also the potential for other communities to be indirectly disturbed during grading and restoration. This potentially significant impact would be mitigated through implementation of Mitigation Measure BR-1.

On a long-term basis, habitat value in the region would increase substantially for common and sensitive wildlife species. The primary benefit would be to riparian-obligate bird species due to increases in cottonwood/willow and mesquite communities. There would also be a substantial increase in habitat for shorebirds and waterfowl associated with the constructed wetlands. In addition, it is anticipated that amphibian species would benefit from implementation of Alternative 5A, and that this alternative would increase foraging habitat for raptors and mammalian carnivores. A substantial increase in nesting and foraging habitat for the southwestern willow flycatcher, the western yellow-billed cuckoo, and the Yuma clapper rail is also anticipated. Finally, implementation of Alternative 5A is expected to increase foraging habitat for sensitive raptor species such as the peregrine falcon and the bald eagle. In summary, the project would have a net, long-term beneficial effect on the habitat value of the aquatic ecosystem.

F. Proposed Disposal Site Determinations

The area to be affected during construction of this project would be confined to the minimum area necessary to construct the project features. The project is expected to comply with applicable water quality standards. Implementation of the proposed mitigation measures would ensure that adverse impacts to jurisdictional Waters of the U.S. are minimized.

G. Determination of Cumulative Effects of Disposal of Fill on the Aquatic Ecosystem

The Salt River is a highly modified and degraded ecosystem. That degradation has occurred over decades of development and impacts to the river ecosystem from both private and public projects. The Feasibility Report and EIS associated with this evaluation describe past activities in detail, EIS Chapter 3 Affected Environment and Feasibility Report Chapters III and IV. Ongoing projects include aggregate mining operations which occur throughout the project area and are anticipated to continue. As described in the reports there are several projects planned in the reasonably foreseeable future. Those include expansion of the 35th Avenue Bridge, proposed South Mountain Freeway and Rio Salado Marsh.

With implementation of appropriate mitigation measures, this project would not significantly contribute to adverse cumulative effects on the aquatic ecosystem of the Salt River. Instead, it would directly contribute to the cumulative beneficial effects on the aquatic ecosystem anticipated to result from implementation of this and other ecosystem restoration projects on the Salt River, including Va Shly'ay Akimel, Rio Salado (Phoenix and Tempe reaches), and Tres

Rios. Coupled with these other restoration efforts on the Salt River, this project may also have the indirect beneficial effect of encouraging the implementation of additional efforts to improve this aquatic ecosystem.

Most of the adverse effects are associated with project construction, with beneficial effects usually following as vegetation is established and benefits begin to accrue. Information on the timing of the construction phase for each of the Salt River projects is provided in Table 5.1-1 in the DEIS. Both the Rio Salado and Tres Rios projects will be constructed and providing ecosystem benefits before Va Shly'ay Akimel and Rio Salado Oeste would begin construction. Thus, the cumulative effects would be spread out over a longer time frame while the benefits associated with the earlier projects would already begin to offset those effects.

H. Determination of Indirect Effects of Disposal of Fill on the Aquatic Ecosystem

Indirect effects are effects that are associated with a discharge of dredged or fill material, but do not result from the actual placement of these materials. Such effects would potentially in include increases in flood potential or changes in wildlife communities in responses to changes in vegetation growing in restored areas. No increase in flood surface water elevations is anticipated as a result of project construction. The indirect effects of this project are generally beneficial. Adequate mitigation is provided for the adverse impacts that may occur.

V. FINDING OF COMPLIANCE

A review of the proposed project indicates the following findings:

1. The discharge represents the least environmentally damaging practicable alternative and, if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to or be located in the aquatic ecosystem to fulfill its basic purpose.

X Yes ___ No

2. The activity does not appear to: (1) violate applicable state water quality standards or effluent standards prohibited under Section 307 of the Clean Water Act; (2) jeopardize the existence of federally listed endangered or threatened species or designated marine sanctuary.

X Yes ___ No

3. The activity would not cause or contribute to significant degradation of waters of the United States, including adverse effects on human health; life stages of organisms dependent on the aquatic ecosystem; ecosystem diversity, productivity, and stability; and recreational, aesthetic, and economic values.

X Yes ___ No

4. Appropriate and practical steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

X Yes ___ No

Note: A negative response indicates that the proposed project does not comply with the guidelines.

On the basis of the guidelines, the proposed disposal site for the discharge of fill material is:

___ (1) Specified as complying with the requirements of these guidelines; or

_X_ (2) Specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem; or

___ (3) Specified as failing to comply with the requirements of these guidelines.

JURISDICTIONAL DELINEATION

CESPL-CO-RA February 22, 2006

MEMORANDUM FOR Los Angeles District Planning Section C

SUBJECT: Jurisdictional Delineation for Rio Salado Oeste

Regulatory File #2006-00553-SDM

A preliminary jurisdictional delineation has been performed for the Salt River, within the Rio Salado Oeste study area located in Phoenix, Maricopa County, Arizona (Sections 20, 21, 22, 23, 24, 27, 28, 29 and 30 T1N, R2E and Sections 25, 26 and 35, T1N, R1E). The study area is approximately 8 miles long, and extends from 19th Avenue (the eastern boundary) to 83rd Avenue (the western boundary).

This is a preliminary, planning level jurisdictional delineation. The Salt River within the study area is primarily an ephemeral watercourses. A preliminary calculation shows that approximately 1,700 acres of jurisdictional waters occur within the study area. A few wetlands have previously been delineated within the study area. The study area includes several sand and gravel mines with pits that fill with water. Additionally, stormwater and agricultural tail water enter the river at various point, sometimes resulting in the development of wetlands. Due to the preliminary nature of this jurisdictional delineation decision, no estimate of jurisdictional waters can be made. Further field work and/or research could identify wetlands within the study area. This preliminary jurisdictional determination will remain in effect for five years from the date of this memorandum unless an unusual flood event occurs. After this five-year period or after an unusual flood event alters stream conditions, the Corps of Engineers reserves the authority to retain the original jurisdictional limits or to establish new jurisdictional limits as conditions warrant.

The Salt River is tributary to the Gila River. The Gila River is tributary to the Colorado River, which is an interstate, navigable waterway. The Section 404 jurisdictional limit for a water of the United States is defined at 33 CFR 328. The jurisdictional limit for a non-tidal water of the United States is determined by the jurisdictional wetland boundary and/or the ordinary high water mark. The presence of the indicators stated in the definition of ordinary high mark (33CFR 328.3(e)) are used to establish the jurisdictional limit of a water of the United States. This preliminary jurisdictional delineation is based on the following:

- Aerial photography interpretation: Aerial photos were provided, dated 2003. They were plotted at a scale of 1"-155' and 1"-300' (approximately). The location of the ordinary high water mark was based on the appearance of scoured areas of the Salt River (i.e. areas that do not show any vegetation on the aerial photo). Other areas that supported some limited vegetation (as interpreted from the aerial photo) were included within the ordinary high water mark.

- Comparison of previously accepted delineations of the area:
    - 2001-01363 – Jurisdictional delineations for wetlands located within the Salt River.
    - 2005-00798 – Individual permit issued for widening of the 35th Avenue bridge crossing the Salt River. No formal jurisdictional delineation was completed.
    - 2003-01303 – Jurisdictional delineation (not field checked) of a portion of the Salt River within the study area.
    - 2005-00023 – Jurisdictional delineation (not field checked) for a portion of the Salt River upstream of 67th Avenue.
    - 2003-01288 – Jurisdictional delineation, confirmed in the field, for a portion of the Salt River upstream of 59th Avenue.
- Phoenix Metropolitan Street Atlas, 2002 Edition, Phoenix Mapping Service
- Aerial photos dated 2005 obtained from the Maricopa County assessor's office website: www.maricopa.gov/Assessor/GIS/Maps/assessor.mwf. These photos also indicated the delineated floodway in the project area.
- Staff knowledge of precipitation and fluvial dynamics of the region: Senior Project Manager has over 8 years experience in the Arizona Regulatory office. During this time she has performed over 400 jurisdictional delineations in Arizona's ephemeral systems, many of which included field work.

\signed by\

Sallie D. McGuire

Project Manager

DRAFT

ENVIRONMENTAL IMPACT STATEMENT

APPENDIX B

Biology and Correspondence

Rio Salado Oeste
Salt River- Phoenix, Arizona

The following are included in this appendix.

- Table B-1 List of Plant and Animal Species Mentioned in the Text
- Federally Listed Threatened and Endangered Species listed as occurring within Maricopa County, USFWS. Downloaded March 8, 2006http://www.fws.gov/arizonaes/Documents/CountyLists/Maricopa.pdf
- USFWS Planning Aid Letter Dated June 21, 2002
- USFWS Fish and Wildlife Coordination Act Report Dated June 20, 2005

Table B-1. List of Plant and Animal Species Mentioned in the Text

Common Name	Scientific Name
Plants	
Acacia	*Acacia greggii*
Bermuda grass	*Cynodon dactylon*
Paloverde	*Cercidium floridum* var. *floridum*
Cheesebush/burrobush	*Hymenoclea salsola*
Cattail	*Typha* spp.
Cottonwood	*Populus fremontii* ssp. *fremontii*
Creosote bush	*Larrea tridentata*
Desert broom	*Baccharis sarothroides*
Desert willow	*Chilopsis linearis*
Gooddings willow	*Salix gooddingii*
London rocket	*Sisymbrium irio*
Marsh fleabane	*Pluchea purpurascens* var. *purpurascens*
Mesquite	*Prosopis velutina*
Willow	*Salix* spp.
Quailbush	*Atriplex lentiformis* ssp. *lentiformis*
Rabbitbrush	*Chrysothamnus* spp.
Filaree	*Erodium cicutarium*
Russian thistle	*Salsola tragus*
Salt Heliotrope	*Heliotropium curassavicum*
Saltbush	*Atriplex* spp.
Saltcedar	*Tamarix* spp.
Sedges	*Cyperus* spp.
Tree tobacco	*Nicotiana glauca*
Reptiles and Amphibians	
Banded Gecko	*Coleonyx variegatus*
Banded Sand Snake	*Chilomeniscus cinctus*
Common Kingsnake	*Lampropeltis getulus*
Desert Black-headed snake	*Tantilla nigriceps*
Desert Tortoise	*Gopherus agassizii*
Earless Lizard	*Holbrookia texana*
Lowland Leopard Frog	*Rana yavapaiensis*

Table B-1. Continued

Common Name	Scientific Name
Mexican Garter Snake	*Thamnophis eques*
Side-blotched Lizard	*Uta stansburiana*
Desert Spiny Lizard	*Sceloporus magister*
Tree Lizard	*Urosaurus ornatus*
Western Diamondback Rattlesnake	*Crotalus atrox*
Western Whiptail	*Cnemidophorous tigris*
Birds	
Abert's Towhee	*Pipilo aberti*
American Coot	*Gallinula chloropus*
American Kestrel	*Falco sparverius*
Anna's Hummingbird	*Calypte anna*
Ash-throated Flycatcher	*Myiarchus cinerascens*
Bald Eagle	*Haliaeetus leucocephalus*
Barn Owl	*Tyto alba*
Belted Kingfisher	*Ceryle alcyon*
Bewick's Wren	*Thryomanes bewickii*
Black Phoebe	*Sayornis nigricans*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Black-throated Sparrow	*Amphispiza bilineata*
Cactus Ferruginous Pygmy Owl	*Glaucidium brasilianum cactorum*
Cactus Wren	*Campylorhynchus brunneicapillus*
Canyon Towhee	*Pipilo fuscus*
Cattle Egret	*Bubulcus ibis*
Cinnamon Teal	*Anas cyanoptera*
Common Merganser	*Mergus merganser*
Curve-billed Thrasher	*Toxostoma curvirostre*
Double-crested Cormorant	*Phalacrocorax auritus*
Dusky Flycatcher	*Empidonax oberholseri*
Elf Owl	*Micrathene whitneyi*
European Starling	*Sturnus vulgarus*
Gambel's Quail	*Callipepla gambelii*
Gila Woodpecker	*Melanerpes uropygialis*

