From Source to Solution: Advancing Water Stewardship in the Non-Road Sector

Final Report
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AEM
Association of Equipment Manufacturers

KEARNEY

1. Executive Summary

2. Segment Overviews

Definition and Scope of Sectors

AGRICULTURE

1. **BROADACRE**

Grain, Oilseeds and Cereals
Large-scale, mechanized and heavily irrigated in some areas

2. **SPECIALTY**

Fruits, Vegetables, Nuts
High-value, water-sensitive, often rely on precision irrigation

3. **LIVESTOCK**

Dairy, Beef, Poultry, Swine
Indirect water use through feed, drinking water and facility sanitation

UTILITY

1. **SUPPLY**

Surface water, groundwater, wholesale or treated wastewater

2. **DISTRIBUTION**

Delivery to residential, commercial and industrial customers

3. **COLLECTION**

Collecting sewage and greywater

4. **TREATMENT**

Purification and testing for public drinking supply

5. **MANAGEMENT**

Managing wastewater and stormwater flows

CONSTRUCTION

1. **RESIDENTIAL**

Single & multi family homes

2. **COMMERCIAL**

Offices & warehouses

3. **INDUSTRIAL**

Factories or large-scale production facilities

4. **INFRASTRUCTURE**

Roads, bridges, airports, and systems that provide utilities (e.g. power, water)

Out of Scope Water Sectors

Data centers | Thermal energy | Desalinization | Mining

Water in North America:

A success story

Doing more with less

Across the agriculture, utility, and construction industries, operations are doing **significantly more with substantially less water**, all while improving water quality and the health of local ecosystems.

Agriculture | Construction | Utility

Cross-sector synergies

Efficiency gains and water savings are **connected across industries**, and work to reinforce one another:

- Utilization of recycled greywater supplies dependable non-potable water for construction and ag industries.
- Construction and infrastructure upgrades, such as leak-resistant pipes and ‘green’ infrastructure, reduce strain on municipalities and utility districts.

World class water stewardship

This progress demonstrates that North America can **be a global leader on both economic growth and environmental stewardship** simultaneously.

North American equipment manufacturers are doing far more than just supplying equipment - they're **enabling some of the most advanced water stewardship practices in the world.**

Agriculture & Water:

Producing more with less

Agriculture

Efficiency at scale

Over the past 50 years:

1. **U.S. irrigated acres** grew by ~30%
2. **Production** of corn, soy and wheat increased by 177%
3. **Average water applied per acre fell by more than 25%**

Saving an estimated **9.7 trillion gallons** per year, or enough to fill over **14.7 million Olympic sized** swimming pools.

Crops doing ‘more with less’

Efficiency gains are exemplified well by California's almond industry, having **reduced water intensity by 33%** while setting ambitious targets for additional 20% cuts.

Similarly, Texas peanut growers have increased production by 50% while **cutting water use by nearly one-third**.

Corn growers have achieved **56% reductions in water use** per bushel since 1980, highlighting row-crop efficiencies.

Technology driven improvements

Efficiency gains have been driven by the **adoption of precision equipment with data-driven decision making**. Variable rate irrigation systems, soil moisture sensors, and GPS technologies are enabling farmers to optimize every drop while increasing yields.

The result is a more resilient agricultural system that **produces more food with less environmental impact.**

Utility & Water:

Managing water for 380 million people

Utility

Serving more, using less

The North American utility sector faces a complex challenge: **serving growing urban populations while aging infrastructure threatens system reliability**.

Yet despite these pressures, utility have achieved **remarkable efficiency gains** over the past two decades.

Investing to repair

The expected infrastructure challenge is substantial, with an estimated **$625 billion of additional investment** needed over the next 20 years to achieve a "good state of repair."

However, utility infrastructure is already demonstrating the value of upgrades. **Water main break rates decreased by 20%** from 2018 to 2023, largely due to replacing aging cast iron and asbestos cement pipes with plastic, along with the increased use of leak detection technologies.

From linear to circular

The emergence of circular water solutions are changing the traditional "take-make-dispose" water model.

Orange County's Groundwater Replenishment System now recycles **44 billion gallons annually**, enough to supply 35% of the county's water needs while improving the health of local waterways.

Construction & Water:

Cutting site demand and protecting water quality

Construction

Jobsites to watersheds

The construction industry has directly participated in water conservation practices thanks to **innovative technologies in concrete production, dust suppression, and closed-loop site management systems**.

Additionally, construction operations are indirectly advancing water stewardship through their role in the development of green infrastructure.

Conservation that pays off

Construction operators are discovering that **water conservation can improves both environmental and economic outcomes**:

- Bio-based dust suppressants have shown the ability to **save millions of gallons of water** while reducing equipment and labor costs.
- Concrete production innovations, such as slurry recycling, are proving to **significantly reduce freshwater needs during concrete production** while simultaneously sequestering carbon.

Managing rain where it falls

Permeable pavements installed by construction operations have shown to **reduce stormwater runoff by 45% while filtering out over 90% of suspended solids**.

Green roofs and bioretention areas built into new developments can **reduce peak stormwater flows by up to 90%**, fundamentally changing how communities handle rainfall and reducing stress on municipal treatment systems.

1. Executive Summary
2. **Segment Overviews**
   - **Agriculture**
   - Utility
   - Construction

The North American Agricultural Industry is diverse

There are three primary industry segments in agriculture:

Grain, Oilseeds and Cereals
Large-scale, mechanized and heavily irrigated in some areas

Fruits, Vegetables, Nuts
High-value, water-sensitive, often rely on precision irrigation

Dairy, Beef, Poultry, Swine
Indirect water use through feed, drinking water and facility sanitation

Agriculture is a major contributor to the North American economic resilience

United States[1]

$1.3T contribution to GDP

5.5% of U.S. GDP

10.4% of the U.S. workforce

Canada[2]

$143.8B contribution to GDP

7.4% of Canadian GDP

10.6% of the Canadian workforce

Agriculture and Water

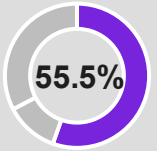
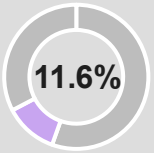
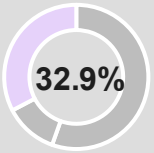
North America's agricultural sector depends on a consistent and high-quality water supply to produce a diverse range of crops and sustain millions of animals, both of which are essential for sustaining food security and meeting the needs over 380 million people across North America.

Source: Kearney

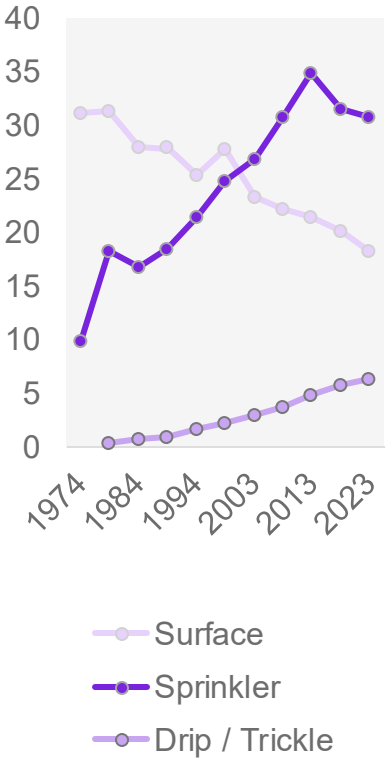
1. U.S. Chamber of Commerce 2023 Data, includes agriculture, food and related industries
2. Canada Chamber of Commerce, includes agriculture, food and related industries

North America's diverse crops require varied irrigation approaches, but major efficiency gains are coming from the adoption of new irrigation equipment and technologies

Illustrative & Non-Exhaustive

	Type	Description	Common Types	Use Cases	Prevalence	Cost	Efficiency*
	**Sprinkler / Sprayer**	Method of applying water in a controlled manner similar to rainfall, typically through a pressurized system by a means of perforated pipes or nozzles.	– Center Pivot – Linear Move – Portable or solid-set	– Broadacre crops including corn, soy and wheat		→	↗
	**Drip / Low Flow**	Water is applied directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe, etc.) operated under low pressure with the applicators being placed either on or below the surface of the ground.	– Surface drip or trickle – Sub-surface drip lines – Low-flow sprinklers	– High value specialty crops (fruits, vegetables, tree nuts) – Permanent crops (orchards, vineyards) – Emerging in some high value broadacre		↑	↑
	**Surface**	Water is applied directly to the field via canals, ditches or other systems either across the entire surface or directed into furrows and channels.	– Controlled or uncontrolled flooding – In-furrow application via poly pipe or other distribution	– Alfalfa – Rice – Pasture – Cotton – Sugar beets		↓	→

U.S. Acres Irrigated by Equipment Type
Million acres



**Efficiency is defined as the efficacy of water applied that becomes available to be utilized by crops (vs. lost to evaporation, wind losses, etc). Efficiency can be impacted by a multitude of factors, including but not limited to: crop types, weather, soil types, application timing and uniformity, etc.*

↑ = Very High
→ = Medium
↓ = Very Low

Sources: United States Geological Survey, USDA Farm and Ranch Irrigation Survey, Statistics Canada Agricultural Water Survey
Prevalence defined a share of North America acres irrigated by equipment type

