River of Service

United States Department
of the Interior

Bureau of Reclamation
Lower Colorado Region

Contents

A River of Service

Since ancient American cultures relied upon its waters for their basic food and water, the Colorado has been a river of service. In today's complex society it provides a multitude of services for the desert Southwest. Without its waters life in the region could not exist in its present form. The Colorado River has well earned its nickname, "Lifeline of the West."

The Bureau of Reclamation, through its multipurpose projects, provides safe, dependable water supplies from the Colorado River to the arid Western states for agricultural, municipal, and industrial use. Water distribution systems, dams, and powerplants built by Reclamation's engineers have also benefited public recreation, fish and wildlife habitat and contributed to regional and national economies.

With the challenge of developing stable water supplies for the West now met, the Bureau of Reclamation moves forward to plan the future with greater emphasis toward protecting the environment and precious resources of this multiserving western river.

The following is a summary of recent accomplishments which the Lower Colorado Region of the Bureau of Reclamation has experienced in working with this river of service.

1991

Building

Visitor Center

An interpretive journey

Regardless of their preconceptions, visitors to Hoover Dam are rarely prepared to grasp the immense proportions of this magnificent structure.

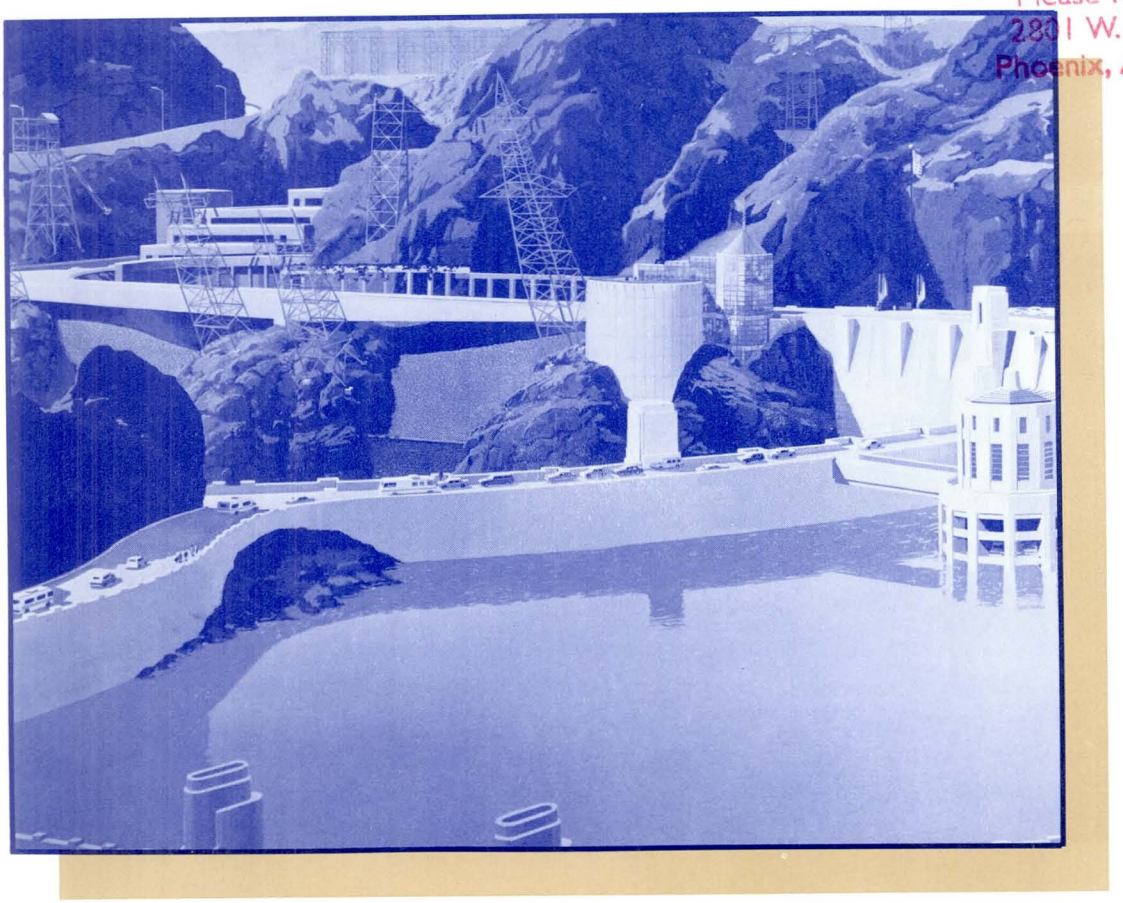
A new visitor center is underway which will lead the visitor into an interpretive journey of the history and significance of Hoover Dam and Reclamation's role in the water management of the Colorado River.

For a number of years, it has been apparent that the visitor parking facilities were inadequate. With the great increase of traffic, it became evident that, for the sake of safety, pedestrian traffic on the dam must be curtailed. A solution to this problem is included in the new visitor center.

Visitors will emerge into the center's promenade through an underground walkway from a five story parking structure reflecting the natural cascading cliffs of the site. The structure will accommodate 420 vehicles including bus and motor home spaces. A gift shop and snacketeria will also be located in this structure.

From the promenade visitors will get their first sweeping glimpse and feel the spirit of Hoover Dam, curved gracefully into its rocky cradle.

Further exploring the new center, they will find an electronic computer-aided video system to provide details of the programs within the center. Passing through a waterfall wall flowing around the reception area entry door, visitors will find a lobby surrounding a revolving theater. The theater has three sections with 200 seats per section. A



Artist's concept of the new visitor center.

12-minute presentation will be made in each. The theater will turn for each of the three presentations on a rotating turntable while the visitors remain seated. Unfolding over a 36 minute period is the history of water in the Southwest and construction and operation of the dam.

Emerging from the theater, visitors may elect to take the tour of the dam by entering one of two 50 passenger elevators that descend 506 feet into the rock, deep into the dam. Here, they will receive an introduction to the interior powerhouse and the inner workings of Hoover Dam guided by either audio wands or a guide. Video monitors will be located at points along the tour routes giving views of turbine blades, control room, and penstock connections. These areas have previously been out of view to the public.

An exhibition gallery in the new visitor center will offer the visitor exhibits which will explain the surrounding area, the construction and importance of the Boulder Canyon Project, and its impact on the Southwest.

The new visitor center is expected to draw 1,000,000 or more visitors each year.

The Central Arizona Project

A multipurpose water project

The first non-Indian irrigation use of the Colorado River water in Arizona was in Yuma County before the 20th Century began. Irrigation was an on-again, off-again enterprise in those early days. Before there were any dams on the river to store the flows, annual flows of the Colorado River were unpredictable, ranging from violent floods to extreme droughts.

At the turn of this century, the Federal Government began investing millions of dollars in the construction of dams to control the Colorado River's flow and to store water.

By 1935 Hoover Dam was completed on the Colorado River to store water and generate hydro-electric power for use in Arizona, California, and Nevada. Arizona was allocated 2.8 million acre-feet annually but no one had yet figured out how to deliver the water to the central part of the State where it was needed. Allocated water is no good to anybody unless it can be delivered.

In the 1940's a lengthy drought brought an acute water shortage to central Arizona. Crop failures and subsequent disaster were avoided only by pumping heavily from underground storage. Thousands of acres of irrigated land would, of necessity, revert to desert wasteland if irrigation were limited to lands that could be adequately supplied from the existing supply. It was evident that, to stabilize the irrigated agriculture of the area, it would be necessary to supply irrigation water from some new source. Many different plans were debated as to how water could be transported to this arid desert.

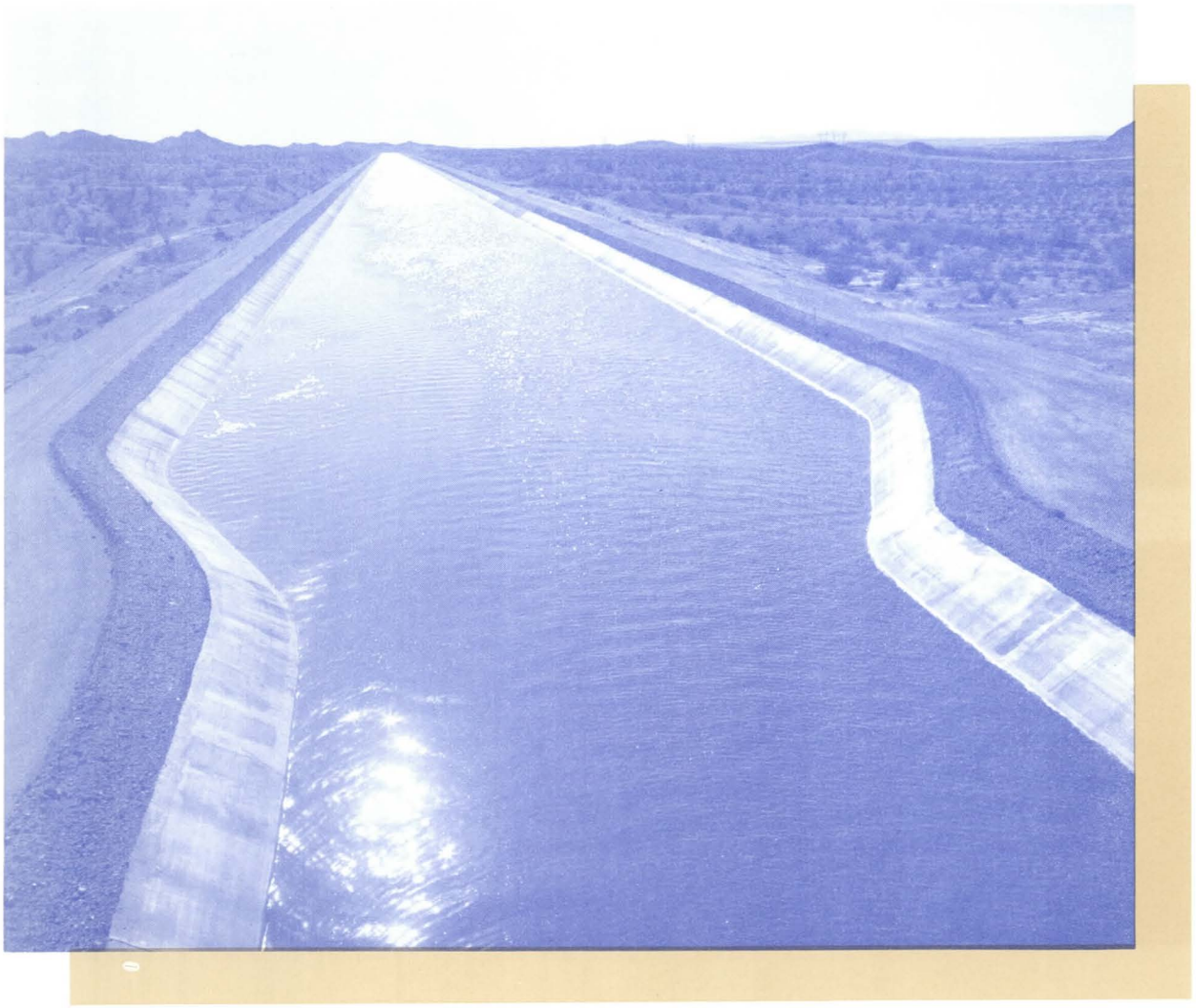
By the early 1960's the economy of central Arizona was dependent on full utilization of the local surface-water supplies and excessive pumping of the area's ground-water resources which were quickly declining.

