AT&T 10x Case Study:

Connected drones reduce cost and environmental impact of water tank inspections

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AT&T believes technology plays a critical role in reducing carbon emissions. So, we're using the power of our network to create a better, more environmentally sustainable world. We've set a goal to enable carbon savings 10x the GHG footprint of our operations by the end of 2025.

To meet this objective, we're working to make our operations more efficient across the company. We're also working with our customers and technology partners to implement and scale carbon-saving solutions. This case study discusses and quantifies the carbon benefits of using AT&T technology to boost efficiency. This is one study in a series we're sharing as we progress toward our 10x goal.

Learn about our goals, our progress, and see more case studies like this at att.com/10x.

Summary

In order to maintain a clean and safe water supply for their communities, water utilities take water storage tanks out of service every 3-5 years to conduct inspections. If water utilities joined drones and remotely operated vehicles (ROVs) with secure AT&T Internet of Things (IoT) connectivity and a video analysis platform, they could keep their tanks in service, reduce inspection time, and avoid unnecessary risk of injury. If utilities used this method to inspect 10% of the water tanks in the U.S., they could save about **1 billion gallons** of wasted water, reduce greenhouse gas (GHG) emissions by roughly **2,000 metric tons of CO_2e**, and lower inspection costs by approximately **$12 million** every year.

Estimated annual benefits if used on 10% of water tanks in the U.S.

- **1B Gal** of water saved
- **2,000** metric tons CO_2e avoided
- **$12M** in inspection costs saved
- **300,000** out-of-service hours saved

Background

Where does our water come from? When we turn on the faucet, we take for granted that we will receive clean, safe water. Water utilities in the U.S. are responsible for providing 322 billion gallons per day[1] of potable water to their customers. The primary function of water tanks is to ensure a continuous and reliable supply of water to local communities. Amidst a background of aging infrastructure, inspecting and maintaining the structural integrity, sanitary conditions, and security of water storage tanks is increasingly important. In the U.S. alone, there are over 115,000 water tanks across over 146,000 public water systems.[2]

1 "Total Water Use in the United States," U.S. Geological Survey, August 16, 2019, https://www.usgs.gov/special-topic/water-science-school/science/total-water-use-united-states?qt-science_center_objects=0#qt-science_center_objects .

2 "SDWIS Federal Reports Advanced Search," U.S. Environmental Protection Agency, August 16, 2019, https://ofmpub.epa.gov/apex/sfdw/f?p=108:1:::NO:1::

The American Water Works Association (AWWA) recommends comprehensive inspections are conducted on water tanks every 3 years,[3] but a report by the Environmental Protection Agency (EPA) found that most facilities inspect every 6 to 8 years, which could prevent significant structural and sanitary issues from being detected.[4] In addition, the AWWA recommends routine visual inspections are conducted externally daily or weekly and periodic inspections are conducted monthly or quarterly to check for deterioration of coatings or obvious signs of water quality problems.

Drones are increasingly being used for 'intelligent inspections,' which includes the inspection service and analytics on the collected data. This type of information is a value-add to businesses and utilities, with Boston Consulting Group estimating that the services and data from drones will represent $23 million of the $50 million total drone market by 2050.[5] In addition to drones, which provide aerial inspections, ROVs provide underwater inspections. Special accessories, such as thickness gauges and rotating arms, can enhance inspection capabilities and allow ROV-based inspections to deliver similar accuracy to that of people-based inspections with lower cost, time and risk of injury.

The Challenge: Reduce environmental impact, safety risks and operational costs of comprehensive water storage tank inspections

Typically, utilities hire third parties to conduct a comprehensive external and internal inspection to look at structural, sanitary, coating, safety and security conditions of its water storage tanks.

For internal inspections, most utilities conduct a washout inspection in which they take the tank out of service and drain the water into a nearby ditch or creek. Utilities have to plan inspection logistics carefully to ensure they can still meet customer demand and drain the tank slowly enough to avoid flooding areas downstream. Some utilities simply can't afford to take a tank out of service due to customer demand, which often leads to infrequent or incomplete inspections.

This method wastes millions of gallons of potable water, and can be expensive and time consuming, with costs ranging from $10,000 to $20,000 per tank and taking up to two weeks to drain, inspect, test, and refill the tank before putting the it back into service.

For external inspections, inspectors use a cherry picker, scaffolding or climb the tank. These methods, while relatively inexpensive, require extensive logistics and coordination, waste energy to use heavy machinery, and create safety concerns for inspectors climbing the tanks. In addition, it's hard for inspectors to get a full view of the tank, limiting their ability to find issues with corrosion or coating on top of the tanks.

