Water Savings Benefits of PepsiCo Recycle for Nature Projects: 2017 Progress Report

Prepared for:
The Nature Conservancy
and PepsiCo, Inc.

April 19, 2018

LimnoTech
Water Environment | Scientists Engineers

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1 Background

PepsiCo and The Nature Conservancy (TNC) have partnered to help improve and protect America's watersheds. The goal is to improve land and water resources through the implementation of water savings projects in critical watersheds across the United States. The projects are designed to benefit more than 36 million people, save at least 1.2 billion gallons of water by 2018, and protect miles of rivers and thousands of acres linked to the health of important water resources. A key component of this partnership is PepsiCo's "Recycle for Nature" program, a five-year effort initiated in 2014, to provide greater awareness about recycling and conservation, increase access to recycling at on-the-go locations, and motivate consumers to recycle. As part of TNC's partnership with PepsiCo, as more people recycle, PepsiCo will contribute more funding for water conservation work in North America (PepsiCo, Inc., 2018; TNC, 2018).

PepsiCo and TNC implement conservation projects in collaboration with agricultural partners, local stakeholders, state and federal agencies, and non-governmental organizations (NGOs). The projects are designed to conserve or restore water quantity and/or water quality to address local water-related issues, and for this reason they vary widely in scope and scale. To date, ten conservation projects in critical areas have been implemented, and several additional projects are in the planning stages or underway. Four of the ten projects were implemented between 2014 and 2016, and they continued to generate water savings benefits in 2017. Six additional projects were implemented in 2016 and 2017.

This report describes PepsiCo and TNC's progress toward achieving the goals set forth as part of the "Recycle for Nature" program in terms of water savings benefits. A summary table of water savings benefits for ten projects implemented by 2017 is provided in Appendix A. Additional details on the ten projects and their water savings benefit quantification results are provided in separate "fact sheets" in Appendix B.

2 Quantification Methodologies

Where applicable, water savings benefits were calculated based on methodologies previously developed by LimnoTech in collaboration with TNC in support of The Coca-Cola Company's (TCCC) "replenish" commitment toward water neutrality (TCCC, 2015). The concepts and quantification methodologies were the subject of scientific technical peer review and are described in a journal paper (Rozza et al., 2013). The type of water savings benefit calculated and the quantification methodology applied varies by project type. For example, the water benefit of a reforestation project in an upland area is estimated as the decreased volume of annual runoff due to the change in vegetative cover, and it is calculated using the Curve Number Runoff method as implemented in the Soil & Water Assessment (SWAT) model.

A total of ten conservation projects had been completed by the end of 2017. Seven of the ten projects involved changes to irrigation as a result of conservation activities (e.g., fallowing, split-season irrigation, low water use crops, etc.) that either avoid consumptive irrigation, decrease the volume of water applied for irrigation, or decrease consumptive use of water during the critical growing season. The water benefit of an agricultural irrigation project can be estimated with different approaches. The approach or method used to quantify the water benefit of an irrigation project is based on the objectives of the project, the activities implemented, and the information and data available to support the calculation. The water benefit for irrigation projects can be calculated based on monitoring data, if available, and/or approaches that take into account the water applied, crop yields, crop consumptive use, crop irrigation water requirements, the efficiency of the irrigation technology used, and the estimated fraction of return flows. The other three projects involved restoration and protection of forest land and protection of wetlands. The water benefit from the restoration and protection of forest land projects was calculated based on either the increase in water yield or the difference in surface runoff between land use conditions that would exist with and without restoration or protection. The water benefit for the wetland protection project was calculated based on the water storage capacity of the wetland.

It is recognized that the estimated benefits have some uncertainty, as they are based on best available data and information using models and estimation techniques. To reduce this uncertainty, scientifically-defensible methodologies and conservative assumptions were employed in the quantification process. In accordance with the established replenish methodology, when a project has been completed during a given year, it "counts" toward the end-of-year benefit for that year. Furthermore, benefits for completed projects will continue to be reported in each subsequent year, provided that the project is maintained and continues to function as intended. In situations where there are multiple project funders, PepsiCo's proportion of the total project cost (PepsiCo's cost share) is used to determine the percent of the total benefit that can be attributed to PepsiCo.

3 Quantification Results

The current estimate is that the ten projects completed by the end of 2017 provide a total water savings benefit of approximately 5,962 million liters per year (ML/yr), as listed in Table 1. PepsiCo's water savings benefit is based on the cost-share for the projects (Appendix A). The resulting cost-share adjusted benefit for PepsiCo is 1,371 ML/yr.

Table 1. Projects completed by end of 2017 and associated benefits

State	Basin/ Watershed	Project Name	Water Savings Benefits Quantified	Total Water Savings Benefit (ML/yr)	PepsiCo Water Savings Benefit (ML/yr)
AR	Kings River Watershed	River Corridor Conservation in Kings River, Arkansas	Avoided increase in surface runoff	242	15
AZ	Verde River Watershed	Barley Conversion Project, Camp Verde, Arizona	Decrease in consumptive use	325	325
AZ	Verde River Watershed	Cropland Fallowing Project, Camp Verde, Arizona	Volume of consumptive irrigation avoided	8	8
AZ	Verde River Watershed	Crop Conversion & Irrigation Efficiency Improvement, Camp Verde, Arizona	Decrease in consumptive use	219	82
CO	Colorado River Basin	Meaker Farm Agricultural Irrigation Improvement, Montrose, Colorado	Volume of consumptive irrigation avoided	187	96
CO	Colorado River Basin	Carpenter Ranch Irrigation Improvement, Hayden, Colorado	Volume of consumptive irrigation avoided	141	116

State	Basin/ Watershed	Project Name	Water Savings Benefits Quantified	Total Water Savings Benefit (ML/yr)	PepsiCo Water Savings Benefit (ML/yr)
CO	Colorado River Basin	Water Conservation Program, Mesa County, Colorado	Volume of consumptive irrigation avoided	3,978	477
CO	Colorado River Basin	Agricultural Water Conservation, Colorado Basin, Colorado	Volume of consumptive irrigation avoided	466	206
CO	Upper South Platte Watershed	Forest Management & Restoration, Denver, Colorado	Increase in water yield	34	11
NC	Black River Watershed	Land Conservation in Black River, Cape Fear, North Carolina	Avoided increase in surface runoff; water storage capacity	362	35
Total 2017 Benefit				**5,962**	**1,371**

Note that these estimates are based on the best available data and information related to the projects, which has been provided to LimnoTech by TNC. LimnoTech has not conducted site visits for all projects, and has not independently verified that the projects have been fully implemented and are functioning as planned.

This estimate of benefits for 2017 represents current performance. The 2017 benefits will be generated through the year 2018 and beyond, provided that the conservation practices continue to be implemented on the same lands and at the same scale. The agriculture water conservation activities in the Colorado River Basin (See Appendix B; Pages B-26 to B-45) are based on annual or multi-year contracts, and the estimated benefits for this project are expected to continue for the duration of the contracts. The future benefits will be verified before they are reported as actual benefits.

Additional details for each project are provided in the summary table in Appendix A, and in individual fact sheets (Appendix B). Each fact sheet includes a basic description of the project activities, the water savings benefit that was calculated, the methodology applied, benefit results, and the sources of data and information used to compute the benefit.

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Appendix A: Summary of Results

State	Basin/ Watershed	Partners	Partner Contact	Project Name	Activity Description	Water Savings Benefit Quantified	Project Area (acres)	Activity Timeline	Total Project Cost ($)	PepsiCo Contribution ($)	PepsiCo Cost Share (%)	Total Benefit (ML/yr)	PepsiCo Benefit (ML/yr)
AR[1]	Kings River Watershed	The Nature Conservancy, Walton Family Foundation, National Fish and Wildlife Foundation	Tim Snell	River Corridor Conservation in Kings River, Arkansas	Forest land protection	Avoided increase in surface runoff	608	2014-2017	$1,400,000	$89,600	6.4%	242	15
AZ	Verde River Watershed	The Nature Conservancy, Friends of the Verde River , Hauser and Hauser Farm, Specks Farm	Kimberly Schonek	Barley Conversion Project, Camp Verde, Arizona	Conservation activities related to irrigation practices	Decrease in consumptive use	144	2017	$103,600	$103,600	100%	325	325
AZ	Verde River Watershed	The Nature Conservancy	Kimberly Schonek	Cropland Fallowing Project, Camp Verde, Arizona	Conservation activities related to irrigation practices	Volume of consumptive irrigation avoided	7.11	2017	$822	$822	100%	8	8
AZ	Verde River Watershed	The Nature Conservancy, Hauser and Hauser Farm	Kimberly Schonek	Crop Conversion & Irrigation Efficiency Improvement, Camp Verde, Arizona	Conservation activities related to irrigation practices	Decrease in consumptive use	35	2017	$126,000	$47,005	37.3%	219	82
CO[1]	Colorado River Basin	The Nature Conservancy, Colorado State University, Meaker Farms	Aaron Derwingson	Meaker Farm Agricultural Irrigation Improvement, Montrose, Colorado	Agricultural irrigation improvement	Decrease in water applied for irrigation	47	2014-2017	-	-	51.6%	187	96
CO	Colorado River Basin	The Nature Conservancy	Michele Battiste	Carpenter Ranch Irrigation Improvement, Hayden, Colorado	Agricultural irrigation improvement	Volume of consumptive irrigation avoided	150	2017	$158,500	$130,000	82%	141	115
CO	Colorado River Basin	The Nature Conservancy, Grand Valley Water Users Association, Colorado River Water Conservation District, Colorado Water Conservation Board, Walton Family Foundation	Aaron Derwingson	Water Conservation Program, Mesa County, Colorado	Conservation activities related to irrigation practices	Volume of consumptive irrigation avoided	1,252,2	2017	$1,039,439	$125,000	12%	3,978	477
CO[1]	Colorado River Basin	The Nature Conservancy, Colorado State University, Colorado Water Institute, Colorado River Water Conservation District, The Southwestern Water Conservation District, Front Range Water Council, Colorado Water Conservation Board, No Chico Brush, Walton Family Foundation, and the Gates Family Foundation	Aaron Derwingson	Agricultural Water Conservation, Colorado Basin, Colorado	Conservation activities related to irrigation practices	Volume of consumptive irrigation avoided	222	2016-2017	-	-	44.3%	466	206

State	Basin/ Watershed	Partners	Partner Contact	Project Name	Activity Description	Water Savings Benefit Quantified	Project Area (acres)	Activity Timeline	Total Project Cost ($)	PepsiCo Contribution ($)	PepsiCo Cost Share (%)	Total Benefit (ML/yr)	PepsiCo Benefit (ML/yr)
CO	Upper South Platte Watershed	The Nature Conservancy, Upper South Platte Partnership, Wells Fargo Foundation, MillerCoors, Denver Water, U.S. Forest Service, Colorado State Forest Service, American Forest Foundation, Coalition for the Upper South Platte, Jefferson Conservation District, and the Colorado Forest Restoration Institute	Michele Battiste	Forest Management & Restoration,	Forest land restoration	Increase in water yield	275	2016-2017	$1,001,000	$333,333	33.3%	34	11
NC[1]	Black River Watershed	The Nature Conservancy, Clean Water Management Trust Fund, Ecosystem Enhancement Grant	Dan Ryan	Land Conservation in Black River, Cape Fear, North Carolina	Forest land restoration and protection; wetland protection	Avoided increase in surface runoff; Water storage capacity	410.8	2016-2017	$605,000	$59,450	9.8%	362	35
Total 2017 Benefit (ML/yr)												5,962	1,371

[1]*Projects implemented before 2017 with continuing benefits. For continuing projects, the water savings benefits for 2015 and 2016 are summarized in separate reports (LimnoTech, 2016; LimnoTech, 2017).*

Appendix B: Fact Sheets

Water Savings Project: Kings River Watershed

Through PepsiCo's "Recycle for Nature" program, PepsiCo is supporting TNC efforts to protect water resources and wildlife in the Kings River Watershed in Arkansas (PepsiCo, 2017). The acquisition of 608-acre river corridor land in Kings River, Arkansas was executed through collaboration with The Walton Family Foundation and the National Fish and Wildlife Foundation.