Agriculture has adopted several practices and technologies to make measurable improvements in water use

	Water Efficiency	Water Quality	Reuse & Circularity
	Doing more with less	Protecting water bodies	Maximizing water value
Practices	– Irrigation scheduling – Crop selection and rotation – Conservation tillage	– Buffer strips along waterways – Nutrient and manure management plans – Conservation tillage and cover cropping	– Reuse of lagoon or flush water in dairy and swine – Drainage water capture and reuse – Greywater use in greenhouses and livestock
Technologies	– Drip / micro irrigation systems – Variable Rate Irrigation – Soil moisture sensors – Smart controllers & telemetry	– Precision crop protection application equipment – Manure injectors – GPS-guided sprayers and Spreaders – Drainage water management	– Slurry separators – Automated flush systems – Settling basins and pumps – Woodchip bioreactors for nitrates
Impacts	– Variable Rate Irrigation can **reduce water use up to 15%** without yield loss – Drip irrigation systems are up to **95% efficient** and utilize **30-50% less water** than flood irrigation	– Cover crops can **reduce nitrogen runoff by 50%** – Precision application systems can **reduce herbicide use by more than 75%**	– Most dairies **recycle their water as many as four times** across animal and crop production – Drainage water recycling **can substantially reduce the need** for external irrigation water

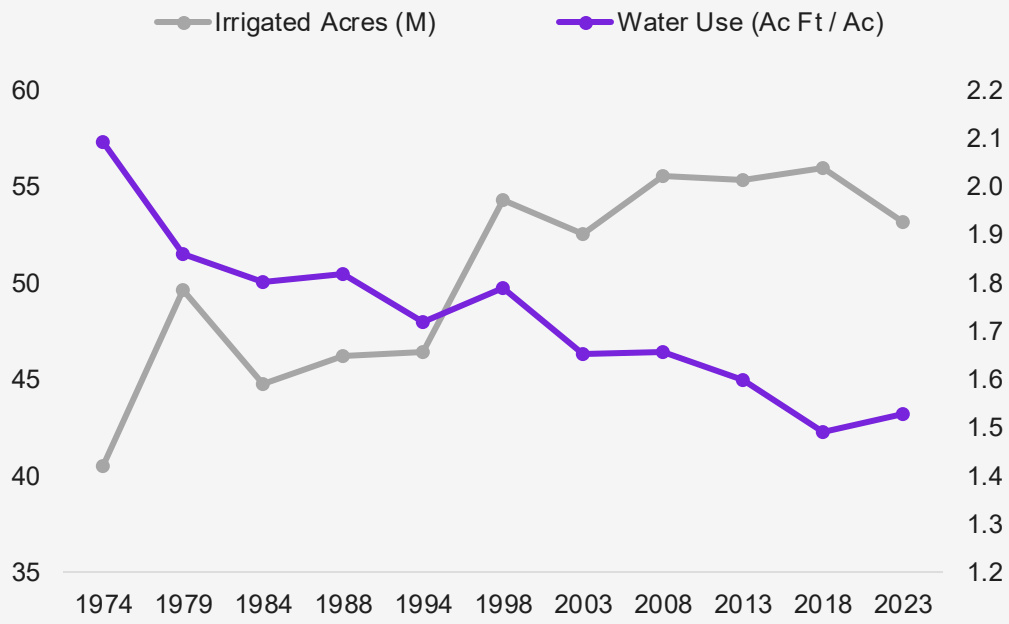
Sources: University of Georgia, The World Bank, SARE, Iowa State University, U.S. Dairy, Purdue University

Technology adoption and improved practices are enabling North American farmers to grow significantly more food with the same, or less, water

Water Efficiency

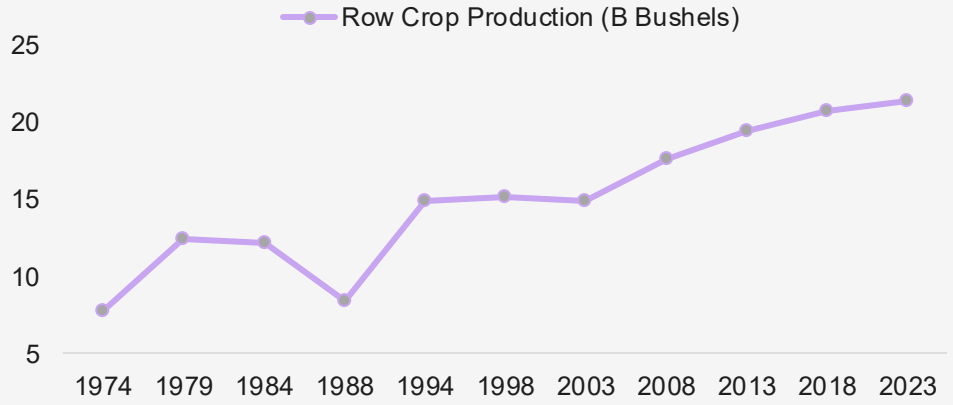
U.S. Irrigation Trends[1]

Acres Irrigated and Water Use per Acre



U.S. Production Trends[2]

Corn, Soy, and Wheat Production



1. USDA Irrigation and Water Management Survey
2. USDA NASS

Insights

- Over the past 50 years the United States has seen a **30% increase in irrigated acres**
- At the same time, **average water use per acre has declined by over 25%,** while total **production of corn, soy, and wheat has increased 177%**
- Both Canada and the U.S. are **producing more food per unit of water,** improving the economic return of water utilized
- Improved efficiency has been driven by:
  - adoption of new irrigation technologies
  - improved irrigation management
  - changes in cropping patterns

Modern irrigation practices are saving the U.S. 9.7 trillion gallons of water annually—water that would have been needed without these efficiency improvements.

Water Use over Time – Commodity Specific

Direct Results of Advances in Agricultural Technologies and Practices impacting Water

	Efficiency Improvement	Contributing Factors	
Corn	**56% less** water used per bushel[1]	Adoption of more efficient irrigation and soil moisture monitoring systems, along with genetic improvements	
Peanuts	**44% less** water used per pound[2]	Geographical shifts in production from arid states, adoption of more efficient irrigation and soil moisture monitoring systems	
Almonds	**33% less** water used per pound[3]	Adoption of micro-irrigation, regulated deficit irrigation, soil moisture monitoring	
Milk	**30% less** water used per gallon[4]	Systemic water recycle and reuse processes, advanced crop irrigation, manure management, and dietary changes	
Pork	**25% less** water used per pound[5]	Improvements in feed conversion, genetic improvements, watering systems and housing	

Water Efficiency

1. Field to Market
2. Field to Market
3. The Almond Board of California
4. American Society of Animal Science
5. National Pork Board

Agriculture conservation efforts are delivering measurable improvements in water quality

Spotlight: USDA NRCS National Water Quality Initiative (NWQI)

- The National Water Quality Initiative is a partnership among NRCS, state water quality agencies and the U.S. EPA to **improve and protect water quality through voluntary conservation**
- NRCS provides targeted funding for financial and technical assistance where **farmers can use conservation practices** that promote soil health, reduce erosion and lessen nutrient runoff
- These practices not only benefit natural resources but **enhance agricultural productivity and profitability** by improving soil health and optimizing the use of agricultural inputs.

36% of **monitored watersheds** under the National Water Quality Initiative (NWQI) have shown improvements in at least one pollutant between 2017 and 2020

73% of these improvements are attributed to **conservation practices implemented by farmers and ranchers**

19 impaired water bodies have been improved and scheduled for de-listing due to successful water quality enhancements

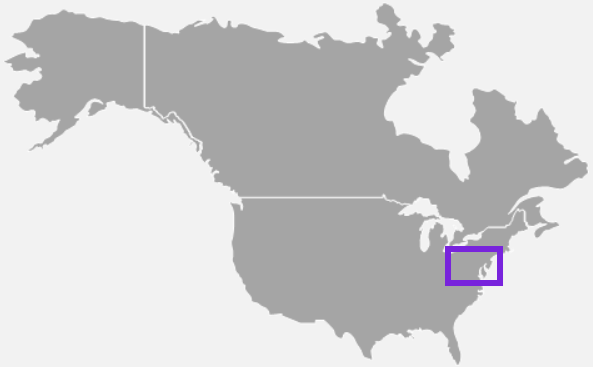
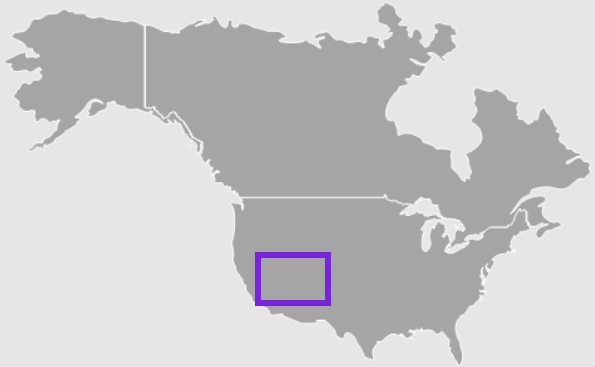
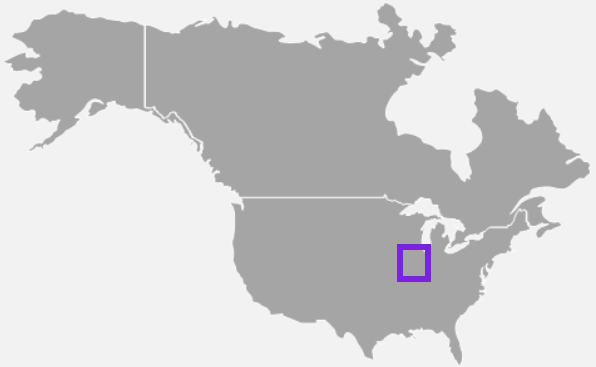
Water Quality