After much political and judicial activity, the Central Arizona Project(CAP) was authorized in 1968. This multipurpose water project would deliver Colorado River water from Arizona's western border through Phoenix, all the way to the Tucson area. This would supply a sufficient quantity to substantially reduce groundwater overdraft.

Designed and constructed by the Bureau of Reclamation, the CAP consists primarily of a 336-mile long main aqueduct system, several hundred miles of smaller distribution canals, one new storage dam, and substantial modifications to one existing storage dam.

After years of planning which began in 1973, the first delivery of water was made to Tucson in the fall of 1991 signifying the operation of the main backbone of the CAP.

When construction is completed the CAP will convey water from Lake Havasu, on the Colorado River, through 190 miles of aqueduct to Phoenix. From Phoenix it will continue to Tucson before terminating at the southern boundary of San Xavier Indian Reservation. This water network will help meet the municipal, industrial, and agricultural water needs of the burgeoning communities of the Southwest as it delivers the Colorado River lifeblood.



The CAP delivers water from Arizona's western border, through Phoenix, to the Tucson Area.

New Waddell Dam

The New Waddell Dam, a major feature of the Central Arizona Project(CAP) Regulatory Storage Division replaces the existing Waddell Dam at Lake Pleasant on the Agua Fria River, about 35 miles northwest of Phoenix. The dam provides water storage, flood control, electricity, and recreation.

With New Waddell Dam, the CAP can deliver more water into Arizona when it is available and store that water for later use.

The canal between the Colorado River and New Waddell Dam may occasionally be out of service for maintenance. During these periods, water could be delivered from Lake Pleasant to Phoenix and Tucson, the highest demand areas for water.

The dam adds 7,000 surface acres to Lake Pleasant, increasing the recreational value of Lake Pleasant Regional Park. Planned facilities include three multilane boat launch ramps, 450 picnic sites, 225 campsites, 14 group use areas, four overlooks, a full-service marina, and seven miles of trail.

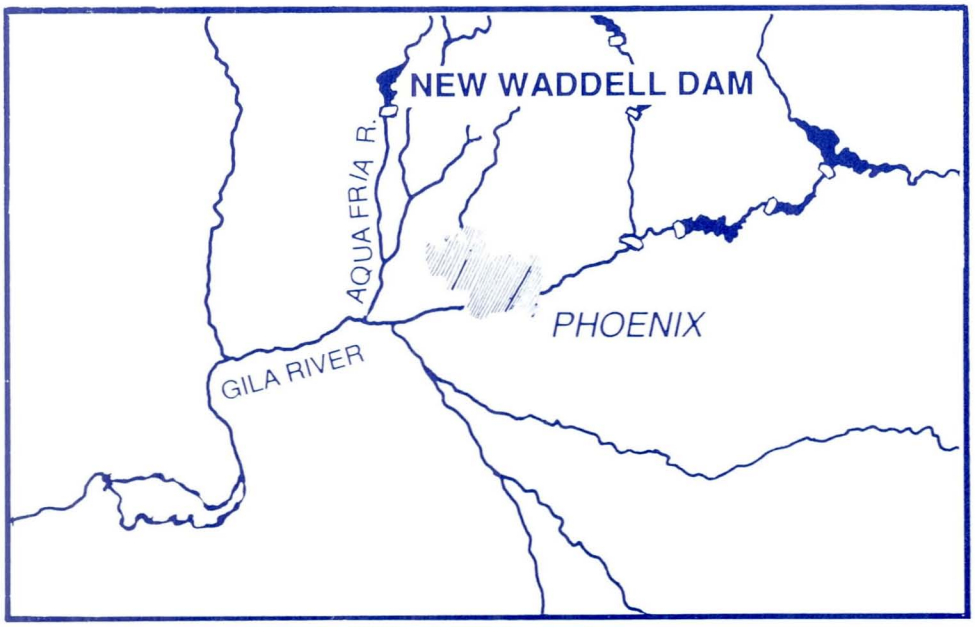
Protecting the natural environment around Lake Pleasant from potential negative effects of New Waddell Dam construction and operation is a high Reclamation priority. Reclamation has:

o constructed several wildlife water catchments on the lake to help reduce animal/vehicle collisions and improve wildlife distribution,

o funded a study to determine what effect the reservoir's operation will have on existing fishery and bald eagles that use the lake, and

o committed to leave as much vegetation in the reservoir as possible for fish habitat.

Artist's concept of the New Waddell Dam



CAP recreation development

Reclamation is acutely aware of the growing demand for recreation opportunities on public lands and waters. It is committed to developing recreation opportunities on the resources under its administration and to offer quality recreation experiences to the public. Because it is a multiple-purpose water resource development project, the CAP includes recreation as a project purpose.

The CAP provides two types of resources for recreation reservoirs and the aqueduct system. The reservoirs, Roosevelt Lake and Lake Pleasant, provide traditional, water-based recreation. The aqueduct system, however, provides Reclamation opportunities for some new types of recreation development. The aqueducts cross Arizona from the Colorado River, through Phoenix to Tucson. This is an outstanding opportunity for a 335-mile long trail within the State.

Agencies of the State of Arizona are working with Reclamation to study the possible development of the CAP Trail for nonmotorized use such as hiking, bicycling, and horseback riding. Limited access to the aqueducts for fishing may also be developed if operation, safety, and liability concerns can be resolved.

Portions of the CAP aqueducts have to be protected from the floodflows that are common with the intense rainstorms experienced in central Arizona. Some of those flood protection works include dikes and retention basins. A few of the retention basins have enough land so that recreational development is possible. Reclamation has entered into agreements with the cities of Phoenix and Scottsdale for the recreational use of 2,300 acres of flood detention basin lands. Two 18-hole public golf courses, a world-class equestrian exhibition center, and a multiple-purpose city park have been constructed. Near Tucson, Reclamation is working with Pima County on the development of two areas for a shooting range and a sport field complex.

Theodore Roosevelt Lake

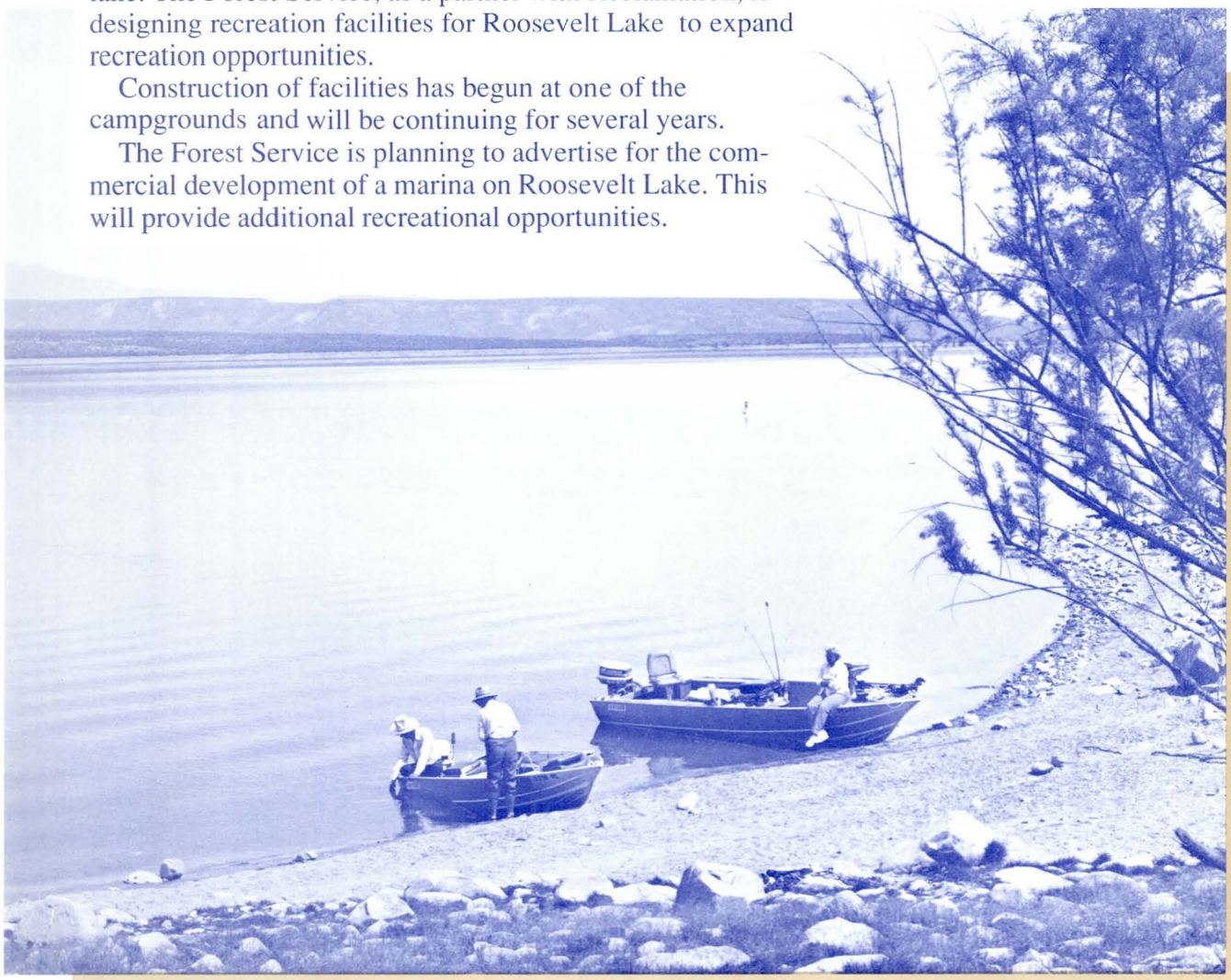
If you think the desert is a barren, desolate place, you've never been to Theodore Roosevelt Lake. As part of the CAP, Reclamation will spend about $41.4 million to improve recreation opportunities at this lake. Although some of that money will replace facilities affected by the changes