Kings River. Photo Courtesy: The Nature Conservancy

Located in Northwest Arkansas, the Kings River contributes to the drinking water for communities in Arkansas and Missouri as it flows across the Ozark Plateau into Table Rock Lake, a major public water supply. In addition to water supply, the Kings River is also a recreational treasure for paddling, swimming, wildlife watching and fishing. The Kings River Watershed is home to diverse wildlife including 18 fish species, crayfish, mussels, turtles and aquatic insects found only in the Ozarks, including a stonefly that lives in this watershed and nowhere else on Earth (TNC 2014). The forested areas around the river provide foraging habitat for endangered gray bats and a wide variety of other terrestrial animals. Maintaining the river's quality is critical to safeguarding the health of these communities and ensuring that a source for recreation and fishing is available for future generations.

Land use changes over more than a century in the Kings River watershed have affected the habitats and water quality of the river. Streamside land was cleared for pasture, leaving few trees to hold the soil in place and allowing cattle access to the river. Changes in the watershed have forced the river to adjust to new pressures, leading to substantial streambank erosion.

The Nature Conservancy established the Kings River Preserve (4,561 acres) in 2010 with a vision to conserve a river corridor large enough to make a difference to wildlife and water quality (Figure 1). TNC has implemented restoration activities in the preserve including lining both sides of the river, reforesting streamside pastures, stabilizing and restoring eroding riverbanks, and improving existing roads to reduce sediment entering the river.

Project Objectives

- Maintain natural hydrologic regime and water quality
- Protect biodiversity
- Purchase and permanently expand the Kings River Preserve, owned by TNC.

Project Activities

In 2014, PepsiCo contributed to the acquisition and protection of an additional 608 acre land area adjacent to the existing TNC preserve (Figure 1). The preserve now spans approximately ten miles of the river. TNC's long term goal for the Kings River in Arkansas is to conserve a 60-mile river corridor connected to state and federal conservation areas.

The current land use in the 608 acre river corridor area is primarily forested landscape ranging from high elevation (approximately 1600 ft) to low elevation of 600 ft. The forest cover includes a wide diversity of native species including Oaks, Hickories, Sycamore, Elms maples, Eastern Red Cedars, Ashe's Juniper and Shortleaf pines. Some riparian pastures (left over from a discontinued cattle operation), are present. Cattle operations that took place prior to the acquisition have also contributed to stream bank erosion and water quality degradation. Cattle grazing is no longer taking place in the property. Without the TNC/PepsiCo land acquisition, the pastures on the property would have continued to increase in size and become increasingly degraded due to cattle grazing. Pasture areas that were affected by cattle operations are now reverting to riparian forest.

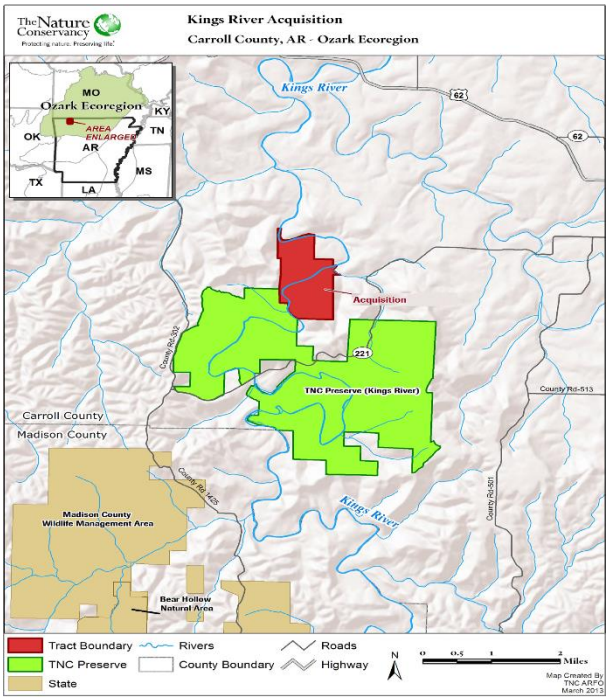

Figure 1. Map of the river corridor acquisition (red polygon) adjacent to the existing TNC preserve.

Erosion from Cattle Access. Photo Courtesy: The Nature Conservancy

Water Savings Benefit Calculation

The water savings benefit was calculated as the difference in runoff from land use conditions that would exist without conservation ("without-project") and with conservation ("with-project").

Water Savings Benefit = Runoff Without-Project – Runoff With-Project

The reporting units are million liters per year (ML/yr). The calculations were performed on an annual basis to estimate benefits in ML/yr.

Methodology

The Curve Number (CN) Runoff method, as implemented in the Soil & Water Assessment Tool (SWAT) model (Neitsch et al. 2005, 2009), was used to estimate the decrease in runoff due to conservation of 608 acres of forested river corridor area. The benefit calculations focused on estimating the change in runoff volume for the project activities because runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Data & Assumptions

Project information was provided by TNC. The datasets and other related information that were used in the benefit calculation are listed below:

- **Climate**: Long-term precipitation and temperature data were obtained for the Eureka Springs station National Oceanographic Administration's National Climate Data Center. A 12-year time period (2000-2011) was used in the calculations with an annual average precipitation of 1,095.3 mm/yr. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).
- **Soil**: Predominantly hydrologic soil group (HSG) D. Source: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx
- **Project Area**: 608 acres
- **Land Condition**:
  - Without-Project: Degraded pastureland/grassland (CN = 89)
  - With-Project: Forested landscape (CN = 77)

The following assumptions were used to calculate the water savings benefits resulting from land conservation:

- The SWAT model parameter "CNCOEF" was set to 1.0 (plant evapotranspiration curve number coefficient used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).
- If the forest areas were not conserved, degradation would continue as a result of livestock grazing and other activities.

Calculation & Results

The water savings benefit calculation for implementing conservation in 608 acre river corridor area is summarized below:

Without-project (no conservation – degraded grassland/pastureland):

- Runoff volume = 1,176 ML

With-project (conservation – forested area):

- Runoff volume = 934 ML

Water Savings Benefit = 1,176– 934 = 242 ML

The total water savings benefit is 242 ML/yr. PepsiCo's water savings benefit is based on the cost-share for this project, which was 6.4% of the total project cost. **Therefore, the resulting cost-share adjusted benefit is 15 ML/yr.**

Additional Benefits Not Quantified

The river corridor conservation results in additional environmental benefits that have not been quantified as part of this assessment. The benefits include:

- Protection of water supply
- Protection of water quality
- Protection of wildlife habitat and biodiversity
- Improved recreational access to the river

Kings River Preserve, Arkansas. Photo Courtesy: TNC

Project Location

- TNC's Kings River Preserve, Arkansas
- Located in the Kings River Basin

Primary Contacts

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Project Timeline

- Land acquisition completed in 2014

Total Project Cost

- Total Project Cost: $1,400,000
- PepsiCo Contribution: $89,600
- 6.4% funded by PepsiCo

Water Quantity - Total Benefit

- 242 ML/yr

Water Quantity – PepsiCo Benefit*

- 15 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc.
- The Nature Conservancy
- Walton Family Foundation
- National Fish and Wildlife Foundation

The Nature Conservancy

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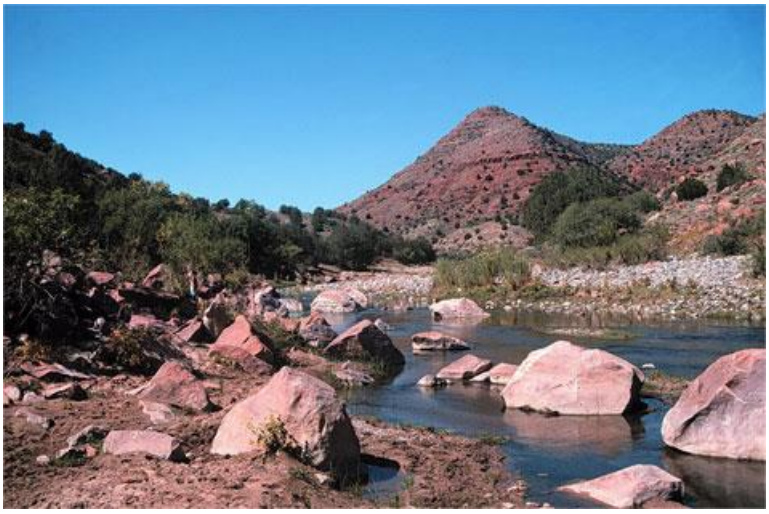
Water Savings Project: Verde River Watershed

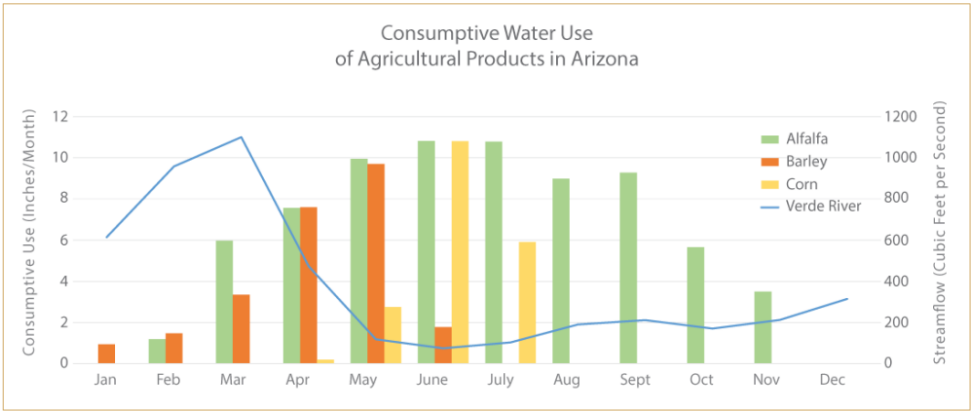
Through PepsiCo's "Recycle for Nature" program, PepsiCo and The Nature Conservancy (TNC) are supporting agricultural improvement projects in the Verde River watershed in the state of Arizona (PepsiCo, 2018). The barley conversion project in Camp Verde, Arizona is being executed through collaboration with local partners including Friends of Verde River Greenway.

The Verde River watershed is located in north-central Arizona and drains an area of approximately 6,600 square miles. The river is a key surface water source for metro Phoenix and a lifeline for wildlife in the arid southwest, including migratory birds, nesting bald eagles, rare species of reptiles and many species of native fish. The Verde valley is an important part of the agricultural economy in the Colorado River Basin. The river is impacted by surface water withdrawals for irrigation, groundwater pumping for drinking water, and long-term drought conditions. Like many western rivers, streamflow is low or non-existent during the hot summer months when the irrigation demands are high throughout the valley. The resulting low river flows impact ecosystem health.



© Peter Warren / The Nature Conservancy

TNC partnered with the local farmers and implemented crop switching to reduce irrigation water use and support local economic development. Traditional summer crops grown in the Verde River Valley such as alfalfa and corn have the largest water requirements in the summer. In contrast, barley is harvested before the critical summer water stress period (Figure 1). A seasonal shift in crop production, such as switching from alfalfa and corn to malt barley has the potential to improve summer flows by reducing the amount of water diverted for irrigation.



Graphic Credit: Chip Norton, Friends of the Verde River

Figure 1. Mean monthly streamflow in the Verde River compared to crop consumptive use, demonstrating that irrigation demand is highest when water is least available.

Project Objectives

The objective of the project is to reduce consumptive crop water use during critical summer months, leaving more water in the river.

Project Activities

In 2017, Hauser and Hauser Farms and Speck Farms (Figure 2) converted 144 acres of alfalfa and corn (a high water demand summer crops) to barley (a lower water demand winter/spring crop) (TNC, 2018). This crop shifting practice provides equivalent revenue at a different time of year and also results in less irrigation water diverted from the river during the high-demand, low streamflow summer period. The result is more water in rivers for people and wildlife during the summer, and a profitable crop for local farmers. This project is intended to set the stage for, and catalyze a shift to, larger scale barely production that will provide water benefits for the river alongside new market opportunities for local farmers. Market analysis indicates that there is extensive demand for malt barley in Arizona among the growing craft brew industry. A local benefit corporation located in Camp Verde, AZ has been created to provide a market solution that helps address declining flows in the river while supporting the needs of local farmers. The company purchases and processes the raw barley and sells the malt to craft brewers who are interested in sourcing locally.

