The Water Report™
Water Rights, Water Quality & Water Solutions in the West

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POST-FLOOD RIVER RESTORATION

APPLE VALLEY NORTH RESTORATION PROJECT IN COLORADO

PUBLIC MOBILIZATION CREATES FLOOD PROTECTION AND RIVER RESILIENCY

by Felix Kristanovich, PhD, PE, David Heinze, PE, Scotty Hayter, PE and Mike Rawitch
Ramboll USA (Seattle, Denver, Ann Arbor and Overland Park offices, respectively)

INTRODUCTION

In the late summer of 2013, the Town of Lyons, Colorado experienced a flood of historic magnitude. The catastrophic event lasted ten days and resulted in lost lives and great financial distress. A massive public response effort was generated following the flood event. The main purpose of this mobilization was to reduce the impact of future flooding events, and to make the river more resilient overall.

This article describes efforts implemented by St. Vrain Coalition (funded in the year following the flood), and history of the Apple Valley North Restoration Project funded by the Coalition — from its inception through construction.

PROJECT BACKGROUND

On September 13, 2013, a one-in-500-year flood event ravaged the St. Vrain River near Lyons, Colorado. The flood devastated the watershed causing loss of life and millions of dollars in damage to homes, personal property, highways, infrastructure, and habitat. Boulder County recorded up to 17 inches of rain during the several days preceding the flood event. The Town of Lyons was isolated; the flood was blamed for taking nine lives, destroying 1,852 homes, damaging 19,000 homes and causing $4 billion in damages across two dozen Colorado counties (Figures 1 and 2).

Figure 1

Stream Restoration

Watershed Plan

The St. Vrain Creek Coalition (a 501(c)(3) non-profit organization) was formed the following year. The Coalition was tasked by the Colorado Water Conservation Board to generate a St. Vrain Creek Watershed Master Plan (Master Plan), which was published in November 2014. The Master Plan articulates the future of the watershed and guides future planning and development activity by highlighting recommended projects that align with diverse community priorities. All proposed watershed activities in the Master Plan must comply with all federal, state, and local requirements prior to implementation.

The St. Vrain Creek Coalition's (Coalition's) mission includes implementing the Master Plan and to pursue: recovery from flood impacts; resiliency to natural hazards; and protection of the natural character and multiple uses of the Saint Vrain watershed through broad stakeholder engagement and collaboration. The SVCC is a locally driven, non-governmental, non-regulatory, community-based organization that facilitates stewardship and restoration projects based on scientific analysis to improve watershed health and develop partnerships to plan, fund, and implement these projects.

Figure 2

The original Coalition membership represented the municipalities and agencies that comprise the primary stakeholder group impacted by the 2013 flood's damage. In 2015, after the public process of completing the Master Plan, the Coalition's membership was expanded to a broader scope of stakeholders including community representation. Today Coalition membership includes 36 individuals representing the diversity of the community responding to flood damage and recovery including: municipalities; governmental agencies; private landowners; agricultural interests; recreational interests; educational interests; and business interests.

The intent of the Master Plan's restoration project was to "promote overall watershed recovery and resiliency by restoring stream function and re-establishing connections between stream reaches and their associated floodplains, to protect values at risk, homes, businesses and infrastructure" (USDA, 2016). The project was managed by the Coalition. The geographic extent of the project is illustrated in Figure 3.

The Coalition was awarded funding from two federal programs for the Creek Rehabilitation Design-Build Construction Project for Apple Valley North. The first funding source is the Emergency Watershed Protection (EWP) Program (Colorado Emergency Watershed Protection Program, 2016). The US Department of Agriculture's Natural Resources Conservation Service (NRCS) administers the EWP Program, which responds to emergencies created by natural disasters. The 2013 Colorado Phase II EWP program was sponsored directly by the Colorado Water Conservation Board, which works with local sub-recipients on individual projects such as the Apple Valley North Restoration Project. Additionally, the Coalition was awarded a cost-share matching grant for implementation from the Colorado Department of Local Affairs (DOLA), Community Development Block Grant – Disaster Recovery (CDBG-DR) Watershed Resilience Pilot Program (Colorado Emergency Watershed Protection Program, 2016a and 2016b).

PROJECT DESIGN

The first phase of the project started in September 2016. A design team led by S2o Design and Engineering and including Michael Baker International, AloTerra Restoration Services and GEI, Inc. (S2o Team) were contracted by the Coalition to layout a flood recovery plan and deliver 30% design services for a creek restoration project in Apple Valley. [A "30% design plan" usually includes many engineering restoration measures; but does not provide engineering details, earthwork, and other details necessary for construction of the project. Moreover, the 30% design plan is based only on the preliminary hydraulic model that shows feasibility of the project in reducing flood extents and flood elevations.]

The S2o Team performed geomorphic assessments and an ecological characterization (desktop reviews and field data collection). S2o reported that aquatic habitat limitations resulting from the 2013 flood included: disconnection from the floodplain; vertical instability in incising reaches; and a lack of habitat variability and complexity throughout the project area. Drop structures installed after the flood provided important interim habitat for larger fishes. However, the S2o Team recommended that these structures be modified to improve overall aquatic habitat quality representative of the region. S2o also recommended that complexity and variability should be increased in the longitudinal and cross-sectional morphology of the river with: the addition of pools and modification of existing drop structures; creation of side/overflow channels; reconnection of river and floodplain; channel reshaping to form bankfull benches; and addition of large wood and boulders in pools and riffles.

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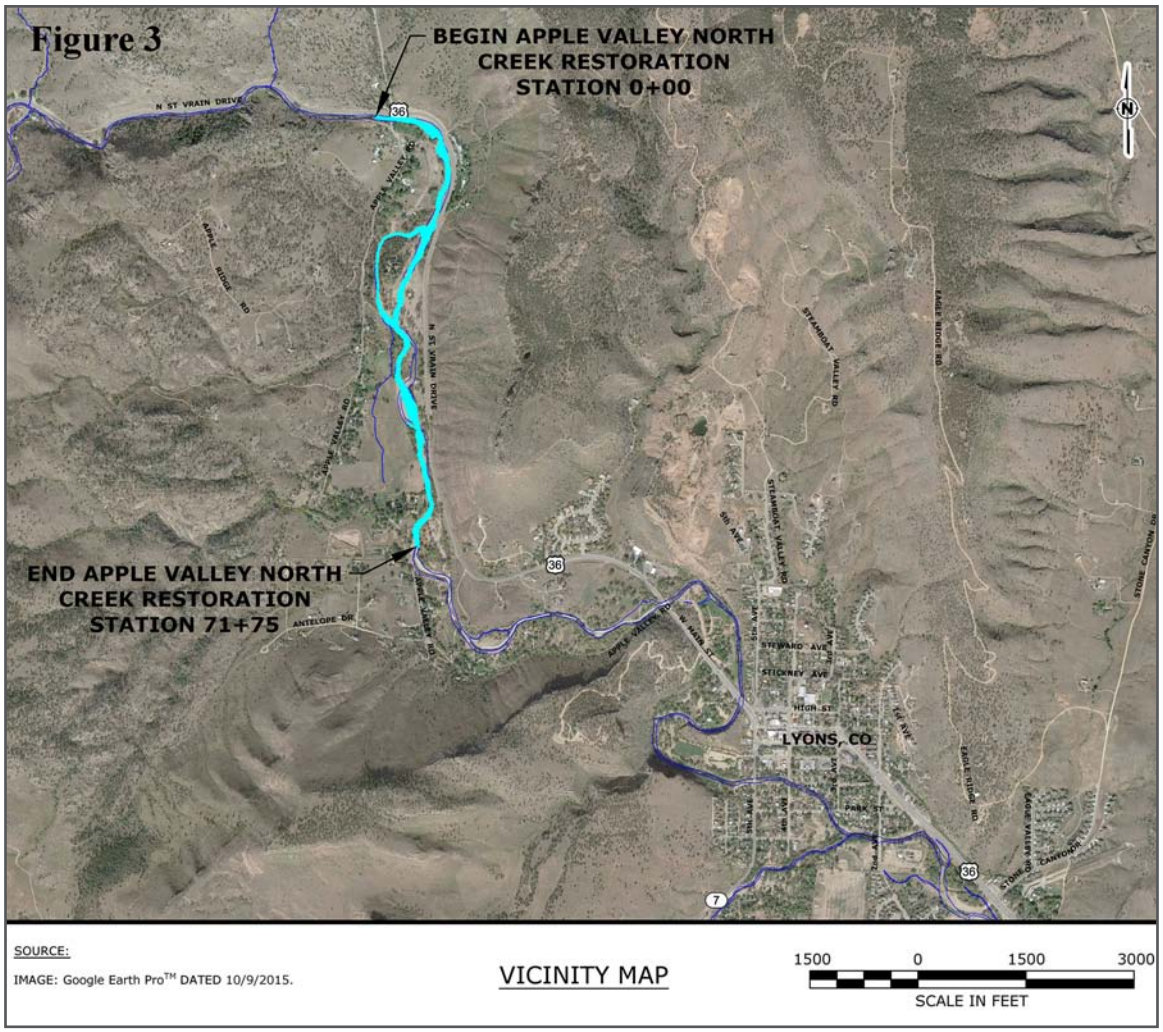
Stream Restoration

Project Extent



Fish Passage

Ensuring fish passage throughout the project reach and restoration of the riparian areas was also identified to be critical. The S2o Design Team created a 30% design plan set that included plan and profile information of the main channel and overflow channel, typical and actual cross sections, channel plan-form dimensions, stream restoration details and a revegetation plan. The Design Team found that considerably more work was warranted in Apple Valley than their design and construction budget allowed (S2O Design and Engineering, 2017).

Limited Impact Special Use

The second phase of the design-build phase of the project was initiated in July 2017 with IronWoman Construction, Ramboll US Corporation (Ramboll), Great Ecology, and FlyWater, Inc. Ramboll, along with Kleinfelder subcontracted to Great Ecology, prepared a Limited Impact Special Use (LISU) application for submittal to Boulder County using the S2o 30% design. The LISU application was officially submitted to referral agencies on August 9, 2017. Boulder County's Board of County Commissioners public meeting for the project was held on September 26, 2017 where they conditionally approved the LISU. Once the team obtained the necessary Boulder County Floodplain Development/Stream Restoration Permit, and other necessary local, state, and federal permits or approvals (*see* PERMITTING, below), construction could begin.

Design Goals

The design team used the S2o 30% design as a basis for the final (100%) design. The Final Design includes: all engineering details; earthwork; biotechnical stabilization measures; and other details necessary for construction of the project. The Final Design was produced in conjunction with the hydraulic model showing project feasibility and satisfying Boulder County and other regulations.

Specific Final Design project goals included:

- Design and construction of a project that protects life and property and restores the North St. Vrain Creek to a stable equilibrium
- Restoration of river function and habitat through a process that leverages hydrology, geomorphology, and aquatic and riparian sciences to enhance natural processes, appropriate to this river and watershed
- Increasing resiliency such that the natural ecosystem restores itself in the context of existing development and uses within the valley in anticipation of the next flooding event

Stream Restoration

Habitat Complexities

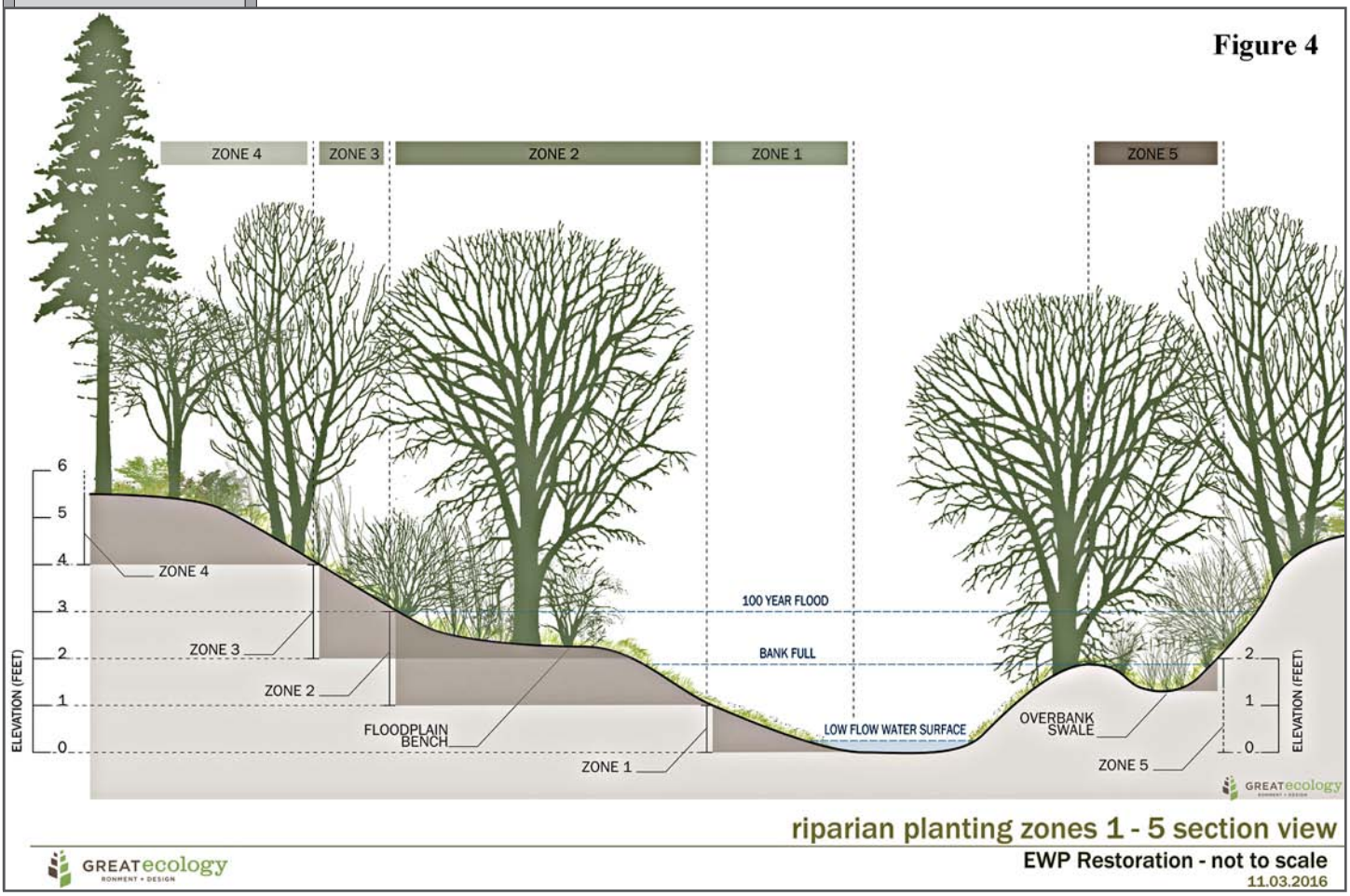
The approximate 7,200-foot reach was designed to protect life and property and improve the overall aquatic habitat and ecological function of the river by increasing the complexities of hydrologic habitats. The design included removing the drop structures installed following the flood and incorporating new pool complexes (riffle, pool, run) with the pool depths planned to sustain overwintering habitat. The design and construction included: removing flood deposited material; increasing the cross-section of the channel in places to increase conveyance and lower the water surface elevation during high flow events; the use of root wad toe structures (*see* Figure 6, page 6); channel reshaping to form bankfull benches; construction of an overflow channel; habitat and roughness rock placed in the channel and along the banks; and a detailed revegetation plan for the different hydrologic zones of the banks (Figure 4). Existing backwater wetlands were present in two locations and were planned to be protected and enhanced by removing flood deposited material that restricted flow to the wetlands and adding grade controls to protect the wetlands during high flow events. Limited hard armoring (boulder block wall) was included around the Rainbow Bridge at the upstream end of the project.

