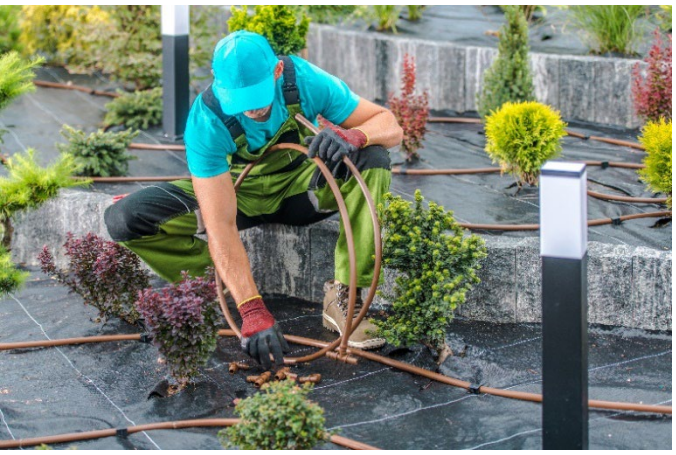
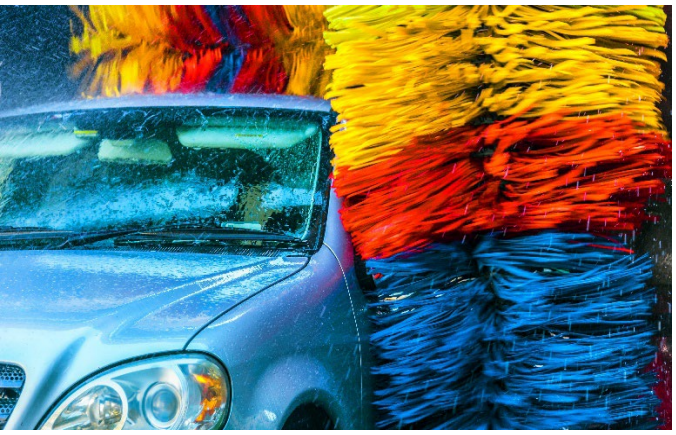


WaterSense at Work

Outdoor Water Use

5.4 Vehicle Washes



Best Management Practices for Commercial and Institutional Facilities

EPA WaterSense

November 2023

WaterSense® is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency (EPA) that seeks to protect the nation's water supply by transforming the market for water-efficient products, services, and practices.

WaterSense at Work is a compilation of water efficiency best management practices intended to help commercial and institutional facility owners and managers from multiple sectors understand and better manage their water use. It provides guidance to help establish an effective facility water management program and identify projects and practices that can reduce facility water use.

An overview of the sections in *WaterSense at Work* is below. This document, covering water efficiency for vehicle washes, is part of **Section 5: Outdoor Water Use**. The complete list of best management practices is available at www.epa.gov/watersense/best-management-practices. WaterSense has also developed worksheets to assist with water management planning and case studies that highlight successful water efficiency efforts of building owners and facility managers throughout the country, available at www.epa.gov/watersense/commercial-buildings.

- **Section 1. Getting Started With Water Management**
- **Section 2. Water Use Monitoring**
- **Section 3. Sanitary Fixtures and Equipment**
- **Section 4. Commercial Kitchen Equipment**
- **Section 5. Outdoor Water Use**
- **Section 6. Mechanical Systems**
- **Section 7. Laboratory and Medical Equipment**
- **Section 8. Onsite Alternative Water Sources**

EPA 832-F-23-003
Office of Water
U.S. Environmental Protection Agency
November 2023

This document is one section from *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities* (EPA-832-F-23-003). Other sections can be downloaded from www.epa.gov/watersense/best-management-practices. Sections will be reviewed and periodically updated to reflect new information. The work was supported under contract 68HERC20D0026 with Eastern Research Group, Inc. (ERG).

Overview

Whether at a dedicated vehicle wash facility or as part of a commercial entity including them, vehicle washes may use a great deal of water, but they also have significant opportunities for savings.

Car wash at trucking facility

Commercial vehicle washes, for light duty trucks or cars, are categorized by the type of equipment at the facility. All types of vehicle washes use some combination of spray and brush equipment, and many use both. Facilities are categorized as one of three types of washes:[1]

- Conveyor systems, which include sprays or brushes mounted on stationary arch(es) which spray a vehicle that moves along a conveyor underneath;
- In-bay automatic, in which a stationary vehicle is washed by sprays or brushes mounted on a moveable gantry; and
- Self-service, in which customers operate hand-held wands and brushes themselves.

