RECLAMATION Oct.-Dec. 2007
Managing Water in the West

S&T Highlights

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U.S. Department of the Interior
Bureau of Reclamation
Science and Technology

Improving Infrastructure Reliability

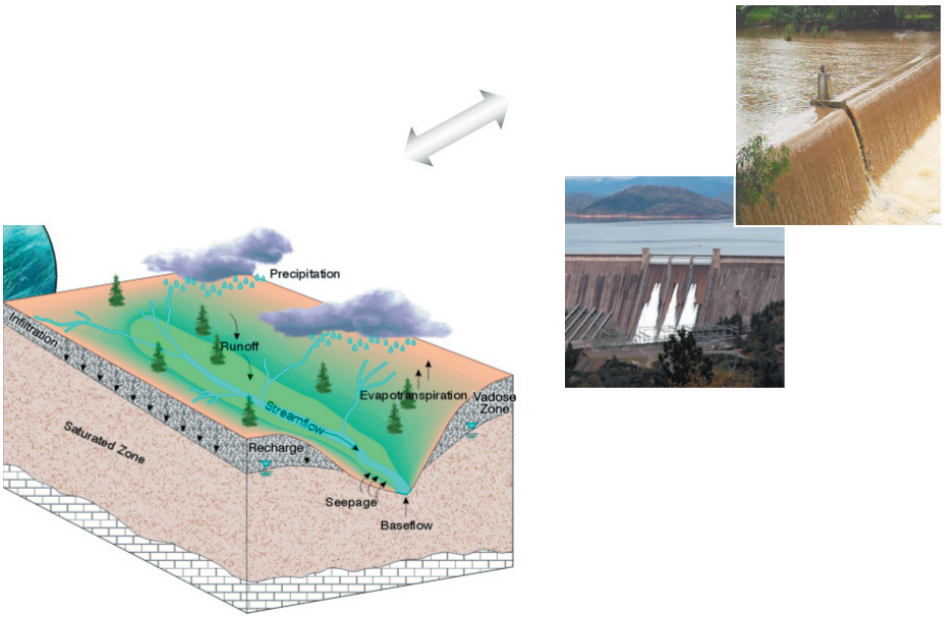
Reclamation team uses laser technology to protect rock art in Kansas.—The rock art at Cedar Bluff Reservoir in Kansas, which dates from the mid-nineteenth century, is threatened by natural erosion and vandalism. The **Nebraska-Kansas Area Office's** S&T study is documenting these historic panels with the help of light detection and ranging (LiDAR) technology from the **Mid-Pacific Region**. LiDAR technology provides highly detailed three-dimensional imagery of the petroglyphs and pictographs to document the baseline condition of the rock art at a very fine scale. Moreover, managers can use this information to pinpoint panels that need intervention to retard erosion or reduce vandalism, thus effectively using our protection resources where they are needed most. LiDAR technology is also significantly less expensive than traditional rock art recording methods as well as provide data that will be used in resource protection and preservation. (Tom Lincoln, 303-445-3311)

Reclamation and partners find ways to clean agricultural drains more effectively.—Farmers install perforated pipe (tile drains) that drain high water tables to remove excess groundwater near the surface. Iron bacteria can be found throughout the Great Plains and often create a biomass inside these tile drains which plug the perforations and reduce their ability to drain excess water. Irrigation districts use scraping brushes or high pressure jetted water to clean the bacterial film off these drains and restore their efficiency. Existing cleaning schedules are often determined by the amount of time and money available which can lead to random cleaning intervals that may adversely impact the ability of the bacteria to naturally remove common agricultural chemicals. Better managing for tile drain cleaning intervals holds promise in preventing excess nutrients, such as nitrate and phosphorus, from being carried downstream. These higher nutrient levels can sometimes contribute to excessive aquatic vegetation.