Table B-1. Continued

Common Name	Scientific Name
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Great horned Owl	*Bubo virginianus*
Greater Roadrunner	*Geococcyx californianus*
House Finch	*Carpodacus mexicanus*
House Sparrow (I)	*Passer domesticus*
House Wren	*Troglodytes aedon*
Bell's Vireo	*Vireo belli*
Loggerhead Shrike	*Lanius ludovicianus*
Lucy's Warbler	*Vermivora luciae*
Mallard	*Anas platyrhynchos*
Mourning Dove	*Zenaida macroura*
Northern Flicker	*Colaptes auratus*
Northern Harrier	*Circus cyaneus*
Northern Mockingbird	*Mimus polyglottos*
Peregrine Falcon	*Falco peregrinus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Rock Dove (I)	*Columba livia*
Snowy Egret	*Egretta thula*
Southwestern Willow Flycatcher	*Empidonax traillii extimus*
Tree Swallow	*Tachycineta bicolor*
Verdin	*Auriparus flaviceps*
Western Burrowing Owl	*Athene cunicularia*
Western Kingbird	*Tyrannus verticalis*
Western Screech Owl	*Otus kennicottii*
Western Wood-Pewee	*Contopus sordidulus*
Western Yellow-billed Cuckoo	*Coccyzus americanus*
White-tailed Kite	*Elanus leucurus*
White-winged Dove	*Zenaida asiatica*
Yellow Warbler	*Dendroica petechia*
Yellow-rumped Warbler	*Dendroica coronata*
Yuma Clapper Rail	*Rallus longirostris yumanensis*

Table B-1. Continued

Common Name	Scientific Name
Mammals	
Lesser Long-nosed Bat	*Leptonycteris curasoae yerbabuenae*
Pocket Gopher	*Pappogeomys castanops*
Coyote	*Canis latrans*
Gray Fox	*Urocyon cinereoargenteus*
Bobcat	*Lynx rufus*
Cactus Mouse	*Peromyscus eremicus*
Deer Mouse	*Peromyscus maniculatus*
Western Harvest Mouse	*Reithrodontomys magalotis*
Whitethroat Wood Rat	*Neotoma albigula*
Hispid Cotton Rat	*Sigmodon hispidus*
Blacktail Jack Rabbit	*Lepus californicus*
Desert Cottontail	*Sylvilagus auduboni*
Striped Skunk	*Mephitis mephitis*
Opossum	*Didelphis virginianus*

Maricopa County

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Arizona agave	*Agave arizonica*	Endangered	Has attractive rosettes of bright green leaves with dark mahogany margins. Flower: Borne on sub-umbellate inflorescences.	Gila, Maricopa, Yavapai	3000-6000 ft	Transition zone between oak-juniper woodland & mountain mahogany-oak scrub.	Scattered clones in New River mountains and Sierra Ancha. Usually found on steep, rocky slopes. Possibly Mazatal mountains. Should be looked for wherever the ranges of Agave toumeyana var. bella and Agave chrysantha overlap.
Arizona cliffrose	*Purshia subintegra*	Endangered	Evergreen shrub of the rose family (Roseaceae). Bark pale shreddy. Young twigs with dense hairs. Leaves 1-5 lobes and edges curl downward (revolute). Flowers: 5 white or yellow petals <0.5 inches long.	Graham, Maricopa, Mohave, Yavapai	< 4,000 ft	Characteristic white soils of tertiary limestone lakebed deposits.	White soils of teritiary limestone lakebed deposits can be seen from a distance.
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Large, adults have white head and tail. Height 28-38 inches; wingspan 66-96 inches. Dark with varying degrees of mottled brown plumage. Feet bare of feathers.	Apache, Cochise, Coconino, Gila, Graham, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	Varies	Large trees or cliffs near water (reservoirs, rivers, and streams) with abundant prey.	Some birds are nesting residents while a larger number winters along rivers and reservoirs. An estimated 200 to 300 birds winter in Arizona. Once endangered (32 FR 4001, 03-11-1967; 43 FR 6233, 02-14-78) because of reproductive failures from pesticide poisoning and loss of habitat, this species was down listed to threatened on August 11, 1995. Illegal shooting, disturbance, and loss of habitat continues to be a problem. Species has been proposed for delisting (64 FR 36454) but still receives full protection under the ESA.
Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*	Endangered	Small (Approx. 7inches), diurnal owl reddish brown overall with cream-colored belly streaked with reddish brown. Some individuals are grayish brown.	Cochise, Gila, Graham, Greenlee, Maricopa, Pima, Pinal, Santa Cruz, Yuma	<4000 ft	Mature cottonwood/willow, mesquite bosques, and Sonoran desertscrub.	Historical distribution in Arizona is from New River (North) to Gila Box (East) to Cabeza Prieta Mountains (West). Only a few documented sites where this species persists are known, additional surveys are needed. Species has been proposed for delisting (70 FR 44547) but still receives full protection under the ESA.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
California Brown pelican	*Pelecanus occidentalis californicus*	Endangered	Large dark gray-brown water bird with a pouch underneath long bill and webbed feet. Adults have a white head and neck, brownish black breast, and silver gray upper parts.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	Varies	Coastal land and islands; species found around many Arizona lakes and rivers.	Subspecies is found on Pacific Coast and is endangered due to pesticides. It is an uncommon transient in Arizona on many Arizona lakes and rivers. Individuals wander up from Mexico in summer and fall. No breeding records in Arizona.
Desert pupfish	*Cyprinodon macularius*	Endangered	Small (2 inches) smoothly rounded body shape with narrow vertical bars on the sides. Breeding males blue on head and sides with yellow on tail. Females and juveniles tan to olive colored back and silvery sides.	Graham, La Paz, Maricopa, Pima, Pinal, Santa Cruz, Yavapai	< 5,000 ft	Shallow springs, small streams, and marshes. Tolerates saline and warm water.	Critical habitat includes Quitobaquito Springs, Pima County, portions of San Felipe Creek, Carrizo Wash, and Fish Creek Wash, Imperial County, California. Two subspeices are recognized: Desert Pupfish (C.m.macularis) and Quitobaquito Pupfish (C.m.eremus).
Gila chub	*Gila intermedia*	Endangered	Deep compressed body, flat head. Dark olive-gray color above, silver sides. Endemic to Gila River Basin.	Cochise, Gila, Graham, Greenlee, Maricopa, Pima, Pinal, Santa Cruz, Yavapai	2,000 - 5,500 ft	Pools, springs, cienegas, and streams.	Found on multiple private lands, including the Nature Conservancy, the Audubon Society, and others. Also occurs on Federal and state lands and in Sonora, Mexico. Critical habitat occurs in Cochise, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz and Yavapai counties.
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	Endangered	Small (2 inches), guppy-like, live bearing, lacks dark spots on its fins. Breeding males are jet black with yellow fins.	Gila, Graham, La Paz, Maricopa, Pima, Pinal, Santa Cruz, Yavapai	< 4,500 ft	Small streams, springs, and cienegas vegetated shallows.	Species historically occurred in backwaters of large rivers but is currently isolated to small streams and springs.
Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	Endangered	Elongated muzzle, small leaf nose, and long tongue. Yellowish brown or gray above and cinnamon brown below. Tail minute and appears to be lacking. Easily disturbed.	Cochise, Gila, Graham, Greenlee, Pima, Pinal, Maricopa, Santa Cruz	< 6000 ft	Desert scrub habitat with agave and columnar cacti present as food plants.	Day roosts in caves and abandoned tunnels. Forages at night on nectar, pollen, and fruit of paniculate agaves and columnar cacti. This species is migratory and is present in Arizona usually from April to September and south of the border the remainder of the year.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	Medium sized with dark eyes and no ear tufts. Brownish and heavily spotted with white or beige.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai	4100-9000 ft	Nests in canyons and dense forests with multi-layered foliage structure.	Generally nest in older forests of mixed conifer or ponderosa pine/gambel oak type, in canyons, and use variety of habitats for foraging. Sites with cool microclimates appear to be of importance or are preferred. Critical habitat was finalized on August 31, 2004 (69 FR 53182). Critical habitat in Arizona occurs in Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Navajo, Pima, Pinal, Santa Cruz, and Yavapai counties.
Razorback sucker	*Xyrauchen texanus*	Endangered	Large, up to 3 feet long and up to 6 lbs, high sharp-edged keel-like hump behind the head. Head flattened on top. Olive-brown above to yellowish below.	Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Pinal, Yavapai, Yuma	< 6000 ft	Riverine and lacustrine areas, generally not in fast moving water and may use backwaters.	Species is also found in Horseshoe reservoir (Maricopa County). Critical habitat includes the 100-year floodplain of the river through the Grand Canyon from confluence with Paria River to Hoover Dam; Hoover Dam to Davis Dam; Parker Dam to Imperial Dam. Also Gila River from Arizon/New Mexico border to Coolidge Dam; and Salt River from Hwy 60/SR77 Bridge to Roosevelt Dam; Verde River from FS boundary to Horseshoe Lake.
Sonoran pronghorn	*Antilocapra americana sonoriensis*	Endangered	Buff on back and white below, hoofed with slightly curved black horns having a single prong. Smallest and palest of the pronghorn subspecies	Maricopa, Pima, Yuma	500 - 2,000 ft	Broad intermountain alluvial valleys with creosote-bursage and palo verde-mixed cacti associations.	Typically, bajadas are used as fawning areas and sandy dune areas provide food seasonally. Historical range was probably larger than exists today. This subspecies also occurs in Mexico.
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered	Small passerine (about 6 inches) grayish-green back and wings, whitish throat, light olive-gray breast and pale yellowish belly. Two wingbars visible. Eye-ring faint or absent.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	<8500 ft	Cottonwood/willow and tamarisk vegetation communities along rivers and streams.	Migratory riparian-obligate species that occupies breeding habitat from late April to September. Distribution within its range is restricted to riparian corridors. Difficult to distinguish from other members of the Empidonax complex by sight alone. Training seminar required for those conducting flycatcher surveys. Critical habitat was finalized on October 19, 2005 (50 CFR 60886) and can be viewed at http://arizonaes.fws.gov. In Arizona there are critical habitat segments in Apache, Cochise, Gila, Graham, Greenlee, Maricopa, Mohave, Pima, Pinal, and Yavapai counties.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Yuma clapper rail	*Rallus longirostris yumanensis*	Endangered	Water bird with long legs and short tail. Long, slender decurved bill. Mottled brown or gray on its rump. Flanks and undersides are dark gray with narrow vertical stripes producing a barring effect.	Gila, La Paz, Maricopa, Mohave, Pinal, Yuma	< 4,500 ft	Fresh water and brackish marshes.	Species is associated with dense emergent riparian vegetation. Requires wet substrate (mudflat, sandbar) with dense herbaceous or woody vegetation for nesting and foraging. Channelization and marsh destruction are primary sources of habitat loss.
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate	Medium-sized bird with a slender, long-tailed profile, slightly down-curved bill, which is blue-black with yellow on the lower half of the bill. Plumage is grayish-brown above and white below, with rufous primary flight feathers.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	< 6,500 ft	Large blocks of riparain woodlands (cottonwood, willow, or tamarisk galleries).	Listing was found warranted, but precluded as a distinct vertebrate population segment in the western U.S. on July 25, 2001. This finding indicates that the Service has sufficient information to list the bird, but other, higher priority listing actions prevent the Service from addressing the listing of the cuckoo at this time.