These types of washes can be found at stand-alone vehicle wash facilities, co-located with another type of business (e.g., gas station, convenience store), or even co-located with each other so customers can choose between the type of wash they wish to use. Similar washing equipment can also be found at industrial facilities for wheel washing to reduce dust entrainment as vehicles leave the sites to enter the public roadway, or at larger washing facilities to clean heavy duty trucks and buses.

The International Carwash Association (ICA) identifies seven steps or cycles in a commercial vehicle wash:[2]

[1] Terminology or technology descriptions may vary depending on the manufacturer. For example, spray washes can be characterized as touchless or frictionless; friction technology can use brushes, curtains, and/or "mitters."
[2] Brown, Chris. 2000. *Water Conservation in the Professional Car Wash Industry*. Prepared for the International Carwash Association (ICA). Page 10.

- Pre-soak: An automated nozzle or handheld spray.
- Wash: A high-pressure spray or brushes that utilize a detergent solution.
- Rocker panel/undercarriage: Brushes or high-pressure sprays on the sides and bottom of the vehicle.
- First rinse: A high-pressure rinse.
- Wax and sealers: An optional surface finish that is sprayed on the vehicle.
- Final rinse: A low-pressure rinse with fresh or membrane-filtered water.
- Air blowers: Air blown over the vehicle to remove water and assist drying.

In conveyor and in-bay automatic washes, the cycles and the length of time they run are determined by the level of wash the customer selects. In self-service washes, the customer chooses which cycle to use and the length of time based upon their individual preference. Some sites offer hand drying; typically, these are at conveyor sites and include wiping down the vehicle with towels or chamois cloths, which are often laundered in onsite washing machines. Refer to *WaterSense at Work Section 3.5: Laundry Equipment* at www.epa.gov/watersense/best-management-practices for information on using water efficiently in commercial laundry systems.

Water Reclamation Systems Save

Water reclamation systems that treat wash and rinse water from previous wash cycles for use during the next vehicle wash offer the greatest potential water savings for vehicle wash systems. At a minimum, water reclaim systems should separate grit, oil, and grease from wash water. This level of water treatment is enough to use reclaimed water during the rocker/undercarriage wash stage. Additional treatment, such as oxidation, filtration, membrane filtration, and/or deionization, is necessary for use of reclaimed water during additional vehicle-washing steps. Studies by the ICA found that facilities using reclamation systems were able to fulfill a significant portion of their water needs from reclaimed water.

Many commercial vehicle wash facilities have adopted water reclamation technology, which treats wash and rinse water from previous wash cycles for use during the next vehicle wash in an effort to reduce fresh water use. Reasons for this include:

- Wastewater discharge limits set by regulatory agencies;
- Reducing sewer discharge fees, which are often calculated based upon a fraction of metered water consumption; and
- Owner and/or operator desire to conserve freshwater supplies.

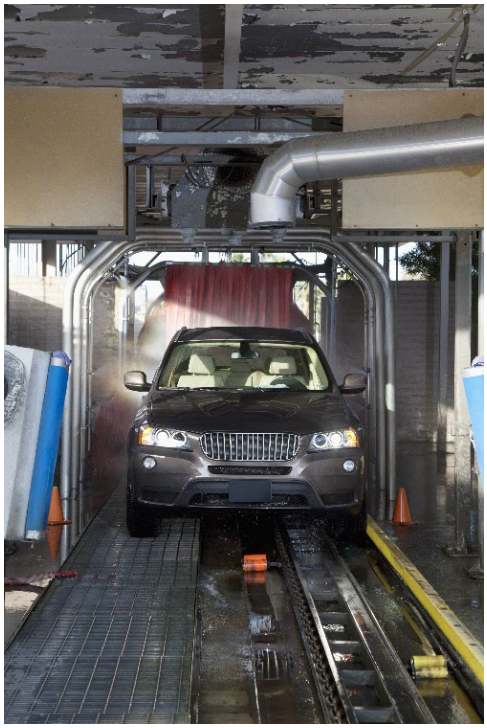
There are several other opportunities for vehicle washes to minimize water use. Field studies have shown that the brush or cloth equipment, typically known as mitters, curtains, or brushes, use less water on average than equipment that use sprays only. Cloth equipment water use can vary based upon specific features of the equipment and

time of cycle. Water use in spray cycles can similarly vary with the time, nozzle size, and pressure they are run. Most in-bay automatic equipment can incorporate sensors to determine vehicle length, which can save water on shorter vehicles.