Overflow Channel

The SVCC requested that the design include details to grade and connect the overflow channel to the existing post-flood channel. Some landowners had expressed a preference for putting the river in the pre-flood channel. However, maintaining the overflow channel was determined by the NRCS EWP to be the highest resiliency option that can be authorized for construction with implementation funds. The Coalition requested that the channel become operational at less than the 25-year storm frequency due to the private bridge located just downstream that reportedly inundates at the 25-year flood frequency. The overflow channel was consequently designed to become operational at approximately the 15-year flood frequency — at the 15-year flood level, the flow will be split between the main channel and the overflow channel.

Detailed descriptions of flooding events were included in the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) 2012 study (FEMA, 2012) and in several hydraulic reports characterizing the historic 2013 flood event (Jacobs 2014, Jacobs 2015). At the time of the study, FEMA was updating the FIS for St. Vrain Creek, and the pre-approved FEMA HEC-RAS hydraulic model for St. Vrain Creek (updated September, 2017, and approved by Boulder County) was used as the effective hydraulic model for St. Vrain Creek (Peter Reinhardt, 2017).

Figure 4



Stream Restoration

Modeling

The US Army Corps of Engineers HEC-RAS hydraulic model (version 5.03, 2017) was used, consistent with FEMA and Boulder County Floodplain Development Permit requirements. The HEC-RAS model was used for all three modeling conditions for this study: (a) effective model; (b) existing conditions model; and (c) proposed conditions model. Additionally, the hydraulic model for floodway conditions was used to develop: (a) floodway for the existing conditions ("existing floodway"); and (b) revised proposed floodway. Flow discharges used as inputs to the hydraulic model were consistent with the discharge flows calibrated to the flows recorded during the September 2013 flood event (Jacobs, May 2015; Jacobs, August 2014).

The proposed conditions model provided consistently lower water surface elevation (during high flood flow events) than the existing model. At several locations however, the proposed conditions model produced higher flood flow elevations than the existing conditions model. The Boulder County Floodplain Development Permit requires submission of a separate Floodway Permit whenever there is any increase in flood flow elevations due to the proposed project (i.e. any increase higher than 0.00 feet). Thus, a separate floodway permit application was submitted with the hydraulic report. While a goal of the design was to prevent a rise in the 100-year water surface elevation anywhere on the project, due to the project funding deadline and limited design funds, a decision was made to submit for the permit with rises included and then make field changes during construction to remove the rises and document the changes in the Construction Completion Report and As-Built drawings. The Floodplain Development/Stream Restoration Permit was issued by Boulder County on December 11, 2017.

Floodway Permit

Permits Acquisition

PERMITTING

Seven different permits were obtained as part of this project, including:

- National Environmental Policy Act (NEPA) Compliance permit
- Section 7 Endangered Species Act (ESA) Compliance
- Section 106 National Historic Preservation Act (NHPA) Compliance
- Boulder County Stream Restoration Permit (which consists of grading and floodplain development components required for this project), including the Floodplain Development Permit (obtained December 11, 2017, but closing of the Floodplain Development Permit requires completion of the Letter of Map Revision (LOMR) that will be completed by others)
- US Army Corps of Engineers Nationwide Permit 37
- Construction Stormwater Permit
- Colorado Department of Transportation (CDOT) Special Use Permit (for stream restoration activities, authorizing truck traffic on access roads)

PROJECT CONSTRUCTION

Sediment & Erosion Control

In anticipation of receipt of the Stream Restoration Permit, a construction kick-off meeting was held on December 11, 2017. The sediment and erosion control features were installed at the start of the project and maintained throughout construction in accordance with the plans and Stormwater Management Plan (SMP). Two temporary sediment control pools were installed at the most downstream end of the project. Initial construction activities focused on removal of flood deposited sand and sediment in the Overflow Channel and transporting and staging it on staging areas initially located at 18564 North St. Vrain Drive. This staging was later moved to 18468 North St. Vrain Drive after approval was received from Boulder County to store material on the Boulder Buyout property. The use of the initial staging area was discontinued after January 31, 2018.

Bank Protection (Rock)

Additional imported rock was needed for the boulder bank protection and for in-stream riffle structures to what was available on site. This was initially planned to be regionally-sourced imported granite. However, a quarry located immediately adjacent to and above the St. Vrain River was identified with a supply of sandstone. The USDA NRCS raised potential concerns with the use of sandstone on the project. A Ramboll geologist performed a field reconnaissance and testing of the proposed sandstone. The subject rock is the Lyons Sandstone formation (Lower Permian). The general description of the formation is as follows: orange to pink to pinkish gray, fine- to medium-grained, well-sorted, quartz sandstone, commonly well cemented with quartz. The sandstone was determined to be suitable for use as boulder bank protection around the Rainbow Bridge and as in-stream structure materials and the results of the investigation documented in a memorandum to the NRCS dated January 2, 2018. The NRCS approved the bank protection on January 3, 2018.


Figure 5

Following completion of the rough excavation of the Overflow Channel, the boulder wall at the upstream end of the project was constructed starting in mid-January 2018. IronWoman planned to work generally from upstream to downstream in constructing in-stream riffle structures and completing grading activities to avoid tracking back over completed work. Construction of the most upstream instream riffle structure was started on January 23, 2018 and when complete, IronWoman then worked downstream. Most of the instream and grading construction work was completed by the end of February 2018 with only minor construction work/punch-list items remaining to be completed after that time. Revegetation activities were started in February 2018 and were completed by the end of May 2018 (*see* Figure 5).

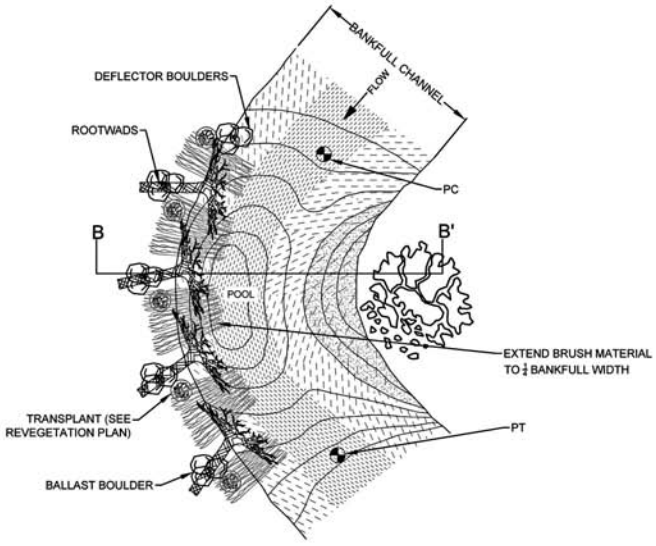
Figures 7 and 8 illustrate performance of root wads shortly following construction (Figure 7), and during higher flows (Figure 8). Root wads are a combination of interlocking tree material where a mass of tree roots (the "root wad") is utilized with other tree parts and revegetation methods to stabilize streambanks and provide aquatic habitat (Sylte and Fischenich, 2000). Installation of root wads along the streambank moves water away from the streambank, so it is less susceptible to erosion. This reduces the energy environment along the streambank/water interface, so that riparian vegetation can provide necessary bank protection. Root wads also provide habitat for fish and other aquatic animals, as well as a food source for aquatic insects.

Instream Root Wads Placement

Ramboll and Great Ecology provided construction oversight to ensure that the project was constructed in accordance with the design documents or approve changes to the design in the field.

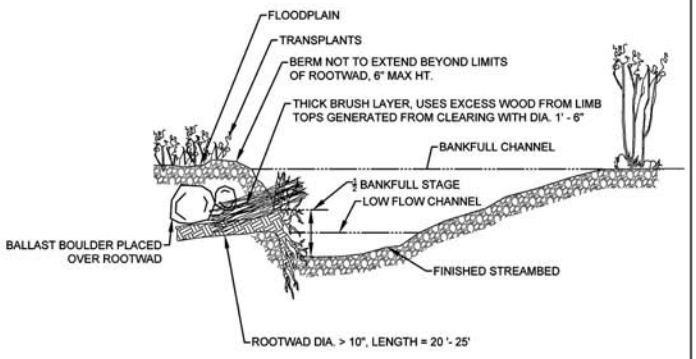
Construction Adjustments

The project was generally built according to the design plans with a few exceptions. During construction, the Project Engineer made adjustments to the project design in response to field conditions, property owner preferences, and Project Sponsor comments. These adjustments included such things as: modifying the length of improvements; adding grade control structures where evidence of scour was observed; changing the type of bank stabilization due to future planned activities by property owners; adding a root wad wall on an outside bend where the bank was found to require additional stabilization; removing additional flood deposited material and reducing bank slope angles in places to reduce the WSEL (**w**ater **s**urface **e**levation **l**evel) during high-flow events; and changing erosion control treatments and planting due to construction amendments and land owner requests.



Rootwad Placement

Figure 6



Rootwad Cross Section


Figure 7


Figure 8

Floodplain Hydraulics

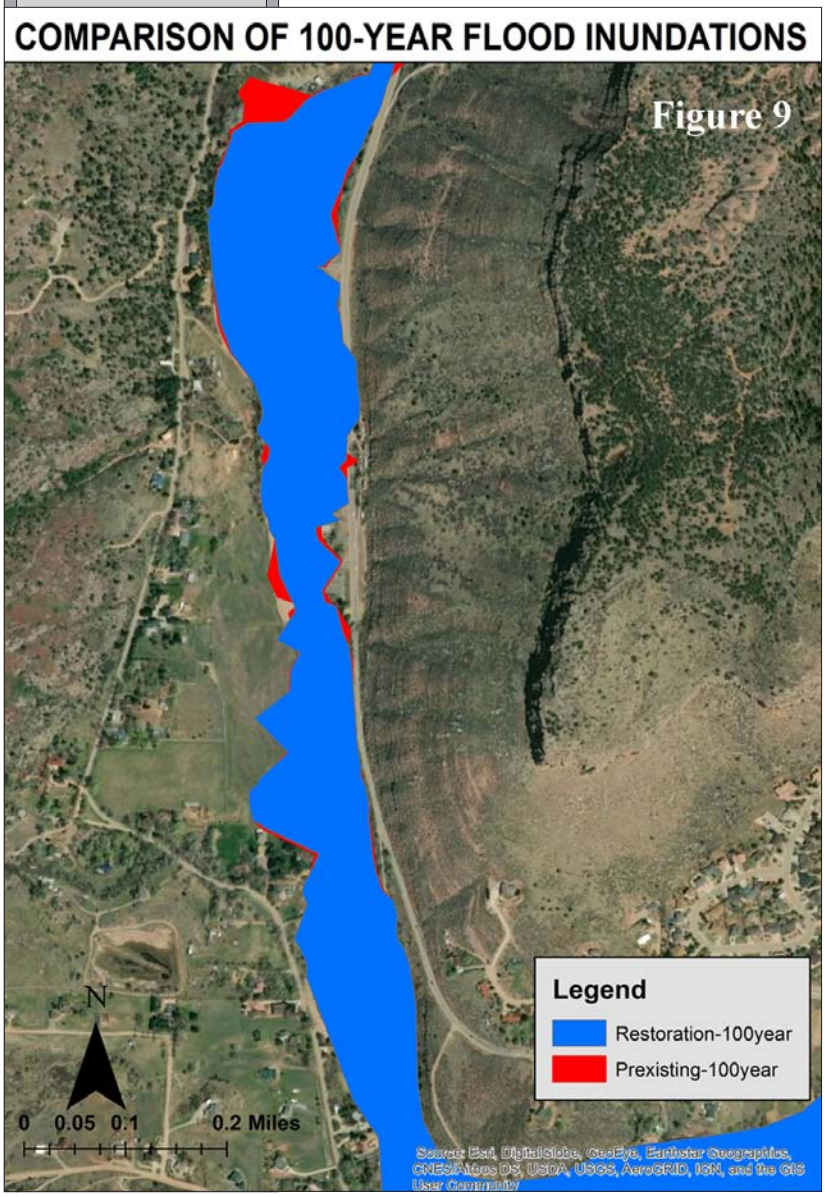
POST CONSTRUCTION FLOODPLAIN MODELING

A series of design changes and field adjustments were made over the course of construction. These adjustments were evaluated during construction in the floodplain model assembled as part of the design phase of the work to ensure that changes in the design would not have detrimental impact on flooding, but would stay within predicted overall decrease in flooding impacts.

In addition to the design changes and field adjustments, slight deviations between design grades and constructed grades were observed when reviewing the as-built survey data. The Hydraulic Model assembled during the design and permitting phase was updated with the as-built survey information.

The updated Hydraulic Model provided consistently lower water surface elevation than the existing model. This was especially true in the centerline reach (Stations 16416 – 17000) where the water surface elevation is over two feet lower from the existing conditions model and over one foot lower from the effective model. This was the reach where a high overflow diversion channel (RAS sections 17000.6 – 15693) helps carry some of the flood-flows through the "right floodplain" (i.e., the floodplain located on the right side of the river looking downstream). The proposed conditions model had higher water surface elevation than the existing conditions model at only two locations. The design/construction team worked with the agencies and landowners to keep the rise below 0.10 feet in these two locations. No hydraulic structures were impacted as the part of this project. The constructed project satisfies Hydraulic Modeling Guidelines in support of the Floodplain Development Permit Application and Stream Restoration Permit Deliverable requirements (Boulder County, 2017a), and Boulder County Land Use Code Article 4, Section 4-404.2(B)(1)(b) (Boulder County, 2017b).

Figure 9 illustrates 100-year flooding in the project area under the pre-existing and constructed project conditions. Rerouting high flood flow through the emergency overflow channel in the central project reach reduced 100-year flood elevations by as much as two feet, and helped significantly in overall reduction of flooding impact.



Stream Restoration

Drone Photography

POST-FLOOD DRONE ANALYSIS

Following the construction phase over the winter of 2017 to 2018, Ramboll evaluated the performance of the design and construction over a period of five months. To assist in this evaluation, Ramboll performed an **u**nmanned **a**erial **s**ystem (UAS or drone) survey at the end of construction on March 6th, 2018, and following re-vegetation and spring high flows on August 15th, 2018.

