RIO SALADO ENVIRONMENTAL RESTORATION PROJECT

Daniel DeSemple, P.E.
CH2M HILL
2625 South Plaza Drive, Suite 300
Tempe, AZ 85282-3397

ABSTRACT

The Rio Salado Environmental Restoration Project (Project) has been 40 years in the making and is the first of its kind in the desert southwest. It has become the benchmark for future river restoration Projects. The Project restores a 5-mile section of the Salt River (Rio Salado) that goes through the very core of the City of Phoenix. The Salt River provides essential 100-year flood protection for the City of Phoenix. The Project changes a dry riverbed eyesore of debris and gravel pits back into restored native wetlands and riparian habitats with recreational and educational uses while maintaining the essential flood control. It also revitalizes the central city area.

The design includes innovative solutions to reestablish self-sustaining natural habits, and uses extensive recycling techniques to describe, interpret, and honor the history of the river, its people, and the City of Phoenix that grew from its banks. The Project provides the right mix of engineered infrastructure to support the riparian habitat establishment and maintenance as well as providing opportunities for public interaction with the Project.

This Project is a partnership between the City of Phoenix and the U.S. Army Corps of Engineers (USACE). The Project design was completed on schedule in five phases over 3 years to meet the fiscal funding and construction schedule constraints.

Challenges included maintaining flood control, developing a sustainable environment, selecting appropriate plant palates and irrigation needs, determining water supply/quality, maximizing the use of nuisance flows from stormwater outfalls, minimizing impacts on the adjacent landfills, reusing existing concrete rubble in the Project, and providing public use features such as trails, kiosks, and ramadas.

KEYWORDS

Environmental restoration, sustainable environment, flood control, recreation, riparian habitat, recycling, education, self-sustaining, stormwater, landfill, water supply, wetlands, river restoration

INTRODUCTION

Phoenix’s early growth was spawned by the city’s proximity to a river—in this case, the Salt River. During pre-Columbian times, the Hohokam—a prodigious farming tribe—established an elaborate network of irrigation canals from the river’s tributaries to irrigate their crops. Those arriving in the Salt River valley of the Arizona territory during the 1800s developed a ferryboat system to navigate the wide river. It was they who discovered the Hohokam’s canal system,
which they reconstructed, giving the name “Phoenix” to their settlement in a symbolic gesture recognizing that their own agrarian economy was emerging from the ashes of the Hohokam’s.

In the early 20th century, the U.S. Bureau of Reclamation constructed several dams along the Salt and Verde rivers to regulate the river’s flow and create a series of lakes that would provide a reliable year-round water supply for the valley. While these goals were accomplished, by the late 20th century, Phoenix’s demand for water had reduced the Salt River to a barren riverbed—an urban eyesore used as a dumping ground and populated by the homeless.

The concept of rejuvenating the Salt River was originally the brainchild of James Elmore, the founding dean of Arizona State University’s School of Architecture, who, in collaboration with his students, conceived what was then called simply the Rio Salado Project. Elmore and his students envisioned the Project as a major undertaking that would reestablish the Salt River as a vital urban waterway by developing a 14-mile stretch of river frontage. That plan, which evolved over the course of nearly two decades, called for the creation of 28 miles of lakes, white-water rapids, islands, and campgrounds. It carried a price tag of $2.5 billion, and when it was finally put before voters in 1987 it was soundly defeated at the polls. In the late 1990s, a less ambitious Rio Salado restoration plan—the Rio Salado Environmental Restoration Project—was developed that entailed restoring a 5-mile section of the Salt River through the central core of Phoenix. This plan was endorsed by Phoenix residents.

The Rio Salado Environmental Restoration Project was a joint venture of the USACE, which in recent years has broadened its scope to embrace the fields of environmental management and environmental restoration, and the City of Phoenix. The concept developed by the City was to restore the central city area by transforming the dry riverbed into an oasis of native wetland and riparian habitats historically associated with the Salt River. This habitat restoration Project would encompass 580 acres within the banks of the riverbed and a 50-foot-wide corridor on each side. The site extends from just west of the Interstate 10 crossing on the eastern end to 19th Avenue on the western end.