in reservoir operations, almost 90 percent will be used to construct new facilities. Ten recreation sites will be developed and include five campgrounds, nine boat launching areas, two picnic areas, and a river access area. There will be 1,195 campsites with 125 being boat-in-only sites. A new visitor center and several information stations will be constructed to inform people about the many recreation opportunities around the lake.

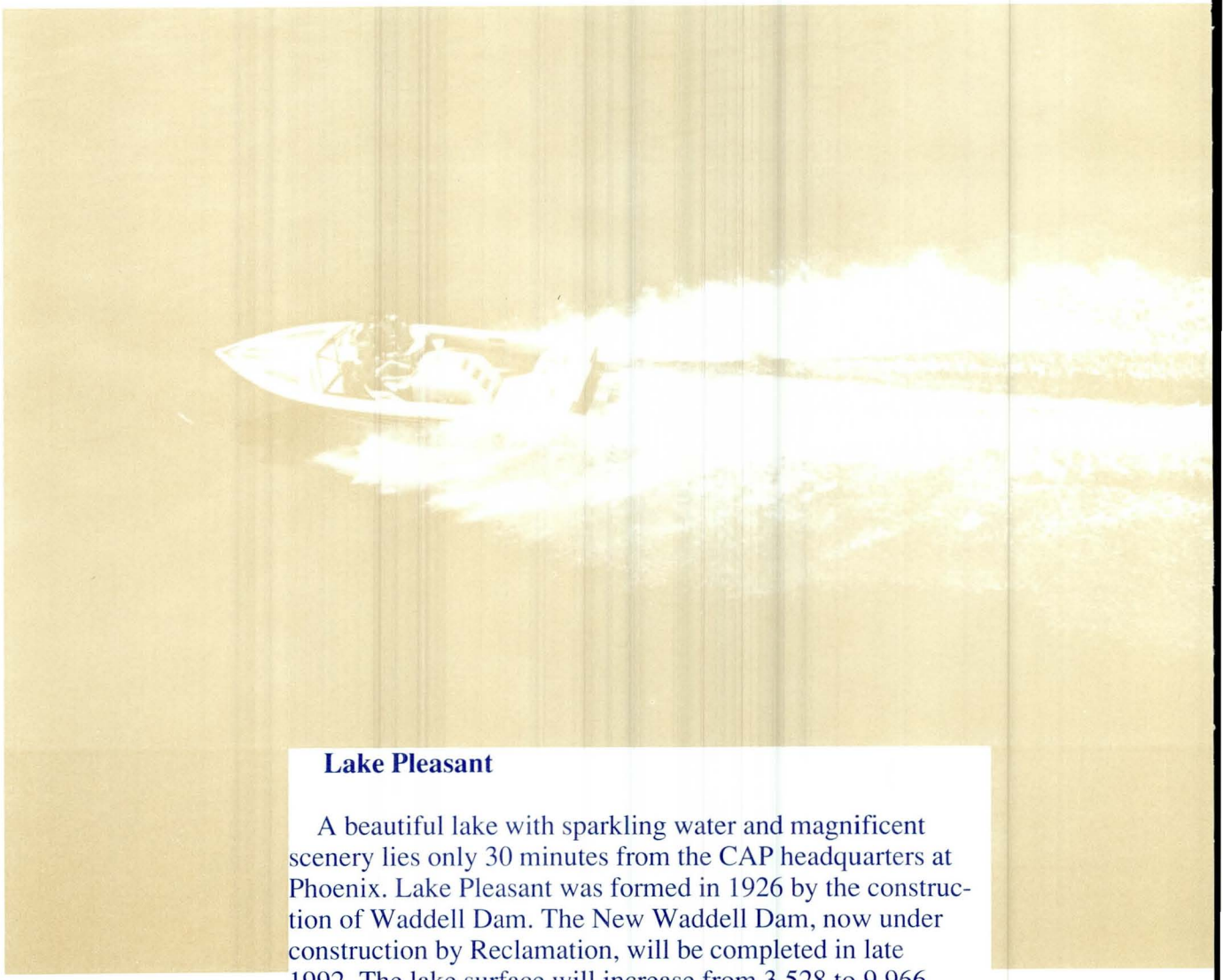
Roosevelt Lake lies within the Tonto National Forest and the Forest Service administers recreation on and around the lake. The Forest Service, as a partner with Reclamation, is designing recreation facilities for Roosevelt Lake to expand recreation opportunities.

Construction of facilities has begun at one of the campgrounds and will be continuing for several years.

The Forest Service is planning to advertise for the commercial development of a marina on Roosevelt Lake. This will provide additional recreational opportunities.



Reclamation is spending about $41.4 million to improve recreation opportunities at Theodore Roosevelt Lake.

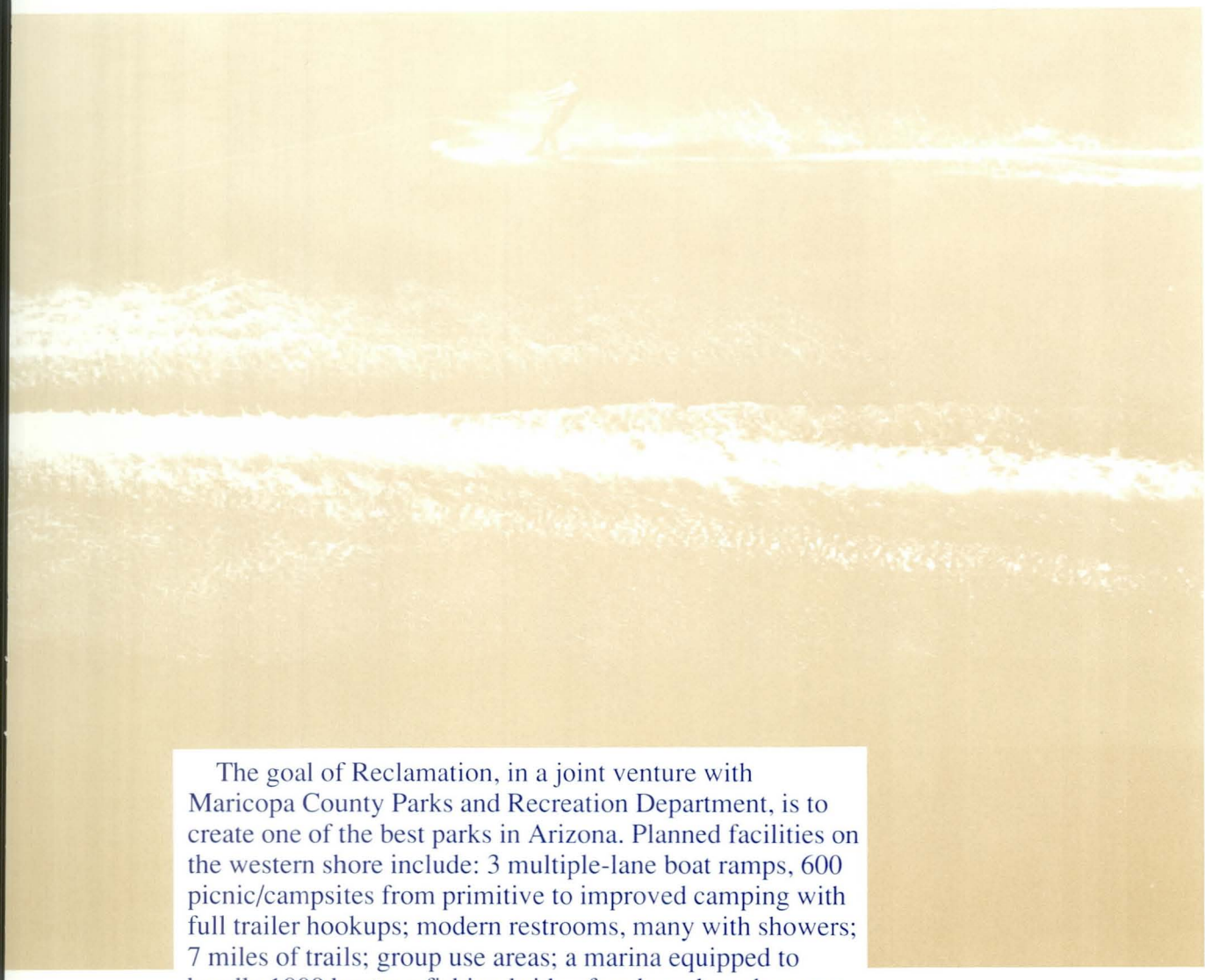


Lake Pleasant

A beautiful lake with sparkling water and magnificent scenery lies only 30 minutes from the CAP headquarters at Phoenix. Lake Pleasant was formed in 1926 by the construction of Waddell Dam. The New Waddell Dam, now under construction by Reclamation, will be completed in late 1992. The lake surface will increase from 3,528 to 9,966 acres. All existing facilities will be replaced since they will be under water with the increase in the lake surface. What this means is a brand new park.