This S&T study examines the optimal interval for cleaning these drains to let irrigation districts help determine how regularly a tile drain needs to be cleaned. Cleaning these tile drains less often while retaining drain efficiency, may remove the high amount of nutrients, thus improving water quality downstream. Reclamation, with the University of North Dakota, North Dakota State University, and state agencies, is testing to determine if periodically cleaning tile drains can be better managed. The full S&T study will use two growing seasons (2008 and 2009) with different tile drain conditions to test if cleaning impacts the effluent water quality. Reclamation stands to benefit from this work by lowering operating expenses while simultaneously improving tile drain water quality. (Allen Schlag, 701-221-1277)

Improving Decision Support

Evaluating climate change impacts with CalSim and HydroGeoSphere.— Managers of California's Central Valley Project (CVP) rely on CalSim to make operational decisions. CalSim is a reservoir-river basin simulation model developed by the California Department of Water Resources and Reclamation. Unfortunately, this model relies on a historical time-series of hydrological data to evaluate impacts of climate change on water resources. It also does not consider water supply, water quality and ecosystem health issues in an integrated manner. HydroGeoSphere, on the other hand, is a physically based process simulation model that can account for flow, contaminant transport and thermal (temperature) transport in fully coupled surface and subsurface water systems. Therefore, linking the two models will provide a valuable numerical tool for optimal management of limited water resources in the MP Region as well as other Reclamation regions. The linked model will also be a valuable tool for analysis of climate change impacts on water resources, and development and management of ecosystem restoration projects. Based on our knowledge, HydroGeoSphere is the only numerical model with the capability to handle temperature in both surface and subsurface water domains. Hence, it can evaluate issues such as the impact of groundwater on surface water temperature. This capability is valuable in management studies designed to identify protective measures for fish. With the linkage, managers will be able to operate resources with accurate, timely information from both of these models. In addition, the linked HydroGeoSphere-CalSim model will be valuable for managing water resources in any watershed/system (i.e., not limited to the CVP system). The **Mid-Pacific Office** is reviewing CalSim and existing linkages of operational and hydrologic models. After this review, this S&T study will develop an optimal linkage approach by the end of fiscal year 2008. (George Matanga, 916-978-5084)



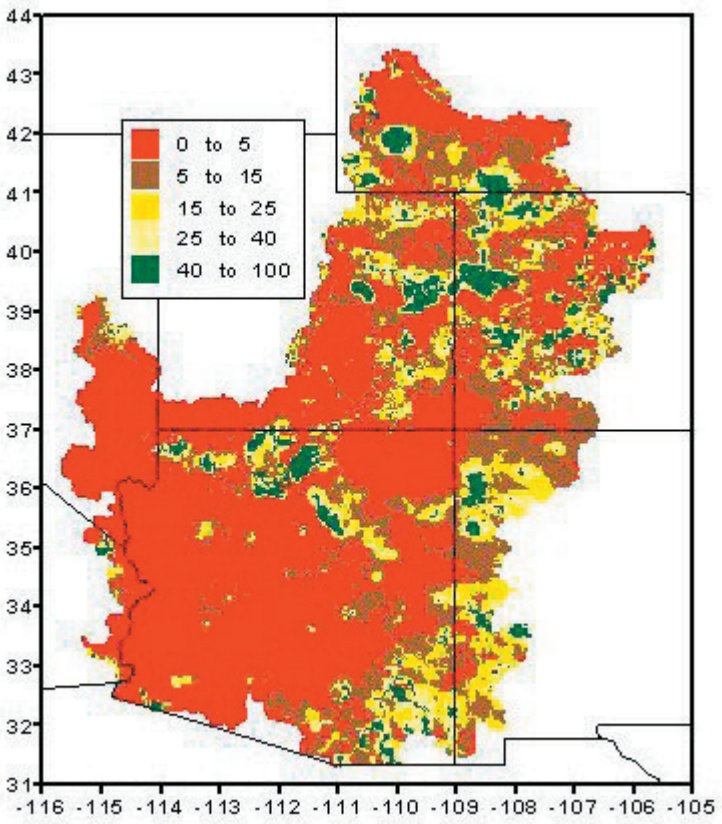
Accurate, timely information from the linked models helps manage flows effectively.

Reclamation and the Arizona State University improve short- and long-term drought forecasting within the Colorado River Basin (CRB).—Historically, efforts to portray drought have relied on confusing indices, contained regional biases, and examined only limited connections within the multiple factors and influences of drought. Arizona State University (ASU), with funding from Reclamation in this S&T study, has begun to derive Hydroclimatic Indexes for the CRB. These indexes are recently derived methods for representing hydroclimatic variability to monitor and predict drought across the CRB. The project also uses various downscaled global climate model forecasts of changes in temperature and precipitation across the CRB during the 21st century to assess the likelihood of more intense, more pervasive, and longer droughts.