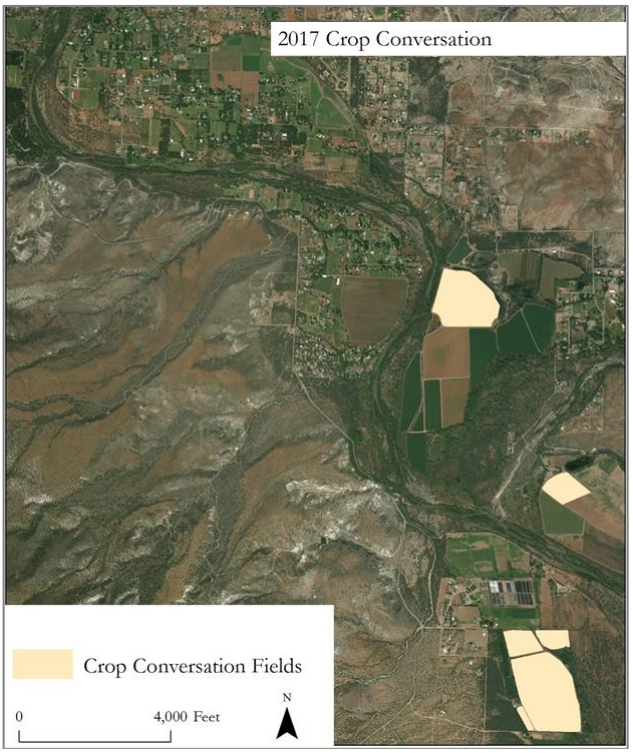


Figure 2. Project location (photo credit: The Nature Conservancy).

Water Savings Benefit Calculation

The water savings benefit is estimated as the reduction in consumptive crop water use due to crop switching on 144 acres.

Water Savings Benefit = Consumptive crop water use Without-Project – Consumptive crop water use With-Project

The calculations were performed on an annual basis to estimate benefits in million liters per year (ML/yr). One million liters (ML) is equal to 264,172 gallons.

Methodology

The consumptive water use for alfalfa and corn is substantially higher than barley during summer months when the water is least available in the Verde River. Therefore, the water savings benefit is calculated as the reduction in consumptive water use during summer months (June, July and August), resulting from the conversion of alfalfa and corn to malt barley.

Data & Assumptions

All of the project information was provided by TNC to support the water savings benefit calculation.

- **Project Area**: 144 acres
  - Acres of alfalfa converted to barley: 72 acres
  - Acres of corn converted to barley: 72 acres
- **Average Consumptive Use for the summer months (June, July, and August)**:
  - Alfalfa: 31 inches
  - Barley: 2 inches
  - Corn: 17 inches

Calculation & Results

The consumptive crop water use requirements during summer months for alfalfa, corn and barley, and the total waters savings are calculated as follows:

<u>Conversion of corn to barley:</u>

Reduction in consumptive use = [Consumptive use for corn] - [Consumptive use for barley]
= 17 – 2 inches = 15 inches = 1.25 acre-feet/acre

Area affected = 72 acres

Consumptive use volume = 1.25 acre-feet/acre x 72 acres = 90 acre-feet = 29,326,590 gallons

<u>Conversion of alfalfa to barley:</u>

Reduction in consumptive use = [Consumptive use for alfalfa] - [Consumptive use for barley]
= 31 – 2 inches = 29 inches = 2.41 acre-feet/acre

Area affected = 72 acres
Consumptive use volume = 2.41 acre-feet/acre x 72 acres = 173.5 acre-feet = 56,535,149 gallons

Total reduction in consumptive use = 29,326,590 + 56,535,149 gallons
= 85,861,739 gallons = 325 ML

The total water savings benefit is 325 ML/yr. PepsiCo's water savings benefit is calculated by multiplying the total water savings benefit by PepsiCo's cost-share for this project. In 2017, PepsiCo's cost share was 100%. **Therefore, the resulting cost-share adjusted benefit is 325 ML/yr.**

The water savings benefit quantified is based on crop switching to barley implemented during the 2017 growing season. In order for the estimated water savings benefits to be realized in the future, the barley cultivation must continue to be implemented on an annual basis.

Additional Benefits Not Quantified

The implementation of this projects results in additional environmental benefits that have not been quantified as part of this work. The benefits include:

- Enhanced wildlife habitat
- Improved recreational access to the river

Photo Credit: The Nature Conservancy

Project Location

- Camp Verde, Arizona
- Located in the Verde River Basin

Primary Contacts

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Project Timeline

- Crop conversion to barley was implemented during the 2017 growing season

Total Project Cost

- Total Project Cost: $103,600
- PepsiCo Contribution: $103,600
- 100% funded by PepsiCo

Water Quantity - Total Benefit

- 325 ML/yr

Water Quantity – PepsiCo Benefit*

- 325 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc.
- The Nature Conservancy
- Friends of the Verde River
- Hauser and Hauser Farm
- Specks Farm

Photo Credit: The Nature Conservancy

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Water Savings Project: Verde River Watershed

Through PepsiCo's "Recycle for Nature" program, PepsiCo and The Nature Conservancy (TNC) are supporting agricultural improvement projects in the Verde River watershed in the state of Arizona (PepsiCo, 2018). The cropland fallowing project was implemented in the Verde valley to reduce irrigation demand.

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The Verde River watershed is located in north-central Arizona and drains an area of approximately 6,600 square miles. The river is a key surface water source for metro Phoenix and a lifeline for wildlife in the arid southwest, including migratory birds, nesting bald eagles, rare species of reptiles and many species of native fish. The Verde valley is an important part of the agricultural economy in the Colorado River Basin. The river is impacted by surface water withdrawals for irrigation, groundwater pumping for drinking water, and long-term drought conditions. Like many western rivers, streamflow is low or non-existent during the hot summer months when the irrigation demands are high throughout the valley. The resulting low river flows impact ecosystem health.

TNC is working with local partners and farmers on ways to reduce consumptive crop water use, particularly during low flow summer months. One strategy for reducing consumptive is fallowing of cropland. This strategy for reducing consumptive use would make payments to participants for fallowing irrigated fields. The fallowing practice has the potential to reduce consumptive use as well as improve summer flows by reducing the amount of water diverted for irrigation.

Project Objectives

The objective of the project is to reduce consumptive crop water use during summer, leaving more water in the river.

Project Activities

In 2017, TNC completed fallowing agreements with two small landowners in the Verde valley. The agreements were implemented in the Norton (1.75 acres) and Watkins (5.36 acres) farms near Camp Verde with a combined area of 7.11 acres (Figure 1). Both farms cultivated bermudagrass pasture during the 2017 growing season. Fallowing is the act of temporarily leaving land unirrigated for a specified duration. According to the fallowing agreement irrigation was not applied during the entire month of July.

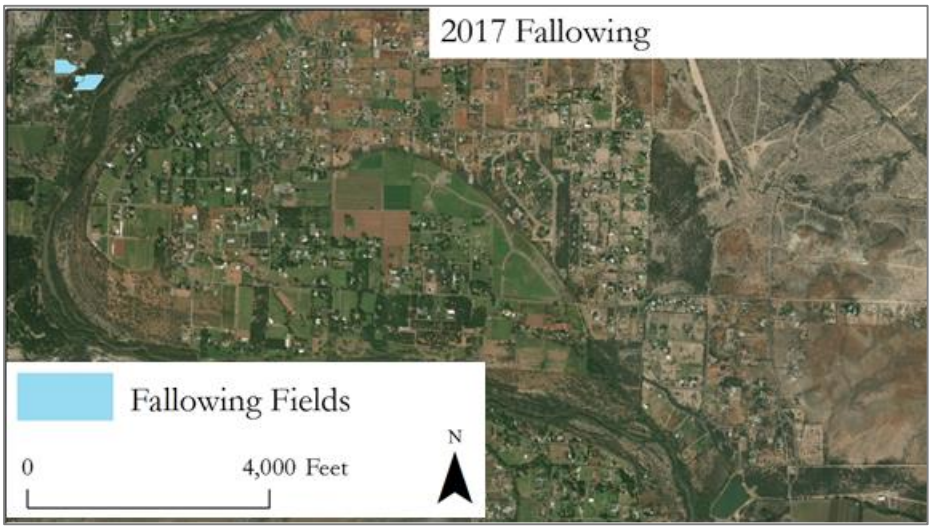

Figure 1. Project location (photo credit: The Nature Conservancy).

Water Savings Benefit Calculation

The water savings benefit was calculated as the volume of consumptive irrigation avoided due to implementation of crop fallowing on 7.11 acres.

Water Savings Benefit = Volume of Consumptive Irrigation Avoided

The calculations were performed on an annual basis to estimate benefits in million liters per year (ML/yr). One million liters (ML) is equal to 264,172 gallons.

Methodology

The consumptive irrigation requirement (CIR) is the maximum amount of water that is consumed for crop production over an irrigation season under ideal conditions. The proportion of consumptive irrigation avoided from the specific project activities is determined based on whether irrigation is avoided altogether for the season (i.e., full fallowing), or the cutoff date for irrigation shutoff (i.e., partial fallowing or split-season irrigation). In this project, irrigation application was avoided during July. Therefore, the volume of consumptive irrigation avoided was estimated based on the CIR for bermudagrass in July.

Data & Assumptions

Unless noted, all of the project information was provided by TNC to support the water savings benefit calculation.

- **Project Area**: 7.11 acres
  - Norton farm: 1.75 acres
  - Watkins farm: 5.36 acres
- **Average Consumptive Use**:
  - The total CIR for bremudagrass over the entire growing season is 43.5 inches, and the CIR for July is 10.3 inches (Erie et al., 1965).
- It is possible that a fraction of the CIR is satisfied by precipitation. Given the arid conditions, the entire CIR for bermudagrass during July was assumed to be provided through irrigation.

Calculation & Results

The calculation inputs and results of water savings due to consumptive irrigation avoided at various farms are shown in Table 2.

The water savings (volume of consumptive irrigation avoided) is estimated as follows:

Water Savings (acre-feet)
= Area (acres) x CIR Avoided (inches) / 12 (inches-feet conversion factor)

Table 2. Summary of water savings from fallowing implemented during the 2017 irrigation season

Property Name	Acres	Fallowing Period	CIR Avoided (in)	Water Savings (ac-ft.)
Norton	1.75	Jul 1 – July 31	10.30	1.5
Watkins	5.36	Jul 1 – July 31	10.30	4.6

Total Water Savings Benefit = 6.1 acre-feet = 7.52 ML = 8 ML

The total water savings benefit is 8 ML/yr. PepsiCo's water savings benefit is calculated by multiplying the total water savings benefit by PepsiCo's cost-share for this project. In 2017, PepsiCo's cost share was 100%. **Therefore, the resulting cost-share adjusted benefit is 8 ML/yr.** The water savings benefit quantified is based on the fallowing activity (i.e., irrigation avoided) during the 2017 growing season. Continuation of the benefits beyond 2017 depends on future implementation of the fallowing activity.

Project Location

- Camp Verde, Arizona
- Located in the Verde River Basin

Primary Contacts

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Project Timeline

- Fallowing was implemented during the 2017 growing season

Total Project Cost

- Total Project Cost: $822.5
- PepsiCo Contribution: $822.5
- 100% funded by PepsiCo

Water Quantity - Total Benefit

- 8 ML/yr

Water Quantity – PepsiCo Benefit*

- 8 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc.
- The Nature Conservancy

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Crop Conversion and Irrigation Efficiency Improvement, Camp Verde, Arizona

Water Savings Project: Verde River Watershed

Through PepsiCo's "Recycle for Nature" program, PepsiCo and The Nature Conservancy (TNC) are supporting agricultural improvement projects in the Verde River watershed in the state of Arizona (PepsiCo, 2018). The crop conversion and irrigation efficiency improvement project was implemented in the Verde Valley to reduce irrigation demand.

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The Verde River watershed is located in north-central Arizona and drains an area of approximately 6,600 square miles. The river is a key surface water source for metro Phoenix and a lifeline for wildlife in the arid southwest, including migratory birds, nesting bald eagles, rare species of reptiles and many species of native fish. The Verde Valley is an important part of the agricultural economy in the Colorado River Basin. The river is impacted by surface water withdrawals for irrigation, groundwater pumping for drinking water, and long-term drought conditions. Like many western rivers, streamflow is low or non-existent during the hot summer months when the irrigation demands are high throughout the valley. Competing demands for water are putting pressure on the watershed.

A collaborative effort between TNC, irrigators, community organizations and others is restoring Verde River flows while supporting the irrigation needs of agricultural producers in the Verde Valley. In 2017, TNC partnered with the Hauser and Hauser Farms and completed an irrigation efficiency and crop conversion project to restore flow to the Verde River and its tributaries (Figure 1). Traditional crops grown in the Verde River Valley such as alfalfa have high water requirements. Cultivation of low water use crops such as carrots, combined with high efficiency irrigation system such as drip irrigation results in less irrigation water diverted from the river, particularly during the high-demand, low streamflow summer period.