In January 2001, USACE officials signed an agreement with Phoenix officials to complete the Project—in all, the federal government would pay approximately 65 percent of the cost of the Project—and in March 2001 Phoenix residents approved a $16 million bond issue to fund the cleanup of the riverbed and the habitat restoration, which would include the re-creation of riparian habitats.

In October 2001, CH2M HILL—in conjunction with several local design and planning firms—was engaged to produce the overall Project plan and contract documents for the Phoenix reach of the Project. The design process began in January 2002, and the first construction contract was awarded in June of that year. The design team delivered more than 1,300 final plan sheets of design documents between January 2002 and March 2004. Each design package required the management of multiple disciplines, including civil, geotechnical, mechanical, electrical, architectural, and structural engineering; landscape architecture; and instrumentation and control.
Aerial View of the Rio Salado Environmental Restoration Project

The Project covers a 5-mile stretch of the Salt River from 19th Avenue on the west and 24th Street on the east. Project features include:

1. Waterfall of Recycled Rock that Supplies Wetlands
2. Central Avenue Gateway
3. Central Avenue Water Supply Reservoir
4. Outdoor Classroom
5. Bridge to Visitor Center and Habitat
6. 7th Avenue Staging Area
7. Saltbush Habitat
8. Equestrian Staging Area
9. Cottonwood-Willow Habitat
10. Gateway
11. Nature Center
12. Mesquite Bosque Habitat
13. Demonstration Wetlands
14. 7th Street Staging Area
15. Low-Flow Channel
16. Lower Sonoran Mesquite Habitat
17. Multiuse Trail
18. 16th Street Staging Area
19. Maintenance Road
20. Lower Sonoran Palo Verde Habitat

Exhibit 1. Rio Salado Environmental Restoration Project Site
GOALS

Essentially the Project was envisioned as an urban renewal Project that would create a small desert stream that would support a riparian ecosystem. The undertaking would also establish a public park that would provide Phoenix residents with recreational and educational opportunities. The ultimate goal was to substantially improve the aesthetic and functional properties of the blighted riverbed area.

The Rio Salado Environmental Restoration Project is the first of its kind in the desert Southwest and constitutes a bench-mark for future river restoration Projects. CH2M HILL’s team applied innovative techniques to reestablish a lost landscape of self-sustaining habitats that would return native wild-life to the riverbed. Challenges included maintaining flood control capacity, developing a sustainable environment, selecting appropriate plant palettes and irrigation needs, determining water supply, setting water quality standards, maximizing the use of nuisance flows from stormwater outfalls, minimizing effects on adjacent landfills, reusing existing concrete rubble in the Project, and providing such public use features as kiosks, ramadas, and roads.

The goal of restoring the native wetland and riparian habitat that was historically associated with the Salt River required an innovative design. The design includes a functionally operating water supply and distribution system that both sustains and promotes the natural regeneration of plant materials and a maintenance road system that is required to support and maintain these habitats.

The design team also focused on incorporating controlled passive recreational and educational elements and features into the Project by adhering to the following design principles:

- **Recycle and reuse:** Use both site-specific and manufactured recycled items in the Project as site furnishings and construction materials that are illustrative of the river’s history and use. This is a guiding principle for the entire Project and was applied to the restoration aspects of the Project and the public use facilities where it was cost effective and feasible.

- **Accessibility:** Provide balanced, controlled, safe, and creative solutions for people of all ages and abilities without sacrificing the variety of challenging experiences and realities that a large multiuse facility will present. Access is balanced and controlled to ensure that it does not negatively affect the environmental restoration aspects of the Project.

- **Local materials:** Use indigenous materials and facilities to minimize maintenance challenges for the future and acquaint the public with the diverse materials and solutions that are both locally and regionally significant and available.

- **Create connections:** Promote the development of connections between different uses and facilities both within and beyond the Project. These connections will include the development and design of several maintenance vehicle bridges.

- **Historical interpretation:** Describe, interpret, and honor the history of the river, its people, and the city that grew on its banks in every aspect of the Project’s design and programming. Position the Project as a national, regional, cultural, and recreational resource for the USACE, the City of Phoenix, and the nation.
- **Respect the setting:** Enhance the river corridor so that it is compatible and consistent with its natural habitat.