Key Practices and Technologies	Impacts
Vegetative buffer strips to trap pollutants prior to entering waterways	Filter strips are capable of **reducing the concentration of nutrient runoff by up to 80%**
More efficient nutrient applications to tailor fertilizer applications to specific field conditions	**Reduces nutrient loss in surface runoff** compared to uniform application, and can result in **40% fertilizer savings without compromising yields**
Installation of **woodchip bioreactors** to treat tile drainage water	Natural denitrification process to treat subsurface drainage water on farms, **reducing nitrogen pollution in water flowing off of the farm by 15-90%+**
Utilization of **AI-powered systems** to identify and spray targeted weeds reducing herbicide usage	**54% decrease in herbicide runoff concentrations** compared to conventional application methods

Sources: USDA NRCS NWQI, Iowa State University, Applied Engineering in Agriculture, Time, James Cook University

Field-scale conservation practices are producing measurable improvements in water quality across multiple U.S. watersheds

Water Quality

Focus Area	Chesapeake Bay Watershed	Colorado River	Upper Macoupin Creek
			
Practices	– Cover cropping – Conservation tillage – Nutrient management plans	– Underground brine injections – More efficient irrigation methods (e.g. drip)	– Erosion control structures – Landowner education – Soil transect surveys
Impact	– High impact conservation practices were estimated to **reduce nitrogen loads by up to 60%** in younger groundwater areas	– Significant reductions in salinity levels, with more than **1.2 M tons of salt now removed annually**	– Reduced downstream nitrate and total phosphorous cumulative yields by **54% and 21%**, respectively

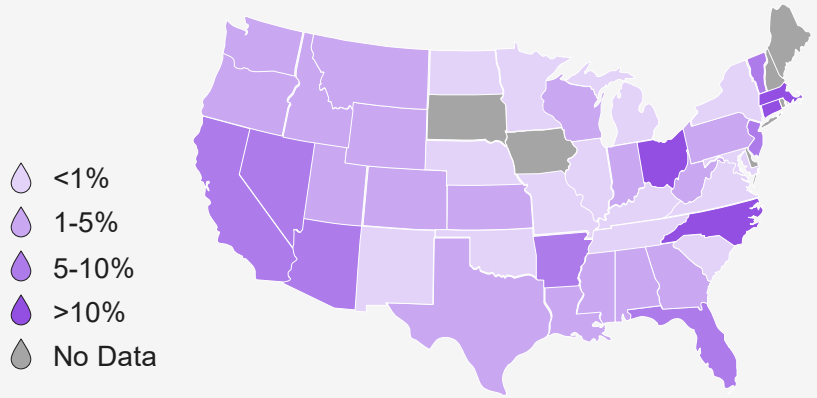
Sources: USGS, USDA NRCS GLRI, Central Arizona Project

The agriculture value chain is closing the loop on water use from production to processing

Water Reuse & Circularity

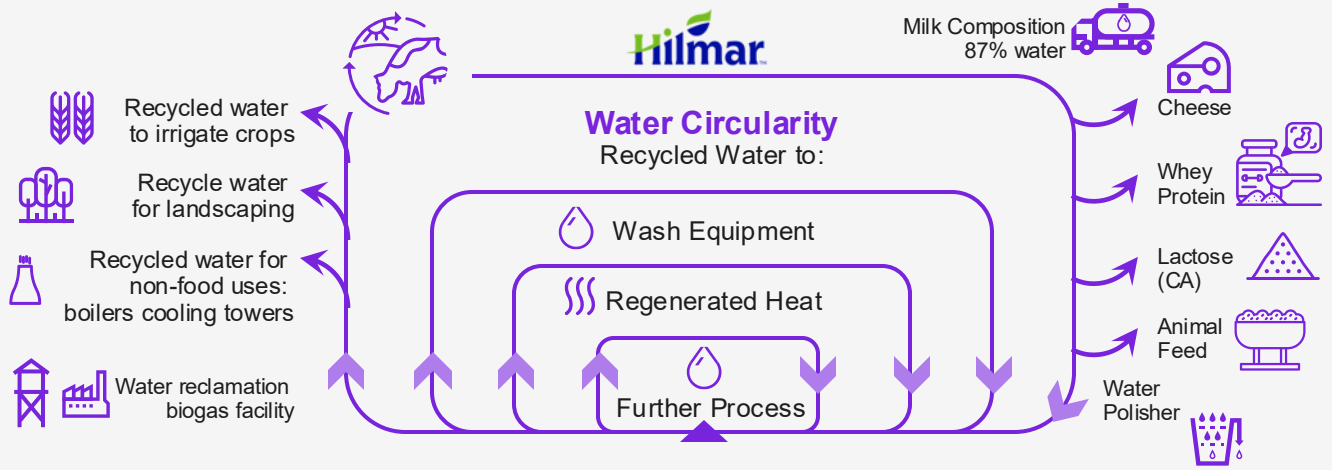
Spotlight: Recycled and Reclaimed Water Use in Irrigation

Percent of irrigated acreage using recycled or reclaimed water, 2023



- In 2023, U.S. farmers utilized recycled and reclaimed water to irrigate **nearly 2 million acres of cropland**
- On-farm livestock operations and municipalities are the **most common sources of reclaimed water** for agricultural irrigation

Spotlight: Water Reuse at Hilmar Cheese Co.



- Since 2001, Hilmar Cheese Company has invested significant time and resources to develop a system **designed to recycled and reuse processing water efficiently**
- More than **70% of the water used in Hilmar's facility is recycled**, a majority of which comes from the milk they process
- Hilmar's processes **reclaims almost 100% of water content in incoming milk**, and **uses it up to three times** for various processes including irrigation, heat regeneration and for further processing

Sources: USDA, Hilmar

Case Study: Improving water use efficiency in Texas peanut production

Situation

- Peanut production in Texas has **traditionally been water-intensive**, relying heavily on irrigation to sustain yields
- Growers have faced **increased challenges in recent decades,** as the Ogallala Aquifer in West Texas has shown significant declines in water levels

Actions Taken

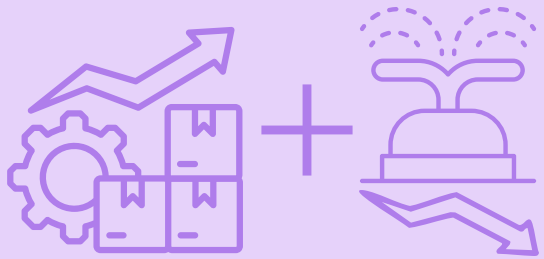
- Widespread adoption of more efficient irrigation practices, including **center pivots and drip irrigation** infrastructure, and **improved soil moisture sensors**
- The Texas Peanut Producers Board has also provided funds to Texas A&M to develop improved peanut varieties that are **more drought tolerant**

Results

- Through the adoption of more efficient irrigation practices and more drought tolerant peanut varieties, **Texas growers have reduced their water usage by nearly 33% since 2010**

Impacts

Compared to just 10 years ago, **Texas peanut growers have increased production by 50% while using nearly 1/3rd less water**, and reduced overall input consumption



Sources: Texas Farm Bureau, National Peanut Board

Case Study: Implementing lined canals in Southern California

Situation

- Open irrigation canals in the U.S. lose **significant water through evaporation**, especially in arid regions, reducing overall irrigation efficiency
- California has **over 4,000 miles of canals**

Actions Taken

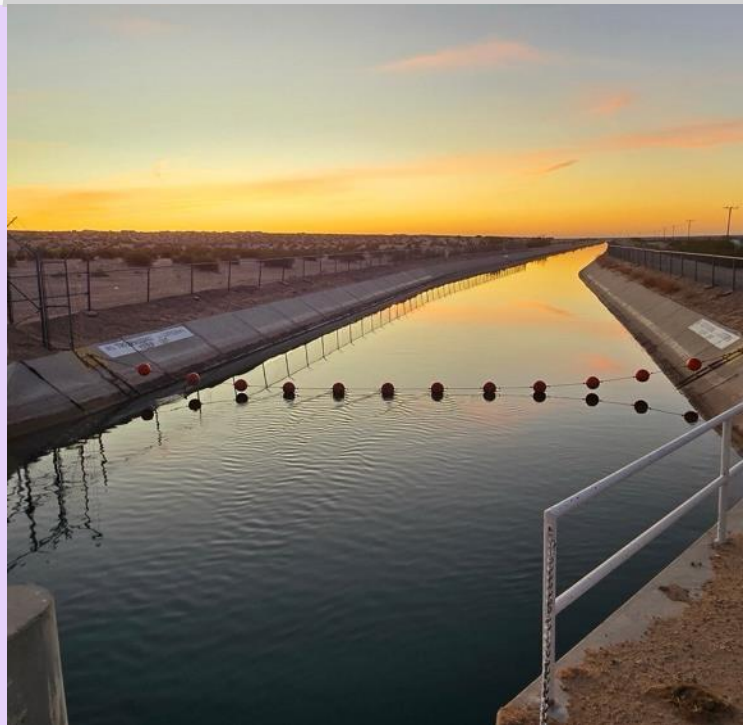
- San Diego County Water Authority, Coachella Valley Water District, and Imperial Irrigation District, among others, partnered to implement **All-American and Coachella Canal lining projects**
- **23 miles** of the All-American Canal and **35 miles** of the Coachella canal were lined with concrete