United States Department of the Interior
U.S. Fish and Wildlife Service
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 FAX: (602) 242-2513

In Reply Refer To:

AESO/FA

June 21, 2002

Ms. Ruth Villalobos
Chief, Planning Division
U.S. Army Corps of Engineers, Los Angeles District
P.O. Box 532711
Los Angeles, California 90053-2352

Dear Ms. Villalobos:

This planning aid letter presents the Fish and Wildlife Service's (Service) preliminary evaluation of potential environmental effects and habitat benefits associated with the U.S. Army Corps of Engineers' Rio Salado Oeste Feasibility Study. It is provided pursuant to the Fish and Wildlife Coordination Act (FWCA)(48 stat. 401, as amended; 16 U.S.C. 661 et seq.) but does not constitute the Service report under Section 2(B) of the FWCA. This planning aid letter is based on coordination with the Arizona Game and Fish Department, literature research, file reviews, and information provided by the Corps. A more detailed evaluation of the Hydrogeomorphic Functional Analysis, existing conditions, and future without project scenario will be incorporated into the 2(B) report.

PROJECT DESCRIPTION

The proposed project would provide ecosystem restoration, flood damage reduction, and public recreation within the portion of the Salt River that runs through Phoenix between 19th and 83rd Avenues, Maricopa County, Arizona. The Corps has been authorized to evaluate opportunities for environmental restoration on the Salt River under the Water Resources Development Act of 2001. The City of Phoenix would be the local non-Federal sponsor.

EXISTING ENVIRONMENT

Due to dams and diversions, water flow in this portion of the Salt River is not perennial and is limited to summer or fall flood events. This has caused significant changes to the biotic communities historically found along the Salt River. The dense multi-storied cottonwood and willow gallery forests that once dominated the project area are gone. Scattered vegetation currently found in the project area includes velvet mesquite (*Prosopsis velutina*), Fremont's cottonwood (*Populus fremontii*), Goodding's willow *(Salix gooddingii*), seepwillow (*Baccharis*

salicifolia), desert broom (*B. sarothroides*), burrobush (*Hymenoclea salsola*), rabbitbush (*Chrysothamnus* sp.), creosote (*Larrea tridentata*), and the non-native salt cedar (*Tamarix* sp.). Substantial sand and gravel mining operations exist within the project area. Mining has created a number of open water areas that support limited cottonwood, willow, cattail (*Typha* sp.), and bulrush (*Scirpus* sp.) vegetation.

Native wildlife species likely found in the project area include coyote (*Canis latrans*), black-tailed jackrabbit (*Lepus californicus*), tree lizard (*Urosaurus ornatus*), garter snake (*Thamnophis* sp.), great blue heron (*Ardea herodias*), turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), Gambel's quail (*Callipepla gambelii*), killdeer (*Charadrius vociferus*), black-necked stilt (*Himantopus mexicanus*), mourning dove (*Zenaida macroura*), and red-winged blackbird (*Agelaius phoeniceus*) to name a few. We are unaware of the occurrence any federally threatened or endangered species within the project area.

ALTERNATIVES

Specific planning alternatives have yet to be developed. However, management measures to address planning objectives have been identified. These include the development of a water supply, creation of a mesquite bosque, establishment of a cottonwood/willow gallery forest, creation of emergent wetlands, incorporation of existing ponds, creation of perennial base flow, vector control, implementation of sanitation program, construction of levee or other flood control features, and development of a recreational corridor.

WITHOUT PROJECT PROJECTION

In the absence of active restoration efforts, particularly the attainment of a secure water source, it is unlikely that significant wetland or hydro-riparian vegetation would become established within this reach of the Salt River. Due to river management, it is unlikely that this stretch of the Salt River would ever be characterized by perennial flow. Water would flow in the project area only during periods of flood release from the dam or storm water runoff from storm drains.

WITH PROJECT PROJECTION

Implementation of the proposed project could restore water and native vegetation to an otherwise barren stretch of the Salt River. The specific nature and configuration of water source and native vegetation has yet to be determined. However, the opportunity exists to provide habitat for a diversity of fish and wildlife, particularly native species.

DISCUSSION

The Service is pleased to participate in the planning process for a riparian restoration project. Riparian biotic communities within the State of Arizona have experienced dramatic degradation and decline over the past century. This has, unfortunately, had detrimental effects on wildlife resources, as the vast majority of native wildlife depend upon riparian areas to satisfy some portion of their life cycle. The Rio Salado Oeste project not only offers a tremendous opportunity to restore native biotic communities along the Salt River, but also offers the unique opportunity to provide a link between two other restoration projects, specifically Rio Salado and Tres Rios. We expect the resultant habitat contiguity and connectivity provided by the combined projects to substantially enhance the biological functions and values along the lower Salt River.

The most important aspect of wetland and riparian restoration is the identification and attainment of a secure water source to ensure adequate hydrologic conditions to support the desired biotic communities. Several parameters that should be used to describe proper hydrologic conditions, include hydroperiod, water depth, and seasonal flood pulses. Accordingly, significant attention should be focused on securing a permanent and sufficient source of water. A combination of effluent, groundwater, and storm water may be beneficial.

Riparian restoration has the potential to benefit a diversity of native wildlife species by restoring critically important habitats, particularly within riverine systems severely degraded by urbanization. For example, most native bird species have not done particularly well in urban environments. Cities are typically dominated by the abundance of a few bird species, in contrast to relatively undisturbed environments that are characterized by high species richness and balanced evenness. Vegetation in urban landscapes often lack the structural components sought by native wildlife. For this reason we suggest the Corps and sponsor consider restoring a mosaic of heterogeneous vegetative cover types juxtapositioned to provide substantial edge and habitat diversity. Within this framework, we believe incorporation of dense multistoried patches with relatively tall canopies would be critical.

Prior to active restoration, assessments should be conducted to ensure that chosen sites would be suitable environments for the establishment, regeneration, and survival of native riparian plants. Consideration should be given to microhabitat conditions such as depth to water table, soil texture, and salinity. Consideration should also be given to large scale ecological processes such as flood regime which species such as cottonwood and willow depend upon for seed bed formation, seed dispersal, germination, seedling establishment, recruitment, and survival. Other considerations may include groundwater fluctuations, site preparation, protection of plantings from herbivory, necessity of irrigation, potential for competition from undesirable species, and long term management potential for the site.

The proposed project could eventually result in the establishment of habitats suitable for a number of native species including those listed as threatened and endangered or those that are candidates for listing. We encourage the local non-Federal sponsor to explore the opportunity to develop a Safe Harbor Agreement, Candidate Conservation Agreement, or Habitat Conservation Plan, as appropriate, to complete future operation and maintenance activities while providing assurance against additional Endangered Species Act restrictions.

PRELIMINARY RECOMMENDATIONS

1) Focus significant attention on securing a permanent and sufficient source of water, perhaps through a combination of effluent, groundwater, and storm water.

2) Evaluate opportunities to restore a mosaic of heterogeneous vegetative cover types that maximizes structural habitat complexity.

3) Conduct assessments to ensure that site specific microhabitat conditions would be conducive to establishment and growth of native riparian plants especially cottonwood, willow, and mesquite.

4) Encourage the non-Federal sponsor to explore the need for a Safe Harbor Agreement, Candidate Conservation Agreement, or Habitat Conservation Plan for operation and maintenance activities.

We appreciate the opportunity to provide planning assistance for the proposed project. We look forward to working with you on continued project development. If we can be of further assistance or you have questions, please contact Mike Martinez (x224).

Sincerely,

David L. Harlow

David L. Harlow
Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, NM
Supervisor, Project Evaluation Program, Arizona Game and Fish Department, Phoenix, AZ
Scott Estergard, Planning Branch, Army Corps of Engineers, Phoenix, AZ

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United States Department of the Interior
U.S. Fish and Wildlife Service
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 242-0210 FAX: (602) 242-2513

In Reply Refer to:

AESO/FA

June 20, 2005

Ms. Ruth Villalobos
Chief, Planning Division
U.S. Army Corps of Engineers, Los Angeles District
P.O. Box 532711
Los Angeles, California 90053-2352

Dear Ms. Villalobos:

The Fish and Wildlife Service (FWS) has reviewed the U.S. Army Corps of Engineers (Corps) proposed Rio Salado Oeste Feasibility Study. This report represents our evaluation of the Rio Salado Oeste ecosystem restoration project and is provided pursuant to Section 2(B) of the Fish and Wildlife Coordination Act (48 stat. 401, as amended; 16 U.S.C. 661 et seq.). This report is based on coordination with the Arizona Game and Fish Department, literature research, file reviews, and information provided by the Corps.

PROJECT DESCRIPTION

The proposed project would provide ecosystem restoration, flood damage reduction, and public recreation within the portion of the Salt River that runs through Phoenix between 19th and 83rd Avenues, Maricopa County, Arizona. The Corps has been authorized to evaluate opportunities for environmental restoration on the Salt River under the Water Resources Development Act of 2001. The City of Phoenix would be the local non-Federal sponsor.

EXISTING ENVIRONMENT

Due to dams and diversions, water flow in this portion of the Salt River is not perennial and is limited to summer or fall flood events. This has caused significant changes to the biotic communities historically found along the Salt River. The dense multi-storied cottonwood and willow gallery forests that once dominated the project area are gone. Scattered vegetation currently found in the project area includes velvet mesquite (*Prosopsis velutina*), Fremont cottonwood (*Populus fremontii*), Goodding's willow *(Salix gooddingii*), seepwillow (*Baccharis salicifolia*), desert broom (*B. sarothroides*), burrobush (*Hymenoclea salsola*), rabbitbush (*Chrysothamnus* sp.), creosote (*Larrea tridentata*), and non-native salt cedar (*Tamarix* sp.). Substantial sand and gravel mining operations exist within the project area. Mining has created a

number of open water areas that support limited cottonwood, willow, cattail (*Typha* sp.), and bulrush (*Scirpus* sp.) vegetation.

Native wildlife species likely found in the project area include coyote (*Canis latrans*), black-tailed jackrabbit (*Lepus californicus*), tree lizard (*Urosaurus ornatus*), garter snake (*Thamnophis* sp.), great blue heron (*Ardea herodias*), turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), Gambel's quail (*Callipepla gambelii*), killdeer (*Charadrius vociferus*), black-necked stilt (*Himantopus mexicanus*), mourning dove (*Zenaida macroura*), and red-winged blackbird (*Agelaius phoeniceus*). We have no information on the occurrence of federally-listed threatened or endangered species within the project area.

ALTERNATIVES

General Features Alternatives

Channel Restoration: This would provide a flow connection through the study reach and be accomplished by grading and terracing to restore an active channel. Average depth would be five ft with a width of 200-400 ft. Due to a drop in the channel downstream of the 35th Avenue Bridge, a grade control structure is recommended in that vicinity. At this time erosion and scour do not appear to be a concern with project features or infrastructure. An estimated 660,000 c.y. would be removed from the channel to implement this measure. Material removed would be utilized onsite for terracing and construction of other project components, such as lake restoration.

Stormwater outfalls: There are stormwater outfalls throughout the study area supporting wetland habitat. In most cases it is dominated by invasive and exotic species, although conditions appear to be suitable for native riparian vegetation. Existing outfalls would be modified to discharge to a concrete/stone channel through the river terrace and directed toward the low-flow channel. Within that channel there would be a low weir to capture the low flows and allow floodwaters to pass. The weir would direct flows to a stormwater wetland constructed for the purpose of harvesting stormwater and supporting adjacent habitat.