Figure 1. Carrot cultivation with drip irrigation at Hauser and Hauser Farms, Camp Verde, AZ

Project Objectives

The objective of the project is to reduce consumptive crop water use and water withdrawal for irrigation, leaving more water in the river.

Project Activities

TNC worked with the Hauser and Hauser Farms, the largest multi-generational farm in the area, and implemented irrigation efficiency and crop conversion activities in 35 acres at the Central Park location (Figure 2). Irrigation water for the property is fed from both West Clear Creek and the Verde River. Historically, the farm has used flood irrigation. In flood irrigation, water is delivered through a pipe or ditch and flows over cropland. However, large amounts of water are lost to evaporation and runoff. In 2017, flood irrigation was replaced with drip irrigation. Drip irrigation provides a slow-moving supply of water directly to soil. Introducing water gradually and directly to crops reduces evaporation and runoff, increasing water efficiency. The second aspect of this project was crop switching. The typical crop grown at this farm is alfalfa. TNC entered into a one-year agreement with the landowner to convert from alfalfa to carrots cultivation. Carrots were an ideal choice because they require low water inputs and have high production under drip irrigation.

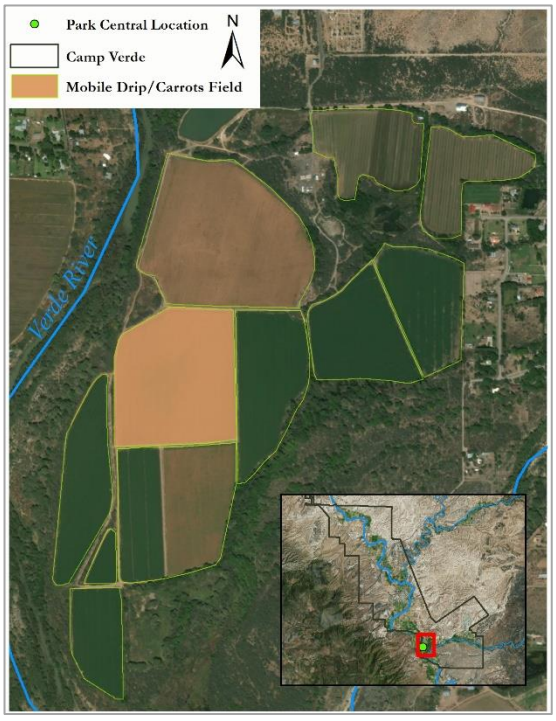

Figure 2. Project location.

Water Savings Benefit Calculation

The water savings benefit is estimated as the reduction in consumptive water use due to crop switching (i.e., alfalfa to carrot conversion) and efficient irrigation (i.e., flood to drip irrigation).

Water Savings Benefit = Consumptive water use Without-Project – Consumptive water use With-Project

The calculations were performed on an annual basis to estimate benefits in million liters per year (ML/yr). One million liters (ML) is equal to 264,172 gallons.

Methodology

Conversion of alfalfa to carrots:

The consumptive water use for alfalfa is substantially higher than carrots. Therefore, the water savings benefit is calculated as the reduction in consumptive water use resulting from the conversion of alfalfa to carrots.

Conversion of flood to drip irrigation:

Consumptive irrigation requirement for carrot cultivation under flood and drip irrigation systems are estimated. The water savings associated with the conversion from flood to drip irrigation was quantified as the difference in consumptive irrigation between the "without-project" (flood irrigation) and "with-project" (drip) conditions.

Data & Assumptions

Unless indicated, all of the project information was provided by TNC to support the water savings benefit calculation.

- **Project Area**: 35 acres
- **Average Consumptive Use**:
  - Alfalfa: 74.3 inches (Erie at al., 1965)
  - Carrots: 16.6 inches (Erie at al., 1965)
- **Irrigation efficiency:**
  - Flood irrigation: 60%
  - Drip irrigation: 90%
- **Water applied for carrot irrigation:**
  - Flood irrigation = 28.3 inches
  - Drip irrigation = 18.9 inches

  Water applied was estimated based on consumptive crop water use for carrots (17 inches) and the irrigation efficiencies for flood (60%) and drip (95%) irrigation systems.

The following assumptions were used in the calculations:

- The return flows associated with flood and drip irritation are 25% and 5%, respectively (Foster and Perry, 2010). The return flow accounts for the water that infiltrates, is not consumed and is available for other uses.

Calculation & Results

The total waters savings associated with crop conversion and efficient irrigation are calculated as follows:

Conversion of alfalfa to carrots:

Reduction in consumptive use = [Consumptive use for alfalfa] - [Consumptive use for carrots]
= 74.3 – 16.6 inches = 57.7 inches = 4.81 acre-feet/acre
Area affected = 35 acres
Consumptive use volume = 4.81 acre-feet/acre x 35 acres = **168.3 acre-feet**

Conversion of flood to drip irrigation:

Without project (flood irrigation):

- Water applied for irrigation = 28.3 inches
- Consumed fraction = (1- fraction of return flow) X water applied
  = (1-0.25) X 28.3 inches = 21.2 inches

With project (drip irrigation):

- Water applied for irrigation = 18.9 inches
- Consumed fraction = (1- fraction of return flow) X water applied
  = (1-0.05) X 18.9 inches = 18.0 inches

Reduction in consumptive irrigation = 21.2 – 18.0 inches = 3.2 inches = 0.27 acre-feet/acre
Area affected = 35 acres
Consumptive use volume = 0.27 acre-feet/acre x 35 acres = **9.3 acre-feet**

Total reduction in consumptive use = 168.3 + 9.3 acre-feet
= 177.6 acre-feet = 219 ML

The total water savings benefit is 219 ML/yr. PepsiCo's water savings benefit is calculated by multiplying the total water savings benefit by PepsiCo's cost-share for this project. In 2017, PepsiCo's cost share was 37.3%. **Therefore, the resulting cost-share adjusted benefit is 82 ML/yr.**

The water savings benefit associated with crop conversion is based on carrot cultivation (instead of alfalfa) during the 2017 growing season. In order for the estimated water savings benefits to be

realized in the future (i.e., beyond 2017), the carrot cultivation must continue be implemented on an annual basis.

The water savings benefit associated with the conversion from flood to drip irrigation is based on carrots cultivated in 2017. The water savings must be evaluated each year beyond 2017 by accounting for the type of crop cultivated.

Additional Benefits Not Quantified

The implementation of this projects results in additional environmental benefits that have not been quantified as part of this work. The benefits include:

- Enhanced wildlife habitat
- Improved recreational access to the river

Project Location

- Camp Verde, Arizona
- Located in the Verde River Basin

Primary Contacts

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Project Timeline

- Crop conversion (alfalfa to carrots) was implemented in 2017
- Conversion to efficient irrigation (flood to drip) was implemented in 2017

Total Project Cost

- Total Project Cost: $126,000
- PepsiCo Contribution: $47,005
- 37.3% funded by PepsiCo

Water Quantity - Total Benefit

- 219 ML/yr

Water Quantity – PepsiCo Benefit*

- 82 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc.
- The Nature Conservancy
- Hauser and Hauser Farm

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Water Savings Project: Colorado River Basin

Through PepsiCo's "Recycle for Nature" program, PepsiCo and TNC are supporting agricultural improvement projects in the Colorado River Basin in the state of Colorado (PepsiCo, 2016; TNC, 2016). The Meaker Farm agricultural irrigation project in Montrose, Colorado is being executed through collaboration with the implementing partners, Randy Meaker of Meaker Farm and Dr. Perry Cabot of Colorado State University (CSU).

The demand for water is great in the Colorado River Basin. Water is used for municipal (e.g., drinking water), industrial, agricultural, and recreational activities as well as for environmental services. The Colorado River Basin supplies drinking water for more than 33 million people in the southwest, including people who live in Denver, Los Angeles, Phoenix, Albuquerque, Las Vegas and Salt Lake City (USGS, 2014). More than four million acres of cropland are irrigated in the United States and Mexico (USGS, 2014). Irrigation is a water use that is vital to the economy and individual livelihoods; however, irrigation can be highly consumptive, and improvements in irrigation technologies and practices can help protect watersheds and sustain water supplies for all users.

Project Objectives

- Reduce the volume of water applied for irrigation of cultivated crops
- Improve reliability of water supply and water quality

Project Activities

Agricultural irrigation improvements were implemented on a total of 47 acres of cropland on Meaker Farm in Montrose, Colorado (Figure 1) to address the project objectives, listed above. The irrigation technology on the project site was converted from a flood/furrow irrigation system to a big gun sprinkler irrigation system in 2015 (Figure 2).

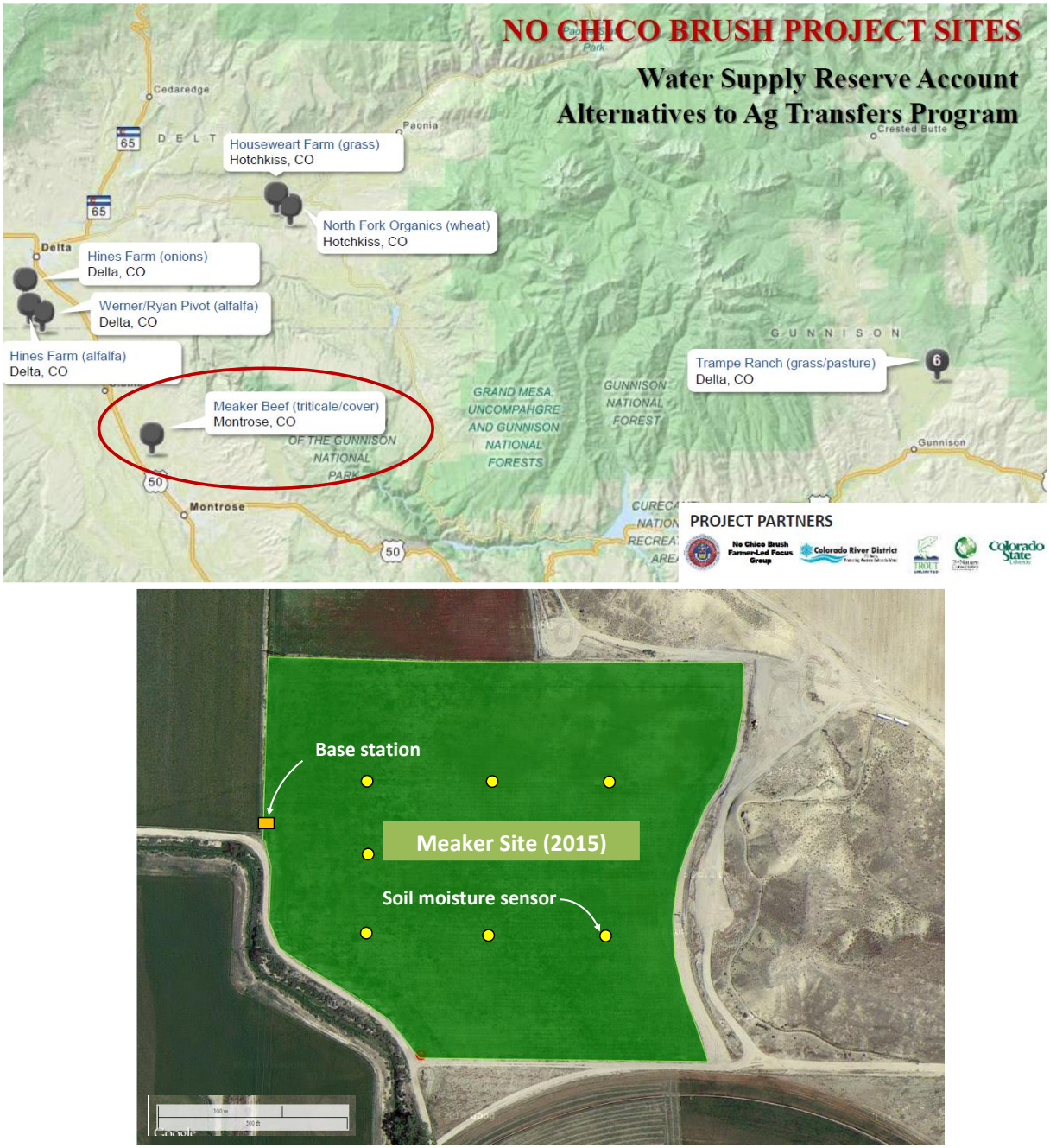

Figure 1. Map of the project location (top) and an aerial image of ~10 acres with improved irrigation technologies installed and monitored with flow meters and soil moisture sensors (bottom) (Cabot, 2015; Derwingson, 2016).