The park is being developed in several stages. A new entry station opened in October of 1990. It has three hi-tech toll booths which set the tone for the entire park.

The next facility to open was the Overlook. A beautiful panoramic view of the lake can be seen from this spot, along with a view of the dam. Exhibits have been placed in the facility including a video, "Century of Vision," which explains construction of the dam; a video on Reclamation, "Water is Life;" a laser display about the water delivery to Tucson; a large table map of the park area, and other displays. This facility is both entertaining and educational.



The goal of Reclamation, in a joint venture with Maricopa County Parks and Recreation Department, is to create one of the best parks in Arizona. Planned facilities on the western shore include: 3 multiple-lane boat ramps, 600 picnic/campsites from primitive to improved camping with full trailer hookups; modern restrooms, many with showers; 7 miles of trails; group use areas; a marina equipped to handle 1000 boats; a fishing bridge for shore-based access; concession facilities; and a ranger station. These facilities are in the planning and design stages. Construction will begin in 1992.

A new outdoor education center will be the only public facility on the eastern shore of the lake. There will be six buildings which will sleep 24 persons each, an auditorium with capacity to seat 300 people, two large classrooms, a nature lab displaying desert creatures, cafeteria, playground, and camp fire arena. This will be a showcase of the West and has already created interest from all over the county. The facility, designed for sixth grade students to study the desert habitat, will also be made available for the public.

Developing

Giant turbine generator units at Hoover Dam powerplant are being uprated to provide increased electrical power for Arizona, California, and Nevada users.

Uprating Hoover Dam

More energy for today's needs

They sit like giant gray and maroon, spaceships, seven stories high, waiting for the Captain of the Starship to send them on their mission. Inside Hoover Dam, 17 turbine-generator units of the Hoover Powerplant are humming away at their mission: providing pollution-free, renewable electrical energy--energy that turns the wheels of industry, pumps well water for farmlands, switches the darkness from homes in Los Angeles and lights the glitter that is uniquely Las Vegas. They are being pushed to their limit as today's modern pioneers continue to migrate West, causing population explosions and seemingly insatiable power requirements.

Most of Reclamation's turbine-generator units are designed to provide rated (or nameplate) output at minimum-planned reservoir levels. Since water in most reservoirs is rarely drawn down to minimum, the turbine is usually capable of more mechanical output than the generator can convert to electrical energy.

Uprating existing units is a most effective and efficient means of contributing to our nation's increasing power requirements. Modern insulation technology has made it possible to manufacture windings of increased electrical capacity which are the same physical size as earlier manufactured windings. Reclamation makes a practice of analyzing turbine generator units and uprating original (nameplate) capacity wherever practical and economically justified by installing new, modern stator windings and upgrading various auxiliary equipment.

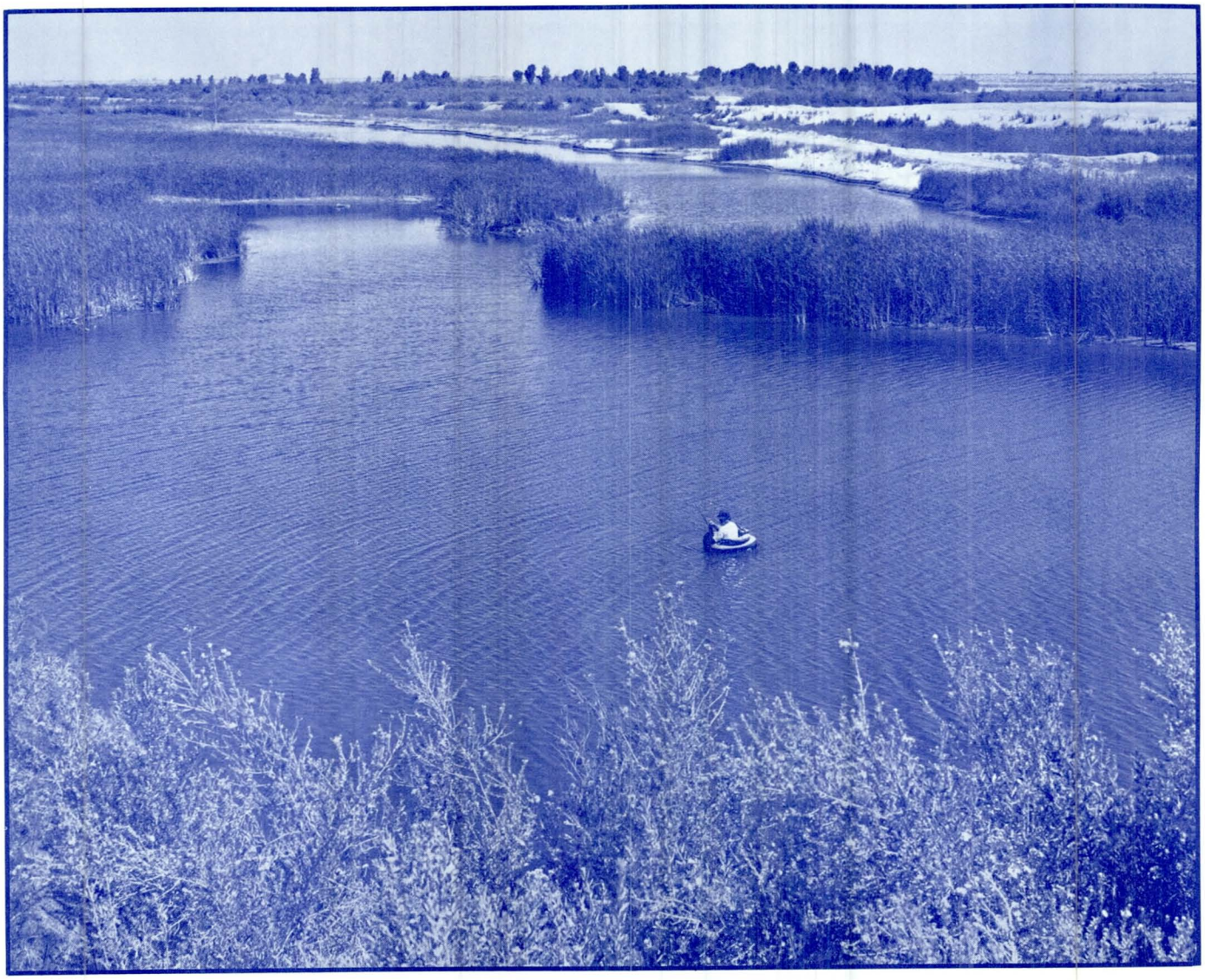
A recent analysis of the Hoover Dam Powerplant showed that uprating the units was technically feasible and would cost less than half as much as installing a combustion turbine giving the same power capacity. An uprating program was included as part of the routine equipment replacement program. The resulting total plant capacity will be increased from the nameplate rating of 1,340,000 kilowatts (kW) to an estimated 2,039,000 kW.

The resultant uprating will provide increased electrical power to Arizona, California, and Nevada users. Contributions from the beneficiaries have enabled this project to be done without Federal funds.

River Mile 33 Backwater Restoration

From wasteland to wetland

Schools of bass and bluegills swim in cool, clear, deep water past a large flock of white pelicans. Nearby, soft-shelled turtles nest in a sand bar. Concealed by cottonwood trees, a bird watcher spies on killdeer chicks in their nest. River Mile 33 is a splashing success.



Less than a year ago River Mile 33, just a few miles north of Yuma, was an ignored stagnant backwater along the Colorado River.

Today it is a flourishing fish and wildlife enhancement area supporting numerous species of fish and fowl. They are already starting their families and the whole place is splashing and flapping with life.

As a result of flooding in 1983 and '84, the Colorado River changed its course, passing through the Mile 33 backwater.

To return the river to its original course, Reclamation erected a dike which closed off the upper end of the backwater. Surrendering to a lack of flowing, fresh water, the shallow backwater became smothered with algae, salt cedar, arrow weed, and cane. Paralyzed by lack of oxygen, it became unproductive and even snubbed by wildlife.

Mile 33 was not a happy place.

The restoration project began in August 1990 with the installation of a culvert allowing fresh water to flow through the backwater.

Reclamation crews dredged to created a 120-foot-wide channel, one-quarter-mile long, 10-15 feet deep, and a secondary channel with several marsh areas and inlets.

Earth was moved along the banks, creating low-lying wetlands. A variety of trees were planted to accommodate certain types of birds and trees were dropped into the channel to provide nesting places for fish.

The project was closely coordinated with the Arizona Game and Fish Department, the California Department of Fish and Game, the Department of the Interior's Fish and Wildlife Service, and the Quechan Indian Tribe Department of Fish and Game.