Cottonwood/Willow: This would include restoration of riparian cottonwood/willow stands adjacent to water sources and low terraces throughout the study area. Cottonwood-willow would be dominated by Fremont cottonwood and Goodding's willow. In addition to cottonwood and willow, other plants species may include are *Baccharis* sp., arrowweed (*Pluchea sericea*), and ash (*Fraxinus* sp.). Other understory species would be planted, depending upon individual site conditions, including arrowweed, elderberry (*Sambucus mexicana*), or burrobush. The cottonwood-willow areas would be planted with a combination of pole plantings and container plants with a density of approximately 50 cottonwoods, 50 willows, and 25 understory brush species per acre. Understory forbes would also be planted using a seed mix. It is assumed five years of irrigation would be required for establishment.

Mesquite: This habitat would be restored over a potentially large portion of the project area and require periodic watering for five years. Watering could be discontinued after five years or when roots reach groundwater or during rainfall. Mesquite bosques would be dominated by velvet mesquite intermixed with honey mesquite (*Prosopsis glandulosa*), understory shrubs such as desert thorn (*Lycium spp.*), palo verde (*Parkinsonia floridia*), and brittlebush (*Encelia farinosa*).

Mesquite bosques would be planted with a density of approximately 100 velvet mesquite, ten honey mesquite, and 40 understory shrubs per acre. Understory forbes would also be planted using a seed mix. In locations throughout the study area with less water supply, xeric stands of mesquite would be established. Planting densities would be less with approximately 25 velvet mesquite, five honey mesquite, and ten understory shrubs per acre.

Wetland: Wetlands can consist of open water, submerged vegetation, or mud flats; all requiring a high water table level at or near the surface. Due to porous soils in the project area, lining would be required to maintain surface water. Excavation and layering of a silt-clay soil substrate approximately 12 inches thick would be sufficient. Emergent wetlands contain primarily cattails, tule (*Scirpus acutus*), and sedges (*Carex* sp.). In addition to wetlands included in the stormwater outfall measure, wetland restoration would be included in several alternatives at various locations throughout the study area, mainly in existing gravel pits or open water bodies within the floodplain.

Lakes: There are existing features created from aggregate mining operations at 27th and 37th Avenues that would require modification to implement lake restoration. These modifications are recommended to restore the floodplain landscape and improve functionality: The existing banks would need to be reshaped for public safety and restoration; possible aeration of the existing water bodies; and potential substrate modification to reduce the annual fluctuation in the lake levels. This measure would be implemented through grading and filling with material excavated for other project features and onsite materials.

Invasive Control: Invasive species such as salt cedar and giant reed (*Arundo donax*) would require removal and management through the project life. Salt cedar is currently found in stands throughout the study area. Arundo, although not yet a significant problem in Arizona, is a problem in neighboring California. A stand of arundo can be found on the south side of the river near a stormwater outfall at 43rd Avenue.

Water Supply: In addition to the stormwater runoff that would be harvested, additional water would be required. Effluent from the 23rd Avenue Waste water Treatment Plant is available. The City of Phoenix estimates that approximately eight MGD (8,964 acre feet) is available. This would require construction of a pump and piping system to deliver water throughout the project area.

Alternative 1 - No Action: Under this alternative the Corps and local sponsor would not pursue environmental restoration in the study area.

Alternative 2 - Stormwater and Channel: This alternative would include the modification of existing stormwater outfall areas to improve retention and water spreading as well as increasing the existing habitat currently supported by these outfalls. It also would include modification and/or restructuring of the primary conveyance channel to a more natural state by grading and terracing the river corridor from 19th avenue to 83rd avenue. No additional water source would be included in this alternative.

Alternative 3 - Stormwater, Channel, Water Supply, Cottonwood, Mesquite, Invasive Species: This alternative would include the features described in alternative 2 and add a supplemental water supply in the form of effluent. At locations identified as suitable throughout the project area, cottonwood/willow and mesquite cover types would be restored. This alternative would also address the management, control, and removal of invasive species within the study area.

Alternative 4 - Stormwater, Channel, Water Supply, Cottonwood, Mesquite, Invasive Species, Emergent Wetlands: This alternative would add restoration of emergent wetlands at the existing lake in the channel immediately downstream of 19th Avenue.

Alternative 5 - Stormwater, Channel, Water Supply, Cottonwood, Mesquite, Invasive Species, Emergent Wetlands, Lake: Added to this alternative would be lake restoration at the existing gravel pits at 29th and 37th Avenues.

Alternative 5A - Wetland Restoration in lieu of Permanent Open Water and Lakes: In lieu of lake restoration this would include regrading of the existing gravel pits to restore them to the floodplain and restoration of emergent wetland and riparian areas.

Alternative 5B - Hybrid of 5 and 5A: This would include restoration of one gravel pit to a wetland/riparian complex and the other to include the lake.

WITHOUT-PROJECT PROJECTION

In the absence of active restoration efforts, particularly the attainment of a secure water source, it is unlikely that significant wetland or hydro-riparian vegetation would become established within this reach of the Salt River. Due to river management, it is unlikely that this stretch of the Salt River would ever be characterized by perennial flow. Water would flow in the project area only during periods of flood releases or stormwater runoff.

WITH-PROJECT PROJECTION

Implementation of the proposed project could restore water and native vegetation to an otherwise barren stretch of the Salt River. Each alternative would provide habitat for a diversity of fish and wildlife, particularly native species.

Alternative 2: This alternative would restore 66 acres of cottonwood/willow, 43 acres of mesquite, 28 acres of wetland at outfalls, and 17 acres of wetland in the low-flow channel.

Alternative 3: This alternative would restore 348 acres of cottonwood/willow, 409 acres of mesquite, 28 acres of wetland at outfalls, and 34 acres of wetland in the low-flow channel.

Alternative 4: This alternative would restore 348 acres of cottonwood/willow, 409 acres of mesquite, 33 acres of wetland at outfalls, and 34 acres of wetland in the low-flow channel.

Alternative 5: This alternative would restore 375 acres of cottonwood/willow, 417 acres of mesquite, 76 acres of wetland at outfalls and lakes, 34 acres of wetland in the low-flow channel, and 40 acres of open water.

Alternative 5A: This alternative would restore 375 acres of cottonwood/willow, 417 acres of mesquite, 156 acres of wetland at outfalls and lakes, and 34 acres of wetland in the low-flow channel.

Alternative 5B: This alternative would restore 375 acres of cottonwood/willow, 417 acres of mesquite, 136 acres of wetland at outfalls and lakes, 34 acres of wetland in the low-flow channel, and 20 acres of open water.

DISCUSSION

We are pleased to participate in the development of your riparian restoration project. Riparian biotic communities within the State of Arizona have experienced dramatic degradation and decline over the past century. This has had detrimental effects on wildlife resources as the vast majority of native wildlife depend upon riparian areas to satisfy some portion of their life cycle. The Rio Salado Oeste project not only offers a tremendous opportunity to restore native biotic communities along the Salt River, but also offers the unique opportunity to provide a link between two other restoration projects, specifically Rio Salado and Tres Rios. We expect the resultant habitat contiguity and connectivity provided by the combined projects to substantially enhance the biological functions and values along the lower Salt River.

The most important aspect of wetland and riparian restoration is the identification and attainment of a secure water source to ensure adequate hydrologic conditions to support the desired biotic communities. Several parameters that should be used to describe proper hydrologic conditions include hydroperiod, water depth, and seasonal flood pulses. Accordingly, significant attention

should be focused on securing a permanent and sufficient source of water. A combination of effluent, groundwater, and stormwater may be beneficial.

Riparian restoration has the potential to benefit a diversity of native wildlife species by restoring critically important habitats, particularly within riverine systems severely degraded by urbanization. For example, most native bird species have not done particularly well in urban environments. Cities are typically dominated by an abundance of a few bird species, in contrast to relatively undisturbed environments that are characterized by high species richness. Vegetation in urban landscapes often lacks the structural components needed by native wildlife. For this reason, we suggest that the Corps and sponsor consider restoring a mosaic of heterogeneous vegetative cover types juxtapositioned to provide substantial edge and habitat diversity. Within this framework, we believe incorporation of dense multistoried patches with relatively tall canopies would be critical.

Assessments should be conducted prior to active restoration to ensure that chosen sites would be suitable environments for the establishment, regeneration, and survival of native riparian plants. Consideration should be given to microhabitat conditions such as depth to water table, soil texture, and salinity. Consideration should also be given to large-scale ecological processes such as flood regime which species such as cottonwood and willow depend upon for seed bed formation, seed dispersal, germination, seedling establishment, recruitment, and survival. Other considerations may include groundwater fluctuations, site preparation, protection of plantings from herbivory, necessity of irrigation, potential for competition from undesirable species, and long term management potential for the site.

This proposed project could eventually result in establishment of habitats suitable for a number of native species including those listed as threatened and endangered or those that are candidates for listing. We encourage the local non-Federal sponsor to consider developing a Safe Harbor Agreement, Candidate Conservation Agreement, or Habitat Conservation Plan, as appropriate, to avoid additional Endangered Species Act restrictions. We offer our assistance in exploring these options.

RECOMMENDATIONS

1) Focus significant attention on securing a permanent and sufficient source of water, perhaps through a combination of effluent, groundwater, and stormwater.

2) Maximize opportunities to restore a mosaic of heterogeneous vegetative cover types that maximizes structural habitat complexity.

3) Ensure that site-specific microhabitat conditions would be conducive to establishment and growth of native riparian plants, especially cottonwood, willow, and mesquite.

4) Encourage the non-Federal sponsor to evaluate Safe Harbor Agreements, Candidate Conservation Agreements, or Habitat Conservation Plans.

We appreciate the opportunity to provide planning assistance for this proposed project. If we can be of further assistance or you have questions, please contact Mike Martinez (x224).

Sincerely,

Thomas A. Gatz
Deputy Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, NM (ARD-ES)
Supervisor, Project Evaluation Program, Arizona Game and Fish Department, Phoenix, AZ
Scott Estergard, Planning Branch, Army Corps of Engineers, Phoenix, AZ

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DRAFT ENVIRONMENTAL IMPACT STATEMENT

APPENDIX C
RECORD OF NON APPLICABILITY (RONA) ASSUMPTIONS FOR AIR QUALITY ANALYSIS

Rio Salado Oeste
Salt River- Phoenix, Arizona

RECORD OF NON-APPLICABILITY
FOR
RIO SALADO OESTE RESTORATION PROJECT
MARICOPA COUNTY, ARIZONA

The Rio Salado Oeste Project – Draft Environmental Impact Statement was completed in March, 2006. The proposed project would include the modification of existing storm-water outfall areas to improve retention and water spreading as well as increasing the existing habitat currently supported by these outfalls. It also includes modification and/or restructuring of the primary conveyance channel to a more natural state by grading and terracing the river corridor from 19th Avenue to 83rd Avenue. No additional water source is included in this alternative other than temporary irrigation to establish vegetation. The alternative also adds supplemental water supply in the form of effluent. It includes restoration of emergent wetlands at the existing lake in the channel immediately downstream of 19th Avenue. At locations identified as suitable throughout the project area, cottonwood/willow and mesquite cover types will be restored. The alternative also addresses the management, control and removal of invasive species within the study area and includes regrading of the existing gravel pits to restore them to the floodplain and restoring emergent wetland and riparian areas.

The Clean Air Act (CAA) as amended in 1990, Section 176(c), specifies that no department, agency, or instrumentality of the Federal Government shall engage in, support in any way, or provide financial assistance for, license or permit, or approve, any activity which does not conform to a State Implementation Plan (SIP). Conformity is defined in Section 176 (c) of the CAA and requires that federal actions conform to the implementation plan purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) while achieving expeditious attainment of such standards. Specifically, federal actions cannot:

1. Cause or contribute to any new violation of any standard in any area; or
2. Increase the frequency or severity of any existing violation of any standard in any area; or
3. Delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

Air quality impacts of each alternative considered at Rio Salado Oeste project fall under both federal and state conformity regulation. In Arizona, the federal conformity regulation in 40 CFR Part 93, Subpart B has been adopted by reference in the Arizona Administrative Code, Section R18-2-1438.