Challenges of typical water tank inspections:

- Wastes treated water
- Takes tank out of service
- Uses excess energy for scaffolding, machinery, and multiple trips to the site
- Prevents inspection of hard to reach areas of the tanks
- Creates safety concerns for inspectors

Once the inspections are complete, the utility receives a final inspection report, typically about a week later, which includes pictures and notes from the inspection company. Utilities then use the report to create maintenance requests or submit proposals for larger capital works projects. Sometimes they will input this data into an asset management system, but typically the report is simply archived. Limited data management and analysis prevent utilities from executing further data analysis that would help them more easily and efficiently manage issues over the life of the tank.

3 American Water Works Association Manual M42, 1998

4 "Finished Water Storage Facilities," U.S. Environmental Protection Agency, August 15, 2002, https://www.epa.gov/sites/production/files/2015-09/documents/2007_05_18_disinfection_tcr_whitepaper_tcr_storage.pdf

5 Alexandre Amoukteh , Joel Janda , and Justin Vincent, "Drones Go To Work," Boston Consulting Group, April 10, 2017, https://www.bcg.com/publications/2017/engineered-products-infrastructure-machinery-components-drones-go-work.aspx

The Solution: Pairing drones and ROVs with a drone video platform saves water, energy, time, and money and creates valuable data for asset maintenance

By using drones and ROVs, utilities can keep their tanks in service, avoid dumping millions of gallons of potable water on the ground and reduce cost and safety concerns. This method also enables utilities to collect and analyze better, real-time data.

Outside the tank, the drone operator flies the drone around the storage tank and takes video of the tank from all angles. The drone communicates with an AT&T IoT-enabled drone video platform developed by AT&T's business partner, KSI Data Sciences, which uses AT&T's network to deliver high quality video where it can be quickly analyzed. By providing higher levels of security, an ability to scale, and faster data processing, the network also enables data analytics.

On the ground, the inspector and water utility staff watch streaming video of the inspection. The video is streamed in near real-time to the cloud for inspectors or utility staff to collaborate with the drone operator. This feature allows both onsite and offsite staff to zoom in on areas of interest and instruct the operator to investigate areas that need closer examination.

Inside the tank, a sanitized ROV navigates the rafters and other obstacles in the tank to measure coating thickness, detect cracks and corrosion, and clean sediment out of the tank. Similarly, the drone video platform uses the AT&T network to stream video to the cloud and help identify areas that need closer inspection. The platform can also integrate a utility's existing sensors or cameras to monitor the overall health of the tank, plan for risks, and accurately predict future maintenance.

Collecting accurate data and applying analytics are crucial to identifying predictive maintenance opportunities. According to Deloitte, predictive maintenance can increase equipment uptime by 10 to 20% and reduce maintenance planning time by 20 to 50%.[6] The streaming video can be combined with analytics software to help utilities quickly and clearly identify areas that need maintenance, such as:

- Identifying precise GIS locations of cracks, leaks, or other structural weaknesses and determine the severity and urgency of repair required
- Running change detection analysis to compare footage from past inspections and identify any major variations, including corrosion, vegetation, or effects of natural disasters
- Determining whether there is sediment in the tank, and use special ROV accessories to remove unwanted debris or check coating thickness
- Developing a 3D photogrammetry model of the site, which can be used for monitoring and surveying changes in the site, for example after a storm or natural disaster

6 "Predictive Maintenance," Deloitte Analytics Institute, Issue 7/2017, https://www2.deloitte.com/content/dam/Deloitte/de/Documents/deloitte-analytics/Deloitte_Predictive-Maintenance_PositionPaper.pdf

Technology in action at local water utilities

To understand the potential benefits of this type of solution, consider a local water utility with 12 water storage facilities delivering 7 million gallons of water every day to 85,000 customers. By using drones and ROVs, this utility could reduce its wasted water annually by **1.3 million gallons** while reducing water costs by around **$5,000 and $20,000** in inspection costs, not including potential savings from avoided energy and operational costs. In addition, they could save almost **500 hours** of out-of-service time by conducting an inspection in **1 day instead of 1-2 weeks**, reducing risk of injury and contamination. Finally, they could reduce GHG emissions by up to **3 metric tons of CO_2e** per year due to avoided travel and avoided electricity for treating and pumping water that was previously dumped.

> "Combining AT&T's secure IoT connectivity with drone-provided data enables us to provide a video analysis platform that can save our customers time, money, and water."
>
> **Jon Gaster,** CEO, KSI Data Sciences

Synergistic Solutions International (SSI), an AT&T drone business partner, has used the system to help solve another type of problem: lost equipment. While conducting maintenance on a pipe running from the water treatment plant to the ground storage tank 600 feet away, a hose inflating a plug in a point of entry to the pipe snapped, deflating the plug and sending it into the pipe. If the plug created a blockage in the pipe, it would have disrupted service to the utility's customers. Typically, the utility would have had to dig up the ground around the pipe and drill a hole every 10-20 feet until they were able to find and rescue the plug. This would have required an immense amount of fuel, time, and money to dig up and replace the pipes.