Ramboll collected high resolution aerial photographs (Figures 12 and 13) of the site using a DJI Phantom 4 Pro UAS flown by a Federal Aviation Administration (FAA) Part 107 certified drone pilot. The objective of this work was to assist in evaluating temporal changes in vegetation and hydrologic surface conditions using high-resolution aerial photography. The extent of the flight area was limited to approximately 200 feet upstream, and 200 feet downstream of the study area. Prior to flight operations, Ramboll performed pre-flight airspace checks of the planned flight area to ensure compliance with FAA regulations (14 CFR Part 107).

Figure 10

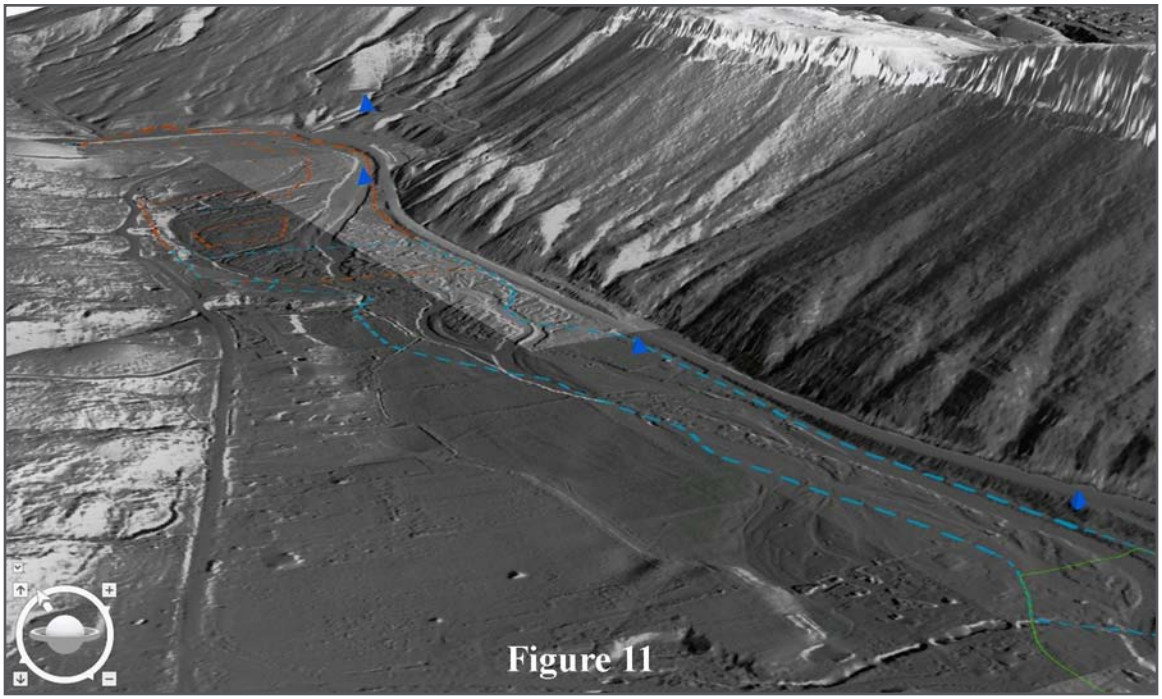


Figure 11

Stream Restoration

Figure 12

Figure 13

Drone Flight Planning

The drone flights resulted in the collection of 1,698 individual aerial images captured with a 20 megapixel camera along pre-determined flight lines (*see* Figure 10). Flight lines were determined by geo-referencing PDF reports provided by partners in the project using ArcGIS Pro. This information was then exported to DroneDeploy where flight planning was executed. Captured images were processed by Ramboll using photogrammetric methods (DroneDeploy). Two high-resolution Orthomosaic images and two digital terrain models of the flown area (one for each date flown) were thereby created.

Spatial Resolution

The spatial resolution of the imagery captured was approximately 1.3 inches per pixel. Ground **c**ontrol **p**oints (GCPs) were also captured using a high-precision **g**lobal **p**ositioning **s**ystem (GPS) to allow for a horizontal accuracy of approximately 1.5 inches and a vertical accuracy of 5.7 inches throughout the digital elevation model and Orthomosaic (a map incorporating layers of information gained from aerial photos). Following processing in DroneDeploy, Ramboll was able to quickly generate a Web Tile Layer within the DroneDeploy interface to add to ArcGIS Online for review with the project team (*see* Figure 11).

Drone Benefits

Interpretation of the photogrammetric data collected from UAS can replace some manual topographic surveys in the future, and could provide significant cost-savings during a project's implementation phase. Future stream restoration design/builds will be able to utilize drones to support the design process and efficiently and effectively document implementation and post-build conditions at a given site. In the case of Apple Valley North, the interpreted UAS data was used to document conditions and showed expected progression across the project area.

Stream Restoration

Stable Equilibrium

CONCLUSIONS

The Apple Valley North River Restoration Project was successfully designed and constructed following the catastropic flood event in 2013. The project-specific goals were met and the river channel was restored to a stable equilibrium where river function and habitat have been optimized. Approximately 20,000 cubic yards of flood deposited material was removed from the channel/floodplain and complexity and variability was increased in the morphology of the river. Fish passage is ensured with overwintering habitat constructed. The revegetation provided appropriate native riparian plants. Post-construction floodplain modeling showed that design changes made during project construction eliminated or reduced rises in the Base Flood Elevations — thus protecting residents from future flooding events.

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Dr. Felix Kristanovich from the Ramboll Seattle office is a senior water resources engineer with 29 years of experience in restoration of streams in the Pacific Northwest and California. Felix was a lead hydraulic and design engineer on numerous streamflow restoration projects in the Pacific Northwest, San Francisco Bay Area, and Southern California. Felix has conducted numerous hydrologic evaluations throughout the Pacific Northwest, and has also complimented hydraulic calculations on numerous streamflow, wetland, and habitat restoration projects. Felix has utilized hydrologic models HEC-HMS, HEC-GeoHMS, HSPF, SWMM and hydraulic models EFDC, CEQUAL-W2, HEC-RAS, HEC-GeoRAS, RiverFlow-2D, and RMA). Felix has led several restoration projects for the Chehalis Tribe, City of Centralia, Colville Confederated Tribes, Ducks Unlimited, and other clients, served as lead hydrologist and hydraulic engineer on costal estuarine restoration projects on the Skagit River Delta (Fir Island), Nisqually Wildlife Refuge, Chinook River/Estuary, and Black River. Felix has also supervised construction of several streamflow enhancement and restoration projects, and conducted expert peer review and quality control of the coastal resilience floodplain mapping of Ventura County, California. Felix holds a PhD in Civil Engineering from LSU, and a MS in Civil/Environmental Engineering from CALTECH. Felix is professionally registered as a Civil Engineer in five US states.

Scott Hayter is an environmental engineer focused on the remediation of contaminated soil, groundwater and sediment. He has more than 25 years of experience in environmental investigation and remediation, with particular emphasis on risk-based corrective action. Scott is an expert in stabilizing contaminated soil within natural and engineered river banks and shorelines.

David Heinze has over 25 years of environmental engineering and consulting experience and is a licensed professional engineer in three states. He has designed and constructed bank stabilization and ecosystem restoration projects in nine states with an emphasis on natural solutions to streambank stabilization, erosion and flood control and ecosystem restoration including wetlands. He also has significant experience with environmental site investigation and remediation under a variety of state and federal programs.

Michael Rawitch is a Senior Consultant at Ramboll's Overland Park, Kansas office. His primary research interests include the application of remote sensing technologies to solve environmental problems specifically related to fate and transport analysis, characterization, and remediation of contaminated soil and groundwater.

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Incentivized Aquifer Recharge

INCENTIVIZED MANAGED AQUIFER RECHARGE

BASIN SCALE IMPLEMENTATION

PROVIDES WATER FOR PRIVATE USERS, GROUNDWATER DISTRICTS, MUNICIPALITIES AND OTHERS

by David R. Tuthill, Jr. and Ronald D. Carlson, Recharge Development Corporation (Boise, ID)

INTRODUCTION

A process of Incentivized Managed Aquifer Recharge, utilizing ownership of marketable Aquifer Recharge Units is being implemented within Idaho's Eastern Snake Plain Aquifer. A powerful tool in establishing balanced and sustainable aquifer management, the Incentivized Managed Aquifer Recharge program could have beneficial application in suitable water basins throughout the West.

Aquifer Storage

Managed Aquifer Recharge (MAR) may be defined as processes designed to move water from land surface to aquifer storage. MAR has been conducted in various locations throughout the world since ancient times. Modern MAR efforts in the western United States have been frequently documented in *The Water Report* (see Recharge References below). Virtually all of these efforts, however, have been undertaken by or through a governmental entity (state or municipal), or by a private entity at a local scale involving one or just a few wells. The State of Arizona created a basin-wide opportunity for crediting recharge water but this system applies only in Arizona. While localized efforts in other basins have been implemented, to date they do not provide cost-effective incentivized solutions at a basin scale.

Basin Scale Incentives

The Recharge Development Corporation (RDC) is an Idaho corporation created for the purpose of developing infrastructure, processes, and strategies that will facilitate water retention projects to benefit residents and water users in the State of Idaho.

RDC is helping incentivize Eastern Snake Plain Aquifer entities to be involved in MAR through the application of Incentivized Managed Aquifer Recharge (patent-pending).

IMAR Concepts

Incentivized Managed Aquifer Recharge (IMAR) includes the following seven concepts:

1) Ownership of Aquifer Recharge Units (ARUs) that are fungible, have value, can be bought and sold and are directly analogous to the space acquired in a surface reservoir
2) MAR volumes are measured and the measured volumes are allocated to ARUs which each represent one acre-foot of virtual space in an aquifer, and are fully tracked
3) Real-time measurements of MAR volumes are based on surface water flow measurements. The evacuation of ARU storage generally relates to a pumped volume attributed to the ARU holder
4) Water allocated to owned ARUs becomes available to enable pumping. When the ability to pump under other established water rights would otherwise not be available, allocated ARU storage can be withdrawn and used as a supplemental water supply — in the same manner in which surface storage credited to the space of a reservoir space holder is used to supplement a surface water right (entitlement) to divert natural stream flow
5) Canal companies are commonly non-profit corporations created to distribute allocated water supplies to the stockholders of the company. Similarly, a local non-profit organization that is owned and operated by ARU owners is established under state law to accomplish long-term management of the ARUs and associated MAR within a basin
6) The ARUs are associated on a one-to-one basis with the shares of stock in the local non-profit corporation
7) Specific MAR allocation protocols that are similar to an allocation priority are applied to certain ARUs based on the date of acquisition of the shares

An eighth concept that is being investigated and discussed but has not yet been achieved is to treat a local aquifer as an additional reservoir that is fully integrated with the surface reservoirs in a basin. Implementation of this concept is a work in progress.

This article provides an overview of the unique IMAR process. From its genesis, a group of Idaho water users, lawyers, engineers and technical experts developed the operational concepts and legal approach for a defensible and robust IMAR program. The article discusses: ARUs; municipal applications; ground water district applications; tribal opportunities; and costs. The existing implementation in the Eastern Snake Plain Aquifer in Idaho is described. Criteria for other eligible basins are listed. The result is a case for application of these concepts in other basins throughout the western United States and internationally.

Incentivized Aquifer Recharge

Supply Option

Basin-Scale Need

Incentives

Basin Attributes

Title

ARUs

Storage in Aquifer

BACKGROUND

As demands increase for water in the western United States, and as climate change results in earlier runoff thus diminishing late season storage in snowpacks, water managers are challenged to provide adequate and reliable water supplies. High costs for constructing surface water storage and the associated environmental challenges incentivize inclusion of MAR as a tool to enhance management options.

MAR has been a topic of significant discussion in *The Water Report*. No fewer than 34 issues have contained articles that incorporate this concept (a comprehensive list follows this article). These *TWR* articles provide a broad survey of concepts and successful implementations of MAR. However, none of the articles sets out an incentivized mechanism for recharge to enhance water use opportunities at a basin scale. The realization that such a mechanism is needed led RDC three years ago to file a patent-pending application that provides an innovative process for MAR to be measured, modeled, tracked, and marketed via the tracking of ARUs and water that fills them.

RDC's contribution to water management is to incentivize MAR by making recoverable MAR fungible and usable at the discretion of the ARU owner. Incentives are intended to motivate the private and municipal sectors, which have built most of the water infrastructure in the nation, to implement true conjunctive management in an eligible basin. As clarified below, this process enables delivery of water for domestic, commercial, industrial, municipal, and agricultural uses.

QUALIFYING BASIN / ATTRIBUTES NEEDED

To be a candidate for implementation of RDC concepts, a basin needs the following four attributes:

1) Diversions from groundwater are regulated or are soon to be regulated.
2) The aquifer has space to accept recharge.
3) A source of water for MAR is relatively close and in reasonable quantity and quality for at least part of most years.
4) The state (or nation) has a regulatory framework that accommodates the RDC concepts identified above. Our analysis suggests that most of the western United States qualify for this fourth requirement. International acceptability is currently being explored.

CONCEPTUAL DESIGN

Seven fundamental concepts comprise the RDC Conceptual Design, as follows.

Concept 1. The first concept of the RDC approach is that a water user can acquire title to virtual space in the aquifer via an ARU. Many water users are already familiar with contracting for space with the US Bureau of Reclamation in a federally constructed reservoir. The space holder is guaranteed space, not water — it is up to Mother Nature to fill the space each year. Some reservoirs, like American Falls Reservoir in Idaho, have senior priority fill water rights on productive rivers so the annual fill is one hundred percent almost every year. Other reservoirs, like Palisades Reservoir, have a less certain source of supply. Typically, Palisades Reservoir will fill three years in five. During years when the reservoir does not fill the space holders receive a percentage of fill in their space.