Conformity regulations ensure that federal actions conform to the local SIP. The Arizona SIP include programs to address air pollution in the areas of the state which do not meet the federal health standards and those which have successfully reduced emissions to levels that meet the health standards (Maintenance Areas). In those areas, federal projects which will have emissions above the regulatory thresholds are subject to the conformity requirements. The Maricopa County Area is currently classified as Non-attainment for PM-10 and the 8- hour Ozone standard. In addition, the area was reclassified as a Maintenance Area for the 1-hour Ozone Standard and the Carbon Monoxide Standard in 2004. The table below summarizes the current air quality attainment status for the Maricopa County Area, as well as the conformity thresholds.

Table C-1. Attainment Status and Conformity Thresholds

December 2005 Maricopa County Area, Arizona			
Pollutant	Attainment Status	Federal Register Citation	Conformity Threshold
Carbon Monoxide	Maintenance Area	70 FR 11553 March 9, 2005	100 tons/yr
Ozone: VOC & NOx	**8-hr Standard** Basic Nonattainment Area **1-hr Standard** Maintenance Area	69 FR 23858 April 30, 2004 70 FR 34362 June 14, 2005	VOC: 100 tons/yr. NOx: 100 tons/yr
PM-10	Nonattainment Area- (Serious Classification) -	June 10, 1996 (61 FR 21372)	70 tons/yr
PM-2.5	Attainment Area	70 FR 944 January 5, 2005	N/A

Estimation of air quality impacts was performed based upon EPA Guidance Document AP-42 *Compilation of Air Pollutant Emission Factors.* The person contacted at the Arizona Department of Environmental Quality (Randy Sedlacek) expressed no concerns with either the methods of analysis or the resulting air quality impacts described in the Draft Environment Impact Statement (DEIS).

Calculations in this appendix show that emissions are below the requirements of the federal/state conformity threshold. Based on the air quality analysis described in this Draft EIS, it has been determined that the proposed project is exempt from demonstrating conformity with State Implementation Plans. The total emissions of each applicable criteria pollutant are below *de minimus* levels as prescribed in 40 CFR 93.153(b). As a result, this project conforms to the State Implementation Plan and the Federal Clean Air Act as amended 1990.

A Record of Non-Applicability has been prepared instead of a Conformity Determination because the direct and indirect emissions do not equal or exceed the federal *de minimus* levels or the state threshold levels, which is more stringent. Therefore, the project is in conformity with the applicable State Implementation Plan

For further information, please contact Mr. Michael Fink, Environmental Coordinator, U. S. Army Corps of Engineers, Los Angeles District, at (602) 640-2001 ext. 232.

_____ _____

DATE

Alex Dornstauder
Colonel, Corps of Engineers
District Engineer

ASSUMPTIONS USED TO GENERATE AIR EMISSION ESTIMATES FOR THE RIO SALADO OESTE PROJECT

The following assumptions were used to estimate emissions associated with each of the Rio Salado Oeste project alternatives. Detailed assumptions, emission factors and worksheets for the calculations are presented in Tables C-2, C-3, C-4, C-5 and C-6. To calculate construction and O&M emissions, emission factors developed by EPA's AP-42, Compilation of Air Pollutant Emission Factors, have been used to calculate exhaust and fugitive dust emissions. Calculations are also based on earthwork quantity and import fill quantity information provided in the feasibility study. The following types of air pollutant emission sources were included in the calculations:

- Fugitive dust emissions from haul trucks, off road equipment and passenger vehicles on unpaved roads within the construction site were estimated based on the assumed number of vehicle trips and travel distance, using AP-42 emission factors applicable for the western United States. For the construction phases, it was assumed unpaved haul roads would be aggressively watered to reduce dust emissions.
- Fugitive dust emissions from excavating, loading, dumping, and spreading of bulk materials during channel excavation and bank stabilization were estimated based on the assumed earthwork volumes, using the EPA's AP-42, *Compilation of Air Pollutant Emission Factors* emission factors for surface mining operations.
- Emissions from construction equipment tailpipes were estimated based on the type and number of equipment, using recent emission factors for off-road equipment the EPA's AP-42, *Compilation of Air Pollutant Emission Factors.*
- Emissions from passenger vehicle traffic associated with the project were based upon the EPA's AP-42, *Compilation of Air Pollutant Emission Factors.*

BANK STABILIZATION/CONSTRUCTED WETLANDS CONSTRUCTION

- Equipment used for construction (assuming 8 hours/day, 200 days per year):
  - 2 Front end loaders
  - 4 Dump trucks

- Pickup truck
- 2 Dozers
- 2 Graders
- 2 Backhoes
- Water Truck
- 2 Rollers

- Bank stabilization materials will be obtained from the constructed wetland excavation sites. Any additional materials needed for the bank stabilization will be obtained from the other proposed restoration sites within the river channel.
- Construction will occur approximately 200 days per year.
- For employee trips, assumed a 40-mile round-trip commute per day.

Table C-2. Assumptions for Channel Excavation and Bank Stabilization Emission Estimates

Alternative	Years of Heavy Earthwork Construction	Daily Employee Trips	Employee Commute Distance (round trip miles)
2	1	10	40
4	2	15	40
5	4	25	40
5A	3	20	40
5B	3	20	40

HABITAT RESTORATION AND MAINTENANCE

- Construction will occur approximately 200 days per year, 8 hours per day.
- Restoration implementation will consist of three general steps: clearing and grubbing, excavation, and preparation for planting.
- Vegetation removal emissions based on dozer emissions only.
- Salt cedar removed during initial implementation will be disposed of by burning.
- Equipment used for construction (assuming 8 hours/day, 200 days per year).

- 2 Front End Loaders
- 2 Dump Trucks
- Dozer
- 2 Backhoes
- Water Truck
- Pickup Truck

- For employee trips, assumed a 40-mile round-trip commute per day.

Table C-3. Assumptions for Construction Emissions Associated with Restoration and Maintenance

Alternative	Years Construction	Daily Employee Trips	Employee Commute Distance (round trip miles)
2	1	5	40
4	2	15	40
5	2	15	40
5A	2	10	40
5B	2	10	40

CONSTRUCTION OF RECREATIONAL FEATURES

- Recreation features will be constructed concurrently with habitat restoration.

- Construction is assumed to occur over 1 year, 200 days, 8 hours per day.

- The following equipment will be utilized for construction

  - 2 Front End Loaders
  - Paver
  - Dump Truck
  - Dozer
  - Backhoe
  - Roller
  - Pickup Truck

Table C-4. Assumptions for Construction Emissions Associated with Recreation Features

Alternative	Years Construction	Daily Employee Trips	Employee Commute Distance (round trip miles)
2	1	5	40
4	1	15	40
5	1	15	40
5A	1	10	40
5B	1	10	40

Table C-5. Construction Equipment Emissions

Emission Factors (lb/hr)	CO	VOC	N0x	S0x	PM-10
Front-End Wheeled Loader	0.572	0.23	1.9	0.182	0.17
Dump Truck	1.8	0.19	4.17	0.45	0.26
Dozer	0.01	0.002	0.021	0.002	0.0005
Grader	0.151	0.0039	0.713	0.086	0.061
Back-hoe loader	0.015	0.003	0.022	0.002	0.001
Water Tank	0.008	0.005	0.017	0.002	0.0015
Roller	0.3	0.065	0.87	0.067	0.05
Paver	0.01	0.002	0.024	0.002	0.001
Pickup Truck	1.8	0.19	4.17	0.45	0.26

Estimated Emissions for Alternatives

Emissions/day, lb/hr		Emissions for entire day, lbs				
Channel Restoration	**hrs/day of use**	**CO**	**VOC**	**N0x**	**S0x**	**PM-10**
Front-End Wheeled Loader (2)	16	9.152	3.68	30.4	2.912	2.72
Dump Truck (4)	32	57.6	6.08	133.44	14.4	8.32
Dozer (2)	16	0.16	0.032	0.336	0.032	0.008
Grader (2)	16	2.416	0.0624	11.408	1.376	0.976
Back-hoe loader (2)	16	0.24	0.048	0.352	0.032	0.016
Water Tank	8	0.064	0.04	0.136	0.016	0.012
Roller (2)	16	4.8	1.04	13.92	0.002	0.8
Pickup Truck	8	14.4	1.52	33.36	3.6	2.08
Daily Average Emissions (lb/day)		***88.83***	***12.50***	***223.35***	***22.37***	***14.93***

Habitat Restoration	**hrs/day of use**	**CO**	**VOC**	**N0x**	**S0x**	**PM-10**
Front-End Wheeled Loader (2)	16	9.152	3.68	30.4	2.912	2.72
Dump Truck (2)	16	28.8	3.04	66.72	7.2	4.16
Dozer	8	0.08	0.016	0.168	0.016	0.004
Back-hoe loader (2)	16	0.24	0.048	0.352	0.032	0.016
Water Tank	8	0.064	0.04	0.136	0.016	0.012
Pickup Truck	8	14.4	1.52	33.36	3.6	2.08

Daily Average Emissions (lb/day)		***52.74***	***8.34***	***131.14***	***13.78***	***8.99***
Recreation Facility Installation	**hrs/day of use**	**CO**	**VOC**	**N0x**	**S0x**	**PM-10**
Front-End Wheeled Loader (2)	16	9.152	3.68	30.4	2.912	2.72
Dump Truck	8	14.4	1.52	33.36	3.6	2.08
Dozer	8	0.08	0.016	0.168	0.016	0.004
Paver	8	0.08	0.016	0.192	0.016	0.008
Back-hoe loader (2)	16	0.24	0.048	0.352	0.032	0.016
Roller	8	2.4	0.52	6.96	0.536	0.4
Pickup Truck	8	14.4	1.52	33.36	3.6	2.08
Daily Average Emissions (lb/day)		***40.75***	***7.32***	***104.79***	***10.71***	***7.31***
Alternative 2	**days of use**	**CO**	**VOC**	**N0x**	**S0x**	**PM-10**
Channel Restoration	200	17766.4	2500.48	44670.4	4474	2986.4
Habitat Restoration	200	10547.2	1668.8	26227.2	2755.2	1798.4
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	***600***	***36464***	***5633.28***	***91856***	***9371.6***	***6246.4***

Alternative 4	**days of use**	**CO**	**VOC**	**N0x**	**S0x**	**PM-10**
Channel Restoration	400	35532.8	5000.96	89340.8	8948	5972.8
Habitat Restoration	400	21094.4	3337.6	52454.4	5510.4	3596.8
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	***1000***	***64777.6***	***9802.56***	***162753.6***	***16600.8***	***11031.2***

Alternative 5	days of use	CO	VOC	N0x	S0x	PM-10
Channel Restoration	800	71065.6	10001.92	178681.6	17896	11945.6
Habitat Restoration	400	21094.4	3337.6	52454.4	5510.4	3596.8
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	***1400***	***100310.4***	***14803.52***	***252094.4***	***25548.8***	***17004***

Alternative 5A	days of use	CO	VOC	N0x	S0x	PM-10
Channel Restoration	600	53299.2	7501.44	134011.2	13422	8959.2
Habitat Restoration	400	21094.4	3337.6	52454.4	5510.4	3596.8
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	***1200***	***82544***	***12303.04***	***207424***	***21074.8***	***14017.6***

Alternative 5B	days of use	CO	VOC	N0x	S0x	PM-10
Channel Restoration	600	53299.2	7501.44	134011.2	13422	8959.2
Habitat Restoration	400	21094.4	3337.6	52454.4	5510.4	3596.8
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	**1200**	***82544***	***12303.04***	***207424***	***21074.8***	***14017.6***

Total Emissions Accumulated Throughout Entire Duration of Construction (lbs)