Results

- An estimated 67,700 acre feet of water are saved annually on the All-American Canal, while the Coachella Canal **conserves 26,000 acre feet each year**

Impacts

As a result of lining nearly 70 miles of the All-American and Coachella canals, **over 93,000 acre-feet of water are conserved annually** from reduced ground seepage



Sources: San Diego County Water Authority

Case Study: Livestock Water Recycling Technology

Situation

- Livestock farms, particularly dairy and swine, **generate large volumes of liquid manure**, containing water, nutrients and solids
- Traditional storage and land application can lead to **nutrient loss, runoff risk** and **high water use**
- Farms face **rising costs and scrutiny over water use**, nutrient runoff and odor emissions

Actions Taken

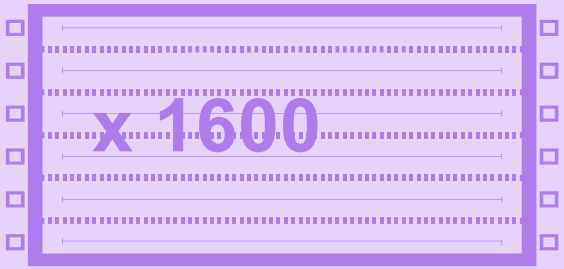
- Producers began **investing in resources and practices** to improve manure, nutrient and water management
- Several companies **began offering manure treatment systems** in the 2010s
- These systems use filtration, chemical separation and digital controls to **reclaim water from liquid manure**

Results

- Farms are able to **reuse water multiple times**, significantly reducing water withdrawals
- The circular design **reduces water and nutrient waste** while **improving storage efficiency** and **odor control**
- Companies such as Calgary based Livestock Water Recycling (LWR) state **1.5 billion gallons of manure were treated in 2024**

Impacts[1]

As a result of LWR's technology, an estimated **1,600 Olympic Swimming pools worth of water** was reclaimed in 2024



Sources: Livestock Water Recycling, Kearney
1. Impact based on manure / digestate treated by Livestock Water Recycling Inc. in 2024

Case Study: Precision Irrigation in California Almond Orchards

Situation

- California produces over **80% of the world's almonds**, generating **$9.2 billion** annually to the state's economy
- Almonds were historically irrigated through **water-intensive** methods
- Increased water scarcity and recurring droughts in the 1980s spurred research to **assess the feasibility of micro irrigation in orchards**

Actions Taken

- **Drip and micro sprinkler irrigation systems** were installed across orchards
- Integrated **soil moisture sensors** and **telemetry** to inform precision irrigation scheduling
- The industry developed the **Irrigation Improvement Continuum** to help growers advance efficient irrigation

Results

- California almond growers have **improved water use efficiency by 33%** and set a goal for an additional 20% reduction by 2025[1]
- Today, **micro irrigation is utilized by nearly 80%** of California almond orchards
- Nearly **90% of growers are using demand-based irrigation scheduling**

Impacts

By utilizing micro irrigation and other improved irrigation practices in California almond production, the amount of water saved annually is equivalent to:

Supplying Los Angeles with water for 3 years

Supplying 5.8 million homes with water annually

Sources: Almond Board of California, Kearney
1. The Almond Board of California states almond growers have achieved 75% of this goal as of 2022

Case Study: Beneficial Management Practice (BMP) impact on Water Quality in Canadian Prairie Watersheds

Situation

- **Deteriorating water quality in Lake Winnipeg** was partially linked to excessive nutrient loading
- Improving water quality **required reducing nutrient losses** from multiple sources, including agriculture
- While BMPs are known to reduce nutrient losses, impacts have been **less studied in cold-climate regions**

Actions Taken

Through the Watershed Evaluation of Beneficial Management Practices program, **five key BMPs were** implemented in Manitoba:

- Runoff holding pond
- Riparian zone and grassed waterway management
- Grazing restriction
- Perennial forage conversion
- Nutrient management

Results

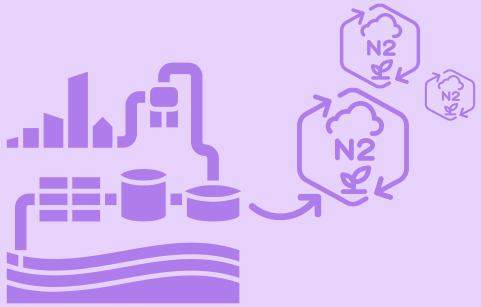
Implementation of BMPs **significantly reduced nutrient losses to surface water** in the Steppler watershed:

- Reduced total nitrogen and phosphorous runoff by 41% and 38%, respectively
- Decreased nutrient inputs to cropland from improved management without impacting crop yields

Impacts

The nutrient reductions from just this 500-acre treatment area were comparable to removing the phosphorous and nitrogen output of

a small municipal wastewater treatment plant



By using on-farm conservation practices

Sources: American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, Kearney

Enablers and Barriers to improved water use, quality and reuse in Agriculture

	Technology	Economic	Regulatory
Enablers	**New tools are enabling smarter, more productive water use**	**Cost-share programs and private investments are accelerating upgrades**	**Policy is pushing long-term accountability and watershed-level planning**
	Advancements in design and cost **enabling adoption of drip and VRI in broadacre** systems	USDA's **Water-Saving Commodities program** directs funding for water-saving infrastructure projects	State driven policies like California's SGMA, which covers more than **7M irrigated acres** and **120+ groundwater basins**
	Next-gen systems delivering **increased precision and automation** in irrigation	Canadian **grants cover up to 30%** of for on-farm irrigation efficiency upgrades	The U.S. **Water Reuse Action Plan** streamlines federal support for potable and non-potable reuse, with agriculture as a key focus

	Infrastructure	Economic	Policy
Barriers	**Many farms rely on outdated irrigation systems and aging rural water infrastructure**	**Even with subsidies, many solutions remain out of reach for small and medium farms**	**Water law and funding design sometimes discourage conservation**
	33% of irrigated acres in the United States **still use gravity / flood systems**, many with high water loss due to open ditch and canal delivery	**Financial constraints are a leading barrier** to growers investing in improved water conservation systems	Many Western states still operate under **"use-it-or-lose-it" water rights,** which potentially penalize those reducing withdrawals
	Limited rural broadband access, affecting nearly 20% of U.S. farms and 40% of rural Canadians, remains a major barrier to adopting precision tech	Despite increases, funding is constrained, with **less than half** of EQIP applicants **receiving contracts**	Current policy is **fragmented and inconsistent**, with lack of clear efficiency targets or reuse guidelines

Sources: Kearney

1. Project Background
2. Executive Summary
3. **Segment Overviews**
   - Agriculture
   - **Utility**
   - Construction

The Utility segment comprises critical activities to ensure a consistent, safe water supply

1 **SUPPLY**
Surface water, groundwater, wholesale or treated wastewater

2 **DISTRIBUTION**
Delivery to residential, commercial and industrial customers

3 **COLLECTION**
Collecting sewage and greywater

4 **TREATMENT**
Purification and testing for public drinking supply

5 **MANAGEMENT**
Managing wastewater and stormwater flows

A sizeable share of North American economic activity is focused on the Utility segment

United States[1]

2.2 million miles of water pipe

150,000 public water systems

90% of population served by public water system

Canada[2]

133 thousand miles of water pipe

11,800 public water systems

86% of population served by public water system

Utility and Water

Each gallon of water delivered supplies clean, reliable water to over 380 million people across North America, enabling public health, supporting industry and commerce, and making possible the safe treatment, transport and reuse of water across communities.