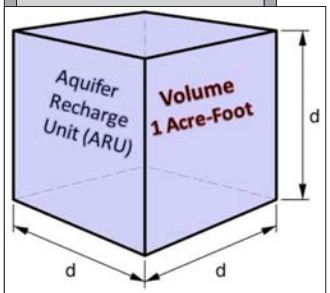
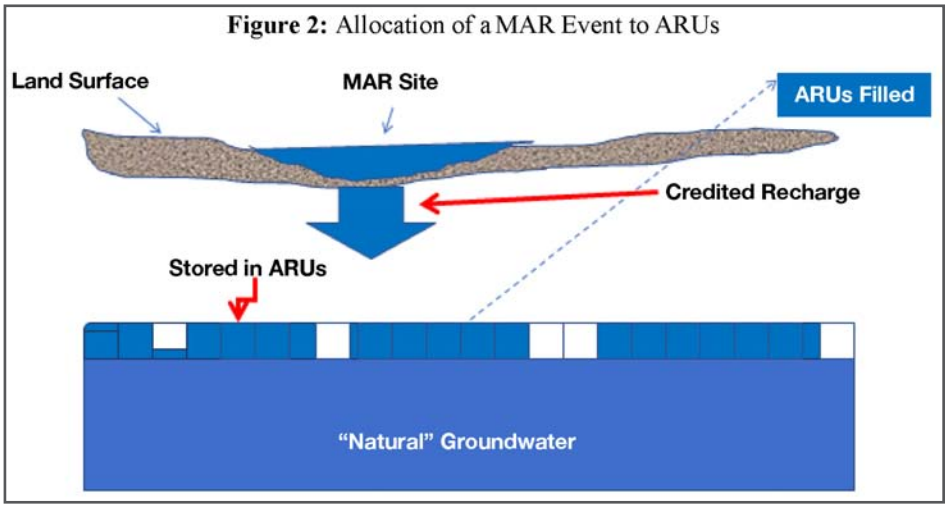


Figure 1: Aquifer Recharge Unit (ARU)

Similarly, an ARU holder in the Eastern Snake Plain Aquifer in southeastern Idaho holds a certificate for the ARUs held. As depicted in Figure 1, an ARU is equivalent to one acre-foot of space. An ARU can be filled annually with a MAR event. The ARU holder is offered water to fill the space at a cost based on the MAR costs for that year, and can decide whether or not to fill the ARUs. Costs are discussed below. RDC is often asked about the location of the ARU. The answer is that it is within the aquifer — just as an acre-foot of Palisades Reservoir storage space is within the reservoir.

Concept 2. The second concept of the RDC approach is that a MAR event is measured, allocated to ARUs, and fully tracked. Note that in Figure 2 that each acre-foot recharged is credited to an ARU. ARU holders retain the water in their ARUs to be diverted for beneficial purposes. All water recharged by RDC is assigned to specific ARUs.

Figure 2: Allocation of a MAR Event to ARUs



Incentivized Aquifer Recharge

Yearly Recharge

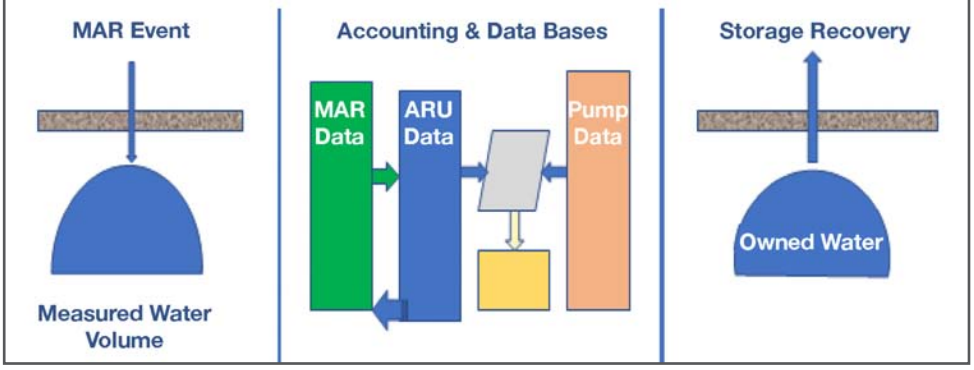
Real Time Accounting

Stored Water

One question about water in ARUs concerns how long the water remains in the ARU. The objective of RDC is to actively recharge every year at multiple sites in a basin so there is an ongoing freshening of the water supply and the ARU holder does not have to be concerned about water in the ARU diminishing. Modeling of groundwater supplies is required in each basin where ARUs are employed. While the model might demonstrate that an aquifer is leaking water over time, the annual use and refilling of ARUs reaches equilibrium where the results of the model do not have to be implemented. Use of the model will vary by basin and by state.

Concept 3. The third concept of the RDC approach is that real-time measurements of MAR events and ARU holder use are incorporated to the extent feasible. This management consists of measurement and tracking of MAR events and use by ARU holders, and on-line visibility of ARU use status by ARU holders and management organizations such as ground water districts. Figure 3 demonstrates this concept schematically. Note that the data are fed into a central location. The technique for data handling is to conduct computations and account tracking with QuickBooks, and to serve the information to users and delivery organizations like groundwater districts via the Web using cloud technology. In this way the account managers use software familiar to them while the power of the Internet is used for data serving.

Figure 3: Stages of Processing a MAR Event



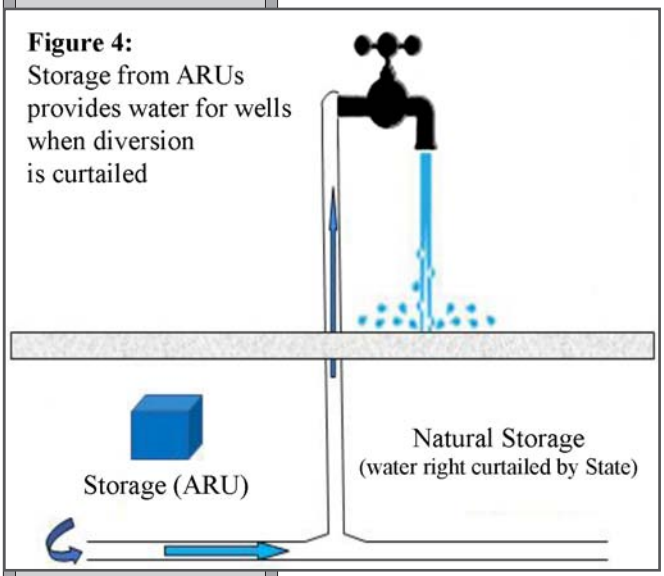


Figure 4: Storage from ARUs provides water for wells when diversion is curtailed

Concept 4. The fourth concept of the RDC approach is that water in ARUs is used to enable pumping when the normal groundwater supplies are no longer available, just as happens with surface water systems supplemented by surface reservoir storage when surface natural flow is no longer available. The schematic in Figure 4 depicts a well, represented as a faucet, with two sources of supply. One is "natural storage" — i.e., the groundwater subject to appropriation. If this source becomes unavailable due to a moratorium on new water rights or administrative curtailment of an existing water right, the water stored in an ARU can be pumped from the well and diverted. This emulates a diversion from a surface water system which has a water right from the stream, is curtailed due to a priority cut, and then continues to divert water placed in the stream from a reservoir. The practice takes place on many streams in Idaho and throughout the West each summer. Water in ARUs allows groundwater users to take advantage of the same efficiency-enhancing opportunity.

Management Organization

Concept 5. The fifth concept of the RDC approach is that a local non-profit organization needs to be created to establish long-term management of the ARUs and MAR within a basin. This concept is modeled after a technique used by American Falls Canal and Power Company (AFCPC). This company, whose predecessors got their starts constructing the first intercontinental railroad across Utah, reached out into eastern Idaho to construct water works and then handed the constructed works over to non-profit canal companies. An example is a large canal system constructed upstream from American Falls Reservoir. The Rexburg Decree decreed that an appropriation was made from the Snake River in the amount of 1,172.1 cubic feet per second with a date of priority of February 6, 1895. The works were conveyed by AFCPC to Aberdeen Springfield Canal Company (ASCC), a non-profit canal company that has managed the project for more than a hundred years. While AFCPC is long gone, the shareholders of ASCC have been enjoying the fruits of these construction efforts.

Incentivized Aquifer Recharge

Handoff

In a similar way, RDC is establishing the structure of ARUs in the Eastern Snake Plain Aquifer (ESPA). A local non-profit organization called Eastern Snake Plain Aquifer Recharge, Inc. (ESPAR) has been created to manage this system. Management for ESPAR is provided by an Executive Director. RDC is in the process of handing over tasks and responsibilities to ESPAR. For example, this year most of ESPAR's new recharge sites are being developed jointly with RDC under the leadership of ESPAR's Executive Director, and operations and maintenance charges for the year will be billed by ESPAR. Present planning calls for a complete handoff to ESPAR within five years. This technique enables RDC to move its efforts to other basins while providing a lasting management structure for ARU holders in the ESPA.

Stock Shares

Concept 6. The sixth concept of the RDC approach is that ARUs mirror shares of stock in the local non-profit. Most canal companies in the western US are comprised of water users who hold shares of stock in the company. In a similar manner, each ARU acquired in a basin mirrors a share in the local non-profit formed for that basin. As an example, water users in the ESPA hold a share of stock in ESPAR for each of their ARUs. Thus, ESPAR functions in a similar way to a surface water canal company, with one vote per share or ARU held.

Priority of ARUs

Concept 7. The seventh concept of the RDC approach is that fill priority of ARUs is based on the priority of acquisition of the shares. For all Class-G ARUs (further defined below), the fill of the ARUs is first offered to the senior ARU priority date. Each year the local non-profit establishes a price for the water that is recharged based on costs for the year. The holders of the most senior ARUs are offered an opportunity to fill their ARUs at this price per acre-foot. To the extent not all the water is used to fill this priority, the water is offered to the holders of the next priority of ARUs, and so on until all of the recharged water has been allocated. Thus the most senior ARUs have the highest value. This process is similar to classes of shares in a surface water reservoir where Class A shares represent the most senior priority date in a reservoir, Class B shares represent the next most senior, etc.

ARU Valuation

The value of ARUs is anticipated to increase over time, in a manner similar to the space holder contract in a Bureau of Reclamation (Reclamation) reservoir. One example in Idaho is the cost of storage space in Palisades Reservoir. When the reservoir was originally planned in the 1950s, Recalmation representatives had difficulty finding buyers of the space at $7.20 per acre-foot, paid with no interest over 40 years, a cost of $0.18 per acre-foot per year. Now the cost to purchase this space is anticipated to be at least $1,000 per acre-foot — if space for sale can be identified. New surface water storage is being priced in the vicinity of $2,500 per acre-foot in some locations.

Integrated Sources

Eighth Concept: Not Yet Achieved

The seven concepts identified above have all been implemented in the ESPA, and are ready to be implemented in other basins in the western US and internationally.

An eighth concept - whereby the aquifer would be regulated as an additional reservoir - has been a goal of RDC (depicted in Figure 5). This concept has been presented and discussed with water users and officials and would certainly enhance the MAR process but is not a requirement for the process already established. RDC intends to further develop this concept and will be providing an article outlining the concept for next month's issue of *The Water Report*.

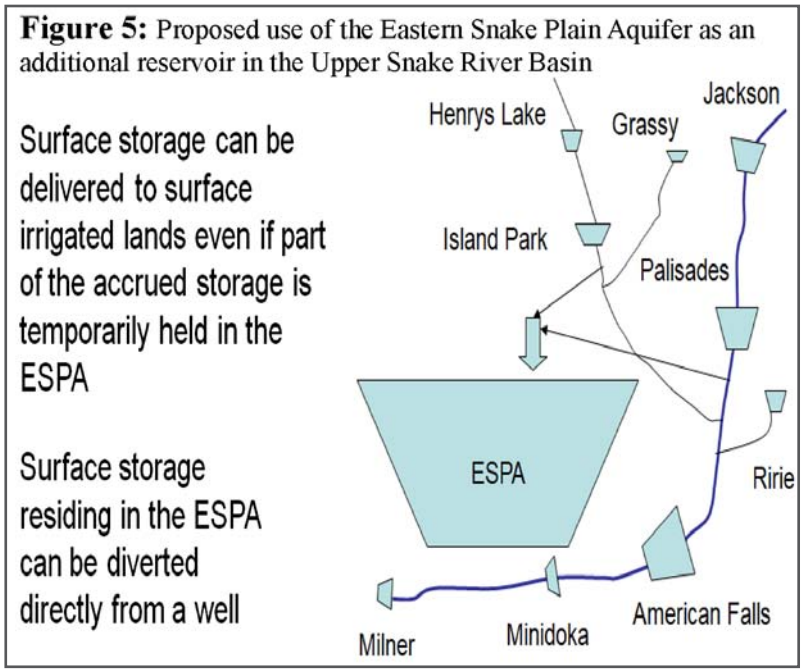


Figure 5: Proposed use of the Eastern Snake Plain Aquifer as an additional reservoir in the Upper Snake River Basin

Incentivized Aquifer Recharge

Credit for Recharge

Implementation (Recharge)

LEGAL FRAMEWORK

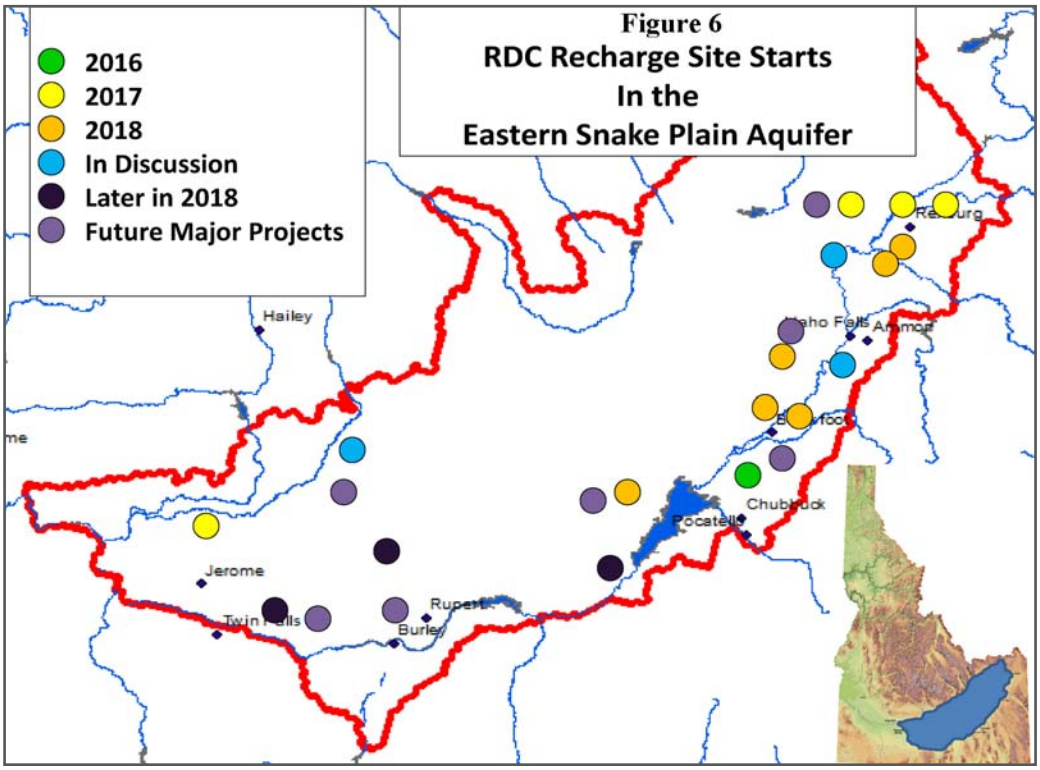
RDC commissioned a study of legal requirements for MAR, as reported in two previous *TWR* issues (see Mortimer, *TWR* #127 and Mortimer & Tuthill *TWR* #129). The concepts in these documents remain in place. In addition, in a letter to RDC dated June 22, 2018, Gary Spackman, Director of the Idaho Department of Water Resources (Department) provided supplemental guidance. The letter first discussed recharge conducted under a mitigation plan, for which RDC has provided mitigation for its clients. The letter goes on to discuss conditions for credit for recharge not conducted under a mitigation plan:

> To the extent the Aquifer Recharge Units, as you label and describe them, may be offered as mitigation for a transfer application or new permit, the Department would expect to follow the procedures already developed by the Department. In other words, time, place, and quantity of recharge are critical and inform a decision by the Department regarding the extent to which recharge, at a specific time and place, can offset a diversion at a specific location at a specific time. Of course, transfer applications and/or new permit applications may be contested, and the arguments raised by the protestants must be addressed by the Director.