Alternative	Days of Use	CO	VOC	N0x	S0x	PM-10
2	600	36464	5633.28	91856	9371.6	6246.4
4	1000	64777.6	9802.56	162753.6	16600.8	11031.2
5	1400	100310.4	14803.52	252094.4	25548.8	17004
5A	1200	82544	12303.04	207424	21074.8	14017.6
5B	1200	82544	12303.04	207424	21074.8	14017.6

Table C-6. Recreation Plan Emissions

Emission Factors (grams)

Vehicle Speed - 65 mph	CO	VOC	NOX	PM-10 Exhaust	PM-10 Tire Wear
Travel Emissions	4.94	0.1	0.49	0.005	0.1
Cold Start	49.96	1.6	1.32	x	x
Hot Start	4.13	0.28	0.64	x	x
Hot Soak	x	0.33	x	x	x
Diurnal	x	0.75	x	x	x

Travel Emissions (pounds/day) - Alternative 2

VMT - 800	CO	VOC	NOX	PM-10
Travel Emissions	8.7	0.18	0.86	0.19
Cold Start	0.55	0.02	0.01	x
Hot Start	0.05	0.003	0.007	x
Hot Soak	x	0.007	x	x
Diurnal	x	0.008	x	x
Total Emissions	**9.3**	**0.218**	**0.877**	**0.19**

Travel Emissions (pounds/day) - Alternative 4

VMT - 2400	CO	VOC	NOX	PM-10
Travel Emissions	26.11	0.53	2.59	0.56
Cold Start	1.65	0.05	0.04	x
Hot Start	0.14	0.009	0.02	x
Hot Soak	x	0.02	x	x
Diurnal	x	0.02	x	x
Total Emissions	**27.9**	**0.629**	**2.65**	**0.56**

Travel Emissions (pounds/day) - Alternative 5

VMT - 2400	CO	VOC	NOX	PM-10
Travel Emissions	26.11	0.53	2.59	0.56
Cold Start	1.65	0.05	0.04	x
Hot Start	0.14	0.009	0.02	x
Hot Soak	x	0.02	x	x
Diurnal	x	0.02	x	x
Total Emissions	**27.9**	**0.629**	**2.65**	**0.56**

Travel Emissions (pounds/day) - Alternative 5A

VMT - 1600	CO	VOC	NOX	PM-10
Travel Emissions	17.41	0.35	1.73	0.37
Cold Start	1.1	0.04	0.03	x
Hot Start	0.09	0.006	0.01	x
Hot Soak	x	0.01	x	x
Diurnal	x	0.02	x	x
Total Emissions	**18.6**	**0.426**	**1.77**	**0.37**

Travel Emissions (pounds/day) - Alternative 5B

VMT - 1600	CO	VOC	NOX	PM-10
Travel Emissions	17.41	0.35	1.73	0.37
Cold Start	1.1	0.04	0.03	x
Hot Start	0.09	0.006	0.01	x
Hot Soak	x	0.01	x	x
Diurnal	x	0.02	x	x
Total Emissions	**18.6**	**0.426**	**1.77**	**0.37**

Total Emissions (duration of project)

	CO	VOC	NOX	PM-10
Alternative 2 (200 days)	1860	43.6	175.4	38
Alternative 4 (200 days)	5580	125.8	530	112
Alternative 5 (200 days)	5580	125.8	530	112
Alternative 5A (200 days)	3720	85.2	354	74
Alternative 5B (200 days)	3720	85.2	354	74

Travel emissions: [(emission factors (exhaust+tire wear)) x (distance traveled(VMT))]/(454 grams/lbs)

Cold start: [(#vehicles) x (cold start emission factor)]/454 gram/lbs)

Hot start emissions: [(# daily trips) - (# of vehicles)] x (hot start emission factor)/454 gram/lbs)

Hot soak emissions: (# daily trips) x (hot soak emission factor)/454 grams/lb)

Diurnal emissions: (#vehicles) x (diurnal emission factor)/454 grams/lbs)

VMT per day: (#trips per day) x (one-way trip distance x 2)

Travel Distance: 40 miles one way

Speed: 65 mph

VMT: Alt 2 (800), Alt 4 (2400), Alt 5 (2400), Alt 5A (1600), Alt 5B (1600)

Number of Workers/Vehicles: Alt 2 (5), Alt 4 (15), Alt 5 (15), Alt 5A (10), Alt 5B (10)

Total Number of Daily Trips Per Day: Alt 2 (10), Alt 4 (30), Alt 5 (30), Alt 5A (20), Alt 5B (20)

Source: EMFAC7EP Emissions Factors For South Coast Air Quality Management District
Vehicles with Gross Vehicle Weight 6,000 Pounds and Less
Calendar Year 2007
Table A9-5-J-8

Table X-X						
Emission Factors (lb/hr)		**CO**	**VOC**	**N0x**	**S0x**	**PM10**
Front-End Wheeled Loader		0.572	0.23	1.9	0.182	0.17
Dump Truck		1.8	0.19	4.17	0.45	0.26
Dozer		0.01	0.002	0.021	0.002	0.0005
Grader		0.151	0.0039	0.713	0.086	0.061
Back-hoe loader		0.015	0.003	0.022	0.002	0.001
Water Tank		0.008	0.005	0.017	0.002	0.0015
Roller		0.3	0.065	0.87	0.067	0.05
Paver		0.01	0.002	0.024	0.002	0.001
Pickup Truck		1.8	0.19	4.17	0.45	0.26

Estimated Emissions for Alternatives						
Emissions/day, lb/hr		**Emissions for entire day, lbs**				
Channel Restoration	**hrs/day of use**	**CO**	**VOC**	**N0x**	**S0x**	**PM10**
Front-End Wheeled Loader (2)	16	9.152	3.68	30.4	2.912	2.72
Dump Truck (4)	32	57.6	6.08	133.44	14.4	8.32
Dozer (2)	16	0.16	0.032	0.336	0.032	0.008
Grader (2)	16	2.416	0.0624	11.408	1.376	0.976
Back-hoe loader (2)	16	0.24	0.048	0.352	0.032	0.016
Water Tank	8	0.064	0.04	0.136	0.016	0.012
Roller (2)	16	4.8	1.04	13.92	0.002	0.8
Pickup Truck	8	14.4	1.52	33.36	3.6	2.08
Daily Average Emissions (lb/day)		***88.83***	***12.50***	***223.35***	***22.37***	***14.93***

Habitat Restoration	**hrs/day of use**	**CO**	**VOC**	**N0x**	**S0x**	**PM10**
Front-End Wheeled Loader (2)	16	9.152	3.68	30.4	2.912	2.72
Dump Truck (2)	16	28.8	3.04	66.72	7.2	4.16
Dozer	8	0.08	0.016	0.168	0.016	0.004
Back-hoe loader (2)	16	0.24	0.048	0.352	0.032	0.016
Water Tank	8	0.064	0.04	0.136	0.016	0.012
Pickup Truck	8	14.4	1.52	33.36	3.6	2.08
Daily Average Emissions (lb/day)		***52.74***	***8.34***	***131.14***	***13.78***	***8.99***

Recreation Facility Installation	**hrs/day of use**	**CO**	**VOC**	**N0x**	**S0x**	**PM10**
Front-End Wheeled Loader (2)	16	9.152	3.68	30.4	2.912	2.72
Dump Truck	8	14.4	1.52	33.36	3.6	2.08
Dozer	8	0.08	0.016	0.168	0.016	0.004
Paver	8	0.08	0.016	0.192	0.016	0.008
Back-hoe loader (2)	16	0.24	0.048	0.352	0.032	0.016
Roller	8	2.4	0.52	6.96	0.536	0.4
Pickup Truck	8	14.4	1.52	33.36	3.6	2.08
Daily Average Emissions (lb/day)		***40.75***	***7.32***	***104.79***	***10.71***	***7.31***

Alternative 2	days of use	CO	VOC	N0x	S0x	PM10
Channel Restoration	200	17766.4	2500.48	44670.4	4474	2986.4
Habitat Restoration	200	10547.2	1668.8	26227.2	2755.2	1798.4
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	***600***	***36464***	***5633.28***	***91856***	***9371.6***	***6246.4***

Alternative 4	days of use	CO	VOC	N0x	S0x	PM10
Channel Restoration	400	35532.8	5000.96	89340.8	8948	5972.8
Habitat Restoration	400	21094.4	3337.6	52454.4	5510.4	3596.8
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	***1000***	***64777.6***	***9802.56***	***162753.6***	***16600.8***	***11031.2***

Alternative 5	days of use	CO	VOC	N0x	S0x	PM10
Channel Restoration	800	71065.6	10001.92	178681.6	17896	11945.6
Habitat Restoration	400	21094.4	3337.6	52454.4	5510.4	3596.8
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	***1400***	***100310.4***	***14803.52***	***252094.4***	***25548.8***	***17004***

Alternative 5A	days of use	CO	VOC	N0x	S0x	PM10
Channel Restoration	600	53299.2	7501.44	134011.2	13422	8959.2
Habitat Restoration	400	21094.4	3337.6	52454.4	5510.4	3596.8
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	***1200***	***82544***	***12303.04***	***207424***	***21074.8***	***14017.6***

Alternative 5B	days of use	CO	VOC	N0x	S0x	PM10
Channel Restoration	600	53299.2	7501.44	134011.2	13422	8959.2
Habitat Restoration	400	21094.4	3337.6	52454.4	5510.4	3596.8
Recreation Facility Installation	200	8150.4	1464	20958.4	2142.4	1461.6
Total	**1200**	***82544***	***12303.04***	***207424***	***21074.8***	***14017.6***

Total Emissions Accumulated Throughout Entire Duration of Construction						
Alternative	Days of Use	CO	VOC	N0x	S0x	PM10
2	600	36464	5633.28	91856	9371.6	6246.4
4	1000	64777.6	9802.56	162753.6	16600.8	11031.2
5	1400	100310.4	14803.52	252094.4	25548.8	17004
5A	1200	82544	12303.04	207424	21074.8	14017.6
5B	1200	82544	12303.04	207424	21074.8	14017.6

Table X-X						
Emission Factors (lb/hr)		**CO**	**ROC**	**N0x**	**S0x**	**PM10**
Front-End Wheeled Loader		0.572	0.23	1.9	0.182	0.17
Dump Truck		1.8	0.19	4.17	0.45	0.26
Dozer		0.01	0.002	0.021	0.002	0.0005
Grader		0.151	0.0039	0.713	0.086	0.061
Back-hoe loader		0.015	0.003	0.022	0.002	0.001
Water Tank		0.008	0.005	0.017	0.002	0.0015
Roller		0.3	0.065	0.87	0.067	0.05
Paver		0.01	0.002	0.024	0.002	0.001
Pickup Truck		1.8	0.19	4.17	0.45	0.26

	Estimated Emissions for Alternative 2					
Emissions/day, lb/hr		Emissions for entire day, lbs				
Channel Restoration	**hrs/day of use**	**CO**	**ROC**	**N0x**	**S0x**	**PM10**
Front-End Wheeled Loader (2)	10	11.44	4.6	38	3.64	3.4
Dump Truck (4)	10	72	7.6	166.8	18	10.4
Dozer (2)	10	0.2	0.04	0.42	0.04	0.01
Grader (2)	10	3.02	0.078	14.26	1.72	1.22
Back-hoe loader (2)	10	0.3	0.06	0.44	0.04	0.02
Water Tank	10	0.08	0.05	0.17	0.02	0.015
Roller (2)	10	6	1.3	17.4	1.34	1
Pickup Truck (2)	10	36	3.8	83.4	9	5.2
Daily Average Emissions (lb/day)		***129.04***	***17.528***	***320.89***	***33.8***	***21.265***