Using existing methods and historical data, ASU is determining the basin's precipitation and PE rates, developing software to evaluate the data, and generating the Hydroclimatic Index. This index represents the difference between precipitation (P) and potential evapotranspiration (PE) through time at a given location. Negative P minus PE values indicate the amount by which the climatic demand for water cannot be met by precipitation, and actual soil moisture declines. Positive values represent the amount of excess water from precipitation that would recharge soil moisture, recharge ground water, and/or run to streams and reservoirs through overland flow, interfiow, or base flow within the natural environment.

Another version of the Hydroclimatic Index represents water supply conditions by generating an aggregate P minus PE value from only those months of 12-month timeframes (with greater precipitation than PE. This water supply version of the Hydroclimatic Index (HIWS) represents nearly all of the volume of excess water generated during the period (minus a relatively small fraction likely used for soil moisture recharge).

Percentiles of P minus PE are constructed for periods of 1, 3, 6, 12, 24, 36 and 48 months to form the Hydroclimatic Index, while percentiles of the HIWS are constructed for the periods of 12 months or greater. Percentile values of the Hydroclimatic Index and HIWS can then be stratified into drought categories, such as those determined by the National Drought Mitigation Center. (Mitch Haws, 623-773-6274)



The Hydroclimatic Index in Arizona for December 2002.

Reclamation compares mammal communities within native- and nonnative-dominated riparian vegetation.—Salt cedar has infested the west and taken over native habitats. The Salt Cedar and Russian Olive Control Demonstration Act tasks the Department of the Interior with assessing the extent of the salt cedar and developing strategic solutions for long-term management and reestablishing native vegetation. Yet these nonnative invaders may provide habitat for protected wildlife species. Thus, Reclamation needs to access salt cedar's effects on wildlife. This study will attempt to expand upon what is known about mammalian communities within salt cedar vegetation along the San Pedro and Gila Rivers in Central Arizona. This study will also provide insight into the "new" riparian norm across the West with native riparian desert ecosystems being displaced by salt cedar.

This S&T study compares the small, terrestrial mammalian communities within native- (cottonwood-willow) and nonnative- (salt cedar) dominated riparian habitats. The study follows the protocols and methodology needed to obtain biodiversity (species composition) and occupancy information for small mammalian communities within the two riparian vegetation types. To find suitable study sites, the **Phoenix Area Office** is using aerial imagery. Infrared technology may be used to delineate vegetation composition along these two rivers by mapping vegetation using the unique signature of each plant species. (Nichole Olsker, 623-773-6258)

Improving Water Delivery Reliability

Reclamation monitors green sturgeon.— Reclamation needs information about green sturgeons' movements and habitat preferences to effectively operate the **Red Bluff Diversion Dam** (RBDD) and help ensure the continued survival of the threatened Southern Distinct Population Segment of the green sturgeon (*Acipenser medirostris*). This S&T study monitors hydroacoustically tagged green sturgeon. Using a boat-mounted portable receiver with a directional hydrophone, Reclamation fish biologists located five tagged green sturgeon in the Sacramento River. Two of the green sturgeon were located together upstream of RBDD after the gates were lowered for the 2007 irrigation season. Several weeks later, these same two green sturgeon were again located together downstream of the RBDD within a large pool along with two other tagged green sturgeon. Later surveys conducted farther downriver of the large pool found another tagged green sturgeon along with one of the individuals that had been previously located upriver. (Richard Corwin, 530-528-0512)

Green sturgeon upstream of Red Bluff Diversion Dam.