Now a happy place, Mile 33 will soon be complete with the planting of additional vegetation. Among the many birds already calling it home are pelicans, cormorants, egrets, black-neck stilts, killdeer, herons, and osprey.

Reclamation begins a new decade with an expanded purpose involving resource development and management. In meeting the national goals set out in President Bush's policy of "no net loss" of wetlands, River Mile 33 may well serve as a model for similar projects in the future.

As a result of Reclamation's efforts, River Mile 33 has changed from a stagnant backwater to a flourishing fish and wildlife enhancement area.

Artificial Reefs

Fish thrive in old tires

They're called - with a smile - "fish condos."

Technically, they are artificial reefs - created by man and placed in bodies of water for fish to hide, eat, spawn, and otherwise survive and thrive. In this case, the fish condos provide a refuge in the rapid flow of life in a canal.

The technology has been around for quite some time, but these river reefs are unique: they're made of salvaged tires - 4,500 tires to be exact.

Years ago Reclamation constructed a series of canals throughout the Southwest to transport water to otherwise arid regions. With such waterways the desert bloomed, farms flourished, and cities grew.

Recently, Reclamation began lining sections of these earthen canals to conserve water that was seeping away. But canal lining increases water velocity and eliminates protective cover for the fish who have made their home in the earthen canals. The only fish who survive are those that evolve and prosper in strong, relentless currents.

In 1989 Reclamation embarked upon a 3-year study to learn whether artificial reefs could improve the canals' fisheries.

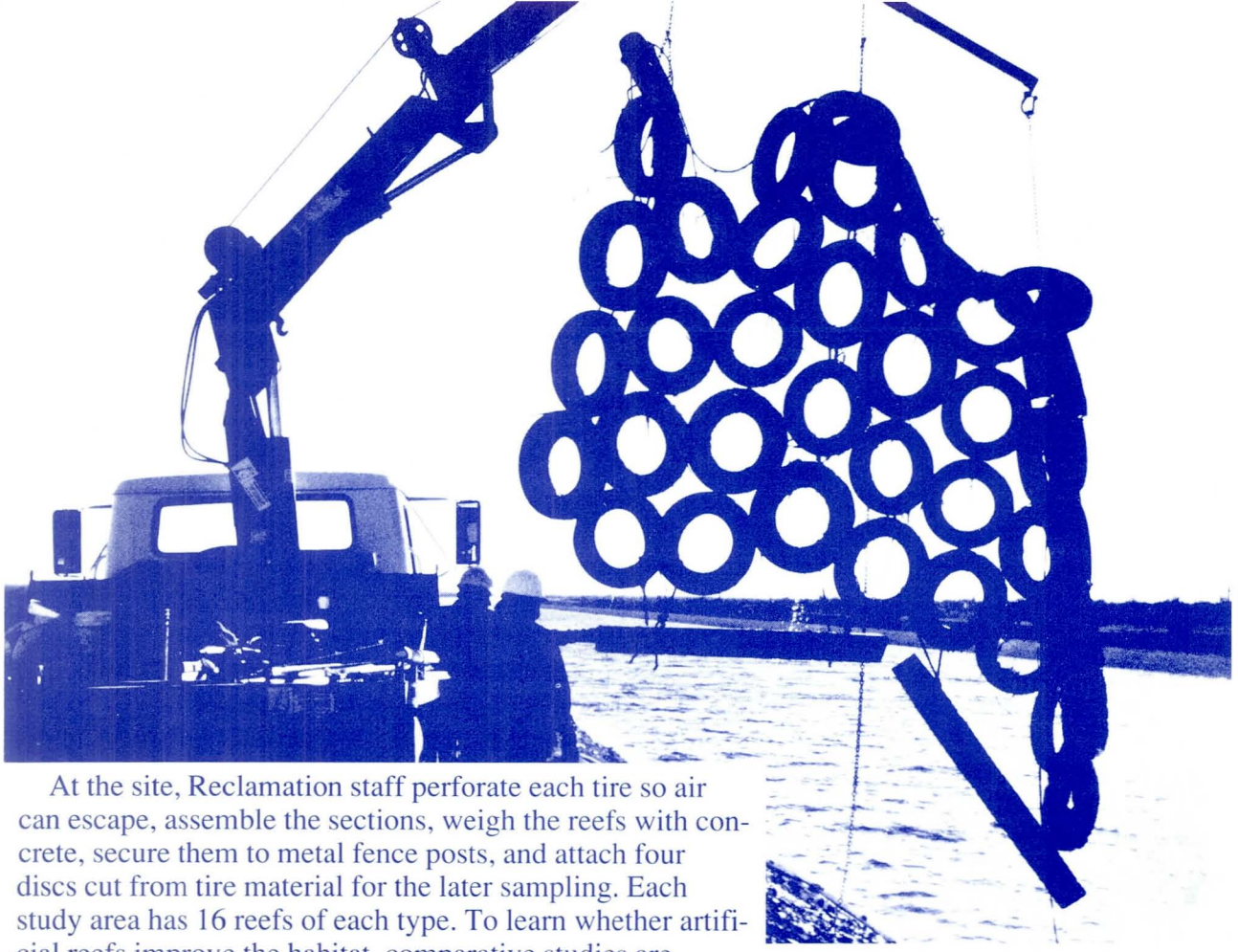
And they used tires.

Tires have never before been used in a flowing canal system. They have been used in lakes, reservoirs, and even the ocean. The commercial fishing industry and recreational anglers have used tires to attract fish, but not in a flowing system.

Why tires? They are readily available, do not degrade, and don't cost much.

Two types of reefs were fabricated: flat reefs resembling big door mats, and cellular reefs, vertically bound and four times the depth of flat reefs. Each reef contains 45 tires. After assembly in Boulder City, Nevada, the reefs are transported to study sites in Arizona and California.

There are three 1.5-mile research areas; two are now under way: Coachella Canal (east of Brawley, California) and Hayden-Rhodes Aqueduct (near Parker, Arizona). A newly lined stretch of the Coachella Canal (northwest of Niland, California) also will be studied.



Artificial reefs created from old tires provide a refuge for fish in the rapid flow of life in a canal.

At the site, Reclamation staff perforate each tire so air can escape, assemble the sections, weigh the reefs with concrete, secure them to metal fence posts, and attach four discs cut from tire material for the later sampling. Each study area has 16 reefs of each type. To learn whether artificial reefs improve the habitat, comparative studies are made at "status quo areas," or control stations.

The sampling, done every 3 months, is designed to address both biological and water conveyance issues. The reef is surrounded with a large net so it can be removed with a boom truck. The net captures fish in their new homes to be measured, weighed and returned to the canal.

Biologists also examine the reef's effect on water velocity, sediment deposits, and aquatic plant stimulation. Tire discs also are examined to gain information about the macroinvertebrates that colonize on the reefs. These organisms provide food for the fish.

The news is good. With each sampling, larger numbers of fish are found.

In a flowing conveyance system, largemouth bass and other sunfish are unable to maintain themselves in the current. It would be similar to a fast-moving treadmill. With the reefs, habitats are created where the fish can rest.

A high percentage of the fish use the reefs. Largemouth bass, bluegill and flathead catfish, usually virtually absent from lined canals, make up 50 percent of the fish found in the reefs.

There appears to be no appreciable impact on operation of the canals. And these reefs seem to have the same drawing card as any good condo: no potential maintenance problems.

Pioneering

Satellite Imagery

Accounting system in the sky

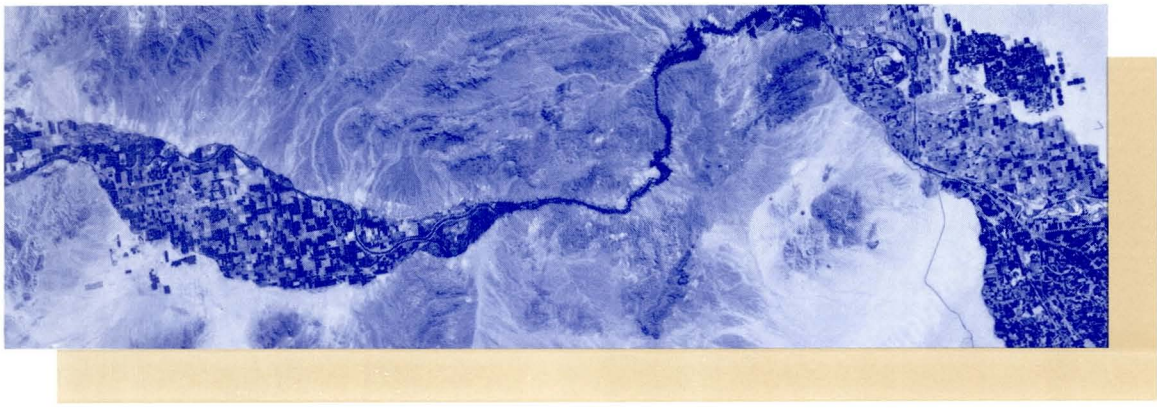
Stargazing has held a fascination for people since prehistoric times. Since 1957, when Sputnik's passing in the night sky brought out the whole neighborhood, many more of these steadily moving starlike lights have filled our skies. Two of these orbiting satellites are collecting data for the Bureau of Reclamation.

Reclamation is applying remote sensing and digital image processing technology to the management of the lower Colorado River. The technology is being used to develop an accounting system for consumptive use of water and will help Reclamation meet its legal responsibility to account for the use and distribution of Colorado River water.

Water use by vegetation is estimated by using a water budget. Consumption of water by vegetation is assigned to agricultural users using evapotranspiration estimates developed from vegetation types and areas derived from the analysis of digital imagery acquired by satellites. A standard water use formula is applied to calculate the quantity of water used by each vegetation type.