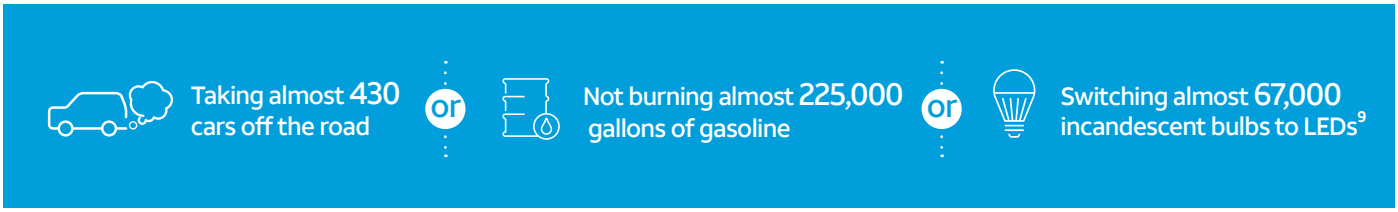
> "Drones collect data that other sensors can't access, which, combined with the drone video platform, allows customers apply analytics in real-time and uncover trends they weren't aware of before."
>
> **Chris Keon,**
> CEO, Synergistic Solutions International

By using an ROV, the SSI team was able to find and remove the plug in 3 days, saving the utility around $340,000. While explicitly measuring other benefits is challenging, it's safe to say that the utility saved significant amounts of water, energy, and time with the ROV and prevented costly service interruption to their customers.

Sustainability Impact: Taken for granted, water tanks offer opportunity for tech-enabled efficiency

We see them in rural towns and in our suburban neighborhoods: water tanks are so commonplace and taken for granted that they almost become invisible. Combined with the pipes connecting them, they are the backbone of the of the U.S. water infrastructure, with over 115,000 dotted across the country.[7]

Water tanks are critical infrastructure, but their maintenance and upkeep can be expensive, dangerous and environmentally wasteful. Drones and ROVs, paired with secure connectivity, create an effective alternative to the traditional way of doing inspections. If just 10% of water tank inspections transitioned to this method, 2,300 inspections each year would achieve water savings of **over 1 billion gallons** of water and GHG emissions reductions of nearly **2,000[8] metric tons of CO_2e** annually. Utilities could also save around **$12 million** and nearly **300,000 hours** of out-of-service time per year. This is equivalent to:



7 "SDWIS Federal Reports Advanced Search," U.S. Environmental Protection Agency, August 16, 2019, https://ofmpub.epa.gov/apex/sfdw/f?p=108:1:::NO:1:.

8 115,818 sites* 10% * per site emission reduction calculation of 0.17 metric tons of CO_2e = 1,993

9 "Greenhouse Gas Equivalency Calculator," U.S. Environmental Protection Agency, August 16, 2019, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator (Note, the average eGRID electricity factors have been used rather than the marginal AVERT electricity factors, this being a more conservative estimate of the savings).

Applying the 10x carbon impact methodology

Carbon Trust and BSR collaborated with AT&T in the development of a methodology to measure the carbon benefits of AT&T's technology. The details of the methodology can be found on the AT&T 10x website. The table below summarizes how the 10x methodology was applied to estimate the environmental impacts described in this case study.

Description of the Enabling Technology	AT&T connectivity enables the inspection of water tanks using drones and ROVs. This provides a more energy and time efficient method to inspect the tanks by avoiding the need to drain and refill the water tank for each inspection. It also reduces the number of times the inspection team has to travel to the water tank and it avoids the need to transport heavy equipment (i.e. scaffolding or cherry pickers) to the site. Similarly, using drones and ROVs enables water tank maintenance operators to fix issues, such as a lost plug in a pipe, in a quick and less disruptive manner. Real-time scanning data and live video is sent via AT&T's network to enable faster inspection.
Impact Category	This case study focuses on the cost, water and energy savings resulting from the implementation of drone and ROV inspection methods at water tank sites, and the GHG impact associated with these savings.
Materiality	Using drones and ROVs to inspect water tanks reduces the cost, emissions, time and water loss associated with the traditional method of inspecting water tanks. The environmental and financial benefits arising from this approach enabled by AT&T connectivity could encourage widespread adoption of improved water tank maintenance and management, thus delivering scalable environmental benefits.
Attribution of Impacts	The cost, emissions, time, and water savings described in this case study are a result of changes to the water tank inspection and maintenance practices supported by drone and ROV technology and AT&T IoT connectivity.
Primary Effects	The drone monitoring and scanning system enables more efficient inspection of water tanks, avoids the need to drain and refill the water tank, and thus reduces the energy, water, and time used for inspecting and maintaining the water tanks.
Secondary Effects	There are also reduced emissions from delivery and water supply infrastructure as smaller vehicles and less pumping equipment is required. The inspection company may also have lower insurance costs.