1. ASCE 2025 Infrastructure Report Card
2. Utah State University, Statistics Canada

Utility districts across North America are deploying a number of practices and technologies to reduce water utilization and improve quality of water

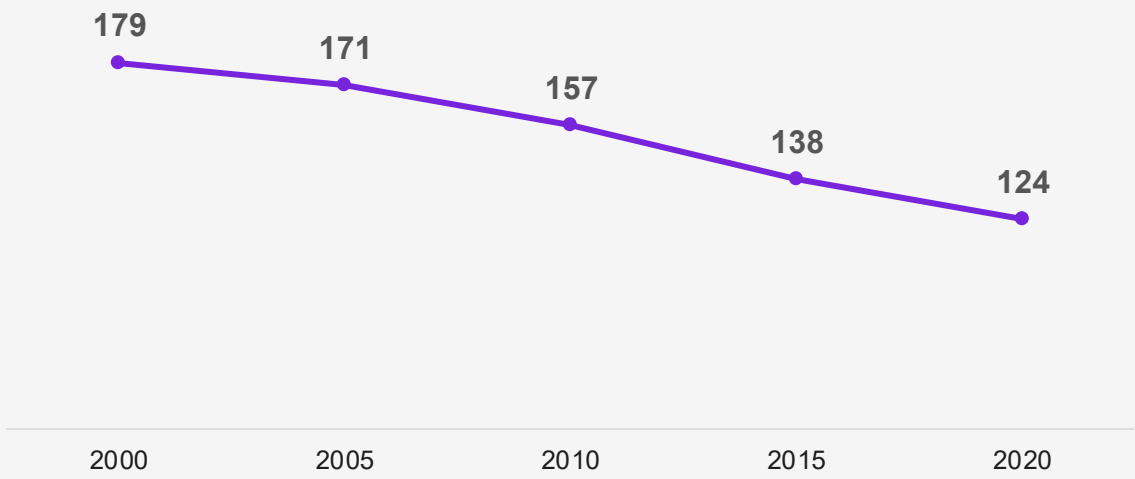
	Water Efficiency Doing more with less	Water Quality Supplying clean water	Reuse & Circularity Maximizing water value
Practices	– Replacing aging water distribution infrastructure from metal to plastic pipes – Increased utilization of water meter data to identify leaks faster	– Removing lead pipes local water distribution networks – New testing and guidelines for monitoring water quality	– Increased use of recycled greywater, both for further treating into potable water, as well as reuse for non-potable needs
Technologies	– Innovative leak detection solutions, such as in-line acoustic technologies – Improved water meter technology	– Improved membrane and filtration technologies, such as Nano Filtration (NF) and Reverse Osmosis (RO)	– Improved and more cost effective wastewater treatment facilities – Nutrient recovery technologies at treatment centers
Impacts	– Plastic pipes have proven to be **2.5x** more effective than asbestos cement, and nearly **9x** more effective than cast iron at reducing water breaks	– Through these practices and technologies, The American Society of Civil Engineer's (ASCE) **water infrastructure grade has improved** over the last decade	– Enables municipal water districts to **recharge local aquifers while improving water quality** of local watersheds

Sources: ASCE, Utah State University, Kearney

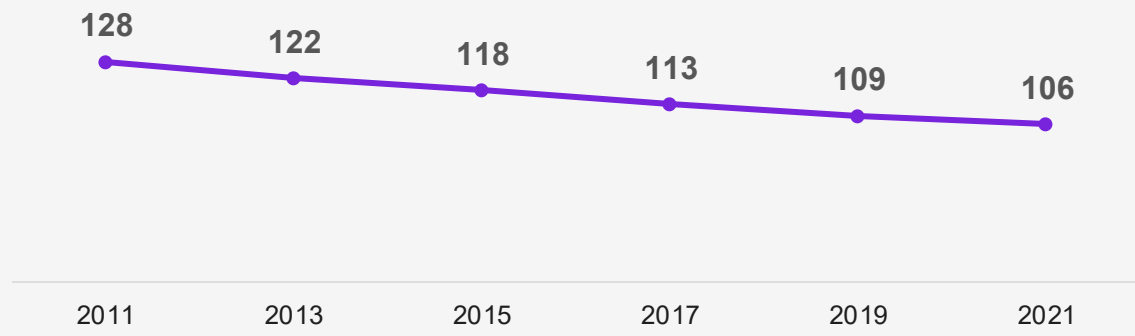
*per- and polyfluoroalkyl substances

U.S. and Canadian Utility segments are serving growing populations with more efficient water use

U.S. Public Supply Water Use Trends[1]
Gallons / Capita / Day



Canada Public Supply Water Use Trends[2]
Gallons / Capita / Day



1. USGS – 2020 based on modeled estimates for conterminous United States – Public supply
2. Statistics Canada – Potable water supply

Insights

- Over the past 20 years **the United States and Canada have reduced per capita water use** by 21% and 17% respectively
- Both countries are **using less water volume** despite increasing populations
- Improved water use has been supported by:
  - Infrastructure upgrades to reduce leaks
  - Advanced metering technology
  - Municipal conservation programs
  - Efficiency standards and regulations

Modern utility efficiencies are saving the U.S. and Canada nearly 4 trillion gallons of water annually—avoiding withdrawals that would otherwise be needed to support today's population

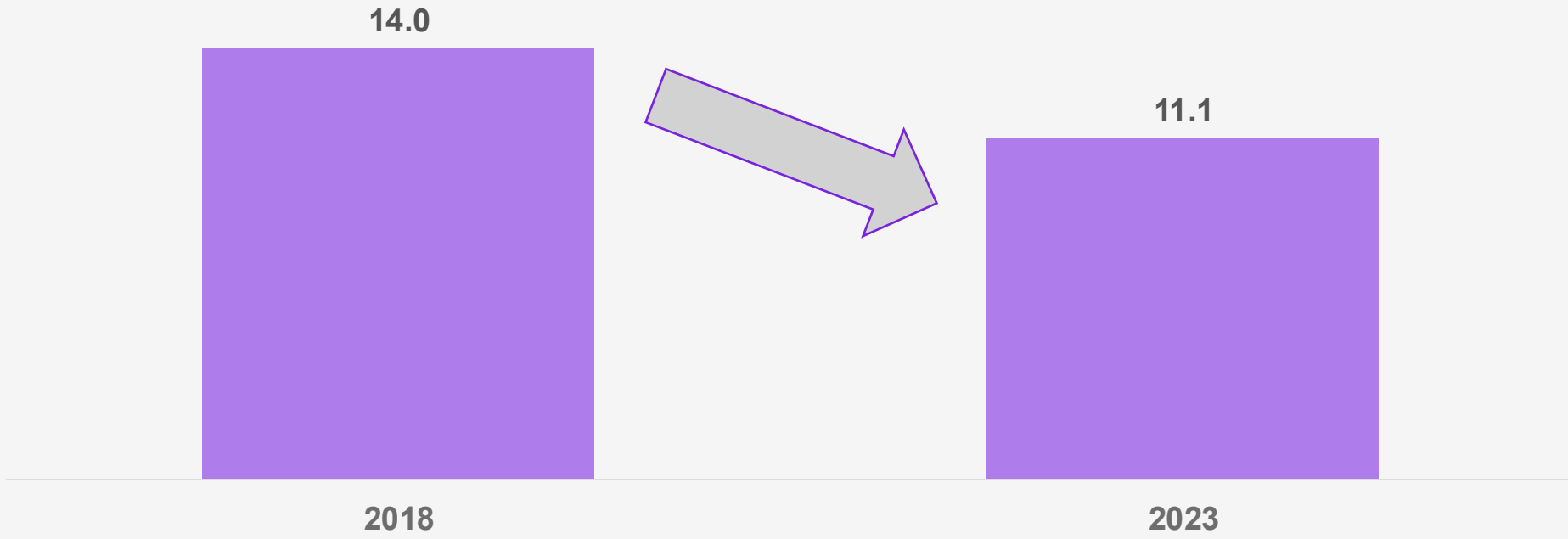
Water Efficiency

Recent investments in infrastructure have helped save water through decreased breaks and leaks

Progress towards replacing aging water infrastructure has reduced water losses, as water main breaks decreased nearly 20% from 2018 to 2023

North America Water Main* Break Rate

Breaks per 100 miles/year



Much of the decrease in break rates can be attributed to the increased use of water meters, adoption of leak detection technologies, and the replacement of cast iron and asbestos cement pipes in favor of plastic pipes.

It is estimated replacing all non-plastic infrastructure with plastic in the U.S. could **save up to 1,480 B gallons of water a year**.

**Water mains defined in the research as any water distribution line (excluding service lines) greater than 3 inches and less than 48 inches in diameter (68% of water mains included in the research were between 3 and 8 inches in diameter)*

Water Efficiency

Sources: Utah State University, ASCE, America's Plastic Makers

Investments towards replacing the aging U.S. water infrastructure have increased significantly in recent years

U.S. Public Construction Water Spending Trends

Monthly Spending, Millions of Dollars

Over the last 20 years, annual U.S. public construction spend on water utility infrastructure has increased by nearly 20%

Insights

- While investments towards public water infrastructure have increased in recent years, **the current pace of spending still lags behind the necessary investment levels to replace aging infrastructure** across the U.S.
- In 2024 alone, there was an estimated **$91B gap between actual and needed spending on U.S. water infrastructure**, highlighting the funding challenges the utility segment faces

Water Efficiency

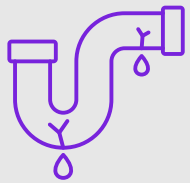
Sources: Federal Reserve Bank of St. Louis, US Water Alliance, ASCE

The aging of water distribution infrastructure is currently outpacing replacement rates across North America, with the gap growing larger each year

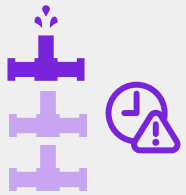
Water Efficiency

Across North America, there are an estimated **260,000 water main breaks** each year, resulting in maintenance and repair costs of over **$2.6B annually**

An estimated **33.3 trillion gallons of water** (over 50 million Olympic sized swimming pools) is lost to water breaks and leaks each year in the U.S., leading to over **$187 billion in revenue losses**