The digital images, or scenes, used to identify and map agricultural resources throughout the study area are acquired by orbiting satellites. The National Aeronautics and Space Administration (NASA) launched the satellites in 1982 and 1984. Each satellite orbits the earth every 99 minutes. The orbits are staggered and provide coverage of the study area every 8 days. Sensors onboard these satellites can simultaneously scan several wavelengths, or bands, of the electromagnetic spectrum and record reflected or emitted electromagnetic energy radiating from earth surface features. This data is then transmitted to a ground receiving station for processing.

Digital image processing involves the manipulation, analysis, and interpretation of digital images using computers.



Digital images, acquired by orbiting satellites, are used to identify and map agricultural resources in study areas.

Remote sensing is the acquisition of digital images, relating to earth surface features, by satellites designed and operated to monitor such features.

Remote sensing of agricultural resources is based on the premise that all earth surface features reflect, emit, or absorb electromagnetic radiation. Green healthy vegetation is highly reflective in the near infrared wavelength and highly absorptive in the visible wavelength. Each crop or vegetation cover tends to have a characteristic structure, or size and shape, which allows discrimination as to specific type. These phenomena have led to the development of image processing techniques which enable us to distinguish vegetation from other land cover types.

A multispectral/multitemporal approach to digital image processing is being used to identify vegetation in the study areas which are extremely diverse in the types of crops grown, cropping patterns, and crop rotation. For these reasons, image acquisition is performed on four separate occasions during the year.

Ground truth, or reference data, of representative sites within the study area are also collected to coincide with the acquisition of the imagery. Direct observation of these sites provides "known information" about the areas being remotely sensed by the satellites.

Crop maps are compiled depicting the specific crop in each field of a selected "ground truth" site. The data are considered time-critical because the characteristics of the sites change appreciably with time. The data is used in the analysis and interpretation of remotely sensed images and for the verification of information extracted from these images.

The old saying, "The sky is the limit," does not apply to usage of Colorado River water. The next time you see a satellite passing through the stars, it just may be Reclamation's accounting system in the sky helping to conserve the Colorado's water.

Enhanced Lower Colorado River Telemetry

From months to minutes

Even before there was a Salton Sea, the lower Colorado River was being monitored to determine its flow rate. Back then, the method used was manually operated current meters.

Water from the Colorado River is not an endless supply, and users are limited by contract in the amount they can use. Reclamation managers need to project when water users will reach their allocations in order to give them time to take remedial action.

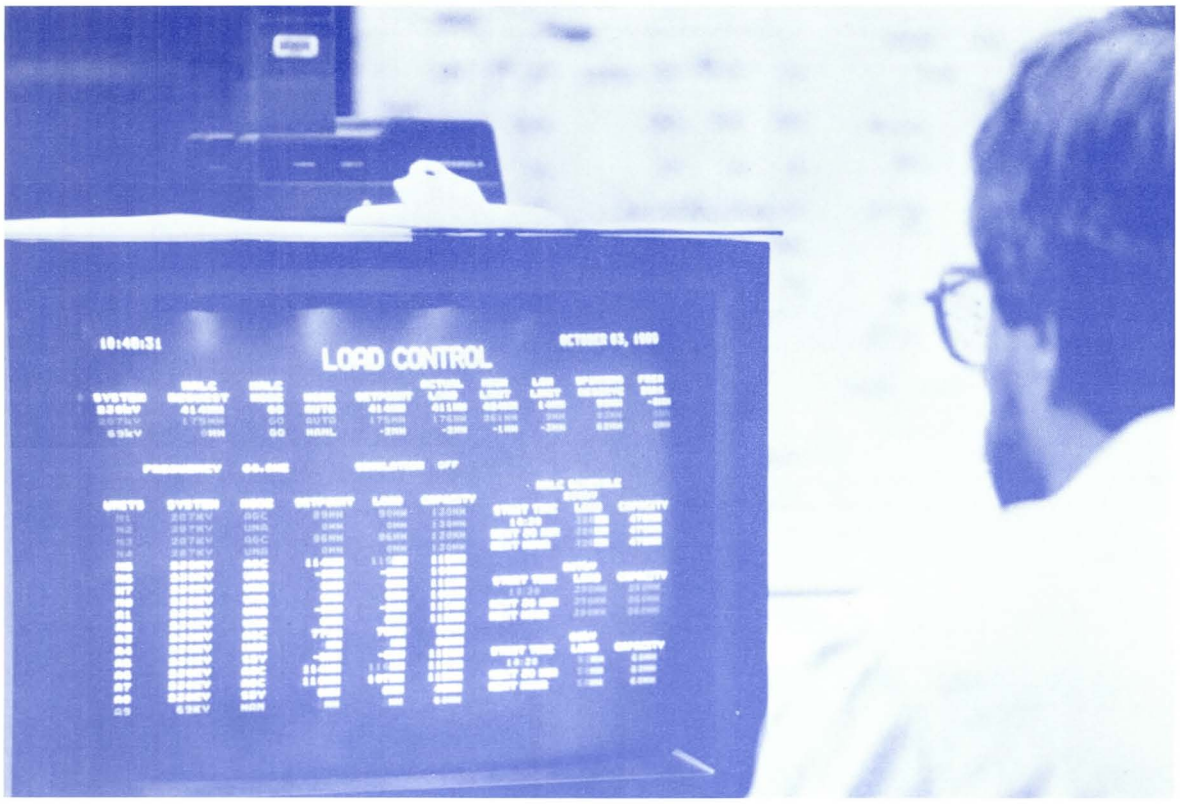
In the late 1950's Reclamation began using recorders that transmitted data via radio frequency. This system used four mountaintop repeaters to obtain the data at the regional office in Boulder City and at Imperial Dam. There were four initial sites for this method. In 1973 Reclamation expanded the monitoring system and installed a system that transmitted data from 10 locations.

Today the river is being monitored by Reclamation and the U.S. Geological Survey (USGS) with a combination of the old classical method and a new generation of electronic telemetry. Information on the diversions and returns of water from the river are being obtained from the USGS.

Reclamation uses a system that hourly polls 17 river sites and stores the information in a database. The flow from Hoover, Davis, and Parker Dams is calculated by acoustic velocity meters (AVM) that print data onsite and enter it into the database.

The current system also includes several upstream satellite sites and two links with Corps of Engineer dams. This data is being sent to a National Oceanic and Atmospheric Administration (NOAA) satellite and is then downloaded to Reclamation's Satellite Data Collection Platform in Boise, Idaho about three times a day. It is then electronically transferred to the database at Hoover Dam.

Even with all this new technology, there is a delay of several months after occurrence before the data is complete, thus delaying the time frame for remedial action by the users by up to several months.



Enhanced telemetry uses a system that hourly polls 17 river sites and stores the information in a database.

To cut the time between data gathering and notifying water users, Reclamation will soon be using an Enhanced Telemetry System (ETS) for monitoring Colorado River water usage. All major water diversion points and surface return flow points will be monitored with radio equipped Remote Telemetry Units (RTUs) which will be polled every 15 minutes and entered into a database. This method will give Reclamation and the water users about 80 monitored sites with near "real time" data on which to base their decisions.

The 80 sites will report not only flows and elevations but, at most sites, an electric conductivity (EC) measurement will be included to help track and define sources of salt loads that return to the river. In the past this had to be done manually at a laboratory.

The new system will electronically identify sources of unwanted elements going into the river. By identifying the sites which need to be sampled, the former manual hunt and physical search system of taking random sampling will be eliminated.

The new EC system will facilitate faster decisionmaking by Reclamation managers, resulting in better service to the water users by giving them up-to-the-minute information rather than data which is months old.

Canal Lining

Conserving the Colorado's water

A narrow ribbon of blue travels through the sun baked Southern California desert, bringing the Colorado River's lifeblood to the nation's winter salad bowl. As the water flows, the thirsty, sandy, desert soil drinks 130,000 acre feet annually of the precious water needed to grow crops that feed our nation.

When the All-American Canal and the Coachella Canal were constructed in the 1930's and 40's, the water loss to seepage was anticipated, but back then water was abundant and cheap. Today, with increasing demands and finite supply, the enormous value of the precious water lost conveys an ultimatum: Line the canals to conserve this nonrenewable resource.

The canals furnish Colorado River water to the Imperial and Coachella Valleys, providing this huge agricultural area with a year-round growing season that produces much of the nation's winter fruits and vegetables.