- **Create discovery zones:** Create spaces and areas along the river corridor that serve as “discovery zones” and destinations that invite and educate the visiting public in a positive and enlightened manner.

- **Encourage frequent and year-round use:** Provide a cohesive mix of attractive, safe elements and spaces along the river that tell the story of the river cycle. This story includes the river’s relationship to the environment and the desert seasons and creates a compelling destination for visitors.

Exhibit 2. This outdoor classroom is adjacent to the water distribution reservoir at Central Avenue. This area will serve as a gathering place for visitors and will provide an opportunity for groups meet to discuss the Project. Salvaged concrete debris was used for the seating.
INFRASTRUCTURE DESIGN

The backbone of the Project is the water distribution and irrigation systems. Five nonpotable groundwater wells provide the approximately 4 million gallons per day peak irrigation demand. The wells deliver water to three open reservoirs located throughout the Project. Each reservoir is lined with a geotextile to minimize water loss. The reservoirs were also designed in accordance with City of Phoenix safety design guides for ornamental lakes as these reservoirs are located in public gathering areas for aesthetic value. The reservoirs serve as forebays to three vertical-turbine pump stations and also provide gravity flows to the Project wetlands and other areas where flood irrigation is used in the Project.

Exhibit 3. This is the completed reservoir at Central Avenue. ADA-accessible hardscape around the perimeter provides access to all visitors. The Project reservoirs comply with City safety standards for ornamental lakes.

The vertical turbine pump stations provide pressurized flows to the Project’s drip irrigation system. Drip irrigation was selected for this Project because the water can be applied in an efficient manner to the habitat to minimize water demand. The drip irrigation systems were designed to be used most heavily during the plant establishment period of approximately 2-years. After 2 years, the irrigation will be applied on a less frequent basis, providing flow essentially as needed to supplement natural rainfall and any water that the vegetation root system draws from the ground.
The gravity flow water delivery systems include open canals and waterfalls to convey the water down the river slopes to the riverbed, where the wetlands are located. The canals and waterfalls are lined to minimize water loss, river rock being used as lining for reasons of aesthetics. The waterfalls were formed from salvaged rock and concrete material that existed throughout the Project limits.

Exhibit 4. This waterfall is an integral part of the wetlands water delivery system. Salvaged rubble from the river was used to construct this functioning aesthetic feature.

The wells and pump stations are connected to several programmable logic controllers. The latter are to be networked via radio communication to a central supervisory control and data acquisition (SCADA) system that will be located at the future maintenance center, which will be within the Project limits. Several irrigation controllers are located along the Project to control the irrigation schedule.

CH2M HILL is currently evaluating the need to install treatment systems to treat the groundwater to meet Arizona Discharge Pollution Elimination System permit requirements. The treatment systems will be designed and installed in the future if water demand persists and water quality issues arise.

The Project includes an approximately 10-mile-long multiuse paved road network that serves a variety of purposes. The primary purpose of the asphalt-paved roadways is to provide a central
corridor for maintenance vehicles. The maintenance roadways also provide loop systems for pedestrians and bicyclists, along with accessible connections to educational features, overlooks, and outdoor classrooms. Access and movement potential for emergency vehicles also are accommodated by the maintenance roadway system.

The north and south roadway systems, which run along the river edge at the top of the slope, provide continuous connections from 15th Avenue in the west to 16th Street in the east by providing roads along the river edge that parallel the Salt River and cross beneath major arterial bridges via ramps that extend to the terrace level. The maintenance road system also provides vehicle and pedestrian connections at selected major arterial locations.

Three single-span steel bridges ranging in length from approximately 100 to 200 feet were required to provide continuous access over several significant stormwater outfall areas along the Project. Weathered steel material was selected to conform to the aesthetic theme while meeting the structural requirements of the Project.

**Exhibit 5.** This steel bridge is installed across one of the stormwater outfalls entering the Project. The bridge is designed to Arizona Department of Transportation and City standards for maintenance and emergency vehicle access. The steel will be allowed to “weather” for aesthetics. Gabion baskets were used for bank protection at the outfall exit.