Habitat Restoration	**hrs/day of use**	**CO**	**ROC**	**N0x**	**S0x**	**PM10**
Front-End Wheeled Loader (2)	10	11.44	4.6	38	3.64	3.4
Dump Truck (2)	10	72	7.6	166.8	18	10.4
Dozer	10	0.1	0.02	0.21	0.02	0.005
Back-hoe loader (2)	10	0.3	0.06	0.44	0.04	0.02
Water Tank	10	0.08	0.05	0.17	0.02	0.015
Pickup Truck (2)	10	36	3.8	83.4	9	5.2
Daily Average Emissions (lb/day)		***119.92***	***16.13***	***289.02***	***30.72***	***19.04***

Recreation Plan	**hrs/day of use**	**CO**	**ROC**	**N0x**	**S0x**	**PM10**
Front-End Wheeled Loader (2)	10	11.44	4.6	38	3.64	3.4
Dump Truck	10	18	1.9	41.7	4.5	2.6
Dozer	10	0.1	0.02	0.21	0.02	0.005
Paver	10	0.1	0.02	0.24	0.02	0.01
Back-hoe loader (2)	10	0.3	0.06	0.44	0.04	0.02
Roller	10	3	0.65	8.7	0.67	0.5
Pickup Truck	10	18	1.9	41.7	4.5	2.6
Daily Average Emissions (lb/day)		***50.94***	***9.15***	***130.99***	***13.39***	***9.135***

Alternative 2	days of use	CO	ROC	N0x	S0x	PM10
Channel Restoration	200	25808	3505.6	64178	6760	4253
Habitat Restoration	200	23984	3226	57804	6144	3808
Recreation Plan	200	10188	1830	26198	2678	1827
Total	***600***	***59980***	***8561.6***	***148180***	***15582***	***9888***

Alternative 4	days of use	CO	ROC	N0x	S0x	PM10
Channel Restoration	400	51616	7011.2	128356	13520	8506
Habitat Restoration	400	47968	6452	115608	12288	7616
Recreation Plan	200	10188	1830	26198	2678	1827
Total	***1000***	***109772***	***15293.2***	***270162***	***28486***	***17949***

Alternative 5	days of use	CO	ROC	N0x	S0x	PM10
Channel Restoration	800	103232	14022.4	256712	27040	17012
Habitat Restoration	400	47968	6452	115608	12288	7616
Recreation Plan	200	10188	1830	26198	2678	1827
Total	***1400***	***161388***	***22304.4***	***398518***	***42006***	***26455***

Alternative 5A	days of use	CO	ROC	N0x	S0x	PM10
Channel Restoration	600	77424	10516.8	192534	20280	12759
Habitat Restoration	400	47968	6452	115608	12288	7616
Recreation Plan	200	10188	1830	26198	2678	1827
Total	***1200***	***135580***	***18798.8***	***334340***	***35246***	***22202***

Alternative 5B	days of use	CO	ROC	N0x	S0x	PM10
Channel Restoration	600	77424	10516.8	192534	20280	12759
Habitat Restoration	400	47968	6452	115608	12288	7616
Recreation Plan	200	10188	1830	26198	2678	1827
Total	**1200**	***135580***	***18798.8***	***334340***	***35246***	***22202***

Emissions for entire job, lbs						
Alternative	Days of Use	CO	ROC	N0x	S0x	PM10
2	600	59,980	8,562	148,180	15,582	9,888
4	1000	109,772	15,293	270,162	28,486	17,949
5	1400	161,388	22,304	398,518	42,006	26,455
5A	1200	135,580	18,799	334,340	35,246	22,202
5B	1200	135,580	18,799	334,340	35,246	22,202

Table 5.4-4
Estimated Daily Emissions from Mobile Sources for Alternatives

	Employee Commuting Emissions, lb/day				
Alternative	**CO**	**VOC**	**N0x**	**S0x**	**PM10**
2	7440	172.4	704.8	x	150
4	27900	629	2650	x	560
5	88764	1937.4	8582	x	1816
5A	54372	1185.6	5262	x	1110
5B	54372	1185.6	5262	x	1110

Table 5.4-5
Summary of Total and Average Daily Emissions from All Sources

	Emissions for entire job, lbs				
Alternative	**CO**	**VOC**	**N0x**	**S0x**	**PM10**
2	43904	5806	92561	9372	6396
4	92678	10432	165404	16601	11591
5	189074	16741	260676	25549	18820
5A	136916	13489	212686	21075	15128
5B	136916	13489	212686	21075	15128
	Average Daily, lbs/day				
Alternative	**CO**	**VOC**	**N0x**	**S0x**	**PM10**
2 (1200 days)	37	5	77	8	5
Exceedance	**No**	**No**	**No**	**No**	**No**
4 (2000 days)	46	5	83	8	6
Exceedance	**No**	**No**	**No**	**No**	**No**
5 (2800 days)	68	6	93	9	7
Exceedance	**No**	**No**	**No**	**No**	**No**
5A (2400 days)	57	6	89	9	6
Exceedance	**No**	**No**	**No**	**No**	**No**
5B (2400 days)	57	6	89	9	6
Exceedance (lbs/day)	**No**	**No**	**No**	**No**	**No**
Significance Thresholds (lbs/day)	**550**	**75**	**100**	**150**	**150**

	Average Yearly, tons/year				
Alternative	**CO**	**VOC**	**N0x**	**S0x**	**PM10**
2	3.32	0.44	7.00	0.71	0.48
Exceedance	**No**	**No**	**No**	**No**	**No**
4	4.20	0.47	7.50	0.75	0.53
Exceedance	**No**	**No**	**No**	**No**	**No**
5	6.12	0.54	8.44	0.83	0.61
Exceedance	**No**	**No**	**No**	**No**	**No**
5A	5.17	0.51	8.04	0.80	0.57
Exceedance	**No**	**No**	**No**	**No**	**No**
5B	5.17	0.51	8.04	0.80	0.57
Exceedance (lbs/day)	**No**	**No**	**No**	**No**	**No**
De Minimus Threshold for General Conformity	**100 tons/yr**	**100 tons/yr**	**100 tons/yr**	**100 tons/yr**	**70 tons/yr**

200 work days per year
2205 lbs: 1 ton

Table X-X
Estimated Emissions for Entire Proje c

			Emissions for entire job, lbs				
Operations Involved	**Alternative**	**Days of Use**	**CO**	**VOC**	**Nox**	**SOx**	**PM10**
Channel Restoration/Wetland Construction	2	200	17,766	2,500	44,670	4,474	2,986
Habitat Restoration	2	200	10,547	1,669	26,227	2755.2	1798.4
Recreation Plan	2	200	8,150	1,464	20,958	2142.4	1461.6
Construction Subtotal		***600***	***36,464***	***5,633***	***91,856***	***9371.6***	***6246.4***
Channel Restoration/Wetland Construction	2	200	3720	85.2	354	x	74
Habitat Restoration	2	200	1860	43.6	175.4	x	38
Recreation Plan	2	200	1860	43.6	175.4	x	38
Employee Commuting Subtotal		***600***	***7440***	***172.4***	***704.8***	***x***	***150***
GRAND TOTAL		***1200***	***43904***	***5806***	***92561***	***9372***	***6396***

			Emissions for entire job, lbs				
Operations Involved	**Alternative**	**Days of Use**	**CO**	**VOC**	**Nox**	**SOx**	**PM10**
Channel Restoration/Wetland Construction	4	400	35,533	5,001	89,341	8,948	5,973
Habitat Restoration	4	400	21,094	3,338	52,454	5510.4	3596.8
Recreation Plan	4	200	8,150	1,464	20,958	2142.4	1461.6
Construction Subtotal		***1000***	***64,778***	***9,803***	***162,754***	***16600.8***	***11031.2***
Channel Restoration/Wetland Construction	4	400	11160	251.6	1060	x	224
Habitat Restoration	4	400	11160	251.6	1060	x	224
Recreation Plan	4	200	5580	125.8	530	x	112
Employee Commuting Subtotal		***1000***	***27900***	***629***	***2650***	***x***	***560***
GRAND TOTAL		***2000***	***92678***	***10432***	***165404***	***16601***	***11591***

			Emissions for entire job, lbs				
Operations Involved	**Alternative**	**Days of Use**	**CO**	**VOC**	**Nox**	**SOx**	**PM10**
Channel Restoration/Wetland Construction	5	800	71,066	10,002	178,682	17,896	11,946
Habitat Restoration	5	400	21,094	3,338	52,454	5510.4	3596.8
Recreation Plan	5	200	8,150	1,464	20,958	2142.4	1461.6
Construction Subtotal		***1400***	***100,310***	***14,804***	***252,094***	***25548.8***	***17004***
Channel Restoration/Wetland Construction	5	800	72024	1560	6992	x	1480
Habitat Restoration	5	400	11160	251.6	1060	x	224
Recreation Plan	5	200	5580	125.8	530	x	112
Employee Commuting Subtotal		***1400***	***88764***	***1937.4***	***8582***	***x***	***1816***
GRAND TOTAL		***2800***	***189074***	***16741***	***260676***	***25549***	***18820***

			Emissions for entire job, lbs				
Operations Involved	**Alternative**	**Days of Use**	**CO**	**VOC**	**Nox**	**SOx**	**PM10**
Channel Restoration/Wetland Construction	5A	600	53,299	7,501	134,011	13,422	8,959
Habitat Restoration	5A	400	21,094	3,338	52,454	5510.4	3596.8
Recreation Plan	5A	200	8,150	1,464	20,958	2142.4	1461.6
Construction Subtotal		***1200***	***82,544***	***12,303***	***207,424***	***21074.8***	***14017.6***
Channel Restoration/Wetland Construction	5A	600	43212	930	4200	x	888
Habitat Restoration	5A	400	7440	170.4	708	x	148
Recreation Plan	5A	200	3720	85.2	354	x	74
Employee Commuting Subtotal		***1200***	***54372***	***1185.6***	***5262***	***x***	***1110***
GRAND TOTAL		***2400***	***136916***	***13489***	***212686***	***21075***	***15128***

			Emissions for entire job, lbs				
Operations Involved	**Alternative**	**Days of Use**	**CO**	**VOC**	**Nox**	**SOx**	**PM10**
Channel Restoration/Wetland Construction	5B	600	53,299	7,501	134,011	13,422	8,959
Habitat Restoration	5B	400	21,094	3,338	52,454	5510.4	3596.8
Recreation Plan	5B	200	8,150	1,464	20,958	2142.4	1461.6
Construction Subtotal		***1200***	***82,544***	***12,303***	***207,424***	***21074.8***	***14017.6***
Channel Restoration/Wetland Construction	5B	600	43212	930	4200	x	888
Habitat Restoration	5B	400	7440	170.4	708	x	148
Recreation Plan	5B	200	3720	85.2	354	x	74
Employee Commuting Subtotal		***1200***	***54372***	***1185.6***	***5262***	***x***	***1110***
GRAND TOTAL		***2400***	***136916***	***13489***	***212686***	***21075***	***15128***

Emission Table for Workers (in pounds) for Channel Restoration/Wetland Construction

Emission Factors (grams)

Vehicle Speed - 65 mph	CO	VOC	NOX	PM10 Exaust	PM10 Tire Wear
Travel Emissions	4.94	0.1	0.49	0.005	0.1
Cold Start	49.96	1.6	1.32	x	x
Hot Start	4.13	0.28	0.64	x	x
Hot Soak	x	0.33	x	x	x
Diurnal	x	0.75	x	x	x

Travel Emissions (pounds/day) - Alternative 2

VMT - 1600	CO	VOC	NOX	PM10
Travel Emissions	17.41	0.35	1.73	0.37
Cold Start	1.1	0.04	0.03	x
Hot Start	0.09	0.006	0.01	x
Hot Soak	x	0.01	x	x
Diurnal	x	0.02	x	x
Total Emissions	**18.6**	**0.426**	**1.77**	**0.37**