Flood/furrow irrigation involves the delivery of large volumes of water onto fields where it flows over the ground and through the crops. With this type of irrigation, a large fraction of the water applied is not used by the crops to meet water needs and instead, is either evaporated, runs off the field, or infiltrates through the soil profile. In the region where the project site is located, deep percolation from flood-irrigated fields can carry salt and selenium to local waterways and adversely impact water quality.

The big gun irrigation system provides improved crop irrigation efficiency, resulting in a reduction in the volume of irrigation water applied and a reduction in surface runoff from crop fields. Under the flood/furrow irrigation system, the sloped nature of the project field site required the producer (Randy Meaker) to run water for long periods of time to maximize saturation at the uphill portion of the site (Cabot, 2016). With the installation of the big gun sprinkler system, the project site was irrigated using a zone-based strategy to optimize efficiency and reduce the volume of water applied for irrigation (Cabot, 2016). Soil moisture sensors were installed to help inform when to apply water and how much to apply (Derwingson, 2016).

Figure 2. Dr. Cabot (CSU) prepares soil moisture sensors for installation (left); installed soil moisture sensors and communication relay units (middle); and big gun irrigation system in operation on Meaker Farm (right).

Water Savings Benefit Calculation

The water savings benefit was calculated as the reduction in the volume of water applied for irrigation as a result of the installation of improved irrigation technologies.

Water Savings Benefit = Irrigation Volume Applied Pre-Project – Irrigation Volume Applied Post-Project

The reporting units are million liters per year (ML/yr). One million liters (ML) is equal to 264,200 gallons (gal). The calculations were performed on an annual basis to estimate benefits in ML/yr.

Methodology

The water savings associated with improved irrigation technologies was quantified based on field measurements of irrigation water applied for the "pre-project" (flood/furrow) and "post-project" (big gun sprinkler) conditions. The irrigation water application rates were determined based on flow meter data from a Seametrics AG 2000 totalizing flow meter and record-keeping by the producer on specific irrigation programs and manufacturer specifications on nozzle ratings for each date/time of

irrigation water was applied to the project site field (Cabot, 2016). Because water was not applied uniformly over the field, a weighted average of irrigation water applied was derived based on zones (Cabot, 2016). A more detailed description of the methodology used to calculate the irrigation water application rates is provided in Cabot (2016).

Data & Assumptions

All of the project information and data were provided by CSU (Cabot, 2016) and TNC (Derwingson, 2016; 2017) to support the efficiency water savings benefit calculation, listed below:

- **Project Area**: 47 acres
- **Land Condition**:
  - Pre-Project: flood/furrow irrigation with spring barley crop
  - Post-Project: big gun sprinkler irrigation system with corn silage
- **Total Volume of Irrigation Water Applied**:
  - Pre-Project: 77,213,110 gallons (60.5 inches)
  - Post-Project: 27,694,620 gallons (21.7 inches)
- The irrigation efficiency of flood/furrow and big gun sprinkler systems are approximately 20% and 63%, respectively.
- The lifespan of big gun sprinkler irrigation system is expected to be 10 years (NRCS, 2007). Therefore, benefit from this project is expected to continue until 2024.

Calculation & Results

The calculations for the reduction in irrigation volume applied, and total waters savings (in terms of improved efficiency) are as follows:

Pre-project (Flood/Furrow):

- Total volume of irrigation water applied = 77,213,110 gallons x 3.78 L/gallon = 291,865,555 L = 292 ML

Post-project (Big Gun Sprinkler System):

- Total volume of irrigation water applied = 27,694,620 gallons x 3.78 L/gallon = 104,685,662 L = 105 ML

Total Water Savings Benefit = 292 ML – 105 ML = 187 ML/yr

The total water savings benefit is 187 ML/yr. PepsiCo's water savings benefit is based on the cost-share for this project, which was 51.6% of the total project cost. **Therefore, the resulting cost-share adjusted benefit is 96 ML/yr.**

The water savings benefit quantified is based on the big gun sprinkler irrigation technology implemented during the 2015 irrigation season. Big gun sprinkler irrigation was continued during the 2017 irrigation season. The typical irrigation season for the project site location is from April to November.

Additional Benefits Not Quantified

The implementation of improved irrigation technologies results in additional environmental benefits that have not been quantified as part of this work. The benefits include:

- Improved water quality (e.g., reduction in salinity and loading of selenium, sediment and nutrients)
- Enhanced wildlife habitat (improved water quality and environmental flow near the site may enhance habitat and biodiversity).

This project also serves as an important demonstration of the potential benefits of installing improved irrigation practices, such as a big gun sprinkler irrigation system. In addition, this project is one of the field sites in CSU's study to quantify the benefits of irrigation efficiency improvements (reduced labor and other inputs, improved yield, etc.) (Cabot, 2016). These efforts support a larger initiative with local producers to advance the adoption of improved efficiency and irrigation water management, and to provide additional funding to support this type of work.

Land of America

Project Location

- Montrose, Colorado
- Located in the Colorado River Basin

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Project Timeline

- The project was initiated in July 2014. Agricultural irrigation improvement practices were implemented from July 2015 through October 2015
- Big gun sprinkler irrigation was continued during the 2017 irrigation season

Project Costs

- 51.6% funded by PepsiCo

Water Quantity - Total Benefit

- 187 ML/yr

Water Quantity – PepsiCo Benefit*

- 96 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc.
- The Nature Conservancy
- Colorado State University
- Meaker Farms

Land of America

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Carpenter Ranch Irrigation Improvement
Hayden, Colorado

Water Savings Project: Colorado River Basin

Through PepsiCo's "Recycle for Nature" program, PepsiCo and The Nature Conservancy (TNC) are supporting irrigation improvement projects in the Colorado River Basin in the state of Colorado (PepsiCo, 2018). An irrigation improvement project was implemented on the Carpenter Ranch Preserve, located near the town of Hayden, Colorado, to protect critical water resources and sustain water supplies for all users.

There is a high demand for water in the Colorado River Basin. Water is used for municipal (e.g., drinking water), industrial, agricultural, and recreational activities as well as for environmental services. Irrigation is a water use that is vital to the economy and individual livelihoods; however, irrigation can be highly consumptive. Improvements in irrigation technologies and practices that increase efficiencies and use less water can leave more water in the river and sustain water supplies for all users.

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Carpenter Ranch Preserve is a working ranch and preserve in Northwest Colorado that is owned by TNC (TNC, 2018). The ranch serves as a demonstration of how conservation and agriculture can work in tandem and provides a model for innovative irrigation applications and land management approaches for other agricultural producers and stakeholders (TNC, 2018).

Project Objectives

The objective of this project was to improve irrigation efficiency and reduce total water consumption.

Project Activities

This project replaced an aging irrigation system with a new water-saving system on the Carpenter Ranch Preserve (Figure 1). The crop planted on the ranch is a perennial hay crop with a mix of grass and alfalfa (TNC, 2018). TNC replaced an aging side-roll wheel line irrigation infrastructure system with a center pivot sprinkler irrigation system in the "Mesa Fields" (Figure 2) (TNC, 2018). The center pivot sprinkler system is designed to irrigate approximately 132 acres of a 150 acre cropland area (TNC, 2018). The remaining 18 acres will either be permanently fallowed or utilized for dryland crop production that would require no irrigation. Before project implementation, water application was uneven and the crop quality suffered with signs of stress, lack of vigor, and instances of weed proliferation (TNC, 2018). After the project was implemented, water application was more even and crop vigor and density improved with less water applied (TNC, 2018).

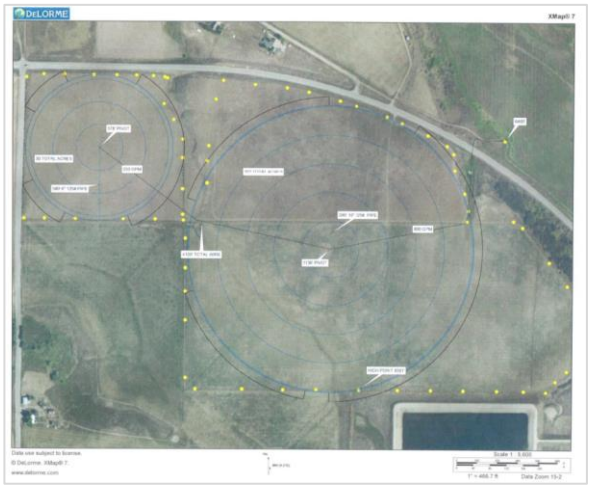

Figure 1. Map of installed center pivot sprinkler irrigation systems on Carpenter Ranch Preserve (TNC, 2018).

Figure 2. Side-roll wheel line irrigation used before project (left) and center pivot sprinkler irrigation used after project (right) at Carpenter Ranch Preserve (TNC, 2018).

Water Savings Benefit Calculation

The water savings benefit was calculated as the reduction in consumptive irrigation associated with the project activities implemented on a total of 150 acres.

Water Savings Benefit = Reduction in consumptive irrigation

The calculations were performed on an annual basis to estimate benefits in million liters per year (ML/yr). One million liters (ML) is equal to 264,172 gallons.

Methodology

Irrigation Efficiency Improvement (conversion from side-roll to center pivot irrigation system):
The water savings associated with the conversion from side-roll to center pivot irrigation was quantified as the difference in consumptive irrigation between the "without-project" (side-roll irrigation) and "with-project" (center pivot irrigation) conditions.

Irrigation Avoided:
Irrigation is avoided altogether on 18 acres which will either be permanently fallowed or utilized for dryland crop production. Without the project, cultivation of perennial hay crop comprised of grass and alfalfa would have continued on 18 acres. Therefore, the benefit is estimated as the volume of consumptive irrigation avoided due to the project.

Data & Assumptions

Unless noted, all of the project information was provided by TNC to support the water savings benefit calculation.

Irrigation Efficiency Improvement (conversion from side-roll to center pivot irrigation system):

- Area: 132 acres
- Crop type: perennial hay crop comprised of grass and alfalfa
- Water applied (side-roll wheel line): 2 acre-feet/acre
- Water applied (center pivot): 1.3 acre-feet/acre, based on 35% reduction in water applied
- Return flow as % of water applied: Return flows are typically low with sprinkler systems (Foster and Perry, 2010). A 10% return flow was assumed for both side-roll and center pivot systems.

Irrigation Avoided:

- Area: 18 acres
- Crop type: perennial hay crop comprised of grass and alfalfa
- Consumptive irrigation requirement (CIR): Average CIR for alfalfa and grass pasture (USBR, 2012) = 20.5 inches = 1.7 acre-feet/acre

Calculation & Results

The annual water savings benefits for implementing irrigation improvement activities in the Colorado River Basin is summarized below.

Irrigation Efficiency Improvement (conversion from side-roll to center pivot irrigation system):

Without project (side-roll wheel line irrigation):

- Water applied for irrigation = 2 acre-feet/acre

- Consumed fraction = (1- fraction of return flow) X water applied

  = (1-0.1) X 2 acre-feet/acre = 1.80 acre-feet/acre

With project (center pivot irrigation):

- Water applied for irrigation = 1.3 acre-feet/acre
- Consumed fraction = (1- fraction of return flow) X water applied

  = (1-0.1) X 1.3 acre-feet/acre = 1.17 acre-feet/acre

Benefit = 132 acres x (1.80 – 1.17 acre-feet/acre) = 83.2 acre-feet

Irrigation Avoided

Reduction in consumptive irrigation = Area (acres) x CIR Avoided (acre-feet/acre)

= 18 acre x 1.7 acre-feet/acre = 30.8 acre-ft

Benefit = 30.8 acre-ft

Total Benefit = 83.2 + 30.8 acre-ft = 114 acre-ft = 140.6 ML = 141 ML

The total water savings benefit is 141ML/yr. PepsiCo's water savings benefit is calculated by multiplying the total water savings benefit by PepsiCo's cost-share for this project. In 2017, PepsiCo's cost share was 82%. **Therefore, the resulting cost-share adjusted benefit is 116 ML/yr.**

Project Location

- Hayden, Colorado
- Located in the Colorado River Basin

Primary Contacts

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Project Timeline

- Irrigation improvement activities were implemented in 2017

Total Project Cost

- Total Project Cost: $158,500
- PepsiCo Contribution: $130,000
- 82% funded by PepsiCo

Water Quantity - Total Benefit

- 141ML/yr

Water Quantity – PepsiCo Benefit*

- 116 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc.
- The Nature Conservancy

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Water Savings Project: Colorado River Basin

Through PepsiCo's "Recycle for Nature" program, PepsiCo and The Nature Conservancy (TNC) are supporting water conservation program projects in the Colorado River Basin in the state of Colorado (PepsiCo, 2018). A water conservation pilot project to test water banking through crop fallowing was implemented in Mesa County near the communities of Grand Junction, Fruita, and Loma, Colorado, to protect critical water resources and sustain water supplies for all users of the Colorado River.