It is estimated that water utility districts across North America are currently **losing 11% of their water supply due to leaks and breaks,** with much of this being high value, post treatment water

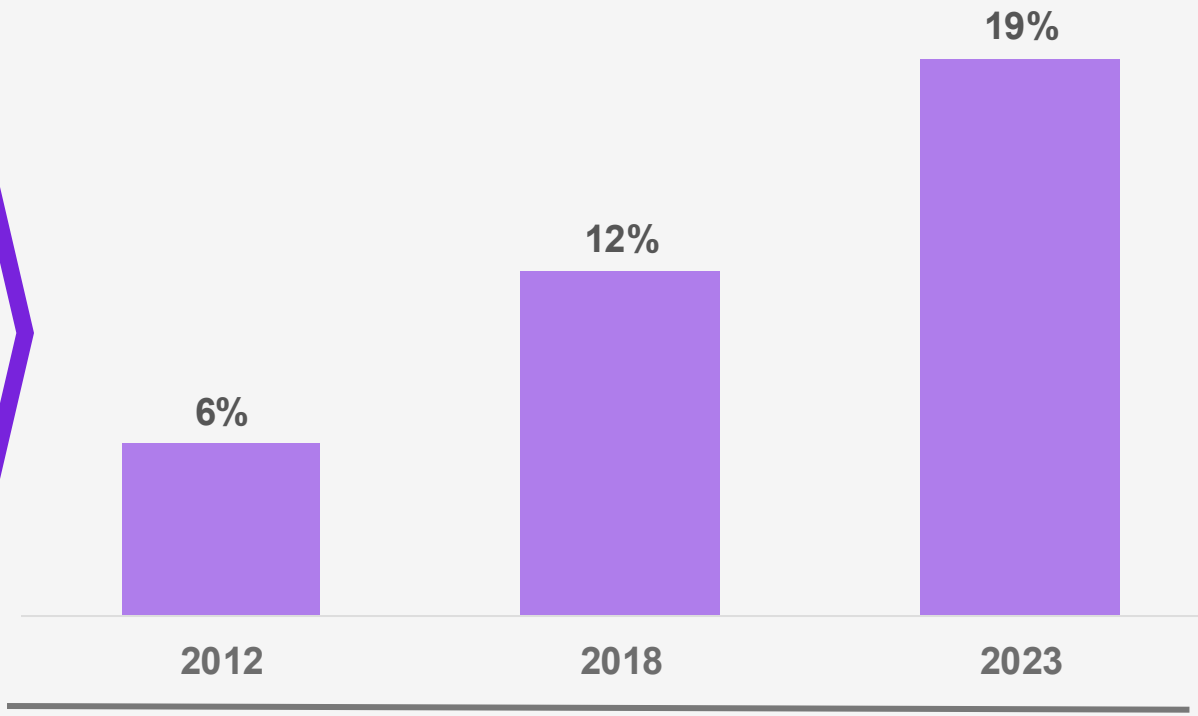


Over **33%** of water mains across North America are **more than 50 years old,** while current replacement programs are on a **200 years per pipe replacement pace**

Nearly 1 out of every 5 water mains across North America are overdue for replacement, equal to approximately 452,000 miles of pipe

North America Water Mains* Beyond Useful Life

% of installed water mains beyond their reported useful life



An **estimated $625B of additional (over the expected) investments will be needed over the next 20 years** for the U.S. water distribution infrastructure to reach a 'good state of repair', **significantly more than the projected actual spending**

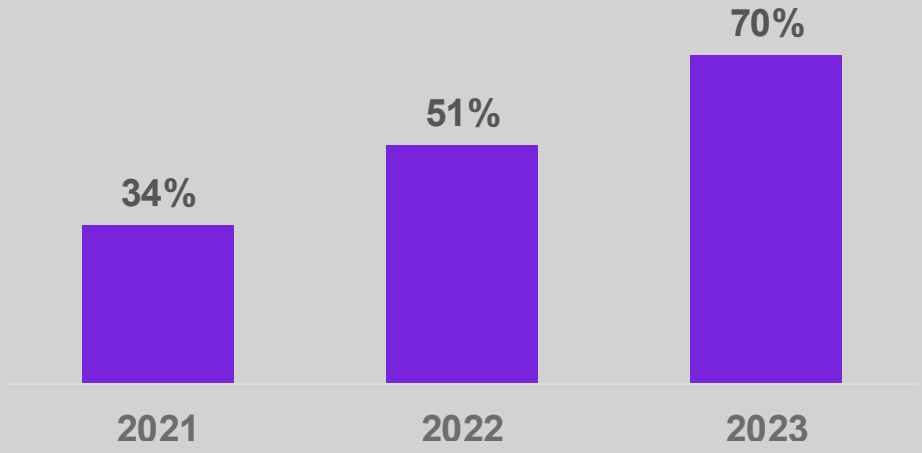
**Water mains defined in the research as any water distribution line (excluding service lines) greater than 3 inches and less than 48 inches in diameter (68% of water mains included in the research were between 3 and 8 inches in diameter)*

Sources: Utah State University, EPA, ASCE

Water quality is becoming a significant concern to residents across North America

Growing Public Concern

% of Americans Concerned About the Quality of Their Tap Water



‘Forever Plastics’

Recent findings from U.S. Geological Services (USGS) suggest that at least one PFAS microplastic, otherwise known as ‘forever plastics’, may be **present in up to 45% of the U.S. drinking water supply**.

Steps are already being made to reduce contaminants, with the EPA championing **new PFAS contaminant limits and testing guidelines** at municipalities, while more treatment centers look to adopt **improved filtration technologies**.

Lead Contaminants

In 2023, the EPA identified **9.2 million lead service lines were still in service** across the U.S.

A recent survey shows **68% of municipal utility bodies already have lead line replacement programs in place**, while EPA’s Lead Service Line State fund program’s $9B funded to date is expected to help **replace up to 1.7 million lead pipes nationwide**.

Water Quality

Sources: American Planning Association, EPA, Aquasana, ASCE, USGS

Case Study: Implementing solar canals in California

Situation

- **Open distribution canals in the U.S. lose significant water** through evaporation, especially in arid regions, reducing overall water utilization efficiency
- California has **over 4,000 miles** of canals

Actions Taken

- Turlock Irrigation District, the California Department of Water Resources, and UC Merced are partnering on **Project Nexus**, aimed at installing solar panels over sections of California's water canals
- **8,500 feet of solar panels** are expected to be installed over **1.6 miles of canals** in California

Results

- UC Merced estimates that if all 4,000 miles of canal were lined with solar panels, **California could save 63 billion gallons of water annually**, mostly stemming from reduced evaporation losses
- Shade provided by panels would **help prevent toxic algal blooms** spurred by sunlight exposure

Impacts

By adopting solar canals across the state of California, **63 billion gallons of water could be conserved annually,** enough to cover the residential needs of **over 2 million people for a year**

State-wide adoption of solar canals could also provide up to **13 gigawatts of renewable energy per year, enough to power Los Angeles from January to October**

Sources: Environmental and Energy Study Institute, American Water Works Association

Case Study: Recycling greywater in Southern California

Situation

- Southern California has historically relied heavily on imported water
- Local **groundwater basins were stressed**, lowering water tables and inviting sea-water intrusion into freshwater aquifers

Actions Taken

- Orange County Water and Sanitation Districts developed the Groundwater Replenishment System (GWRS), which now acts as the **world's largest purification system** for indirect potable reuse
- System treats water through microfiltration, reverse osmosis, and UV technologies

Results

- Produces **44 billion gallons of recycled water annually**, or nearly 10% of Los Angeles County's annual public water utilization
- **Fully recycles 100% of Orange County's reclaimable wastewater** to naturally recharge local aquifers
- **Reduced seawater intrusion** into local aquifers and watersheds

Impacts

The **GWRS supplies around 35% of Orange County's total water needs**, drastically reducing the need for importing water while significantly reducing wastewater discharge to the Pacific Ocean.

Along with supplying potable water, **the recharge of local aquifers has led to decreases in seawater intrusions**, improving water quality as well.