RDC accepts and concurs with this guidance as the review standard for use of water from ARUs.

IMPLEMENTATION IN THE EASTERN SNAKE PLAIN AQUIFER

Filling of ARUs in the Eastern Snake Plain Aquifer started in 2016 with one recharge location, operated by the Shoshone Bannock Tribes, in the amount of 1,600 acre-feet. During 2017 the number of recharge sites increased to six, resulting in the recharge of about 19,000 acre-feet and enabling the filling of all existing ARUs. As depicted in Figure 6, during 2018 the number of recharge sites has been doubled thus far, with anticipation of several more being added before the end of the year. We anticipate recharging at a minimum of 20 sites by the end of 2019.



MUNICIPAL APPLICATIONS

During 2018, RDC has extended the principles of IMAR to municipalities and is finding significant opportunity to save costs and provide for city growth using these principles. On February 21, 2018, RDC and the Eastern Idaho Water Rights Coalition jointly hosted a symposium in Idaho Falls, Idaho, to explore water supply alternatives with a target audience of those with interest in municipal, subdivision, commercial, and industrial uses. A portion of the invitation flyer is depicted in Figure 7. The symposium was well attended by representatives from more than a dozen communities in Eastern Idaho and other interested parties. Slides for ten of the presentations at the symposium are available on the RDC website at: www.rechargedevelopment.com/symposium/

Incentivized Aquifer Recharge

Supply Options

Three techniques were presented for obtaining additional water supplies: (1) purchase a water right associated with irrigated ground and move it to a new use; (2) install a dual system whereby in-house use is provided from groundwater and lawn watering is provided from the surface water system; and (3) use ARUs to mitigate additional diversions from groundwater. A presentation entitled "*Water Supply Evaluation Spreadsheet*" describes a spreadsheet tool for comparing the costs and benefits of the three options provided, and any other options identified, on a case by case basis. The presentations have led to more specific discussions with various water purveyors, and thus far the ARU option is proving highly cost effective.

Wastewater Basins

City of Shelley Application

The City of Shelley owns some old wastewater basins that appear to be ideal locations for MAR. The City is considering using its water delivery facilities to bring water to the site, and in cooperation with the local irrigation district and RDC it has the opportunity to conduct recharge that will provide mitigation for its growth and for the use of other ARU holders. The City has the prospect of long-term positive returns on its investments and thus is considering becoming an ARU holder.

Discharge Effluent

EIRWWA Application

The Eastern Idaho Regional Wastewater Authority (EIRWWA) maintains the Oxbow Treatment Plant located southwest of Shelley, Idaho. The plant is capable of producing Class A wastewater but is facing increasingly stringent requirements to reduce phosphorous in its discharge effluent to the Snake River. While phosphorus is regulated when introduced as a point source to the Snake River (current situation), there is no regulation of phosphorus for recharged water. This is because phosphorus is a nutrient that can cause excess growth of algae in a river, but is not a pollutant regulated for groundwater.

RDC introduced an opportunity to conduct MAR with this water to both address the phosphorous issue and create credits for recharged water. This is possible because even though the Snake River flows by the plant, the river is not connected to the aquifer in this reach, resulting in the water table being about 80 feet below ground surface. EIRWWA is presently investigating ways to get credit for its MAR, and is working with their engineers and RDC to find an optimal outcome.

Recharge Facilities

City of Gooding Application

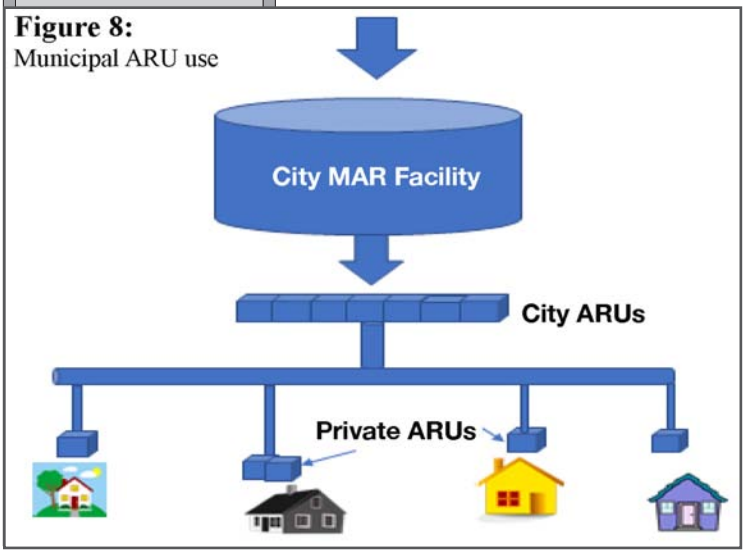
The City of Gooding in central Idaho already has a mitigation solution to account for impacts on the ESPA caused by pumping City water. However, the City also has an opportunity to recharge additional water to earn credits under MAR. Accordingly, the City has entered into a 20-year agreement with RDC to implement MAR and share returns. At the end of the 20-year period the recharge facilities will resort to full ownership by the City. Between June, 2017, and March 31, 2018, a total of 10,021.3 acre-feet were recharged in the City facility. Plans are underway to enhance the recharge to enable even higher amounts in the future.

Dual System v. ARUs

City of Blackfoot Application

The City of Blackfoot in eastern Idaho is growing. Water is a critical requirement. Prior to an ARU solution being made available, the City had opted to require dual systems for all new subdivisions. A dual system has one piping system for in-home potable water and a separate non-potable system for lawns and gardens. At first glance implementation of a dual system is attractive, enabling use of surface irrigation water for lawn watering purposes. However, there are multiple, costly challenges with implementing such systems including: (1) often the surface water system needs to be conveyed to a subdivision requiring costly crossings of roads, railroads and other properties; (2) a pumping plant and filtration system are needed between the surface canal and the subdivision supply (these works are costly to install and require ongoing maintenance and periodic replacement); (3) the flow provided by the surface water system is typically a continuous flow and is not suited to the desires of residents to water lawns primarily during early morning hours; (4) the ongoing management of the system is left to either a homeowners association or the irrigation district or canal company (this is often a major and unwanted additional task); and (5) some surface water systems are curtailed prior to the end of the irrigation season depending on annual water supply availability. City of Blackfoot leaders are now considering the option of ARUs, allowing a single system where irrigation flows from groundwater are mitigated by IMAR. Figure 8 depicts one option for use of ARUs within the city, whereby ARUs are purchased by the City, and then are sold by the City to either developers or lot holders. If, for example the City purchases Class-S ARUs (as described below) at $25.00 each, and sells them to lot owners at $250.00 each, then the City receives funds for the development and installation of its MAR system.

Figure 8:
Municipal ARU use



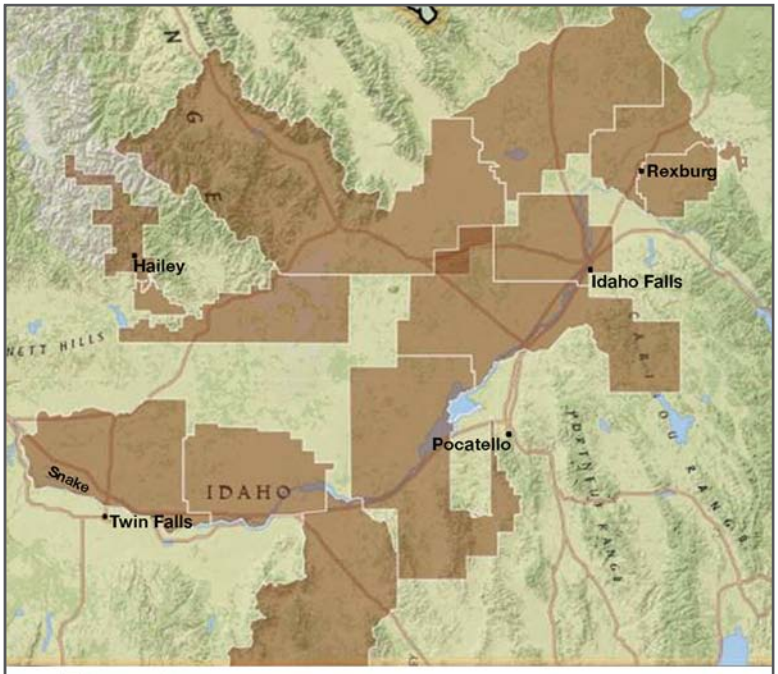
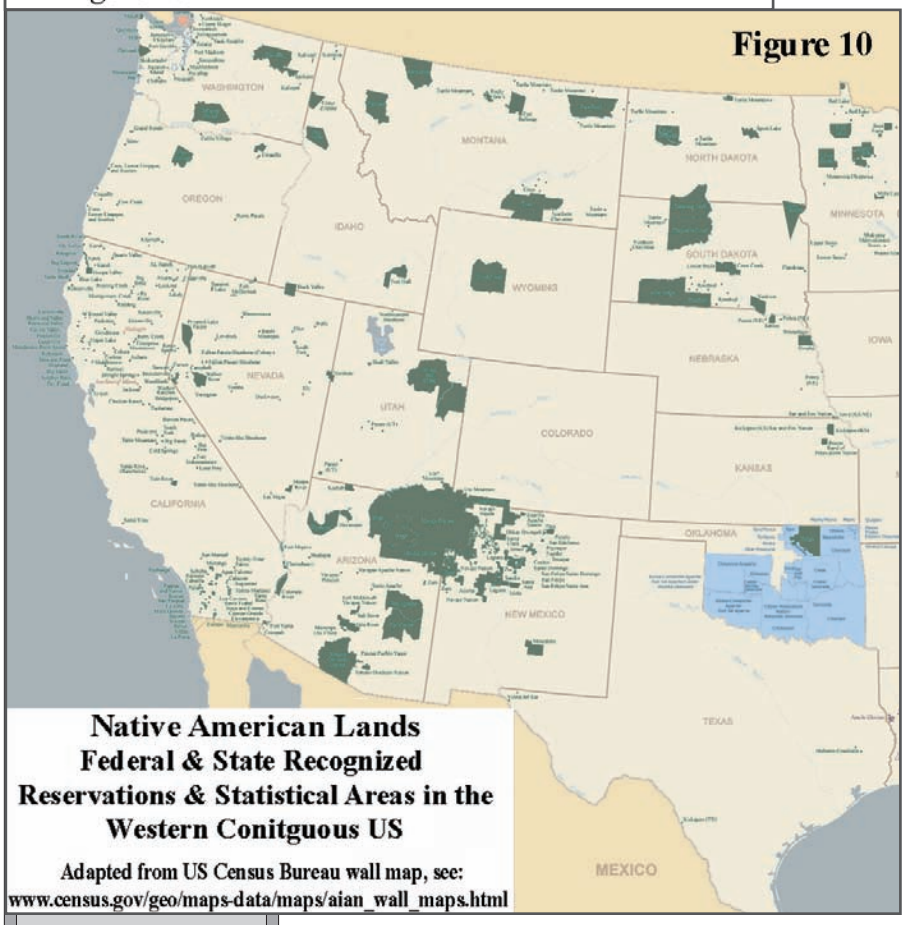


Figure 9: Ground Water Districts in Southeastern Idaho

GROUND WATER DISTRICT APPLICATIONS

Idaho has established ground water districts in locations where groundwater is now regulated or is anticipated to be regulated. Locations of ground water districts in eastern Idaho are depicted in Figure 9. As defined by the enabling statutes in Chapter 52, Title 42, Idaho Code, these districts have the power to develop mitigation solutions on behalf of their members.

In December, 2017, the Board of the American Falls Aberdeen Ground Water District presented to their general membership meeting a proposal to acquire 2,500 Class-G ARUs, if supported by the general membership. After significant discussion and debate, the proposal passed unanimously pending a due diligence effort by the Board. The Board hired a water attorney to conduct a legal review of ARUs, resulting in a significant investigation of the ARU process. This review resulted in finding no reason to alter the plan for purchase. On March 14, 2018, the agreement to purchase 2,500 ARUs was signed and water is now being made available to fill the ARUs. RDC is now in discussion with other ground water districts regarding purchase of ARUs. This technique is nicely aligned with the purposes for which the districts were formed, either on a district-wide basis of for individual water users within a district.



TRIBAL FACTOR IN MAR

As depicted in Figure 10, American Indian Reservations cover significant lands in the western United States. Much of this land is located in headwater areas, where opportunities exist for MAR. For example in Idaho, RDC and the Shoshone Bannock Tribes signed a two year pilot agreement in 2016 whereby credits for MAR conducted by the Tribes would be marketed by RDC, with a sharing of revenues. This agreement resulted in recharge of 1,600 acre-feet in 2016 and 1,430.7 acre-feet in 2017. The pilot agreement has recently been extended with a new four-year agreement between the parties. The Tribes have expressed an interest in expanding their recharge capabilities, encouraged by RDC.

RDC will work to encourage participation by tribes in other basins where IMAR is being implemented.

Real Time Data Acquisition

DATA ACQUISITION TECHNIQUES

Real-time data acquisition enables improved water management by providing water managers with opportunities to make decisions on water use based on water supplies. For example, watering of alfalfa for a marginally profitable fourth cutting might be influenced by water availability. Historically the costs of real-time data acquisition have been high, requiring the installation of meters and on-site inspection of read-outs. Presently in the ESPA, water users are required to install meters on irrigation wells so real-time management can be made available via the transmittal and management of the data output.

Incentivized Aquifer Recharge

Data Sending

Figure 11: Telemetered Data Acquisition Installation

Teton Technology has developed a data sending device, shown in Figure 11, that can be attached to most types of flow meters, to send the data daily or more frequently to a radio tower located up to 35 miles away. The data are collected by the cloud-based system developed by Teton Technology as sponsored by RDC and two ground water districts, and served out as described below. This system is being tested this year for wider application in the future.

Management Technology

MAR Management Software

In 2017, RDC teamed with the American Falls Aberdeen Ground Water District and the Bingham Ground Water District to develop the web based portion of tracking diversions from wells and filling of ARUs. Teton Technology developed the software package that is presently in the testing phase. This software enables individuals to see their own water pumping status, and water filled in and used from their ARUs. It also enables visibility at the ground water district level and the basin level. The software calculates assessment algorithms that include: priority dates, tiered systems, and recharge credits; pairing with moisture sensing technology and other agri-sensors to enhance management capabilities; and full insight to both farm managers and district managers. Figure 12 is a screenshot of this software.