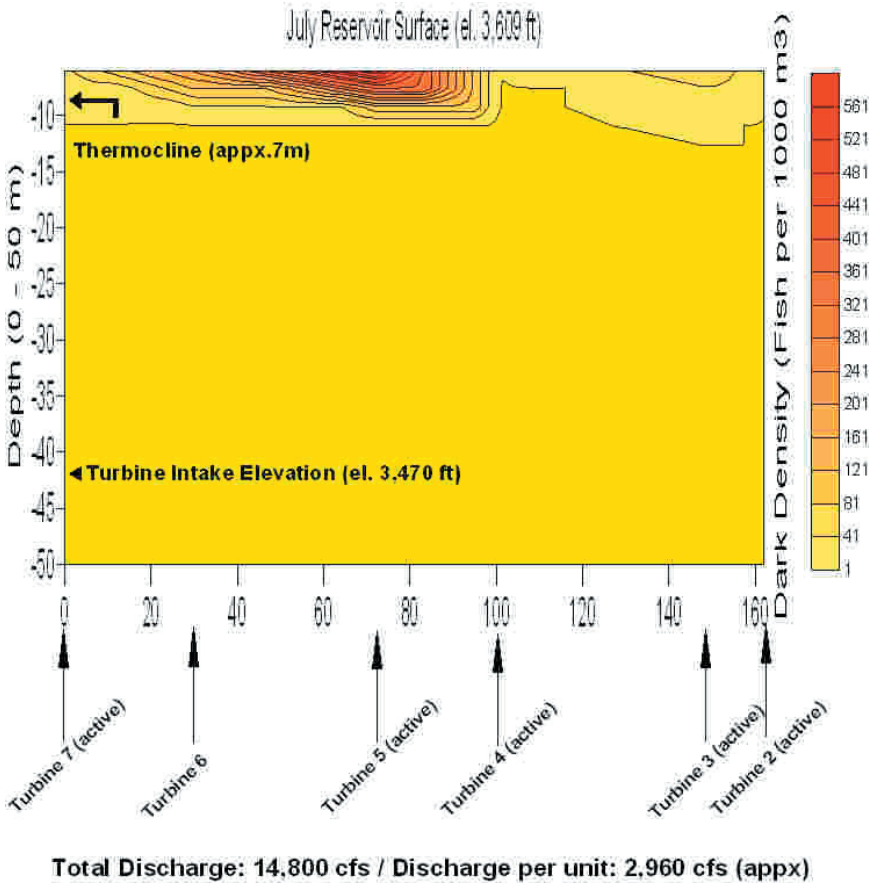
Reclamation examines potential threats to the endangered humpback chub at ***Glen Canyon Dam.***—The endangered humpback chub (*Gila cypha*), thought to have evolved around 3-5 million years ago, is a native in the swift currents and white water of the Colorado River canyons. Reclamation spends millions of dollars annually on recovery efforts for this fish. Temperature control devices (TCDs) could be installed on the dam as part of recovery efforts to provide the warmer water these fish need to spawn. The TCD would withdraw water from the warmer water near the surface of the reservoir (above the thermocline).

Reclamation is determining the potential, if any, for fish entrainment should one or more TCDs be constructed at the dam. Both State and Federal agencies are cooperating in this project to perform monthly hydroacoustic fish surveys of the density and distribution of fishes that live in deep open water lake near the dam. This S&T study began in June 2007, and is expected to continue through May, 2009.

Survey equipment includes a split-beam acoustic system consisting of both down- and side-looking transducers coupled with a scientific echosounder and laptop. Surveys involve day and night components as well as stationary and mobile data collection. Repeatability is accomplished using a removable transect line set into the canyon wall that serves as a navigation guide and anchor point. Data analysis uses a variety of software programs and provides information on fish density, fish size, vertical distribution of fish within the water column, and biomass.

This information, including real-time fish distribution and density information, will be valuable for determining potential designs and operations of potential TCDs. For example, operators could access a desired water temperature stratum at a time and/or depth when fish have a low probability of being entrained into the Colorado River downstream. (Juddson Sechrist, 303-445-2198)

Just upstream of Glen Canyon Dam. The sampling vessel is attached to a transect line running perpendicular to the reservoir.



An example of a volumetric density plot (fish per 1,000 m^3) for fish sampled after sunset near the Glen Canyon Dam, July 2007.

Reclamation improves model accuracy for the San Joaquin River Basin.—Better and more accurate models are needed for an integrated management approach for water quantity, water quality, and ecosystem health in the San Joaquin River basin. This S&T study is developing a HydroGeoSphere model for the San Joaquin River basin in **California** to facilitate application to large river basins over long periods of time; characterize and quantify exchange fluxes within and across the surface and subsurface water regimes; develop a basin-wide integrated surface-subsurface hydrologic model for conjunctive analyses of the basin's water resources; evaluate capability of the drainage water reuse system at Red Rock Ranch to control drainage water and salinity; and support the San Joaquin River Restoration Program. Capability to account for water temperature has been incorporated into the model. The study is being testing subtiming and subgridding techniques that have been incorporated into the model. Data collection and conceptual model construction are almost done and some hydraulic data are being collected g along the San Joaquin River restoration reaches. Temperature data in both surface and subsurface water is being collected. Input data files should be ready by the end of May 2008. The analyses will start thereafter. (George Matanga, 916-978-5084)