Undercrossing ramps constructed at 7th Avenue, Central Avenue, 7th Street, and 16th Street provide continuous connection of the roadway system along the river edge without requiring
vehicles or pedestrians to make east-west crossings at any of the major arterial roads. The ramps drop from the top of the slope to the terrace level and are asphalt paved. At certain locations, gabion retaining walls were constructed to contain the fill slopes for these ramps. River hydraulic characteristics were modeled and evaluated at each of the undercrossings to ensure the 100-year flood conveyance capacity was maintained.

Twenty-two City of Phoenix stormwater outfalls discharge into the Project at various locations. Each of these locations includes a trash rack structure to screen debris. Operations and maintenance considerations in the design include access for trash removal by city staff. At several of these locations, the design team created ponds for flood irrigation of existing and new habitat planted in the vicinity of the outfalls.

Exhibit 6. Trash racks are installed at several of the 22 stormwater outfalls that enter the river along the Project. The trash rack screens debris and provides access for maintenance staff to collect it. The road across the trash rack design provides for access for maintenance staff and Project visitors. The stormwater is conveyed through the trash racks and conveyed via channels to vegetated areas for flood irrigation. This photo was taken during construction and the roads in the foreground, background, and across the trash rack had not been paved yet. Behind the trash rack are wetlands. In the background you can see piles of debris that are being used to construct a waterfall, one of the bridges, an overlook ramada, and some City of Phoenix skyline.
HABITAT/RECREATION DESIGN

The Project wetlands consist of six ponds in series along the south bank of the river just west of Central Avenue. The six wetland ponds each range in wetted surface area from approximately 0.5 to 2.5 acres.

The wetland pond liner uses fine-grained soil combined with other natural materials (clay) to create a low-permeability (approximately 10 centimeters per second) liner that will reduce the movement of water from the wetlands into the underlying soil. The liner was placed a minimum of 12 inches below the wetland bottom and extends approximately 1 foot beyond the perimeter of each wetland basin. This approach serves to retain water in the wetlands and provides a wetted perimeter with saturated soil conditions. The saturated soil conditions in the 10-foot area support the growth and maintenance of native riparian species such as cottonwood and willow. The liner is surrounded on top and bottom by a sand and gravel filter. The filter material prevents the migration of the fine-grained lining soil into the subgrade caused by the flow of water through the lining.

Exhibit 7. The wetlands consist of a series of six separate ponds designed to provide water velocities sufficient to minimize vector growth. The wetlands soil liner was designed to retain water (minimize water loss due to infiltration) around the perimeter of the wetlands for the surrounding vegetation.
Advantages of the selected material and approach for pond liners include the following:

- The system emulates natural conditions present within the Salt River corridor
- The liner significantly reduces infiltration rates into the soil below the wetlands
- Fine-grained soil allows for some infiltration through the liner, reducing the potential for salinity buildup within the wetlands
- The buried liner reduces the likelihood of scour damage during storm events
- Soil liner material will not create a downstream hazard (as a synthetic membrane or concrete material might) if displaced by scour during a storm event

The selected approach to the lining of the wetlands had its origin in field observations of existing conditions within the Project site. In several Project areas shallow buried lenses of fine-gained soil occur below the very porous surface soil. These lenses have created perched water tables. In these areas, infiltration rates are substantially reduced and stormwater from upstream or water from stormdrain outfall structures has resulted in pockets of dense riparian vegetation.

Upstream water Projects have curtailed year-round water flows and converted the Salt River into a dry riverbed devoid of habitat. The Project reestablishes a lost landscape (environmental restoration) of native habitats including marshy wetlands, mesquite groves, woody shrubs, cottonwood and willow trees, and grasslands that support native wildlife. The Project includes the following:

- 140 acres of mesquite bosque habitat
- 43 acres of cottonwood and willow habitat
- 65 acres of lower Sonoran habitat (paloverde and mesquite association)
- 80 acres of saltbush, quail hush, and burro brush
- 51 acres of aquatic strand
- 200 acres of open space
- 16 acres of wetland marsh

The plantings on the banks help to stabilize and reduce the potential for erosion during large storm events and prevent damage to the Project components that are on the slope to the river and at the terrace level.