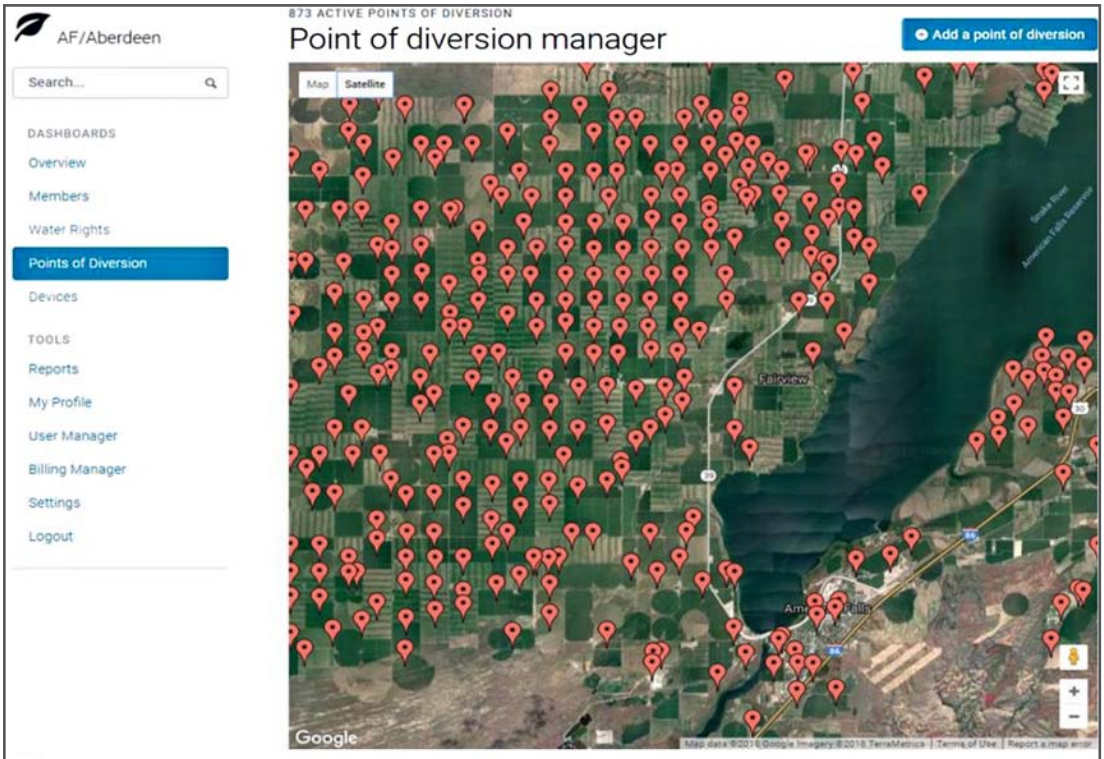


Figure 12: Screenshot of Data View of Wells — The point of diversion manager shows all active wells within the district. Hovering over well yields additional information.

Incentivized Aquifer Recharge

TYPES OF ARUs

The most common type of ARU is "Class-G" (for general). For this type of ARU, RDC or its assign is responsible to acquire water, arrange for facilities, and implement MAR. "Class-S" (for supply) ARUs are different in that they are available for sale only to a buyer who has a water supply and facilities, and can recharge its water. Typically a Class-S ARU is purchased by a canal company or other water delivery organization, or a municipality recharging its wastewater. A Class-G ARU can be purchased by any water user within the basin.

Costs

Implementation Costs

Costs of implementing RDC concepts will vary based on the specific nature of a basin. The costs in the ESPA provide an example. These costs consist of two parts: annual O&M (**o**peration and **m**aintenance) costs and the purchase of ARUs. One consideration in the ESPA is many of the initial costs were borne by initial ARU holders for development purposes in exchange for ARUs. Other basins will benefit from the information gained in the ESPA.

Figure 13 depicts costs for O&M in the ESPA. The reasons for a decrease in O&M costs are better economy of scale and an increase in the efficiency of system development and management.

O & M Costs

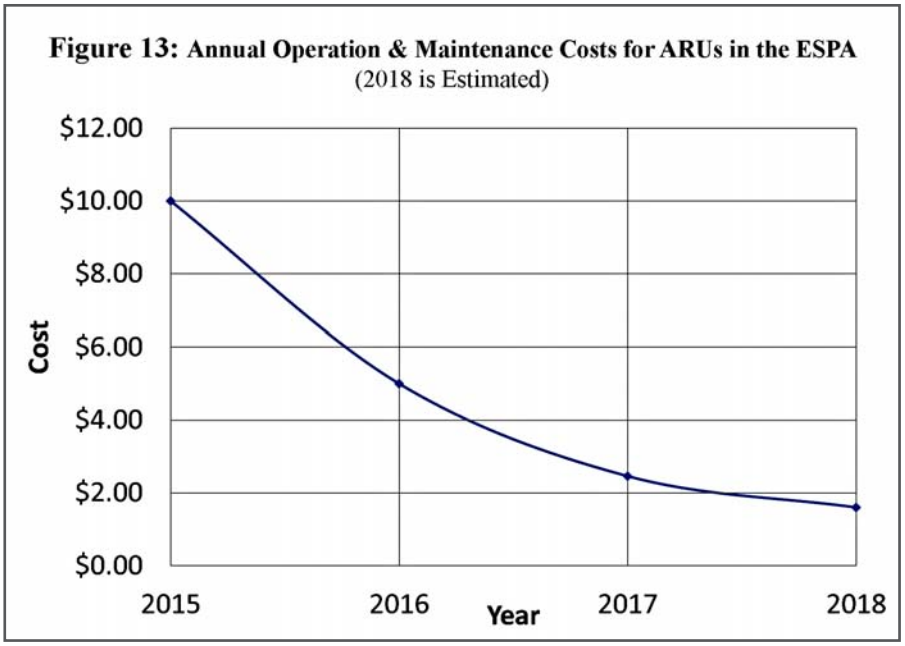


Figure 13: Annual Operation & Maintenance Costs for ARUs in the ESPA (2018 is Estimated)

Cost Comparison

Costs to acquire Class-S and Class-G ARUs are depicted in Figure 14. Note that the cost of a Class-S ARU is ten percent of the cost of a Class-G ARU. This is because owners of Class-S ARUs are responsible to obtain the water and develop the works to fill their ARUs. While Class-G ARUs cost ten times as much, ninety percent of the cost is placed in a trust fund to construct system works. The Class-G ARU is more appropriate for an individual, a municipality or a ground water district that does not have a location to develop their own recharge sites. The reason for increases in the costs of Class-S and Class-G ARUs over time is that the value of the ARUs increases as the system becomes more established.

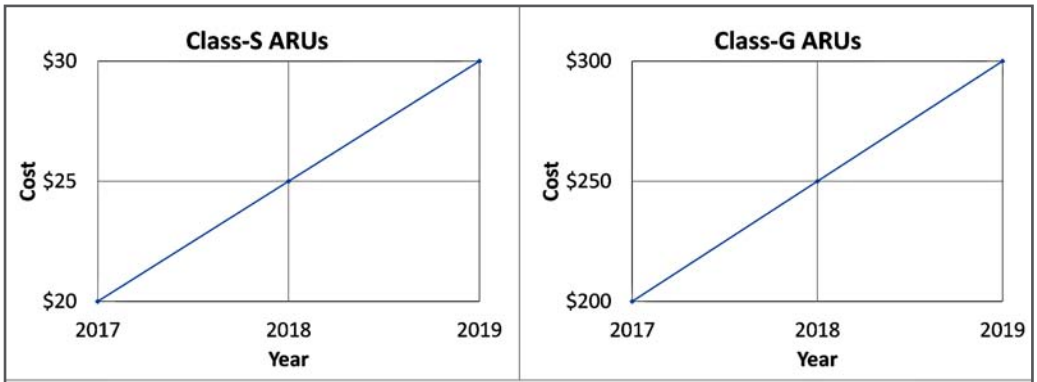


Figure 14: Costs of Class-S & Class-G ARUs in the ESPA (2019 is estimated)

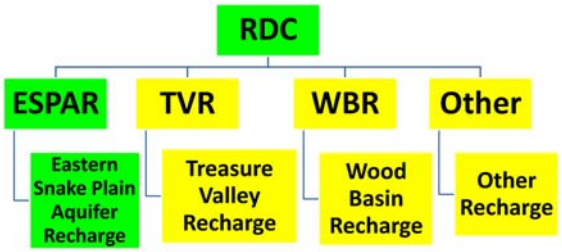
Water Supply & Demand

The price of water acquired to fill ARUs will vary depending on the available supply and associated demand each year, and water will be more expensive in dry years. The cost of water for fill in 2016 was $30.00 per acre-foot and in 2017 was $15.00 per acre-foot. The cost for 2018 is yet to be determined.

POTENTIAL FOR IMPLEMENTATION IN OTHER BASINS

Starting in the summer of 2018, RDC has been is actively seeking opportunities for implementation in other basins. Initial outreach has resulted in feedback for potential implementation in additional basins in Idaho, and in Oregon, Washington, Nevada, and New Mexico. As depicted in Figure 15, the RDC organizational structure anticipates the addition of other basins, with RDC providing start-up assistance, which will lead to long-term operations by a local non-profit.

Figure 15: RDC Organizational Structure



RDC & ESPAR are in place. Others are proposed.

CONCLUSION

The principals of RDC have spent eight years developing the concepts and techniques described in this paper, to provide for implementation of Incentivized Managed Aquifer Recharge. The system is now operational in one basin, with movements toward starting the process in many others. These processes provide opportunities for implementation of conjunctive management and for additional beneficial use of water in the spirit of western water law. The principals look forward to assisting others with implementation of these concepts.

For Additional Information:

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Dave Tuthill has worked in the field of water resources throughout his career. He earned a B.S. in Agricultural Engineering from Colorado State University, an M.S. in Civil Engineering from the University of Colorado, and a Ph.D. in Civil Engineering from the University of Idaho. He worked for 33 years at the Idaho Department of Water Resources, serving as Director the last two years. In 2009 he founded Idaho Water Engineering, and is a founding member and Vice President of Recharge Development Corporation.

Ronald Carlson started his work in the field of water resources as a farmer and surface water irrigator. It was from this vantage point that he commenced a 45 year career in the field of water resource administration and water management. He earned a B.S. and M.S. in Agricultural Engineering from the University of Idaho. He was licensed in the State of Idaho as a professional engineer and land surveyor in 1975. He served as the Watermaster of the Snake River in Idaho for 29 years and while in that capacity implemented automated data gathering and computerized accounting for the water district he was elected to serve. While Watermaster he managed basin-wide recharge programs as proof of concept efforts and was successful in establishing the Water Bank and Rental Pool structures in Snake River Water District 1. He also was instrumental in getting the aquifer recognized as a reservoir when the Teton Dam failed in 1976. He is a founding member and Treasurer of Recharge Development Corporation.

Incentivized Aquifer Recharge

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IDWR Aquifer Recharge Project in Idaho Awarded 2025 Grant (*TWR* #24, Water Briefs: February 15, 2006)
Aquifer Recharge: Eastern Snake Plain Aquifer Assessments Funded (*TWR* #34, Water Briefs: December 15, 2006)
Aquifer Recharge and Storage: Ongoing Implementation Concerns by Peter G. Scott (*TWR* #54, August 15, 2008)
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Aquifer Recharge and Wastewater Treatment Project (*TWR* #153, Water Briefs: Nov. 15, 2016)
Hydrogeology & Water Rights Transfers in Washington State - Know Your Source by Tyson D. Carlson (*TWR* #155: Jan. 15, 2017)
Aquifer Storage & Recovery - An Important Tool for Western States: Permitting Developments & Opportunities in Washington by Chris Pitre (*TWR* #156: Feb. 15, 2017)
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Groundwater Conveyance

GROUNDWATER & THE CLEAN WATER ACT

POINT SOURCES, GROUNDWATER CONVEYANCE OF POLLUTANTS, AND THE CLEAN WATER ACT

by David Moon, Editor

CWA Inapplicable

In two cases handed down on September 24th, the 6th Circuit Court of Appeals (6th Circuit) ruled that the federal Clean Water Act (CWA) does not apply to regulate pollutants that travel from a point source through hydrologically connected groundwater before entering rivers and lakes. According to the Sixth Circuit, the clear language of the CWA strictly limits its jurisdictional reach to those situations where the source of pollution dumps *directly* into "navigable waters." *See Kentucky Waterways Alliance v. Kentucky Utilities Company*, Case No. 18-5115 (Sept. 24, 2018) (*Kentucky Waterways*) and *Tennessee Clean Water Network v. TVA*, Case No. 17-6155 (Sept. 24, 2018) (*Tennessee Clean Water*).

Kentucky Waterways

Hydrological Connection

In *Kentucky Waterways,* 6th Circuit referred to the crux of the jurisdictional issue and the plaintiffs' arguments concerning the hydrological connection between groundwater and navigable waters. "The backbone of Plaintiffs' argument in favor of the hydrological connection theory is that the relevant CWA provision does not contain the word 'directly.' Because it only prohibits the discharge of pollutants 'to navigable waters from any point source,' *id*. § 1362(12)(A), they argue that the CWA allows for pollutants to travel from a point source *through* nonpoint sources en route to navigable waters." *Kentucky Waterways, Slip Op.* at 11 (emphasis in original).

The 6th Circuit then turned to the language in the Clean Water Act concerning "effluent limitations" and the Webster and Oxford Dictionaries to support its conclusion.

> First, the guidelines by which a CWA-regulated party must abide — the heart of the CWA's regulatory power — are known as "effluent limitations." *Id*. § 1362(11); §1314(b). These are caps on the quantities of pollutants that may be discharged from a point source and are prescribed on an industry-by-industry basis. *See id.* § 1314(b). The CWA defines effluent limitations as restrictions on the amount of pollutants that may be "discharged from point sources *into* navigable waters." *Id*. § 1362(11) (emphasis added). The term "into" indicates directness. It refers to a point of *entry*. *See Into*, Webster Third New International Dictionary, Unabridged. 2018.. Web.21 Aug. 2018 ("[E]ntry, introduction, insertion."); *Into*, Oxford English Dictionary (2d ed. 1989) ("Expressing motion to a position within a space or thing: To point within the limits of; to the interior of; *so as to enter*.") (emphasis added). Thus, for a point source to discharge into navigable waters, it must dump directly into those navigable waters — the phrase "into" leaves no room for intermediary mediums to carry the pollutants.
>
> Moreover, the CWA addresses only pollutants that are added "*to* navigable waters *from* any point source." 33 U.S.C. § 1362(12)(A) (emphasis added). Accordingly, the CWA requires two things in order for pollution to qualify as a "discharge of a pollutant": (1) the pollutant must make its way to a navigable water (2) by virtue of a point-source conveyance. Under the facts of this case, KU [Kentucky Utilities Company] is discharging pollutants into the groundwater and the groundwater is adding pollutants to Herrington Lake. But groundwater is not a point source. Thus, when the pollutants are discharged to the lake, they are not coming *from* a point source; they are coming from groundwater, which is a nonpoint-source conveyance. The CWA has no say over that conduct.