Travel Emissions (pounds/day) - Alternative 4

VMT - 2400	CO	VOC	NOX	PM10
Travel Emissions	26.11	0.53	2.59	0.56
Cold Start	1.65	0.05	0.04	x
Hot Start	0.14	0.009	0.02	x
Hot Soak	x	0.02	x	x
Diurnal	x	0.02	x	x
Total Emissions	**27.9**	**0.629**	**2.65**	**0.56**

Travel Emissions (pounds/day) - Alternative 5

VMT - 8000	CO	VOC	NOX	PM10
Travel Emissions	87.05	1.76	8.63	1.85
Cold Start	2.75	0.09	0.07	x
Hot Start	0.23	0.02	0.04	x
Hot Soak	x	0.04	x	x
Diurnal	x	0.04	x	x
Total Emissions	**90.03**	**1.95**	**8.74**	**1.85**

Travel Emissions (pounds/day) - Alternative 5A

VMT - 6400	CO	VOC	NOX	PM10
Travel Emissions	69.64	1.41	6.91	1.48
Cold Start	2.2	0.07	0.06	x
Hot Start	0.18	0.01	0.03	x
Hot Soak	x	0.03	x	x
Diurnal	x	0.03	x	x
Total Emissions	**72.02**	**1.55**	**7**	**1.48**

Travel Emissions (pounds/day) - Alternative 5B

VMT - 6400	CO	VOC	NOX	PM10
Travel Emissions	69.64	1.41	6.91	1.48
Cold Start	2.2	0.07	0.06	x
Hot Start	0.18	0.01	0.03	x
Hot Soak	x	0.03	x	x
Diurnal	x	0.03	x	x
Total Emissions	**72.02**	**1.55**	**7**	**1.48**

Total Emissions (duration of project)	CO	VOC	NOX	PM10
Alternative 2 (200 days)	3720	85.2	354	74
Alternative 4 (400 days)	11160	251.6	1060	224
Alternative 5 (800 days)	72024	1560	6992	1480
Alternative 5A (600 days)	43212	930	4200	888
Alternative 5B (600 days)	43212	930	4200	888

Travel emissions: [(emission factors (exhaust+tire wear)) x (distance traveled(VMT))]/(454 grams/lbs)
Cold start: [(#vehicles) x (cold start emission factor)]/454 gram/lbs)
Hot start emissions: [(# daily trips) – (# of vehicles)] x (hot start emission factor)/454 gram/lbs)
Hot soak emissions: (# daily trips) x (hot soak emission factor)/454 grams/lb)
Diurnal emissions: (#vehicles) x (diurnal emission factor)/454 grams/lbs)
VMT per day: (#trips per day) x (one-way trip distance x 2)

Travel Distance: 40 miles one way
Speed: 65 mph
VMT: Alt 2 (1600), Alt 4 (2400), Alt 5 (8000), Alt 5A (6400), Alt 5B (6400)
Number of Workers/Vehicles: Alt 2 (10), Alt 4 (15), Alt 5 (25), Alt 5A (20), Alt 5B (20)
Total Number of Daily Trips Per Day: Alt 2 (20), Alt 4 (30), Alt 5 (50), Alt 5A (40), Alt 5B (40)

Source: EMFAC7EP Emissions Factors For South Coast Air Quality Management District
Vehicles with Gross Vehicle Weight 6,000 Pounds and Less
Calendar Year 2007
Table A9-5-J-8

Emission Table for Workers (in pounds) for Habitat Restoration

Emission Factors (grams)

Vehicle Speed - 65 mph	CO	ROC	VOC	PM10 Exaust	PM10 Tire Wear
Travel Emissions	4.94	0.1	0.49	0.005	0.1
Cold Start	49.96	1.6	1.32	x	x
Hot Start	4.13	0.28	0.64	x	x
Hot Soak	x	0.33	x	x	x
Diurnal	x	0.75	x	x	x

Travel Emissions (pounds/day) - Alternative 2

VMT - 800	CO	ROC	VOC	PM10
Travel Emissions	8.7	0.18	0.86	0.19
Cold Start	0.55	0.02	0.01	x
Hot Start	0.05	0.003	0.007	x
Hot Soak	x	0.007	x	x
Diurnal	x	0.008	x	x
Total Emissions	**9.3**	**0.218**	**0.877**	**0.19**

Travel Emissions (pounds/day) - Alternative 4

VMT - 2400	CO	ROC	VOC	PM10
Travel Emissions	26.11	0.53	2.59	0.56
Cold Start	1.65	0.05	0.04	x
Hot Start	0.14	0.009	0.02	x
Hot Soak	x	0.02	x	x
Diurnal	x	0.02	x	x
Total Emissions	**27.9**	**0.629**	**2.65**	**0.56**

Travel Emissions (pounds/day) - Alternative 5

VMT - 2400	CO	ROC	VOC	PM10
Travel Emissions	26.11	0.53	2.59	0.56
Cold Start	1.65	0.05	0.04	x
Hot Start	0.14	0.009	0.02	x
Hot Soak	x	0.02	x	x
Diurnal	x	0.02	x	x
Total Emissions	**27.9**	**0.629**	**2.65**	**0.56**

Travel Emissions (pounds/day) - Alternative 5A

VMT - 1600	CO	ROC	VOC	PM10
Travel Emissions	17.41	0.35	1.73	0.37
Cold Start	1.1	0.04	0.03	x
Hot Start	0.09	0.006	0.01	x
Hot Soak	x	0.01	x	x
Diurnal	x	0.02	x	x
Total Emissions	**18.6**	**0.426**	**1.77**	**0.37**

Travel Emissions (pounds/day) - Alternative 5B

VMT - 1600	CO	ROC	VOC	PM10
Travel Emissions	17.41	0.35	1.73	0.37
Cold Start	1.1	0.04	0.03	x
Hot Start	0.09	0.006	0.01	x
Hot Soak	x	0.01	x	x
Diurnal	x	0.02	x	x
Total Emissions	**18.6**	**0.426**	**1.77**	**0.37**

Total Emissions (duration of project)	CO	ROC	VOC	PM10
Alternative 2 (200 days)	1860	43.6	175.4	38
Alternative 4 (400 days)	11160	251.6	1060	224
Alternative 5 (400 days)	11160	251.6	1060	224
Alternative 5A (400 days)	7440	170.4	708	148
Alternative 5B (400 days)	7440	170.4	708	148

Travel emissions: [(emission factors (exhaust+tire wear)) x (distance traveled(VMT))]/(454 grams/lbs)
Cold start: [(#vehicles) x (cold start emission factor)]/454 gram/lbs)
Hot start emissions: [(# daily trips) – (# of vehicles)] x (hot start emission factor)/454 gram/lbs)
Hot soak emissions: (# daily trips) x (hot soak emission factor)/454 grams/lb)
Diurnal emissions: (#vehicles) x (diurnal emission factor)/454 grams/lbs)
VMT per day: (#trips per day) x (one-way trip distance x 2)

Travel Distance: 40 miles one way
Speed: 65 mph
VMT: Alt 2 (800), Alt 4 (2400), Alt 5 (2400), Alt 5A (1600), Alt 5B (1600)
Number of Workers/Vehicles: Alt 2 (5), Alt 4 (15), Alt 5 (15), Alt 5A (10), Alt 5B (10)
Total Number of Daily Trips Per Day: Alt 2 (10), Alt 4 (30), Alt 5 (30), Alt 5A (20), Alt 5B (20)

Source: EMFAC7EP Emissions Factors For South Coast Air Quality Management District
Vehicles with Gross Vehicle Weight 6,000 Pounds and Less
Calendar Year 2007
Table A9-5-J-8

Emission Table for Workers (in pounds) for Recreation Plan

Emission Factors (grams)

Vehicle Speed - 65 mph	CO	VOC	NOX	PM10 Exaust	PM10 Tire Wear
Travel Emissions	4.94	0.1	0.49	0.005	0.1
Cold Start	49.96	1.6	1.32	x	x
Hot Start	4.13	0.28	0.64	x	x
Hot Soak	x	0.33	x	x	x
Diurnal	x	0.75	x	x	x

Travel Emissions (pounds/day) - Alternative 2

VMT - 800	CO	VOC	NOX	PM10
Travel Emissions	8.7	0.18	0.86	0.19
Cold Start	0.55	0.02	0.01	x
Hot Start	0.05	0.003	0.007	x
Hot Soak	x	0.007	x	x
Diurnal	x	0.008	x	x
Total Emissions	**9.3**	**0.218**	**0.877**	**0.19**

Travel Emissions (pounds/day) - Alternative 4

VMT - 2400	CO	VOC	NOX	PM10
Travel Emissions	26.11	0.53	2.59	0.56
Cold Start	1.65	0.05	0.04	x
Hot Start	0.14	0.009	0.02	x
Hot Soak	x	0.02	x	x
Diurnal	x	0.02	x	x
Total Emissions	**27.9**	**0.629**	**2.65**	**0.56**

Travel Emissions (pounds/day) - Alternative 5

VMT - 2400	CO	VOC	NOX	PM10
Travel Emissions	26.11	0.53	2.59	0.56
Cold Start	1.65	0.05	0.04	x
Hot Start	0.14	0.009	0.02	x
Hot Soak	x	0.02	x	x
Diurnal	x	0.02	x	x
Total Emissions	**27.9**	**0.629**	**2.65**	**0.56**

Travel Emissions (pounds/day) - Alternative 5A

VMT - 1600	CO	VOC	NOX	PM10
Travel Emissions	17.41	0.35	1.73	0.37
Cold Start	1.1	0.04	0.03	x
Hot Start	0.09	0.006	0.01	x
Hot Soak	x	0.01	x	x
Diurnal	x	0.02	x	x
Total Emissions	**18.6**	**0.426**	**1.77**	**0.37**

Travel Emissions (pounds/day) - Alternative 5B

VMT - 1600	CO	VOC	NOX	PM10
Travel Emissions	17.41	0.35	1.73	0.37
Cold Start	1.1	0.04	0.03	x
Hot Start	0.09	0.006	0.01	x
Hot Soak	x	0.01	x	x
Diurnal	x	0.02	x	x
Total Emissions	**18.6**	**0.426**	**1.77**	**0.37**

Total Emissions (duration of project)	CO	VOC	NOX	PM10
Alternative 2 (200 days)	1860	43.6	175.4	38
Alternative 4 (200 days)	5580	125.8	530	112
Alternative 5 (200 days)	5580	125.8	530	112
Alternative 5A (200 days)	3720	85.2	354	74
Alternative 5B (200 days)	3720	85.2	354	74

Travel emissions: [(emission factors (exhaust+tire wear)) x (distance traveled(VMT))]/(454 grams/lbs)
Cold start: [(#vehicles) x (cold start emission factor)]/454 gram/lbs)
Hot start emissions: [(# daily trips) – (# of vehicles)] x (hot start emission factor)/454 gram/lbs)
Hot soak emissions: (# daily trips) x (hot soak emission factor)/454 grams/lb)
Diurnal emissions: (#vehicles) x (diurnal emission factor)/454 grams/lbs)
VMT per day: (#trips per day) x (one-way trip distance x 2)

Travel Distance: 40 miles one way
Speed: 65 mph
VMT: Alt 2 (800), Alt 4 (2400), Alt 5 (2400), Alt 5A (1600), Alt 5B (1600)
Number of Workers/Vehicles: Alt 2 (5), Alt 4 (15), Alt 5 (15), Alt 5A (10), Alt 5B (10)
Total Number of Daily Trips Per Day: Alt 2 (10), Alt 4 (30), Alt 5 (30), Alt 5A (20), Alt 5B (20)

Source: EMFAC7EP Emissions Factors For South Coast Air Quality Management District
Vehicles with Gross Vehicle Weight 6,000 Pounds and Less
Calendar Year 2007
Table A9-5-J-8