There is a high demand for water in the Colorado River Basin. Water is used for municipal (e.g., drinking water), industrial, agricultural, and recreational activities as well as for environmental services. Irrigation is a water use that is vital to the economy and individual livelihoods; however, irrigation can be highly consumptive, and improvements in water saving practices can help protect watersheds and sustain water supplies for all users.

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TNC joined with farmers, municipalities and other partners to test a large-scale water bank pilot project with the Grand Valley Water Users Association (GVWUA) to reduce the consumptive water use in the Colorado River Basin (GVWUA, 2016; TNC, 2018). The GVWUA operates the Grand Valley Diversion Dam, the 55-mile long Government Highline Canal, and 150 miles of piped and open laterals, to provide irrigation water to approximately 23,500 acres of irrigated land in Western Colorado (GVWUA, 2016). The water banking project, referred to as the Conserved Consumptive Use Pilot Project (CCUPP), builds upon the past work to provide a large-scale test of how a voluntary and compensated program to reduce water use can work on the ground to help address issues associated with the Colorado River Compact and declining reservoir levels in ways that work for water users, water managers, and other stakeholders, while benefitting the environment (GVWUA, 2016). The CCUPP with the GVWUA was launched in April of 2017 (TNC, 2018). The CCUPP's 10 participants reduced irrigation on approximately 1,250 acres of cropland to improve river flows and provide system-wide benefits (TNC, 2018). The intent of the CCUPP is to increase

the understanding of what it takes to build a program that successfully addresses the risks and uncertainties associated with increasing demand on Colorado River Basin water resources (GVWUA, 2016).

Project Objectives

The objective of the project is to reduce consumptive uses in the Colorado River Basin in Colorado in order to address the risks of drought and potential water shortages.

Project Activities

This project was implemented during the 2017 irrigation season. Irrigation water for GVWUA is diverted from the Colorado River at the Grand Valley Project Diversion Dam into the Government Highline Canal outside of Palisade, Colorado (GVWUA, 2016). The GVWUA contracted with 10 participating shareholders in Mesa County, near the communities of Grand Junction, Fruita, and Loma, to implement four different water savings practices on a total of 1,252.2 acres (Figure 1) (GVWUA, 2016). The practices included a full season of fallowing and three options for partial-season fallowing with irrigation water available after August 1, September 1, and October 1 (GVWUA, 2016). Each practice had an associated estimate of reduced consumptive use and corresponding payment for the practice (GVWUA, 2016). GVWUA monitored each participant in the pilot project for compliance in reducing consumptive use and accounted for and managed the water from conserved consumptive use within its system (GVWUA, 2016). The monitoring included periodic field verification to ensure that no water was delivered during the contract timeframe and that participants complied with all contract terms (GVWUA, 2016).

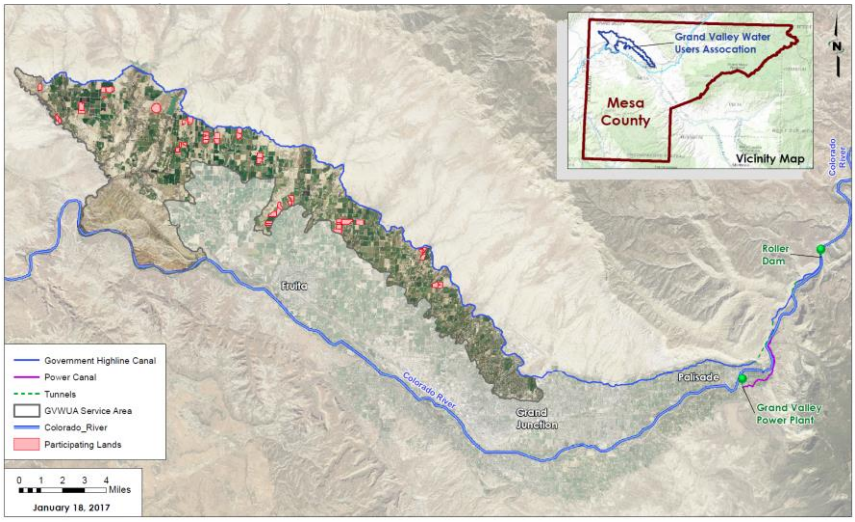

Figure 1. Location map of the conserved consumptive use pilot project 2017 (JUB Engineers, Inc. and GVWUA, 2017)

Water Savings Benefit Calculation

The water savings benefit was calculated as the volume of consumptive irrigation avoided due to the implementation of project activities on a total of 1,252.2 acres.

Water Savings Benefit = Volume of Consumptive Irrigation Avoided

The calculations were performed on an annual basis to estimate benefits in million liters per year (ML/yr). One million liters (ML) is equal to 264,172 gallons.

Methodology

The consumptive irrigation requirement (CIR) is the maximum amount of water that is consumed for crop production over an irrigation season under ideal conditions. An engineering consultant from J-U-B estimated a CIR of 2.8 acre-feet/ac (33.1 inches) by taking a weighted average of the water use of the three dominant crop types, including alfalfa, corn and winter wheat, within the GVWUA service area (GVWUA, 2016). The proportion of consumptive irrigation avoided from the specific project activities was determined based on whether irrigation is avoided altogether for the season (i.e., full fallowing), or only for part of the season (i.e., partial fallowing). The volume of consumptive irrigation avoided was estimated based on the crop CIR for the full season and the proportion of CIR avoided.

Data & Assumptions

Unless noted, all of the project information was provided by TNC to support the water savings benefit calculation.

- **Project Area**: 1,252.2 acres (Table 1).
- **Type of activity**: full and partial fallowing (Table 1).
- The CIR of 2.8 acre-feet/acre (AF/ac) was estimated by taking a weighted average of the water use of the three dominant crop types, including alfalfa, corn and winter wheat, as determined by the 2014 NASS CropScape data layer associated with fields greater than 18 acres in size and within the 23,500 acre GVWUA service area (GVWUA, 2016).
- The fallowing contracts were implemented for the 2017 irrigation season. Therefore, the benefits are not expected to continue beyond 2017.

Calculation & Results

The annual water savings benefits for implementing a water conservation program in the Colorado River Basin is summarized below.

The water savings (volume of consumptive irrigation avoided) is estimated as follows:

Water Savings (AF) = CIR Avoided (AF/ac) x Area Affected (acres)

The results are summarized in Table 1 below.

Table 1. Summary of the fallowing activities and estimated consumptive irrigation avoided.

Program Activity	Consumptive Irrigation Avoided (CIR) (AF/ac)	Area Affected (acre)	Water Savings (AF)
Full Fallow	2.8	354	991.2
Fallow until October 1 (partial fallow)	2.6	663	1,723.8
Fallow until September 1 (partial fallow)	2.3	192.5	442.8
Fallow until August 1 (partial fallow)	1.6	42.7	68.3
Total	**-**	**1,252.2**	**3,226.1**

Total Water Savings Benefit = 3,226.1 AF/yr = 3,998 ML/yr

The total water savings benefit is 3,998 ML/yr. PepsiCo's water savings benefit is calculated by multiplying the total water savings benefit by PepsiCo's cost-share for this project. In 2017, PepsiCo's cost share was 12%. **Therefore, the resulting cost-share adjusted benefit is 477 ML/yr.**

Project Location

- Mesa County, Colorado
- Located in the Colorado River Basin

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Project Timeline

- Fallowing was implemented during the 2017 growing season

Total Project Cost

- Total Project Cost: $1,039,439
- PepsiCo Contribution: $125,000
- 12% funded by PepsiCo

Water Quantity - Total Benefit

- 3,978 ML/yr

Water Quantity – PepsiCo Benefit*

- 477 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc.
- The Nature Conservancy
- Grand Valley Water Users Association
- Colorado River Water Conservation District
- Colorado Water Conservation Board
- Walton Family Foundation

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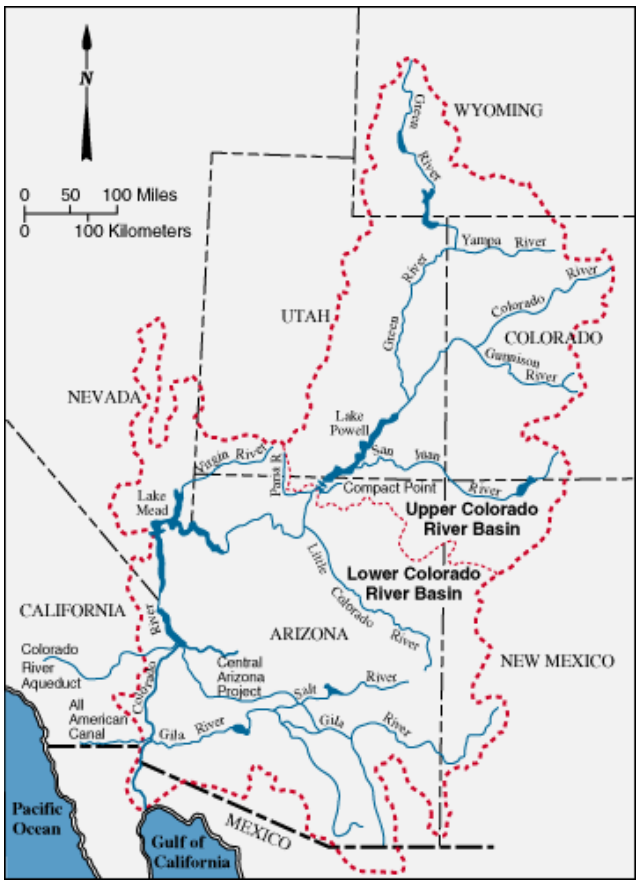
Water Savings Project: Colorado River Basin

Through PepsiCo's "Recycle for Nature" program, PepsiCo and TNC are supporting agricultural improvement projects in the Colorado River Basin in the state of Colorado (PepsiCo, 2017; TNC, 2017).

The Colorado River Basin supplies water to seven western states and Mexico. The Basin provides domestic water supplies to more than 36 million people and irrigates more than five million acres of agricultural lands (USBR, 2012). It also supports diverse wildlife and a vibrant economy. The river ecosystem and much of the economic productivity depends on water availability, and during water shortages, there is much at risk. The Basin has experienced a severe drought since the late 1990s and a trend of declining water supplies (USBR, 2012). Irrigation is a water use that is vital to the economy and individual livelihoods; however, irrigation can be highly consumptive, and improvements in irrigation technologies and practices can help protect watersheds and sustain water supplies for all users.



US Bureau of Reclamation

The Nature Conservancy is participating in the regional conservation efforts in the basin aimed to reduce water risk, improve water conservation, and increase benefits to water resources. These conservation measures include the System Conservation Pilot Program. These efforts help promote conservation practices by testing new approaches to reducing water demand and mitigating the impacts of long-term drought on the Colorado River System while still protecting water rights and compensating water users for implementing water-saving measures.

Gunnison River, Tributary to the Colorado River. Photo Courtesy: Mark Skalny/TNC

In 2014, the U.S. Bureau of Reclamation (USBR) implemented the Colorado River System Conservation Pilot Program. The System Conservation Pilot Program is another effort based on voluntary, market-based, compensated agreements to reduce consumptive water use. The program provides funding for water conservation projects aimed at increasing water security in the Colorado River Basin system by reducing water uses to protect critical storage levels in Lake Mead and Lake Powell. Colorado River water conserved as a result of the Pilot Program is for the sole purpose of increasing storage levels in Lake Mead and Lake Powell and will not accrue to the benefit or use of any individual water user (USBR, 2017).