"Into" Definition

Must Dump Directly

Kentucky Waterways, Slip Op. at 11-12.

"By Way of Groundwater

The 6th Circuit in *Kentucky Waterways* concluded that the plaintiffs' CWA suit should be dismissed, stating its rationale succinctly in the Conclusion of the opinion: "The CWA does not impose liability on surface water pollution that comes by way of groundwater." *Slip Op*. at 19. The 6th Circuit did rule that the defendant's (Kentucky Utilities Company's) conduct is governed by the federal Resource Conservation and Recovery Act (RCRA) and the federal district court must hear that claim.

Escaping Liability

The 6th Circuit's decision as to CWA jurisdiction, however, was a 2-1 split decision. Judge Clay disagreed with the reasoning of the majority and framed the issue much differently. "Can a polluter escape liability under the Clean Water Act ('CWA'), 33 U.S.C. §§ 1251–1387, by moving its drainage pipes a few feet from the riverbank? The Fourth and Ninth Circuits have said no. In two cases today, the majority [of the 6th Circuit] says yes. Because the majority's conclusion is contrary to the plain text and history of the CWA, I respectfully dissent from the majority's conclusion that Plaintiffs' CWA claim was properly dismissed." *Slip Op*. at 20.

Groundwater Conveyance

Judge Clay at the end of his dissent explained his reasoning and cited the other Circuit Court decisions. "I believe the CWA clearly applies to the allegations in this case. Accordingly, I would join our sister circuits in holding that the CWA prohibits all pollution that reaches navigable waters 'by means of ground water with a direct hydrological connection to such navigable waters[.]'*Upstate Forever*, 887 F.3d at 652; *see Hawai'i Wildlife Fund*, 886 F.3d at 745–49. Under this standard, Plaintiffs have stated a valid claim that Kentucky Utility Company's unpermitted leaks are unlawful." *Slip Op*. at 29.

Tennessee Clean Water

In *Tennessee Clean Water*, the case also involved coal ash pollution. The issue on appeal was CWA applicability to "wastewater [that] is allegedly discharged through leaks from the ponds through the groundwater into the Cumberland River, a waterway protected by the Clean Water Act… ." *Slip Op*. at 2.

Pollutant Leaks

> After a bench trial, the district court found that TVA violated the CWA because its coal ash ponds at the Gallatin plant leaks pollutants through groundwater that is "hydrologically connected" to the Cumberland River without a permit. This theory of liability has been labeled the "hydrological connection theory" by the Federal Environmental Protection Agency ("EPA"). As explained in the companion decision also issued today, *Kentucky Waterways All., v. Kentucky Utilities Co*., No. 18-5115, --- F. 3d ---, (6th Cir. -- , 2018) ("*Kentucky Waterways*"), we find no support for this theory in either the text or the history of the CWA and related environmental laws. We therefore hold that the district court erred in granting relief under the CWA.

Slip Op. at 2-3. The 6th Circuit decision in *Tennessee Clean Water* was another 2-1 decision, with Judge Clay again dissenting.

In his dissent in *Tennessee Clean Water*, Judge Clay clarified the question of whether or not the regulation of groundwater pollution — which is governed by the states — was at issue.

Discharge to Navigable Waters

> But imposing liability in this case would not marginalize the states. To the contrary, the district court made clear that it was not regulating the pollution of groundwater itself. *See Tennessee Clean Water Network*, 273 F. Supp. 3d at 826 ("The Court agrees with those courts that view the issue not as whether the CWA regulates the discharge of pollutants into groundwater itself but rather whether the CWA regulates the discharge of pollutants to navigable waters via groundwater." (quotation marks, alteration, and citation omitted)). Instead, the district court was addressing pollution of a navigable water — specifically, the Cumberland River — via groundwater. This distinction was clear to the Fourth and Ninth Circuits.

Tennessee Clean Water at 23.

Conclusion

The US Supreme Court will undoubtedly make the final decision on the CWA's applicability, due to the ramifications of the issue on the regulated community and the split between the Circuit Courts. The 9th Circuit and 4th Circuit both ruled that the Clean Water Act does apply in similar situations where pollutants traveled through hydrologically connected groundwater before going into "navigable waters."

The Water Report previously reported on the two earlier Circuit Court rulings on this issue (referenced above) in two excellent articles by Kathy Robb of Sive, Paget & Riesel, PC. *See* Robb, *TWR* #170, April 15, 2018 and Robb, *TWR* #171, May 15, 2018.

For Additional Information:

Kathy Robb, Sive, Paget & Riesel, 646/ 378-7248 or krobb@sprlaw.com

Kentucky Waterways and *Tennessee Clean Water* at: www.opn.ca6.uscourts.gov/opinions/opinions.php

WATER BRIEFS

WATER MARKETS — US

RECLAMATION STRATEGY GRANTS

On October 4, Bureau of Reclamation Commissioner Brenda Burman announced that Reclamation has awarded $1.3 million to seven projects to establish or expand water markets or water marketing activities. These seven projects are located in California, Colorado, Nevada, Oklahoma, and Washington.

Water marketing strategy grants are used to conduct planning activities in developing a water marketing strategy. Water marketing refers to water rights transactions and includes the lease, sale or exchange of water rights undertaken in accordance with state and federal laws between willing buyers and sellers.

The selected projects are:
• Carson Water Subconservancy District (NV)
— Reclamation funding: $100,000
non-federal funding: $111,649
• City of Grand Junction (CO)
— Reclamation funding: $200,000
non-federal funding: $200,000
• County of Madera (CA)
— Reclamation funding: $199,999
non-federal funding: $200,000
• Inland Empire Utilities Agency (CA)
— Reclamation funding: $400,000
non-federal funding: $1,266,949
• McMullin Area Groundwater Sustainability Agency (CA)
— Reclamation funding: $193,000
non-federal funding: $193,000
• Seleh-Moxee Irrigation District (WA)
— Reclamation funding: $72,90
non-federal funding: $72,900
• The Chickasaw Nation (OK)
— Reclamation funding: $149,228
non-federal funding: $149,228

Reclamation's WaterSMART program works cooperatively with States, Tribes, and local entities as they plan for and implement actions to increase water supply through investments to modernize existing infrastructure and attention to local water conflicts. Visit www.usbr.gov/watersmart for additional information about the program.
For info: Complete description of projects available at: www.usbr.gov/watersmart/watermarketing/index.html

FLOW RESTORATION — WA

IMPLEMENTATION GRANTS

Washington State has a new streamflow restoration law in response to the "*Hirst* decision." *Hirst* was a 2016 Washington Supreme Court decision that changed how counties approve or deny building permits that use permit-exempt wells for a water source. *See* Water Briefs, *TWR* #168 and Pitre, *TWR* #169. The law, RCW 90.94 Streamflow Restoration, helps protect water resources while providing water for families in rural Washington.

In its 2018 session, the Washington Legislature authorized $300 million in capital funds until 2033 as part of the Streamflow Restoration law. The funding is for projects that will help fish and streamflows with much of the funding being passed through the Washington Department of Ecology (Ecology) to on-the-ground projects across the state.

Ecology has launched a grant program for Streamflow Restoration implementation projects. The first round of grants will focus on projects that improve streamflows and instream resources. Ecology has developed interim guidance for project proponents seeking funding in this first round. Future funding cycles under this 15-year grant program will be based on a rule currently under development. The grant cycle opened October 1, 2018, and closes at 5 pm October 31, 2018. Applications are being accepted through Ecology's Administration of Grants & Loans (EAGL) system.

Funding is available statewide, but priority will be given to watersheds and areas addressed in the law and basins with Endangered Species Act-listed fish species. Eligible applicants are limited to public entities (state and local agencies, and special use districts) and non-profit organizations. Eligible projects include water acquisition, water storage, altered water management or infrastructure, and riparian and fish habitat improvement.
For info: Al Josephy, Ecology, 360/407-6456, alvin.josephy@ecy.wa.gov or https://ecology.wa.gov/Water-Shorelines/Water-supply/Streamflow-restoration

CWA SETTLEMENT — CA

"DEEP RIPPING" REMEDIATION

On September 12, the US Department of Justice announced a settlement to address damage done by "deep ripping" through streams and wetlands. Goose Pond Ag, Inc., a Florida corporation, and its manager of operations Farmland Management Services, Inc. (FMS), an affiliate of the John Hancock Life Insurance Company, have agreed to pay a civil penalty, preserve streams and wetlands, and perform mitigation to resolve violations of the Clean Water Act (CWA). The property involved in this case, near the Sacramento River, was acquired from Duarte Nursery Inc. and adjoins a Duarte site that was the subject of a previous settlement agreement approved by a federal judge in December, 2017). In that settlement, Duarte agreed to pay $1.1 million in civil penalties and costs for damages resulting from deep rippers.

Goose Pond Ag and FMS have agreed to pay $5.3 million in civil penalties and mitigation for substantial acres of disturbed streams and wetlands. The settlement also requires the companies to permanently preserve hundreds of acres of streams, wetlands, and buffer areas. The agreement allows the companies to continue using the site for cattle grazing, to apply for a CWA permit to conduct other activities in jurisdictional waters on the site, and to seek future determinations concerning jurisdictional waters at the site.

This case stems from activities the companies conducted after they purchased property that had laid fallow and unfarmed for more than 20 years. Goose Pond Ag bought the 1,500-acre property in 2012. Shortly thereafter, FMS began operating heavy machinery through streams and wetlands as part of the companies' efforts to convert the property to a walnut orchard. That machinery included "deep rippers" that drag long metal shanks through the ground to break up or pierce highly compacted, impermeable or slowly permeable surface layers, or other similar kinds of restrictive soil layers. The deep ripping in this case destroyed or significantly degraded the streams and wetlands at the site.

WATER BRIEFS

Even before purchase of the site, the companies received aerial photographs, advice from environmental consultants, and other information that alerted them to federally-protected streams and wetlands on the property. Despite that information, the companies conducted extensive ripping and other activities in streams and wetlands without a CWA dredge-or-fill permit.

The US Department of Justice gave assurances that these cases are not (and will not be used as) a pretext for federal prosecution of farmers who engage in normal plowing on their farms. No federal dredge-or-fill permit is required for plowing as defined in the regulations, and no such permit is required for discharges from "normal farming…activities" such as plowing, if they are part of an established ongoing farming operation and not for the purpose of converting federally protected waters to new uses.

The proposed consent decree, lodged in the US District Court in Sacramento, is subject to a 30-day comment period and final court approval. A copy of the proposed consent decree is available on the Justice Department website.

For info: USDOJ website at: www.usdoj.gov/enrd/Consent_Decrees.html

WATER BOARD SUES FEDS CA

MEXICAN WATER TREATMENT

Alleging years of inaction and growing concern of an environmental calamity along the US-Mexico border, the San Diego Regional Water Quality Control Board (Water Board) filed suit September 5 against the United States Section of the International Boundary and Water Commission (USIBWC). Filed in US District Court for the Southern District of California, the lawsuit alleges that the USIBWC repeatedly violated provisions of the federal Clean Water Act (CWA) and its National Pollution Discharge Elimination System (NPDES) permit program by discharging millions of gallons of waste — including untreated sewage, trash, pesticides, and heavy metals — from its water treatment facilities into the Tijuana River, the vast and vulnerable Tijuana River Estuary and, ultimately, into the Pacific Ocean.

The suit is asking the court to declare that USIBWC violated the CWA on numerous occasions, has failed to prevent and recover waste from its many illicit discharge events, and that it must now take all actions necessary to comply with the CWA.

The lawsuit maintains that USIBWC is responsible for addressing cross-border flows of waste from Mexico into California as required by its NPDES permit and that chronic mismanagement of its water treatment facilities through the years has led to this drastic and necessary legal action.

For info: Blair Robertson, Water Board: blair.Robertson@waterboards.ca.gov; Suit available at: www.waterboards.ca.gov/water_issues/programs/enforcement/orders_actions.shtml

OIL SPILL VERDICT CA

CRIMINAL CHARGES

On September 7, California Attorney General Xavier Becerra and Santa Barbara County District Attorney Joyce Dudley today announced guilty verdicts were obtained in *People v. Plains All American Pipeline, L.P.* regarding the 2015 Refugio Oil Spill in Santa Barbara County, California. After a four-month trial in Santa Barbara County Superior Court, a jury found oil pipeline company Plains All American Pipeline, L.P. (Plains) guilty of a felony for failing to properly maintain its dangerous, highly-pressurized pipeline, which led to the discharge of crude oil into the Pacific Ocean. Plains was also found guilty of eight misdemeanor charges. These include: one count of failing to timely call emergency response agencies following this catastrophic oil spill; six counts of killing marine mammals, protected sea birds, and other marine life; and one count of violating a county ordinance prohibiting oil spills.

"Engaging in this kind of reckless conduct is not just irresponsible—it's criminal. Today's verdict should send a message: if you endanger our environment and wildlife, we will hold you accountable," said Attorney General Becerra. "At the California Department of Justice, we will continue prosecuting corporate negligence and willful ignorance to the fullest extent of the law."

The verdict stemmed from an incident on May 19, 2015, when a highly-pressurized pipeline operated by Plains to transport crude oil ruptured on shore just north of Refugio State Beach in Santa Barbara County. Evidence presented at trial demonstrated that over 140,000 gallons of crude oil were released from the pipeline, spilling crude oil into the Pacific Ocean and spreading across coastal beaches. At trial, testimony revealed that over 100,000 gallons of crude oil were never recovered. Immediately after the oil spill, the Attorney General's Office and the Santa Barbara County District Attorney's Office initiated a multi-agency criminal investigation, with the California Department of Fish and Wildlife, Office of Oil Spill Prevention and Response acting as the lead investigating agency. Plains is scheduled to be sentenced on December 13, 2018.

For info: California Department of Justice, 916/ 210-6000 or agpressoffice@doj.ca.gov

WATER AGENCY AWARDS OR

STEWARDSHIP/CONSERVATION

On September 6, the Oregon Water Resources Department (OWRD) announced the winners of its 2018 Stewardship and Conservation Awards. The "Tyler Hansell Award for Efficiency in Agriculture" was presented to Woody and Megan Wolfe, early adopters of conservation practices in Wallowa County. The Wolfe family, The Freshwater Trust, Oregon Water Resources Department, and the Columbia Basin Water Transaction Program worked together to fund and implement a large-scale irrigation efficiency upgrade that converted 872 acres of land from flood irrigation to pivot irrigation. Ninety percent of the conserved water was allocated to the state and permanently transferred instream. The remaining ten percent of the conserved water was allocated to the Wolfe Family to irrigate 60 acres of previously dry land during the early irrigation season.