Reclamation determines the best way to revegetate the Cibola National Wildlife Refuge burn.—A fire burned a mix of salt cedar and native vegetation over nearly 5,000 acres in Cibola National Wildlife Refuge, La Paz County, Arizona. Reclamation is working with the U.S. Fish and Wildlife Service (USFWS) to restore natural vegetation. Most of the burn area is not a candidate for revegetation with willow and cottonwood species, and more information about how native revegetation species will respond is needed. Reclamation is thus conducting a two-year demonstration study with baseline inventories, treatment applications, and posttreatment monitoring and weed management. The demonstration project area is next to the Colorado River, about 2.5 miles south of Cibola, Arizona.

This S&T study focuses on (1) native species selection and adaptation, (2) revegetation species response to mechanical techniques for saltcedar biomass reduction and seedbed preparation, (3) augmentation of soil moisture regime with limited irrigation, and (4) manipulation of soil fungus. The study will evaluate the response of 11 native revegetation species (shrubs, forbs, and grasses) to (1) plant material type (seeding vs. transplanting of containerized nursery stock); (2) irrigation regime (no irrigation, limited [early, supplemental] irrigation, and full [season-long] irrigation); (3) seeding/planting techniques (incorporating varying levels of seedbed preparation and depth of propagule placement); and (4) root zone moisture augmentation. These studies incorporate single-row (or broadcast block), single-species trials, using both seed and seedling transplants.

Reclamation obtained local or regional native revegetation species through acquisition of local native harvest or commercial source material. Final species selection was determined in consultation with local/regional cooperators such as the USFWS, Ducks Unlimited, and Natural Resources Conservation Service Plant Materials Centers. (Ken Lair, 303-445-2005)

Resident wild burros take in the revegetation activites.

Revegetation of a burned area on the Cibola National Wildlife Refuge.

Reclamation investigates a promising new algaecide.—Throughout the year, algae grows in the Franklin Eddy Canal in Reclamation's Closed Basin Project near **Alamosa, Colorado**. The **Alamosa Field Office** has been using mechanical methods and biological control (grass carp) for this problem. However, these methods have not effectively controlled algae in this slow moving canal. This S&T study evaluates an algaecide, PAK27, as an alternative to algaecides containing copper, which can potentially elevate copper levels.

PAK27 acts as a contact herbicide and can be used to control both blue-green and green algae. Its active ingredient is hydrogen peroxide; the product is encapsulated with a sodium coating to safely handle and apply it. Applying the

active ingredient forms sodium carbonate, water, and oxygen. Results from applying PAK27 at minimum and maximum rates indicated that the product did not significantly raise total dissolved solids (TDS) concentrations, a major concern. The product label indicates it can be used in water systems with multiple uses, including drinking water reservoirs, irrigation, drainage, conveyance ditches, canal and laterals.

While some initial impacts to the algae were seen, further research is needed to determine what label rates are the most effective for controlling algae and how well this product performs in various types of water conveyance systems with various velocities and volumes. Since copper compounds are used in algaecides throughout the west, Reclamation would benefit from alternative algaecides, especially ones like PAK27 that appears to leave little or no residues. (David Sisneros, 303-445-2228; John Boutwell, 303-445-2224)

PAK27 being applied to the Franklin Eddy Canal to determine the effect on the canal's TDS concentration over a 300-foot long test section. Once applied, the formulation started to release the active ingredient resulting in a white cloud that spread from the initial application site. Water samples were then collected at upstream and downstream sampling sites to determine TDS concentrations.