Project Objectives

- Test methods to reduce consumptive water use in different sectors and geographies
- Improve reliability of water supply

Project Activities

During the 2016 irrigation season, TNC facilitated implementation of conservation activities on a total of 222 acres under the System Conservation Pilot Program (Table 1). Activities implemented include full fallowing (i.e., no irrigation), partial fallowing and transition to low water use crops. Fallowing was implemented in 200 acres of irrigated corn at the Grand Valley Farms located near Grand Junction, CO. Corn production will be forgone on 200 acres in 2016 and 2017. At the McCracken (10 acres) and Nauyokas (12 acres) farms the project activities involve partial season fallowing and conversion to low water use cover crop instead of alfalfa. The McCracken Farm is located near Olathe, CO. The Nauyokas Farm is located near Delta, CO. At the McCracken and Nauyokas farms, project activities will be continued through 2018.

Table 1. Summary of project activities implemented during the 2016 irrigation season

Program	Waterbody	Farm	Activity Description	Acres
System Conservation Pilot Program	Colorado River	Grand Valley Farms	Fallowing (no irrigation) of 200 acres of irrigated corn.	200
	Uncompahgre River - Gunnison Basin	McCracken	Partial fallowing and conversion to a low water use cover crop while the producer transitions to a certified organic operation.	10
	Uncompahgre River - Gunnison Basin	Nauyokas	Partial fallowing and conversion to a low water use cover crop while the producer transitions to a certified organic operation.	12

Water Savings Benefit Calculation

The water savings benefit was calculated as the volume of consumptive irrigation avoided due to implementation of conservation activities.

Water Savings Benefit = Volume of Consumptive Irrigation Avoided

The reporting units are million liters per year (ML/yr). The calculations were performed on an annual basis to estimate benefits in ML/yr.

Methodology

The consumptive irrigation requirement (CIR) is the maximum amount of water that is consumed for crop production over an irrigation season under ideal conditions. The CIRs of various crops grown in the Colorado Basin are provided in a NRCE (2012) report. The CIRs are based on the Colorado StateCU model (Colorado Division of Water Resources, 2008). The StateCU model uses the modified Blaney-Criddle equation with an adjustment for elevation to calculate crop ET. To estimate CIR values at different elevations, climate stations at different elevations were utilized in the StateCU model. Climate stations containing more than 25 years of data were used. By multiplying irrigated acres by the appropriate consumptive irrigation requirement values obtained from the StateCU model based on elevation, the potential irrigation volume consumed (i.e., full irrigation) by crops was estimated. The proportion of consumptive irrigation avoided from the specific project activities was determined based on whether irrigation is avoided altogether for the season (i.e., full fallowing), or the cutoff date for irrigation shutoff (i.e., partial fallowing), or the difference between previously grown crops and the low-water use crops planted for the pilot projects. The volume of consumptive irrigation avoided was estimated based on the crop CIR for the full season and the proportion of CIR avoided.

Data & Assumptions

Project information and data were provided by TNC:

- **Project Area**: Listed by activity in Table 1
- **Type of activity**: Described in Table 1
- CIR values are inferred from StateCU model results presented in NRCE (2012) report. The CIR values are based on crop type, water divisions and elevation. Site specific CIR and CIR avoided are provided in Table 2.
- At McCracken and Nauyokas farms, cover crops were planted instead of Alfalfa. The cover crops are irrigated for part of the season. Cover crops have much lower CIR (1 acre-feet/acre or 12 inches) compared to the traditional alfalfa crop (3 acre-feet/acre or 36 inches). The consumptive irrigation avoided at these sites is 2 acre-feet/acre.
- The estimated benefits are expected to continue for the duration of the projects. The duration of projects are noted below.

- Grand Valley Farms: Rotational fallowing at expected to continue through 2017. Benefit will not continue beyond 2017.
- McCracken Farm: Cultivation of low water use cover crop expected to continue through 2018. Benefit will continue in 2018.
- Nauyokas Farm: Cultivation of low water use cover crop expected to continue through 2018. Benefit will continue in 2018.

Calculation & Results

The calculation inputs and results of water savings due to consumptive irrigation avoided at various farms are shown in Table 2.

The water savings (volume of consumptive irrigation avoided) is estimated as follows:

Water Savings (acre-feet/Year)
= Area (acres) x CIR (inches) x CIR Avoided (%) / 12 (inches-feet conversion factor)

Table 2. Summary of water savings from activities implemented during the 2016 irrigation season

Program	Farm	Area (acre)	CIR (Inches)	CIR Avoided	Water Savings (ac-ft./Year)
System Conservation Pilot Program	Grand Valley Farms	200	20.0	100%	333.5
	McCracken Organic Transition	10	36.0	67%	20.1
	Nauyokas Organic Transition	12	37.1	65%	24.1
Total		**222**	**-**	**-**	**377.7**

Total Water Savings Benefit = 378 acre-feet/yr = 466 ML/yr

The total water savings benefit is 466 ML/yr. PepsiCo's water savings benefit is based on the cost-share for this project, which was 44.3% of the total project cost. **Therefore, the resulting cost-share adjusted benefit is 206 ML/yr.**

Additional Benefits Not Quantified

The implementation of these water conservation projects results in additional environmental benefits that have not been quantified as part of this work. The potential benefits include:

- Positive impacts from fallowing including breaking disease cycles, potential improvement of organic matter, increases in soil fertility.
- Improved water quality (e.g., reduction loadings of sediment and nutrients)
- Enhanced wildlife habitat (improved water quality and environmental flow near the site may enhance habitat and biodiversity).

Project Location

- Various farms in Colorado
- Located in the Colorado River Basin

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Project Timeline

- Project contracts were implemented during the 2016 irrigation season

Project Costs

- 44.3% funded by PepsiCo

Water Quantity - Total Benefit

- 466 ML/yr

Water Quantity – PepsiCo Benefit*

- 206 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc. The Nature Conservancy, Colorado State University, Colorado Water Conservation Board, No Chico Brush, Walton Family Foundation, and the Gates Family Foundation

The Nature Conservancy

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Water Savings Project: Upper South Platte Watershed

Through PepsiCo's "Recycle for Nature" program, PepsiCo and The Nature Conservancy (TNC) are supporting forest management and restoration projects in the surrounding Denver area in the state of Colorado (PepsiCo, 2018). A forest management and restoration project was implemented in the Upper South Platte watershed to protect critical water resources that would be negatively impacted if a severe or catastrophic forest fire occurred in the area.

The Upper South Platte watershed is the principle water source for the Denver metro area (TNC, 2018). Many of the forests surrounding Denver and its main water sources are overgrown and in poor condition, lacking in plant diversity and susceptible to severe and catastrophic fires. Forest fires contribute to flooding, erosion, and sedimentation of rivers and reservoirs; threaten drinking water supplies and aquatic habitats; and can require significant rehabilitation costs. In 2002, the Hayman fire resulted in more than $40 million in cleanup and water treatment costs for Denver Water.

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The Nature Conservancy (TNC) has identified more than 1.5 million acres of forests along Colorado's Front Range that are in need of restoration and treatment. This project targets five sites in the Upper South Platte watershed (located within Colorado's Front Range) with an overall target of 675 acres of forest treated (TNC, 2018). In 2017, a total of 275 acres at four sites were treated in the Upper South Platte watershed (TNC, 2018).

While the focus of TNC's forest management initiative is on improving watershed health, forest treatments can also increase water yield due to reduced vegetation and associated reduction in evapotranspiration (ET). TNC conducted a preliminary assessment of the water supply benefits of forest restoration in the Northern Sierra Nevada. A review of peer-reviewed literature indicates a linear increase in water yield with an increase in the percentage of forest removed, regardless of the

forest type or the precise logging method. The assessment indicated that if treatments were conducted at sufficient scale, there could be up to a six percent increase in the mean annual streamflow for individual watersheds (Podolak et al., 2015). This research, including on-the-ground monitoring, is ongoing.

Project Objectives

The objective of the project is to improve forest conditions to protect nature, to safeguard communities, and to secure vital water supplies.

Project Activities

In 2015, mapping and modeling tools were used to strategically select project areas and design forest management and restoration strategies. In 2016, TNC conducted pre-monitoring to establish a baseline of forest health. In 2016 and 2017, TNC worked with the Upper South Platte Partnership (USPP) to complete manual and mechanical cutting, thinning, mastication, slash piling, and pile burning on a total of 275 acres across four sites (TNC, 2018).

The forest areas treated as part of this project include the following: 60 acres at Ridge Road, 25 acres at Ridge Road II, 90 acres at Resort Valley III, and 100 acres at Beaver Ranch (Figure 1). The forest conditions before and after treatment is shown below in Figure 2.

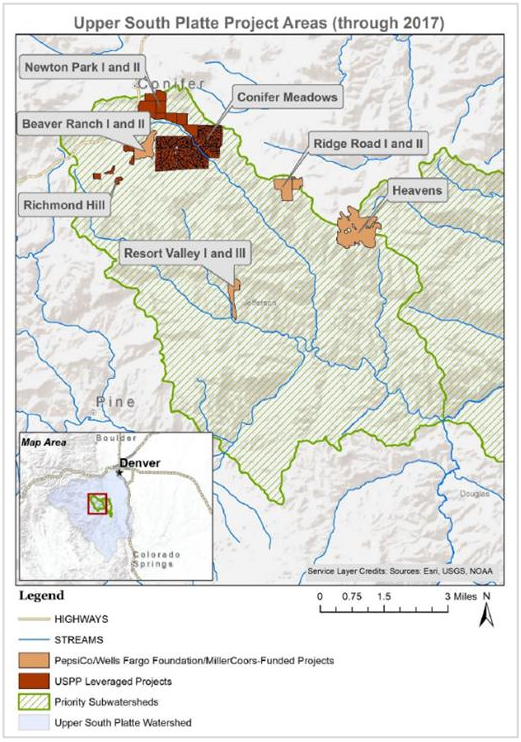

Figure 1. Project location map (TNC, 2018).

Figure 2. Forest condition before treatment (left) and after treatment (right) at Beaver Ranch (TNC, 2018).

Water Savings Benefit Calculation

The water savings benefit was calculated as the increase in annual water yield associated with forest treatments on 275 acres.

Water Savings Benefit = Increase in Annual Water Yield

The calculations were performed on an annual basis to estimate benefits in million liters per year (ML/yr). One million liters (ML) is equal to 264,172 gallons.

Methodology

Water yield (WY) in a forested catchment is primarily affected by rainfall and evapotranspiration. The mean annual WY is estimated as follows.

WY = P – ET

Where,

P = precipitation (average annual in mm), ET = evapotranspiration (mm)

Various studies that evaluated the hydrologic impact of vegetation changes suggest that a reduction in forest cover increases water yield by decreasing evapotranspiration (Bales et al., 2011; Podolok et al., 2015; Zhang et al., 2001). The long-term average annual evapotranspiration under the same climatic conditions is mainly determined by vegetation characteristics, and the difference may be attributed to the way different kinds of vegetation use soil water. Zhang et al (2001) developed a generalized approach to estimate annual ET from forested catchments based only on average annual rainfall and fraction of forest cover. The generalized equation is expressed as

$$ET = \left(f \frac{1 + 2\frac{1410}{P}}{1 + 2\frac{1410}{P} + \frac{P}{1410}} + (1 - f) \frac{1 + 0.5\frac{1100}{P}}{1 + 0.5\frac{1100}{P} + \frac{P}{1100}} \right) P$$

Where,

f= forest cover (%).

The effect of forest treatment (i.e., thinning or burning) on ET can be estimated by using the appropriate values of forest cover percent (f) in the equation above. Water yields were estimated for two scenarios of percent forest cover; untreated baseline (i.e., 70% forest cover) and treated (i.e., 30% forest cover) conditions. Water yield gains were estimated as the difference in water yield between the treated and the untreated baseline conditions.

Data & Assumptions

Unless noted, all of the project information was provided by TNC to support the water savings benefit calculation.

- **Project Area**: 275 acres

  - Ridge Road: 60 acres
  - Ridge Road II: 25 acres
  - Resort Valley III: 90 acres
  - Beaver Ranch: 100 acres
- The appropriate fraction of forest cover for the untreated baseline and treated conditions were provided by TNC staff.
- Annual precipitation for the project site is 533 mm (21 inches) (NRCS, 2010).
- The ET and WY approach used is not designed for exploring inter-annual or intra-annual variability.
- There are no empirical studies completed yet on the effect of ecologically-based forest thinning on water yield in the Front Range forest.
- A relatively simple approach was applied to quantify water yield response. Further research would be needed to more precisely quantify the water yield response from ecologically-based forest thinning.