The main entrance to the Project is at Central Avenue, where four gateways (two existing, two future) serve as Project landmarks. The gateways can be used for public gatherings, bird watching, and public events. A parking area, restroom is, a water supply reservoir, and other public gathering areas also are located at Central Avenue.
Exhibit 8. The gateway site on Central Avenue was built-up with gabion baskets using river rocks that were screened from the excavations. These rocks would have been unsuitable in the fill materials but worked well in the gabion walls.

Additional parking and gathering areas are provided at 7th Avenue, 7th Street, and 16th Street. The gathering areas were designed to be accessible to visitors of all ages and abilities. Viewing areas with seats and ramada shade structures are located throughout the Project along the multiuse road network along the river edge. Visitors are encouraged to explore the Project on foot, bicycle, or horseback. Equestrian parking areas are planned.

The Salt River has the capacity to convey a 100-year storm event. Flows into the river are controlled through dams upstream of Phoenix. Basic criteria for the Project were to maintain the 100-year river capacity. The Flood Control District of Maricopa County, the City of Phoenix, and the USACE constructed what is called a low-flow channel in the center of the riverbed throughout the Project area in the late 1990s. The purpose of the channel is to convey the majority of controlled releases of water from the dams to minimize damage to the Project features in the riverbed.

The USACE carried out hydraulic modeling of pre-Project and post-Project conditions to facilitate vegetation size and density selections. The maintenance road undercrossings were designed to minimize constriction of river channel cross sections at the bridges.
In keeping with the goal to recycle and reuse as much indigenous material as possible, some material recovered at the site was used for bank stabilization and for constructing such water conveyance features as the waterfall. Concrete rubble was used to create benches and tables. River rock was used to create gabions along the banks and pillars for ramadas.

There are 18 documented active and inactive landfills along the Project limits. The Project features were designed to minimize effects on the landfills. Plant pits for plantings in areas of known landfill gas were designed to minimize infiltration and provide a barrier to prevent gas migrating into the root system, which would harm the plants or stunt their growth. Additionally, “hydroteed” (a mixture of natural grass seeds and amendments) was used throughout the Project along the landfill and debris areas. To minimize the possibility of affecting existing landfill and debris areas, these areas are not irrigated and will rely on natural rainfall.

In essence, the Project constitutes a long narrow park that carves a new path through the city to immerse visitors in a desert river habitat consisting of streams, ponds, wetlands, mesquite groves, stands of cottonwood and willow trees, and desert grasslands and shrubs. The park is now home to a wide variety of native species of wildlife and birds and also provides trails for hiking, biking, jogging, and horseback riding as well as areas for picnicking. Additionally, the park will soon establish an educational center to provide visitors with information about the Sonoran Desert, its wildlife, and its vegetation. The design makes unique use of such recycled materials as concrete rubble, rock, and other debris found at the Project site and incorporated into the design as site furnishings and construction materials.

CONSTRUCTION

The first construction contract was awarded in the summer of 2002 for initial debris removal. During that initial contract materials were identified for reuse throughout the Project. Site cleanup resulted in the removal of 1,200 tons of abandoned tires, 1,900 tons of scrap metal, and 5,000 tons of abandoned construction debris. Construction for the remainder of the Project was completed in phases through 2005.

The bulk of the Project is complete. Its grand opening was celebrated on Saturday, November 2, 2005, and was followed by a nature festival. City fathers view the Project as more than a successful environmental restoration Project. They also see it as a catalyst for neighborhood renewal. Not only has the Project successfully rejuvenated this once blighted area; it has also inspired the Rio Salado Beyond the Banks of the Phoenix Rio Salado Environmental Restoration Project, a comprehensive planning effort underway for the area situated beyond the banks of the restoration Project. The purpose of the plan is to protect the investment in the Rio Salado Environmental Restoration Project and maximize the long-term benefits for the community while increasing the potential value of the properties adjacent to the river.
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