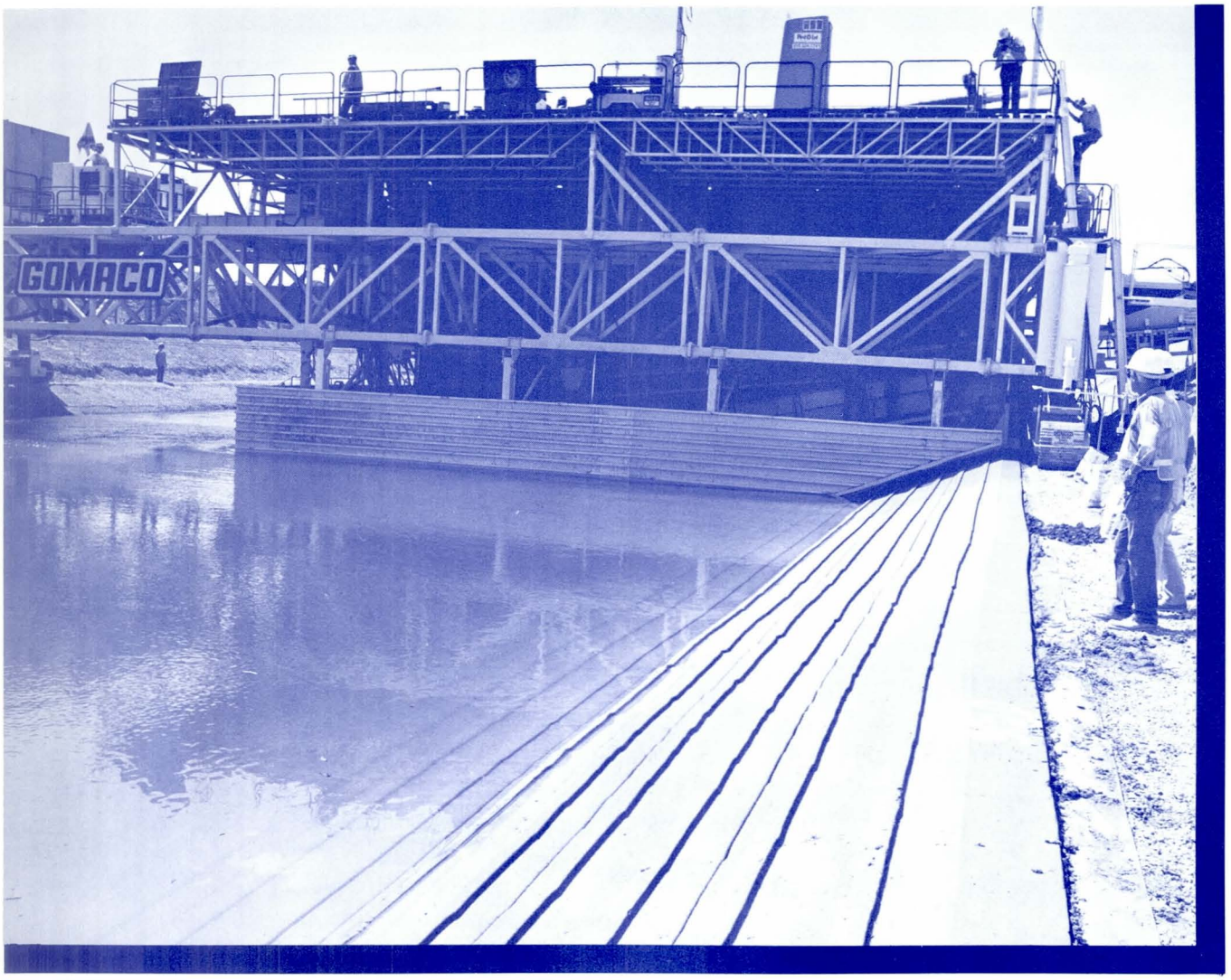
Since the canals operate year-round, interruptions of the water supply can impact crops and the local economy.

Building new canals is the standard solution to the problem, but it is expensive. For years Reclamation sought a reliable method of lining a canal while avoiding service interruption.

New method is born

Over the years, lining experiments were done with bentonite clay, chemical soil sealants, asphalt, and waterproof membranes such as polyvinylchloride (PVC). The membrane approach was promising because of its water tightness, but it needed protection. Soil and gravel covers would not do because of canal cleaning problems. Then it occurred to Reclamation designers that a layer of concrete might be slip-formed on top of the PVC membrane. A new method was born.

The unique operation is the first of its kind in the world. A continuous sheet of PVC is unrolled in half the width of a canal and topped off with a 3-inch layer of concrete specially mixed for use under water. PVC liner provides the water seal and the concrete provides a protective cover to withstand canal maintenance activities such as aquatic weed control. Geotextile fabric, glued to the PVC, anchors



Coachella Canal in-place lining prototype is the first of its kind in the world.

the concrete on the canal sideslopes. The center joint of the canal is cemented with an adhesive that can be used under water, such as that used to repair swimming pool liners.

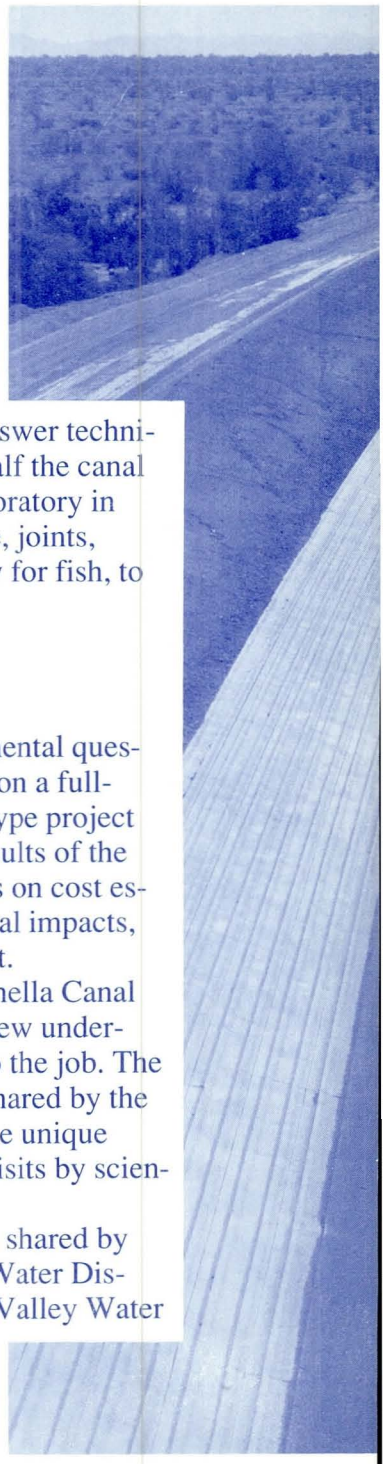
Model tests in laboratory

Numerous technical and environmental questions arose on this lining method, among them were:

o What are the vibration requirements for placing concrete under water?

o What is the maximum water velocity before erosion occurs on fresh concrete?

o How much will the fresh concrete affect water quality for fish?



To test the proposed method of lining and answer technical questions, a one-third scale model of one-half the canal prism was built in Reclamation's hydraulic laboratory in Denver. Then tests were performed on concrete, joints, temperature effects, turbidity, and water quality for fish, to name a few.

Prototype built

Since a number of engineering and environmental questions needed to be answered before embarking on a full-scale project, Reclamation constructed a prototype project along 1.5 miles of the Coachella Canal. The results of the prototype project provide guidance to designers on cost estimates, design data requirements, environmental impacts, and equipment suitability for a full scale project.

Proposed for lining are 38 miles of the Coachella Canal and 28 miles of the All-American Canal. The new underwater method provides an alternative way to do the job. The benefits of this unparalled test project will be shared by the entire nation and, indeed, the world. Already the unique operation has drawn worldwide attention and visits by scientists and engineers to study the technology.

The cost of the Prototype Lining Project was shared by the Bureau of Reclamation, The Metropolitan Water District of Southern California, and the Coachella Valley Water District, Coachella, California.

Lining canals conserves water by eliminating seepage into the thirsty desert soil. Ridges on the sides allow wildlife safe access to the water.

Preserving

Cultural Resource Program

Preserving the past

About 1700 years ago expert farmers inhabited the Sonoran Desert, leaving behind artifacts and other clues through which we are learning about their culture. The Central Arizona Project (CAP) Cultural Resource Program, the largest in the United States, is conducting archaeological research on these ancient farms and other sites.

A major archaeological and historic preservation program is being conducted through a series of sponsored research and compliance efforts. Inventory surveys and mitigative data recovery investigations have been completed for all components of the CAP system, including the many miles of distribution canals that will deliver CAP water to irrigation districts and municipal water consumers.

Many of the research efforts focus on issues of Hohokam prehistory. The Hohokam Indians began farming the Sonoran Desert about A.D. 300. Reclamation-sponsored research in this area led to an advance seminar held at the Amerind Foundation in southeastern Arizona. Attending the seminar were many Hohokam scholars. The extremely successful seminar resulted in the publication (Spring 1991) of a major work on Hohokam archaeology: Exploring the Hohokam: Prehistoric Desert Peoples of the American Southwest (University of New Mexico Press).

An important investigation was conducted at two Archaic Period village sites. These rare sites, located near the Tator Hills in the Santa Cruz Flats, document occupation about 1000 B.C. The research results paint a picture of a resilient people who successfully lived in the harsh desert environment without the benefit of agricultural technology.

Arizona Projects Office (APO) has now shifted its focus from canals to reservoirs and the archaeology program has shifted as well. Much effort is being expended in the Roosevelt Lake area where archaeological research is focused on investigating the Salado Indians. The Salado, a prehistoric people, flourished from A.D. 1000 to A.D. 1450 in the "transition" zone between the desert and the northern Arizona plateau. They built impressive towns centered around elevated platform mounds where the elite of the society lived. The Salado share many traits with the Hohokam, and like the Hohokam and the mountain Mogollon people, the Salado disappeared about 100 years before the Spanish entered the area in the mid-16th Century.

The APO cultural resource program is also investigating the history of the Bureau of Reclamation. Because Reclamation is changing the character of its first great dam, Theodore Roosevelt Dam, a major program has begun to preserve its significant history. Theodore Roosevelt Dam, completed in 1911, is still the world's largest masonary gravity-arch dam. It is a monument to Reclamation's engineering expertise and has been recognized as a National Historic Landmark and a National Historic Engineering Landmark.

To help preserve its history, Reclamation has conducted historic archaeology investigations at Roosevelt Dam and several other Phoenix area dams. The excavations concentrated on the construction camps and will result in a history of the workers who struggled to build these technical marvels. Also nearing completion is an engineering history of Roosevelt Dam. It will be the hallmark of a series of Historic American Engineering Record reports that APO will complete for each of the seven dams and eight major aqueducts in the Salt River Project system.

The last component of the program to preserve Roosevelt Dam is a major museum exhibit. The exhibit is part of the new Arizona Historical Society Marley Center.