Improving Water Supply Technologies

Reclamation and partners develop automatic irrigation controls to improve water use efficiency.—Irrigators use manual controls to open gates and deliver water to farms. However, this is often inefficient: laborers may not be trained properly, gates may need to be opened in the middle of the night or other inconvenient times, etc. Further, flow rates, water levels, intake changes, and other information may be difficult or impossible to obtain. Automating these controls could mitigate

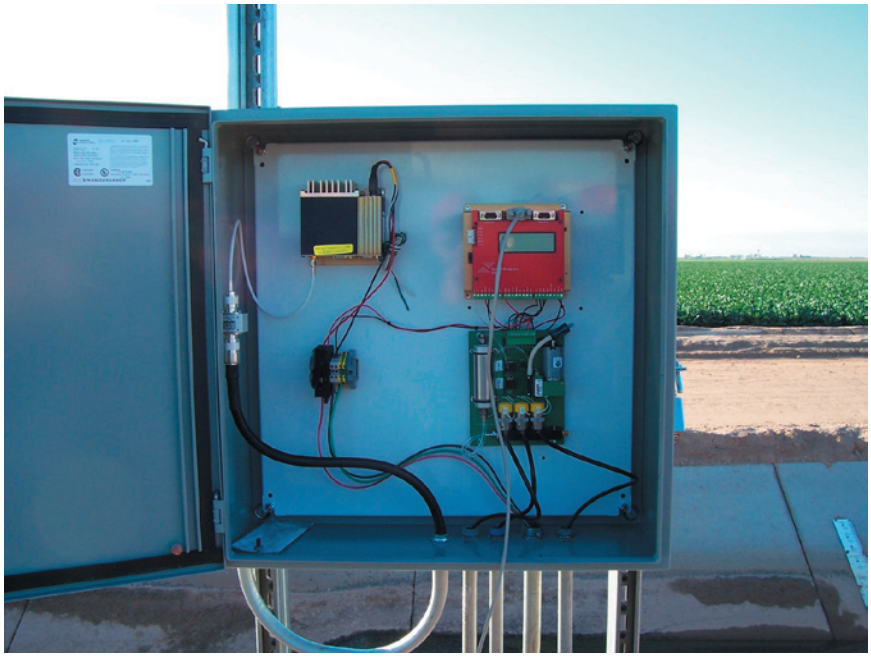
these difficulties and incorporate hydraulic data and other information to irrigate fields at the optimum efficiency, especially in the desert-dry Yuma and Imperial Valleys in southern Arizona and California..

Significant improvements in the last two decades in electronic automation equipment for pressurized irrigation and water system control make irrigation automation even more promising. This study uses programmable logic controllers and electric actuators to demonstrate automatic control systems. This S&T study uses two different types of systems for a site in Yuma and a site in the Imperial Valley. The study held an onsite project start-up and coordination meeting to research this potential. Along with Reclamation personnel, representatives attended from the Valleys' farms, the University of Arizona, the University of California, and the automated control industry. The participants discussed sites to use for research and demonstration, development and installation of automated systems, and scheduling and budgeting for the project. Now, Reclamation is working with the universities to develop the algorithms to write the software code and designing the components. Construction for the two demonstration sites is anticipated in the summer of 2008. (Mark Niblack, 928-343-8253)

Submerged flume measurement.—Limited head availability and associated submergence problems limit measuring flows at sites on many irrigation districts in the western United States. This S&T study is submerged flow measurement system to help provide a way to measure these flows. Three flumes on laterals in the Yuma, Arizona vicinity are part of this field study to evaluate a method for measuring flow at long-throated flumes that are occasionally submerged. This effort is an extension of ongoing work looking at measuring flow under submerged conditions by measuring water levels at both the approach section and in the throat of a submerged, laterally contracted long throated flume. With both water levels known, discharge is calculated using the same solution used for flow measurement in venturi pipe meters.

Initial equipment installation at these sites was carried out in early December 2007. Additional work at these sites is scheduled for February 2008, including refining the programmable logic control programming along with stream-gauged verification of computed discharge rates under submerged conditions. Cooperating participants of this project include the Yuma County Water Users Association (YCWUA), the Unit B Irrigation District, the Yuma Area Office, the Technical Service Center's Hydraulics Laboratory and the Science and Technology Program. (Tom Gill, 303-445-2201)

A view of a YCWUA flume looking upstream. Bubbler tubes for the level sensing system are installed underneath the green strips seen attached to the canal lining.



The bubbler board at the same site linked to a programmable logic controller (PLC). Information is relayed from the PLC to a data radio compatible with YCWUA's supervisory control and data acquisition (SCADA) system.

A new laterally contracted, long-throated flume that was installed with the submerged measurement bubbler system at the Unit B Irrigation District. A flume had not previously been installed at this site due to submergence concerns.