Rebound Effects	There are also reduced emissions from delivery and water supply infrastructure as smaller vehicles and less pumping equipment is required.
Trade-Offs or Negative Effects	This technology does not appear to create other outsized or irreparable environmental or social impacts.
Carbon Burden from the Enabling Technology	The embodied and in-use carbon emissions of the drones and ROVs, which will be minimal compared with the emissions reductions.
Scope	The scope for this case study covers the comparison between the use of drones and ROVs to inspect a water tank and the traditional water tank inspection method, which involves draining the tank. The case study also assesses the impacts of using drones to fix specific water tank issues compared to traditional repair methods.
Timeframe	Savings were calculated on a yearly basis, even though inspections only occur every 3 to 5 years.
Functional Unit	The functional unit for the carbon emissions reduction is metric tons CO_2e per tank per year. The functional unit for water reduction is U.S. gallons of water used per tank per year. The functional unit for cost savings is U.S. dollars per tank per year.
Methodology	The GHG emissions reductions were calculated by comparing the emissions associated with the traditional water tank inspection method and the drone-enabled inspection method. For the traditional method of inspection, the carbon emissions were calculated for the transportation of equipment and staff to and from the water tank site and the draining and re-supplying of water to the water tank. This was then compared to the emissions associated with the drone/ROV inspection method, which involved less transportation of staff to the water tank sites and no requirement to drain or re-supply the tank with water but included the emissions from the use of the drones and ROVs during the time of inspection. The GHG emission reductions were also calculated for comparing the use of an ROV against a traditional method of finding a lost plug. For the traditional method of solving a lost plug, the carbon emissions are calculated by estimating the emissions from the heavy equipment used to dig to the pipe, as well as create and weld a hole in the pipe. This was then compared to the emissions associated with using an ROV to fix the issue, which required only digging one hole and welding it back together.

Key Assumptions	• Average capacity of a water tank: 500,000 gallons of water • Time to refill water tank: 6 hours • Height of water tank: 300 feet or 100 meters • Price of water: $3.70 per 1,000 gallons • Cost of traditional inspection method per tank: $10,000 • Cost of drone inspection method per tank: $5,000 • Frequency of water tank inspections: between 3 and 5 years. Assumptions for example utility were 3 years based on county data. Extrapolated assumptions used 5 years for most conservative calculation. • Average distance from nearest town to water tanks: 31.4 miles • Approximate power rating of water pump: 120kW • Approximate power consumption of ROV: 0.18kW • Use of ROV for inspection: 11.5 hours • Approximate power consumption of drone: 3kW • Use of drone for inspection: 1 hour • Number of holes required to find lost plug using traditional method: 56 • Number of holes required to find lost plug using ROV: 1
Exclusions	• The embodied emissions of the drone and ROV devices, as well as emissions related to data communication processing.
Data Sources	• Water tank data during interviews with several water utilities across the U.S. • Pump data. Example data retrieved from https://product-selection.grundfos.com • Drone data. Example data retrieved from https://www.dji.com/uk/matrice-200-series/info • ROV data. Example data retrieved from http://download.videoray.com/documentation/mss/html_defender/equip_connections.html • EPA. Emissions & Generation Resource Integrated Database (eGrid 2016). Retrieved from https://www.epa.gov/energy/emissions-generation-resource-integrateddatabase-egrid • DEFRA. Greenhouse gas reporting: conversion factors 2019. • Retrieved from https://www.gov.uk/government/publications/greenhouse-gas-reportingconversion-factors-2019

Carbon Abatement Factor	The result of using drones and ROVs leads to carbon savings of 0.17 tCO_2e per year for a 500,000 US gallon tank, inspected every 5 years. Extrapolating this to 10% of water tanks in the US would lead to savings of 1,993 tCO_2e.
Water Savings Factor	Avoiding the need to drain a water tank every 5 years for inspection leads to savings of 100,000 gallons per year for every 500,000 US gallon tank.
Lessons Learned	The carbon savings are relatively low, although there are other environmental savings (reduced water wastage) and cost savings. Most of the carbon savings are from avoiding the re-supply and pumping of water to refill the tanks.