The award for the "Best Conservation Program – Commercial or Industrial" was given to Central Oregon

WATER BRIEFS

Irrigation District (COID). Since 2000, COID has increased stream flows in the Deschutes Basin by nearly 39 **c**ubic **f**eet per **s**econd (cfs). One such example of their dedication to the environment is the Siphon Power Property Canal Piping Project which resulted in 5 cfs of water being returned to the Deschutes River.

The awards for "Best Conservation Program – Large Municipalities and Water Suppliers" (serving more than 1,000) were as follows: the City of Ashland and the City of Bend tied for the First Place Gold award; the City of Lake Oswego received the Second Place Silver award.

Ashland offers multiple water efficiency programs and resources to its customers. The City's popular lawn replacement program provides a monetary incentive for removal of lawn-covered areas that are then replaced with drought-tolerant plants that require less irrigation. Since 2014, the City has saved more than 7.5 million gallons of water annually.

Bend continues to operate its robust WaterWise Program, which includes: educational programs for customers, K-12 students, and landscape contractors; web pages and publications promoting efficient water use; and a Sprinkler Inspection Program. Bend also subjected their original WaterWise program to a rigorous verification process by the Alliance for Water Efficiency (AWE), an internationally recognized water conservation and efficiency organization. AWE compared Bend's programs to the newly created ANSI-AWWA-G480 Standard for Water Conservation Programs. Bend was one of the first in the country to be reviewed and earned a "Silver rating." The City plans to seek the AWE "Platinum rating" in the future.

In 2007, Lake Oswego's annual average water consumption was about 170 **g**allons **p**er **c**apita per **d**ay (GPCD), and that number swelled to over 370 GPCD in the summer. At-risk infrastructure, coupled with increases in demand, put the reliability of the City's water treatment plant and its attached distribution system in question. Lake Oswego established three goals regarding the protection and stewardship of their drinking water supply: 1) Adopt a **w**ater **m**anagement and **c**onservation **p**rogram (WMCP); 2) Adopt a water curtailment plan; and 3) Develop and adopt a pricing structure (tiered water rates) for water that encourages conservation of water. Lake Oswego's implementation of its WMCP, water curtailment plan, and water rates have reduced historic consumption and peak per-capita water demand by almost 20 percent. Implementation of the conservation program also helped delay the timing of future water system expansions and reduced pressure on the current system.

For info: OWRD website at: www.oregon.gov/OWRD/programs/WaterRights/Conservation/Awards/Pages/default.aspx

PUBLIC WORKS ID/WA

APWA AWARDS WATER PROJECTS

On August 28, the American Public Works Association (APWA) has announced the winners of its 2018 Public Works Projects of the Year competition. The awards program promotes excellence in the management and administration of public works projects, recognizing the alliance among the managing agency, the contractor, the consultant, and their cooperative achievements. This year's award winners were recognized during APWA's Public Works Expo in Kansas City, Missouri.

Within the environment category, two water projects were deemed best-in-class:

- $5 million, but less than $25 million: Dixie Drain Phosphorus Removal Facility (City of Boise Public Works Department)
- More than $75 million: Chambers Creek Regional Wastewater Treatment Plant Expansion (Pierce County Planning & Public Works)

Dixie Drain Facility

Treating 130 **m**illion **g**allons of water **d**aily (MGD), the $21 million Dixie Drain Phosphorus Removal Facility is the first of its kind in the U.S. and considered a model facility in watershed-based approaches to meeting total maximum daily load limits. *See* Malmen, *TWR* #129.

Located 34 miles downstream from Boise's primary water renewal facilities, the facility collects ground and surface water from agricultural operations in the lower Boise River watershed, removing 140 pounds of phosphorus per day (10 tons annually). The facility yields significant environmental benefits as it collects 50 percent more phosphorus downstream from the Boise River. For every pound not removed at an upstream water renewal facility, 1.5 pounds are removed downstream. The result is a better quality of water flowing through the Boise and Snake rivers.

Conceptualized and designed by Brown and Caldwell and J-U-B Engineers, the facility is no stranger to the engineering excellence spotlight. The APWA award marks a continuation of the facility's recognition by industry peers having received a 2017 Grand Award from the American Council of Engineering Companies.

Chambers Creek Wastewater Plant

Supporting Pierce County's future growth and economic development, the $342 million Chambers Creek Regional Wastewater Treatment Plant Expansion Project increased capacity at the plant from 28.7 MGD to 45 MGD. Brown and Caldwell led a team including Kennedy/Jenks to design and manage construction of the upgrades, including the installation of an innovative sidestream treatment process. Pierce County was one of the first utilities in North America to pilot the method. De-ammonification, or DEMON for short, uses a naturally-occurring bacteria (anammox) to strip nitrogen from wastewater, reducing chemical use by 50 percent and oxygen (energy) demands by 25 percent. The upgrades will save the county $7 million in life-cycle costs, in addition to the $30 million saved by efficiently repurposing existing structures rather than constructing new facilities.

Further upgrades include increased biogas utilization capacity to generate heat for the treatment process and occupied spaces. The addition of a reclaimed water production and distribution system provides Class A reclaimed water for in-plant use, therefore reducing effluent discharges to Puget Sound.

The upgraded plant will serve a population projected to double to 361,000 by 2040.

"These exemplary projects set a precedent for innovation in water quality treatment approaches," said Brown and Caldwell CEO Rich D'Amato. "We applaud the City of Boise and Pierce County for their commitment to improving public health in a sustainable, environmentally-friendly way. Brown and Caldwell is proud to have played a role in enhancing the health of these communities now, and well into the future."

For info: Cameron McWilliam. Brown and Caldwell, 303-968.2055

CALENDAR

October 16 WA
"Hirst, Foster, Boldt, and Beyond: A New Era of Water Management?" - 2018 AWRA Washington State Conference, Seattle. Moutaineers Seattle Program Center, 7700 Sand Point Way NE. Presented by American Water Resources Association - Washington Chapter. For info: www.waawra.org/event-2837056

October 16 CA
2018 Association of California Water Agencies (ACWA) Regulatory Summit, Sacramento. Hilton Sacramento Arden West. For info: www.acwa.com/events

October 16-19 AZ
11th Annual International Conference on Irrigation and Drainage, Phoenix. Sheraton Mesa Hotel at Wrigleyville West. For info: http://uscid.org/18azconf.html

October 22 TX
Edwards Aquifer Protection Program (Pollution) Public Hearing, Austin. TCEQ Park 35 Office Complex, 12100 Park 35 Circle, Bldg. E, Room 201S, 1:30 pm. Written Comments by 5:00 pm on Oct. 23. For info: www.tceq.texas.gov/permitting/eapp/history.html

October 22 WA
CERCLA / MTCA / NRDA / Sediments: 23rd Annual Environmental Cleanup & Restoration Conference, Seattle. Washington State Convention Center. For info: Holly Duncan, Environmental Law Education Center, 503/ 282-5220, info@elecenter.com or www.elecenter.com

October 22-23 TX
Innovations in Water Conservation & Management: 9th Annual Texas Water Law Conference:, San Antonio. La Cantera. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

October 23 TX
Edwards Aquifer Protection Program (Pollution) Public Hearing, San Antonio. Tesoro Bldg., Alamo Area Council of Governments, 8700 Tesoro Drive, Ste. 100, 2:00 pm. Written Comments by 5:00 pm on Oct. 23. For info: www.tceq.texas.gov/permitting/eapp/history.html

October 23 WA
Streamflow Restoration Funding & Guidance for Net Ecological Benefit - Public Workshops, Everett. Everett Public Library. Presented by WA Dept. of Ecology; 1-3 pm. For info: Rebecca Inman, Ecology, 360/ 407-6450, Rebecca.Inman@ecy.wa.gov or https://ecology.wa.gov/

October 23 DC
ELI 2018 Environmental Achievement Award Dinner, Washington. Omni Shoreham Hotel, 2500 Calvert Street. Award to Lisa Jackson Presented by the Environmental Law Institute. For info: Environmental Law Institute at www.eli.org/award-dinner

October 23 DC
A New Environmental Paradigm: 2018 ELI-Miriam Hamilton Keare Policy Forum, Washington. Omni Shoreham Hotel, 2500 Calvert Street, 4-5:30 pm. Register by Oct. 19th. For info: Environmental Law Institute at: www.eli.org

October 23-26 ID
2018 Western States Water Council Fall (188th) Council Meeting, Coeur d'Alene. The Coeur d'Alene Resort. For info: www.westernstateswater.org/upcoming-meetings

October 24 OR
Oregon Floodplain Development Conference, Portland. The Mark Spencer Hotel. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

October 24-25 CO
2018 South Platte Forum, Loveland. Embassy Suites Loveland. For info: http://www.southplatteforum.org/

October 24-26 NE
2018 Water Symposium - National Institutes for Water Resources Regional Symposium, Lincoln. Nebraska Innovation Campus. Water Resources of the US Great Plains Region: Status & Future. For info: https://watercenter.unl.edu/2018-water-symposium

October 24-26 NM
23rd Annual New Mexico Infrastructure Finance Conference, Albuquerque. Isleta Resort & Casino. Presented by New Mexico Environment Department. For info: www.nmifc.com

October 24-26 PA
The American Water Summit 2018, Philadelphia. Loews Philadelphia. For info: www.americanwatersummit.com

October 25-26 AZ
2018 Tribal Water Summit, Phoenix. Wild Horse Pass Casino & Events Center. Presented by WestWater Research; Hosted by Gila River Indian Community; The Gila River Indian Community is hosting a two-day summit on Tribal water management issues, focused on developing water management programs & federal policy concerning Tribal water. For info: Julie Mai, WestWater Research, 208/ 433-0255 or mai@waterexchange.com or 208/ 433-0255 or www.tribalwatersummit.com

October 26 CA
Clean Water Act Jurisdictional Determinations - Army Corps Regulatory Program Workshop, Sacramento. Corps Sacramento District Headquarters, Room 814; 1:30 - 4 p.m.. Free - Limited to first 75 people to Register; Register by emailing to: CESPK-REGULATORY-INFO@usace.army.mil. For info: www.spk.usace.army.mil/Missions/Regulatory/References/RegulatoryProgramWorkshop.aspx

October 28-31 GA
Water Infrastructure Conference & Exposition, Atlanta. Hotel Regency Atlanta. Presented by American Water Works Assoc.. For info: www.awwa.org/conferences-education/conferences.aspx

October 30 OR
Columbia River Toxics Reduction Working Group Meeting: Columbia River Restoration Act Implementation Plan, The Dalles. Columbia Gorge Discovery Center. For info: RSVP to Catherine Corbett, ccorbett@estuarypartnership.org

November 1-2 WA
11th Annual Water Rights Transfers Seminar, Seattle. Washington Athletic Club. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

November 1-2 CA
2018 California H2O Women Conference, Santa Barbara. Ritz-Carlton Bacara. Women Only - Invitation Only. For info: http://water.bhfs.com/event/2nd-annual-california-h2o-women-conference/

November 4-8 MD
2018 AWRA Annual Water Resources Conference, Baltimore. Baltimore Marriott Inner Harbor at Camden Yards Hotel. Presented by American Water Resources Association. For info: www.awra.org/meetings/Baltimore2018/index.html

November 7-9 CA
NWRA Annual Conference, Coronado. Hotel Del Coronado. Presented by National Water Resources Assoc. For info: www.nwra.org/upcoming-conferences-workshops.html

November 8-9 OR
Oregon Water Law Conference - 27th Annual, Portland. Two World Trade Center Bldg., 121 SW Salmon Street, Auditorium. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

November 9 CO
Cost-Nothing Analysis: Environmental Economics in the Age of Trump: Lecture by Prof. Lisa Heinzerling, Boulder. Wolf Law Bldg.-Wittemyer Courtroom, Univ. of Colorado. Presented by the Getches Wilkinson Center for Natural Resources, Energy, and the Environment. For info: www.getches-wilkinsoncenter.cu.law/events/

November 11-15 ON, Canada
Water Quality Technology Conference & Exposition, Toronto. Sheraton Centre Toronto Hotel. Presented by the American Water Works Assoc.. For info: www.awwa.org/conferences-education/conferences/water-quality-technology.aspx

November 13 WY
Wyoming Water Forum: Updates on Wyoming StreamStats, Cheyenne. WWDO Conference Room, 6920 Yellowtail Road. Presentation by Kathy Chase / Paul Caffrey, USGS. For info: http://seo.wyo.gov/interstate-streams/water-forum

November 13-15 IL
Storm Water Solutions Conference & Exhibition, Chicago. Tinley Park Convention Center. Training, Exhibits & Seminars. For info: www.estormwater.com or www.swsconferenceexpo.com

November 14-16 CA
National Clean Water Law & Enforcement Seminar, San Diego. The US Grant Hotel. Presented by the National Assoc. of Clean Water Agencies. For info: www.nacwa.org/conferences-events

November 15-16 ID
Idaho Water Users Assoc. 35th Water Law Seminar, Boise. The Riverside Hotel. For info: IWUA, 208/ 344-6690 or www.iwua.org/

November 17 OR
WaterWatch of Oregon's 16th Annual Celebration of Oregon Rivers, Portland. Leftbank Annex, 101 N. Weidler Street. For info: https://waterwatch.ejoinme.org/auction2018

November 27-28 DC
Public-Private Partnership Federal Conference: Using P3s to Meet Our Infrastructure Challenges, Washington. Marriott Marquis. For info: www.p3federalconference.com

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CALENDAR

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November 28-29 NV
Nevada Water Law Conference, Reno. Peppermill Resort Spa Casino. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

December 3-4 CA
Climate Change in California Conference, San Francisco. 50 California Street Building. For info: Law Seminars International, 206/ 567-4490 or www.lawseminars.com/

December 5-6 OK
39th Annual Oklahoma Governor's Water Conference & Research Symposium, Midwest City. Reed Conference Center. For info: www.owrb.ok.gov/GWC/

December 6-7 CO
Today's Environmental Agencies: Regulatory Enforcement, Citizen Suits, and the Energy Industries Course, Denver. Le Meridien Denver Downtown. Presented by Rocky Mountain Mineral Law Foundation. For info: www.rmmlf.org

December 6-7 CO
Regulatory Enforcement Conference, Denver. Presented by the Rocky Mountain Mineral Law Foundation. For info: www.rmmlf.org/

December 10 WA
Tribal Natural Resource Damage Seminar, Seattle. Crowne Plaza Hotel, 1113 Sixth Avenue. For info: Law Seminars International, 206/ 567-4490 or www.lawseminars.com/

December 11 WY
Wyoming Water Forum: Environmental Sample Processor for DNA Sampling, Cheyenne. WWDO Conference Room, 6920 Yellowtail Road. Presented by Elliott Barnhart, USGS. For info: http://seo.wyo.gov/interstate-streams/water-forum

December 11-12 OR
Business & The Environment Conference & Expo, Portland. Jantzen Beach Red Lion. Presented by Northwest Environmental Business Council, Oregon Dept. of Environmental Quality, Washington Dept. of Ecology. For info: www.businessandenviroment.com