Excavating Salado Platform Mound Village near Roosevelt Lake in Arizona has yielded cultural treasures such as those at left above.

It tells much of the history of constructing Roosevelt Dam and its importance to regional history.

The CAP Cultural Resource Program began in 1965. Since then a total of 4,301 sites have been recorded in over 713 square miles of land inventoried. Data recovery excavations have been conducted at 555 sites and almost 200 research documents have been produced. Mitigation programs are being initiated at Roosevelt Lake and along the Verde River that will add 57 new sites to the pool of knowledge about the Hohokam and Salado, as well as many more pages of spirited archaeological interpretation.

Researching

Razorback Sucker

Help is on the way

The razorback sucker is in trouble, but help is on the way. This large, and less than beautiful, fish was once common throughout the mainstream and major tributaries of the Colorado River. The species is now dwindling in numbers and has recently been proposed for federal listing as an endangered species.

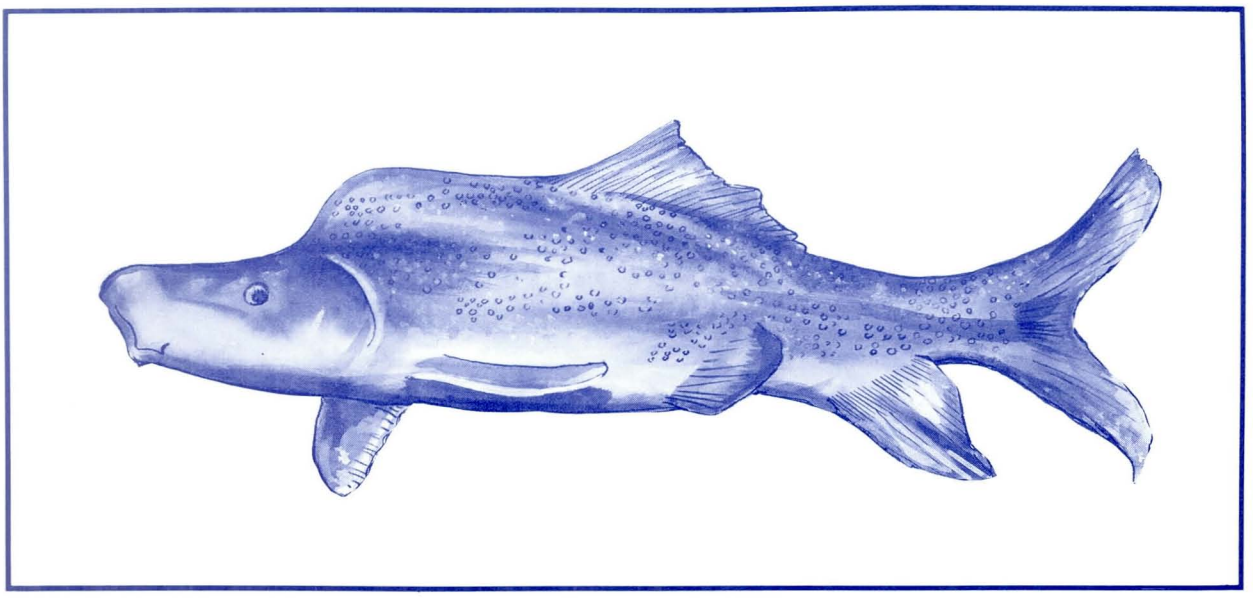
Lake Mohave contains the largest remaining population, estimated at about 60,000. Most of the fish are old, ranging from between 25 and 45 years.

The fish spawn, incubate, and hatch, but then something happens. The young disappear, never to be seen again. Most scientists agree that predatory game fish seem to be the problem. The suckers spawn weeks before any of the other fish and their tiny larvae become food for older game fish. If this continues, the population will disappear.

Technical representatives from Reclamation, the National Park Service, Arizona State University, Nevada Department of Wildlife, Fish and Wildlife Service, and the Arizona Game and Fish Department have been working together, studying the species, and are embarking on a pilot program to rescue the razorback sucker from its predicament.

This multientity effort is intent upon protecting the young fish and releasing them when they are large enough to fend off their enemies. A backwater area of Lake Mohave is being isolated from the reservoir, creating barriers to prevent both the escape of fish from the backwater and entrance of other fish. Yuma Cove was selected as the ideal location for this project because it is a natural spawning area.

In 1989 a technical committee of biologists formed a plan which outlines a five-year strategy of rearing razorback suckers to a length of 10-12 inches before releasing them



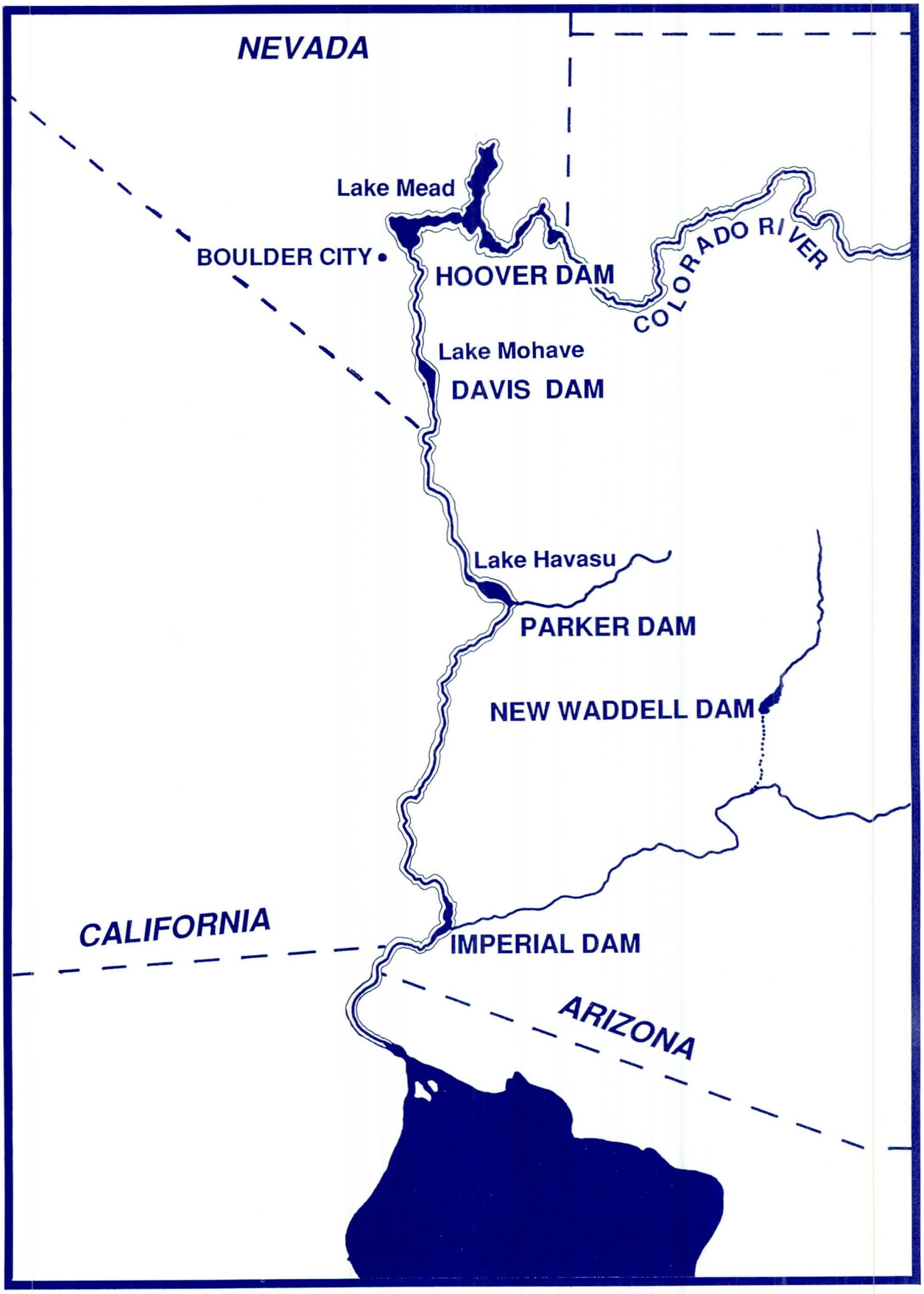
The razorback sucker has been proposed for listing as an endangered species.

into the reservoir. During January of each year, hundreds of spawning suckers congregate along the berm. Biologists seined 30 sexually ripe females and 60 males from the reservoir side of the berm to stock the backwater. The fish were measured, weighed, and inspected for abnormalities.

The spawners were then injected with small tags, resembling what can be described as an "electronic sliver" which will allow biologists to identify the spawners and their tagged offspring from other suckers. The fish were then released into the backwater where they successfully spawned.

Currently efforts are being made to monitor their success. The group anticipates that the effort will result in the production of several thousand 2-3 inch suckers. These will be collected from the backwater to a larger rearing area at Davis Cove. In one year they should reach a length of 10-12 inches and will be released into the reservoir. Over the next five years the adult sucker population will be monitored to determine if, and how many, cove reared fish reach adulthood.

If this management/research approach works on Lake Mohave, expansion of the project to other areas of the drainage is anticipated. This approach may be used in the future with other long-lived Colorado River fish such as the endangered bonytail chub, which is also found in Lake Mohave; the humpback chub, now found only in the Little Colorado River and isolated parts of the Grand Canyon; and the Colorado River squawfish, which is found only in isolated portions of the Upper Colorado River drainage.


NEVADA
Lake Mead
BOULDER CITY
HOOVER DAM
COLORADO RIVER
Lake Mohave
DAVIS DAM
Lake Havasu
PARKER DAM
NEW WADDELL DAM
CALIFORNIA
IMPERIAL DAM
ARIZONA

MISSION: As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

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