Calculation & Results

The annual water savings benefits for implementing fire management and restoration activities in the Upper South Platte watershed is provided in Table 1 below. The effect of forest treatments (e.g., thinning and burning) on ET was estimated by using the appropriate values of forest cover percent (f) in the ET equation described in the "Methodology" section above (Table 1).

Table 1. Estimates of ET and WY for the baseline and treatment conditions.

	Forest Cover (f)	Precipitation (mm)	ET (mm)	WY (mm)
Baseline	0.7	533	481	52
Treatment	0.3	533	452	81

The difference in WY = 81 – 52 = 29 mm = **0.1 acre-feet/acre**

Treated area in 2017 = 275 acres

Increase in WY = 275 acre x 0.1 acre-feet/acre = 28 acre-feet = **33.9 ML**

Annual increase in WY = **34 ML**

The total water savings benefit is 34 ML/yr. PepsiCo's water savings benefit is calculated by multiplying the total water savings benefit by PepsiCo's cost-share for this project. In 2017, PepsiCo's cost share was 33.3%. **Therefore, the resulting cost-share adjusted benefit is 11ML/yr.**

Project Location

- Denver, Colorado
- Located in the Upper South Platte watershed

Primary Contacts

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Project Timeline

- Fire management and restoration activities were implemented in 2016 and 2017

Total Project Cost for 675 Acres

- Total Project Cost: $1,001,000
- PepsiCo Contribution: $333,333
- 33.3% funded by PepsiCo

Water Quantity - Total Benefit

- 34 ML/yr

Water Quantity – PepsiCo Benefit*

- 11ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc., The Nature Conservancy, Upper South Platte Partnership, Wells Fargo Foundation, MillerCoors, Denver Water, U.S. Forest Service, Colorado State Forest Service, American Forest Foundation, Coalition for the Upper South Platte, Jefferson Conservation District, and the Colorado Forest Restoration Institute

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Water Savings Project: Black River Watershed

Through PepsiCo's "Recycle for Nature" program, PepsiCo is supporting TNC efforts to protect water resources and wildlife in the Black River in the Cape Fear basin in North Carolina (PepsiCo, 2017). The acquisition of a 411-acre parcel consisting of upland and bald cypress wetland areas was supported with funds from PepsiCo, The Clean Water Management Trust Fund and an Ecosystem Enhancement Grant.

Black River Bald Cypress Swamp. Photo Courtesy: Dan Ryan, The Nature Conservancy

The Black River is one of the most outstanding blackwater river systems in the southeastern United States. A blackwater river system is a type of river with a deep, slow-moving channel flowing through forested swamps or wetlands. The Black River is characterized by meanders, oxbows, artesian springs and mature swamp forests including extensive old-growth bald cypress swamps along the lower portion. Trees there have been dated to nearly 2,000 years in age, the oldest trees known in eastern North America. The river is home to rare fish species such as the Santee chub and broadtail madtom and numerous rare mussels such as the Cape Fear spike. Many wildlife species inhabit the river's floodplain, including bobcat, river otter, black bear, and neotropical songbirds including the prothonotary warbler and yellow-throated vireo (TNC, 2017). The waters of the Black River are designated as "Outstanding Resource Waters" with at least 5 rare mussel species and spawning habitat for several anadromous fish species (capable of migrating between sea water and freshwater).

The Nature Conservancy has protected important tracts along the Black River and its tributaries for nearly 20 years, and approximately 14,540 acres have been protected to date. In addition TNC protects approximately 3,000 acres in its Black River Preserve (Figure 1), which includes the project area (410.8 acre) described in this summary.

Project Objectives

- Maintain natural hydrologic regime and water quality
- Protect biodiversity
- Purchase and permanently expand the Black River Preserve, owned by TNC.

Project Activities

TNC completed acquisition of the 410.8 acre Squires Tract in 2016, which includes upland (267.8 acres) and old-growth cypress swamp (143 acres) areas. The Squires tract adds to the existing TNC Black River Preserve and completes protection of almost all of the old-growth bald cypress in a 13 mile stretch. TNC has ongoing discussions with North Carolina State Parks to turn the Black River Preserve into a new state park.

Current land use in upland areas (267.8 acres) include active row-crop production (15 acres), 20-year old longleaf pine plantation (60 acres) and clear-cut areas sloping down to the river (192.8 acres). The anticipated future land cover for the entire upland area is longleaf pine forest. TNC will undertake groundcover restoration to implement longleaf plantings over most of the 267 acres where appropriate.

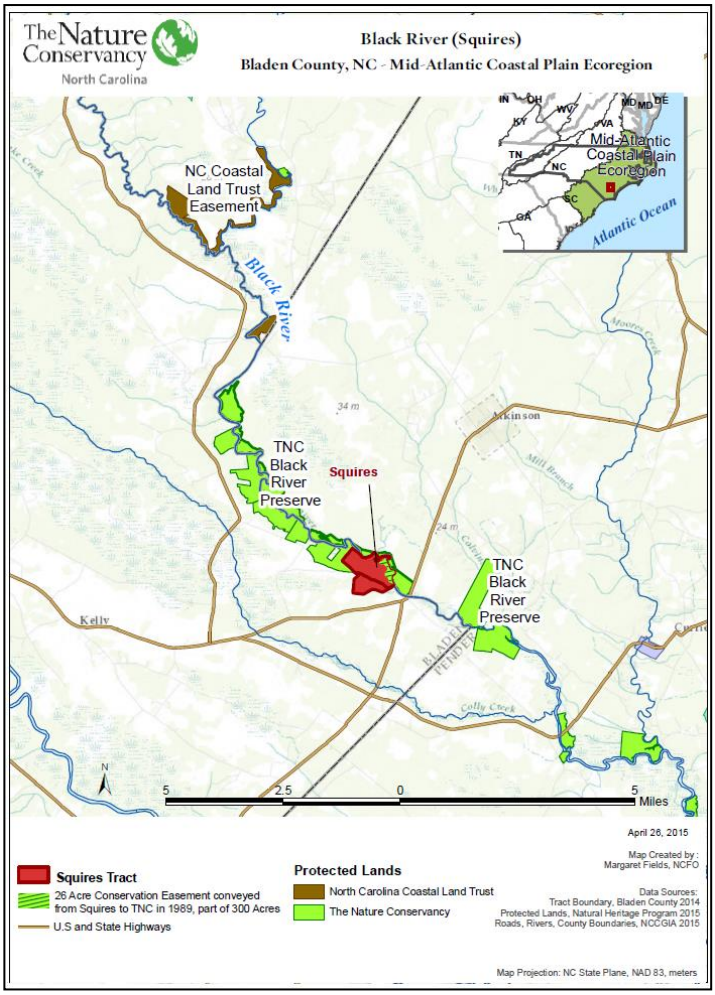

Figure 1. Map of the river corridor acquisition (red polygon) adjacent to the existing TNC preserve.

The wetland area (143 acres) is characterized by old-growth bald cypress swamp. Bald cypress is a deciduous conifer that grows on saturated and seasonally inundated soils. In addition to contributing to biological diversity, bald cypress swamps provide important hydrologic services, including water storage, groundwater recharge, and storm surge protection of coastal areas. Current threats to the swamp are incompatible forestry practices, invasive species and water quality impairment caused by upstream nutrient inputs. The effects of incompatible forestry include altered hydrologic regime, swamp drainage, altered soil structure, changes in species composition, loss of dominant species and changes in habitat structure. The acquisition protects the swamp from incompatible forestry practices and preserves its ecological functions.

Water Savings Benefit Calculation

Upland

For the 267.8 acre upland area, the water balance benefit was calculated as the difference in annual runoff from land use conditions that would exist "without-project" and "with-project".

Water Savings Benefit = Runoff Without-Project – Runoff With-Project

Wetland

For the 143 acre bald cypress swamp, the water balance benefit was calculated as the annual water storage capacity of the swamp.

Water Savings Benefit = Storage Capacity of the Swamp

The reporting units for water savings benefits are million liters per year (ML/yr). The calculations were performed on an annual basis to estimate benefits in ML/yr.

Methodology (Upland)

The Curve Number (CN) Runoff method, as implemented in the Soil & Water Assessment Tool (SWAT) model (Neitsch et al. 2005, 2009), was used to estimate the decrease in runoff due to conservation and restoration of 267.8 acres of upland area. The benefit calculations focused on estimating the change in runoff volume for the project activities because runoff serves as a useful indicator for both hydrologic improvements (e.g., enhanced baseflow) and predictions of runoff are more certain than predictions for changes in baseflow for relatively small land areas.

Methodology (Wetland)

The annual storage capacity of the swamp is estimated using the area and average inundation depth. Inundation depths vary seasonally. Across similar swamp sites, the inundation depth typically varied from 0.15 to 1 m (Middleton and Mackee, 2005; Devall, 1998). Conservatively, an inundation depth of 0.5 meters is assumed for the calculations.

Data & Assumptions

Project information was provided by TNC.
The datasets and other information related to the upland benefit calculations are listed below:

- **Climate**: Long-term precipitation and temperature data were obtained for the Moores Creek National Battlefield station from National Oceanographic Administration's National Climate Data Center. A 7-year time period (2006-2012) was used in the calculations with an annual average precipitation of 1,168.5 mm/yr. The Hamon method was used to estimate daily potential evapotranspiration (PET) based on daily average air temperature and latitude (Hamon, 1963).

- **Soil**: Predominantly hydrologic soil group (HSG) D. Source: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx
- **Upland Area**: 267.8 acre
    - Row crop production –15 acre
    - Pine plantation –60 acre
    - Clear-cut –192.8 acre
- **Land Condition**:
    - Without-Project:
        - Row crop production (CN = 64)
        - Pine plantation(CN = 30)
        - Clear cut/open areas (CN = 39)
    - With-Project:
        - Forested landscape (CN = 30)

The datasets and other information related to the wetland benefit calculations are listed below:

- **Wetland Area**: 140 acre
- **Inundation Depth:** 0.5 m. The inundation depth is expected to vary seasonally. An average depth of 0.5 m was assumed in the calculations.

The following assumptions were used to calculate the water savings benefits:

- The SWAT model parameter "CNCOEF" was set to 1.0 (plant evapotranspiration curve number coefficient used to calculate the daily change in the retention parameter based on daily potential evapotranspiration rates).
- Without land acquisition and planned restoration activities, current practices would continue and contribute to land degradation.
- Without protection, the old-growth bald cypress swamp would undergo degradation including loss of ecological function and water storage capacity.

Calculation & Results

The water savings benefit calculation for implementing conservation in the upland 267.8 acre river corridor area is summarized Table 1:

Table 1. Summary of water savings benefit due to conservation implementation

Area (acre)	Without-Project		With-Project		Benefit (ML/yr)
	Land use	Runoff (ML/yr)	Land use	Runoff (ML/yr)	
15	Row Crop	16	Pine Forest	1	15
60	Pine Forest	5	Pine Forest	5	0.0
192.8	Clear-cut	80	Pine Forest	16	64
Total					**79**

The water savings benefit calculation for conservation of the 140 acre wetland is provided below:

Storage capacity (m3) = Total Area (566,560.4 m2) x Average inundation depth (0.5 m)
Benefit (m3) = 283,280.2 m3 = 283 ML

Water Savings Benefit = 79 + 283 = 362 ML

The total water savings benefit is 362 ML/yr. PepsiCo's water savings benefit is based on the cost-share for this project, which was 9.8% of the total project cost. **Therefore, the resulting cost-share adjusted benefit is 35 ML/yr.**

Additional Benefits Not Quantified

The river corridor conservation results in additional environmental benefits that have not been quantified as part of this assessment. The benefits include:

- Protection of water supply
- Protection of water quality
- Protection of wildlife habitat and biodiversity
- Improved recreational access to the river

Black River Bald Cypress. Photo Courtesy: Dan Ryan, The Nature Conservancy

Project Location

- TNC's Black River Preserve, North Carolina
- Located in the Cape Fear Basin

Primary Contacts

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Project Timeline

- Land acquisition completed in 2016

Total Project Cost

- Total Project Cost: $605,000
- PepsiCo Contribution: $59,450
- 9.8% funded by PepsiCo

Water Quantity - Total Benefit

- 362 ML/yr

Water Quantity – PepsiCo Benefit*

- 35 ML/yr

*The water quantity benefit is a function of the cost-share for the project.

Project Partners

- PepsiCo, Inc.
- The Nature Conservancy
- Clean Water Management Trust Fund
- Ecosystem Enhancement Grant

The Nature Conservancy

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