GWRS has received over 80 awards for its impact, acting as a blueprint for similar water recycling projects across North America

Sources: Orange County Water District GWRS, USGS

Case Study: Leak Detection and Repair in Dallas, TX

Situation

- Dallas Water Utilities (DWU) operates one of the largest water systems in the U.S
- The city faces **seasonal leak risks** due to shifting clay soils during heat and drought
- In 2022 alone, **Dallas lost around 15 B gallons of water** from breaks and leaks, equal to over 12% of Dallas County's annual public water utilization

Actions Taken

- DWU implement proactive leak detection technologies, including **inline acoustic tools**
- These technologies **detect leaks as small as 0.1 gallons per minute** in pressurized lines without service disruptions

Results

- DWU has **identified and repaired over 285 leaks** on large-diameter transmission mains
- Reduced average main break rates from 40 to under 21 per 100 miles, a **nearly 50% reduction**

Impacts

DWU's leak detection and repair initiative has significantly improved operational efficiency, reduced unplanned outages, and enhanced system reliability, while having saved **over 2.6 billion gallons of water annually, enough to supply over 133,000 new residential connections in a year**

Sources: Xylem, USGS

Case Study: Replacing lead contaminated water lines in Denver, CO

Situation

- In 2020, Denver Water identified it had more than **64,000 lead service lines** in its system, posing a long-term public health threat
- The total population impacted by these lines included over **100,000 households**

Actions Taken

- Denver Water initiated the Lead Reduction Program to **replace all lead lines by 2035**
- **$727M** has been invested in the program to date, including $33M from the Bipartisan Infrastructure Law

Results

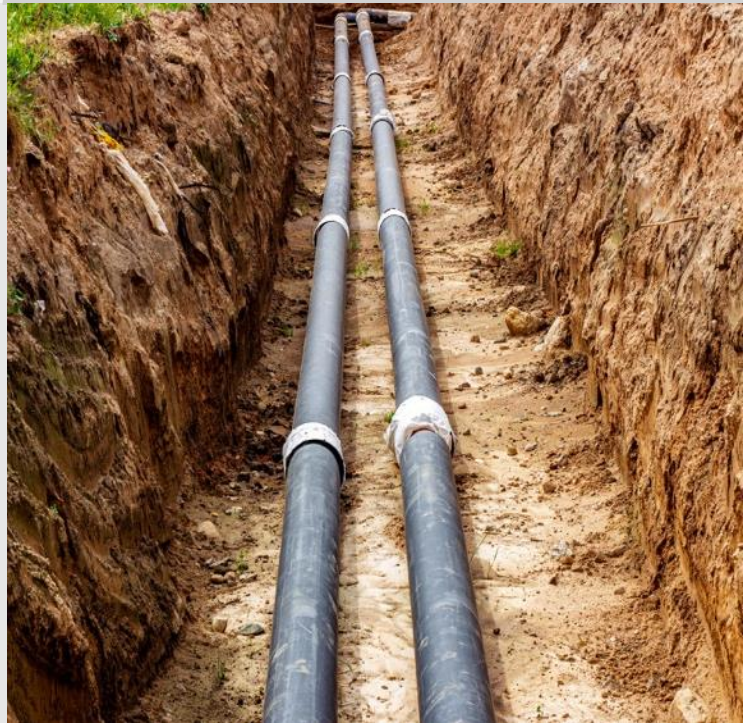
- Nearly **8,000 lead service lines were replaced in 2024 alone**, while more than 25,000 have been replaced to date
- Reduction in **90th percentile** value for lead from 11.0 µg/L in 2019 to 3.6 µg/L in 2024

Impacts

Denver Water's Lead Reduction Program has become a model for lead mitigation for municipalities across the nation

With over 25,000 lines removed and millions of gallons of clean water delivered, the program is significantly reducing lead exposure risk for hundreds of thousands of residents annually

The program has also lead to an improvement in public trust, as reflected in reduced public complaints



Sources: Denver Water

1. Project Background
2. Executive Summary
3. **Segment Overviews**
   - Agriculture
   - Utility
   - **Construction**

The Construction Industry spans all domains related to infrastructure and buildings

Single & multi family homes

Offices & warehouses

Factories or large-scale production facilities

Roads, bridges, airports, and systems that provide utilities (e.g. power, water)

Construction comprises a significant portion of the North American economy

United States

$1.3T contribution to GDP

4.5% of U.S. GDP

5.5% of the U.S. workforce

Canada

$162B contribution to GDP

7.5% of Canadian GDP

7.8% of the Canadian workforce

Construction and Water

The construction industry across North America is highly involved in protecting water use and quality, both directly through on-site utilization, as well as indirectly through the implementation of 'green' infrastructure on building and infrastructure development.

Sources: US BEA, US BLS, StatCan, Canadian Construction Association

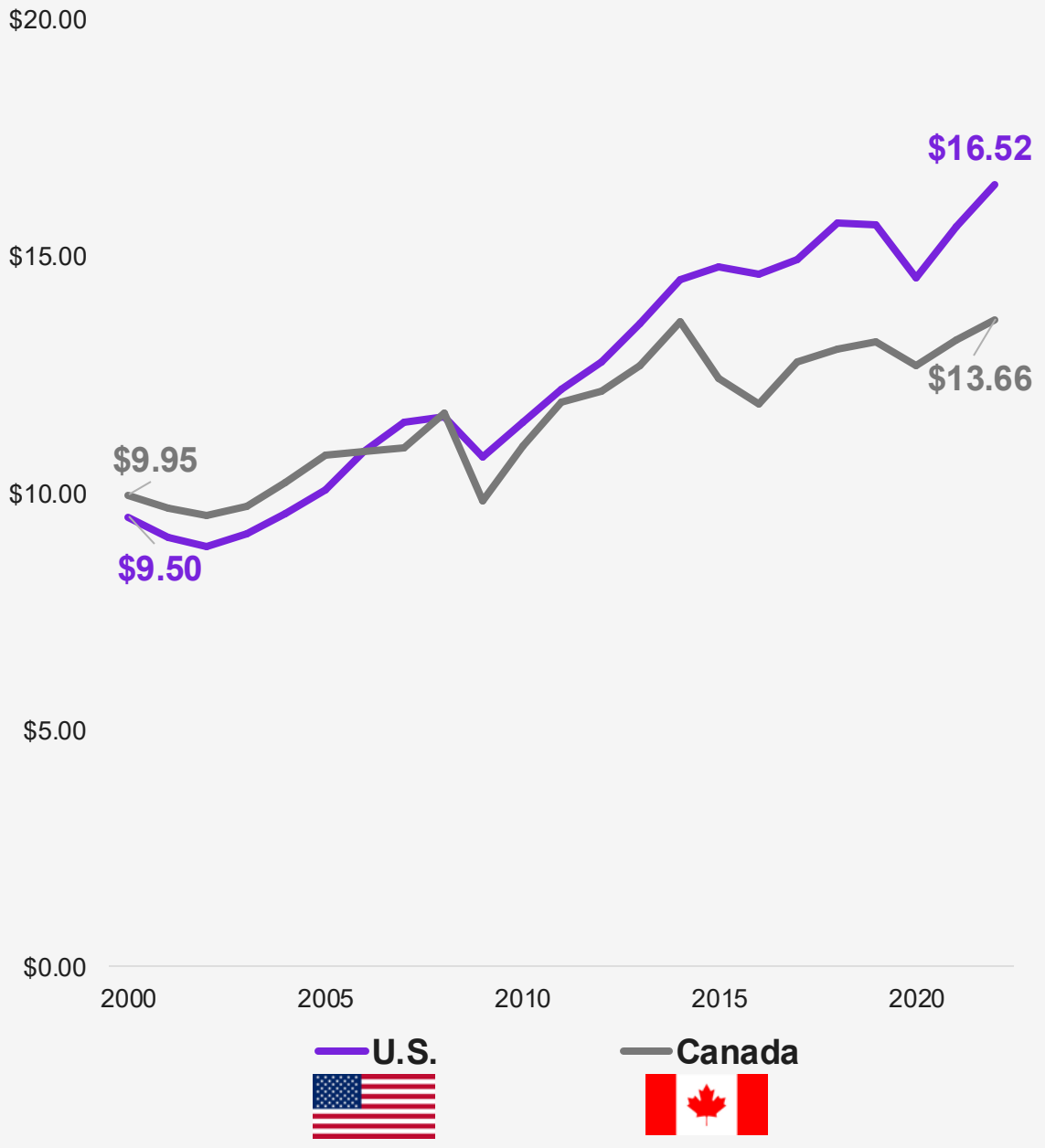
The Construction industry plays a vital role in helping reduce water utilization and improve water quality

	Water Efficiency Doing more with less	Water Quality Protecting water bodies	Reuse & Circularity Maximizing water value
Practices	– Increased utilization of recycled water / more efficient water infrastructure for dust suppression and equipment washing	– Increased implementation of silt fences, sediment / retention ponds, and erosion control blankets on-site	– Implementation of stormwater management infrastructure, such as permeable pavements, bioretention sites, and green roofs
Technologies	– Automated high-pressure equipment wash-out systems – Improved concrete materials and mix processes	– Improved GPS site configurations and grade mapping / grade control technologies – Attachments for mechanized silt fence instillation	– Closed-looped systems on construction sites for reuse and recycling of water
Impacts	– Utilizing concrete additives and improved washout systems has shown to **significantly reduce water utilization** on construction sites	– Increased usage of erosion control practices has lead to a **direct improvement of water quality** near construction developments	– Sites implementing green infrastructure on developments has lead to notable **improvements in groundwater recharge while reducing strain on local treatment facilities**

North American industrial water use has become more efficient over the last two decades, generating more economic value per unit of water

North America Industrial Water Use Efficiency*

Economic Value Generated per Unit of Water Withdrawn, USD/m³



Insights

- Both the U.S. and Canada have become **significantly more productive** with their water use in construction and other industries
- Efficiency gains have been driven by a number of factors, including:
  - Stronger focus on **monitoring and tracking water use data**, including more improved use of water meters
  - Increased implementation of **closed loop and recycling systems**

**Industrial water use includes construction, mining and quarrying, manufacturing, and energy production (excluding thermal cooling)*

Since 2000, the Canadian Industrial sector has become 37% more efficient with water use, while the U.S. has improved by over 74%

Water Efficiency

Sources: FAO AQUASTAT

On-site measures are helping construction operators reduce water use while improving water quality

Water Efficiency / Water Quality / Reuse and Circularity

Controlling Runoff

- Construction operations have placed an **increased focus in recent years on controlling water runoff and improving water quality**, achieved mainly through the more effective use of silt fencing and sediment ponds
- The development of silt fence plow attachments have made it **easier for operators to install fencing**
- Improved GPS and grade control technologies have enabled operations to **optimize site configuration and placement of erosion control infrastructure**

Improved Concrete Processes

- Concrete has been estimated to be responsible for nearly **10% of industrial water withdrawals**
- Incorporating Water Reducing Admixtures (WRAs) lower the water to cement ratio, **reducing water needs by 5-10% in most cases**
- Tank cleanout is also a water intensive process, leading more operators to adopt water reduction methods such as **automated high-pressure washers, utilizing recycled water during washout, and even incorporating slurry mixes back into concrete production**

Sources: US DOT, Intelligent Living, Kearney

Implementing ‘green’ stormwater management infrastructure has proven to improve water circularity and water quality

Water Quality / Reuse and Circularity

Permeable Pavement

- **Aids in water circularity** by reducing peak stormwater runoff and promoting aquifer recharge
- **Improves water quality** by removing harmful pollutants from runoff, including up to 99% of total suspended solids:

Surface Type	Total Suspended Solids	Metals	Nutrients
Porous asphalt	94-99%	76-97%	42-43%
Pervious concrete	91%	75-92%	N/A

Bioretention Areas

- Bioretention areas, such as rain gardens, capture and filter stormwater from hard surfaces through soil and vegetation, **reducing runoff, removing pollutants, and helping recharge groundwater**
- Proven to filter out over **90%** of total suspended solids, up to **50%** of nitrogen, and up to **90%** of phosphorus

Green Roofs

- Absorbs and retain rainwater through layered soil and vegetation, with the **ability to reduce stormwater runoff by 35% - 90%** depending on the system used and rain event
- By capturing and slowly releasing rainwater, green roofs **improve groundwater recharge while reducing the transport of pollutants** into local waterways

Sources: US DOT, Intelligent Living, USGS, EPA, Engre, Kearney

Case Study: Utilizing alternatives to traditional water-based dust suppression in the US

Situation

- Construction operations utilize **millions of gallons of water each year** for the purpose of dust control
- Use of traditional water applications for dust suppression requires constant, frequent applications

Actions Taken

- Construction sites across the US are **increasingly utilizing water alternatives for dust suppression**, including foam sprays, chlorides, synthetic polymers, and fully bio-based solutions
- Some sites are also implementing wind barriers and surface covers to help reduce the need for dust control measures

Results

- In studies conducted across Washington state, dust suppression alternatives have shown to be very effective at reducing dust while conserving water:
  - Utilizing foam sprays was shown to reduce dust by **85%** while consuming **80%-90%** less water
  - Windscreens were demonstrated to reduce dust emissions by up to **75%**

Impacts

It is estimated that nearly **4.7 M gallons of water could be saved** on a 12 acre construction site* by using bio-based dust suppression alternatives compared to traditional water applications over the same period

**Calculations based on a 50 day period*

Sources: Pacific Northwest National Laboratory, Profile

Case Study: Implementing permeable pavements in Vaughan, Ontario

Situation

- The Toronto and Region Conservation Authority (TRCA) was interested in **implementing more permeable pavements throughout Ontario**, while also increasing their understanding of the effectiveness of these systems

Actions Taken

- Four 230 m^2 cells were installed at the Kortright Centre's visitors parking lot
- Three cells were constructed **utilizing permeable pavers and concrete**, while one cell was installed with traditional asphalt for comparison

Results

- TRCA found the following benefits of permeable pavements compared to traditional asphalt:
  - Reduced stormwater runoff volumes by **45%**
  - Removed over **90%** of total suspended solids
  - Heat loads were **36% - 61%** lower, reducing thermal stress on local waterways

Impacts

TRCA's study confirmed that permeable pavements can manage both the quantity and quality of stormwater effectively—helping to reduce peak flows, improve groundwater recharge, and minimize pollutant loads

Notably, **pollutant load reductions ranged from 40% to 95% across key contaminants**, offering strong support for their use in sustainable urban drainage systems

Sources: Toronto and Region Conservation, University of Toronto

Case Study: Utilizing innovative concrete production technologies in Victoria, BC

Situation

- The Southern Vancouver Islands rely on a steady and consistent supply of concrete
- In recent decades, concrete production companies have placed an **increased focus on providing more sustainable concrete** to its customers

Actions Taken

- New concrete production facilities were developed in 2018 using new technologies aimed at **recycling reclaimed water from washout slurry mixes** back into new concrete production

Results

- Utilizing reclaimed water from washout slurry mixes has proven to have the following benefits:
  - Reduced concrete production fresh water needs by **17% - 20%**
  - **Removed over 80 MT of CO_2** from concrete operations in less than two years

Impacts

By implementing innovative cement mix recycling technologies, concrete production organizations have demonstrated the ability to **reduce freshwater needs during production while simultaneously reducing CO_2 footprints**

Sources: CarbonCure

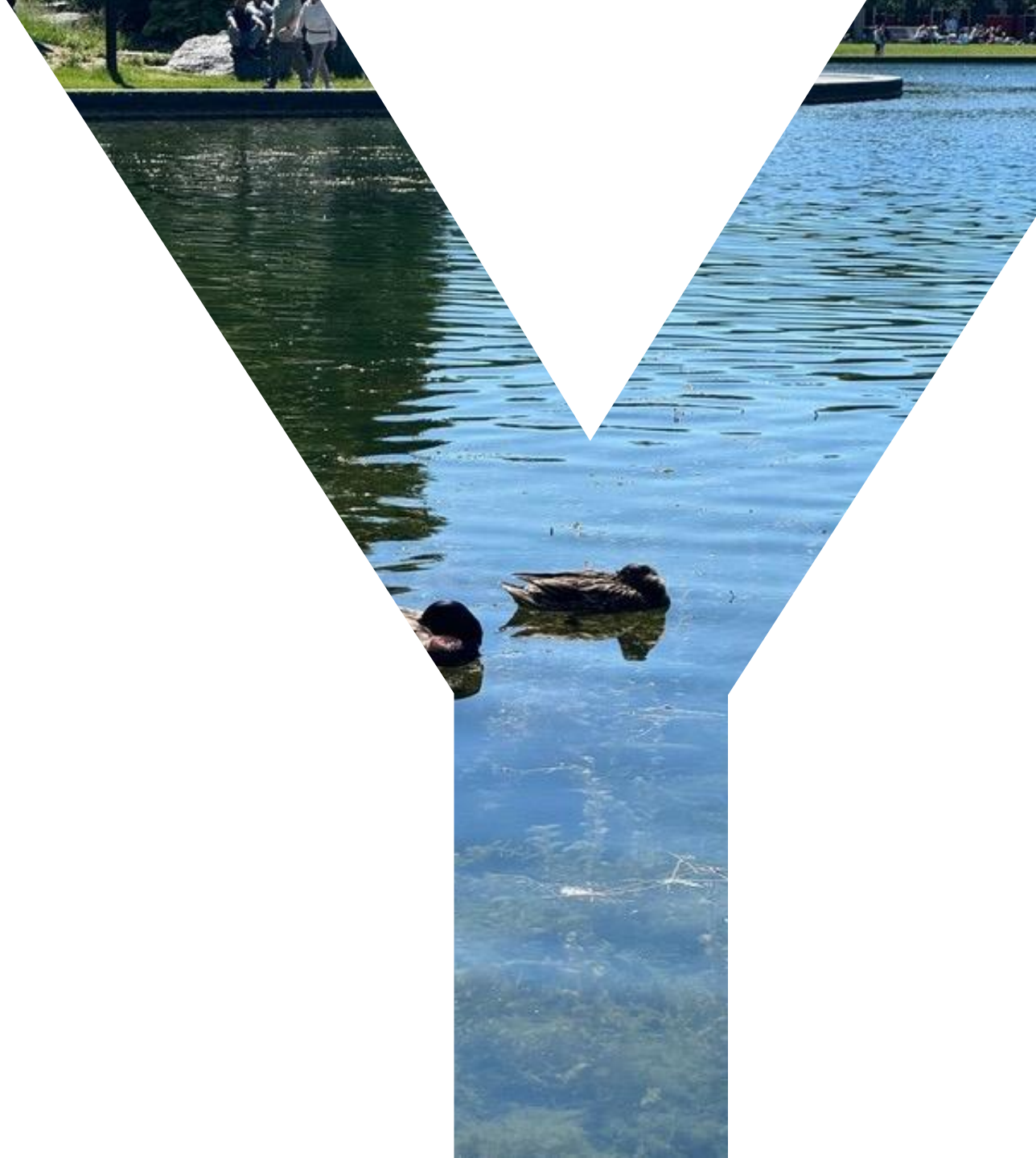
Thank you

Doug Griffin
Partner
Doug.Griffin@kearney.com
Atlanta

Tyler Uden
Manager
Tyler.Uden@kearney.com
Chicago

Jacob Luna
Associate
Jacob.Luna@kearney.com
Dallas

Chad Robertson
Sr. Analyst
Chad.Robertson@kearney.com
Chicago



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