Conveyor Systems

Conveyor vehicle wash systems use a conveyor belt to pull vehicles through a washing tunnel, which consists of a series of spray arches and/or washing cloths. Vehicle washing can be conducted with the customer inside the vehicle during the wash process, or the customer can wait outside the vehicle as both the interior and exterior are cleaned. In some states, the driver and passengers are required to wait outside the vehicle during washing. Conveyor facilities employ two different methods of washing: friction or frictionless. During friction washing, the wash equipment (e.g., a cloth curtain, mitter, or brush) makes contact with the vehicle. Frictionless, or touch-free, washing relies on high-pressure nozzles to clean the vehicle. Conveyors with friction wash cycles use less water per vehicle, because the cloth brushes or curtains collect water and detergent from previous washes and require less re-wetting.[3]

Conveyor vehicle wash facilities are good candidates for installing reclamation systems because they are typically staffed and have a larger equipment room in which to install the reclamation equipment. In a 2002 study on water use in commercial car washes, conveyors averaged 34 gallons per vehicle (gpv) (129 liters per vehicle [lpv]) fresh water.[4] A 2018 study found conveyor washes used on average 30 gpv (114 lpv) of fresh water.[5] The balance of water used varies widely with the individual wash facilities based upon how their operators design and adjust the system's flow rates, timing, and pressure. In both studies, the amount of reclaimed water being used in these washes was significant. Conveyor washes with a reclaimed water system that were evaluated for the 2002 study used twice as many gallons of reclaimed water as fresh water. The average amount of reclaimed water used in conveyor systems ranged from 1.9 to 4.9 gallons per gallon (7.2 to 18.5 liters per liter) of fresh water in the 2018 study.



Conveyor vehicle wash

[3] East Bay Municipal Utility District (EBMUD). 2008. *WaterSmart Guidebook: A Water-Use Efficiency Plan Review Guide for New Businesses*. Pages WASH1-6. www.ebmud.com/water/conservation-and-rebates/commercial/watersmart-guidebook.
[4] Brown, Chris. 2002. *Water Use in the Professional Car Wash Industry*. Prepared for ICA. Page 35.
[5] Brown, Chris. 2018. *Water Use, Evaporation, and Carryout in Professional Car Washes*. Prepared for ICA. Page C-4.

Manufacturers estimated that without reclaimed water, conveyor vehicle washing can use 65.8 gpv (249 lpv) of fresh water during friction washing and 85.3 gpv (323 lpv) of fresh water during frictionless washing.[6]

In-Bay Automatic Systems

In-bay automatic vehicle washes can be found at many gas stations or similar facilities where vehicle washing is a secondary service option. For in-bay automatic vehicle washing, the vehicle remains stationary while the washing process occurs. As with conveyor vehicle washing, a series of nozzles and/or brushes is used to complete either a friction or frictionless wash process.

In-bay automatic vehicle wash

Equipment varies by manufacturer, with some designed so that one set of nozzles is used to perform all wash cycles, and the lines are emptied between soap and rinse cycles. Other designs use a manifold system that stores washing and finish products in different lines than rinse water. Still other systems offer the customer the choice of using a friction or frictionless equipment mounted on the same gantry. In-bay automatic vehicle washing facilities can also benefit from the use of a water reclamation system. Average fresh water use among in-bay automatics from the 2002 and 2018 studies was 43.3 gpv and 44.8 gpv (164 lpv and 170 lpv) of fresh water, respectively.[7,8] In-bay automatic washes with a reclaimed water system that were evaluated for the 2002 study used 1.1 gallons (liters) of reclaimed water for every gallon (liter) of fresh water.

Without a reclamation system, in-bay automatic system fresh water use can be as much as 74.1 gpv (280 lpv). By contrast, with a reclaimed water system, an in-bay automatic wash can use as little as 19.1 gpv (72 lpv).[9]

Self-Service Car Washes

Self-service car washes allow customers or employees to wash vehicles using a handheld nozzle to perform all washing processes. In some cases, there could be a brush available for the wash cycle. The pricing structure for a commercial self-service car wash is typically

[6] Brown, Chris 2000, *op. cit.*, Page 16.
[7] Brown, Chris 2002, *op. cit.*, Page 34.
[8] Brown, Chris 2018, *op. cit.*, Page I-3.
[9] Brown, Chris 2002, *op. cit.*, Page 32 and 39.

set up so that the customer pays for a base amount of time of water use and can make additional payments for each additional time increment.

Of the three types of vehicle washing, self-service vehicle washing tends to use the least amount of water—15.0 gpv (57 lpv), on average.[10] While self-service vehicle washing typically uses the smallest amount of water per vehicle, water reclamation systems are often not feasible for use with a self-service washing facility, because customers may discharge debris or change oil in the stalls, which would foul the filtration system. Coupled with the fact that water use in these facilities is driven by user behavior, self-service vehicle washing offers the least potential for water savings through retrofit or replacement.

Operation, Maintenance, and User Education

For optimal vehicle wash system efficiency, consider the following:

- Conduct routine inspections for leaks and train appropriate custodial and cleaning personnel and users to identify and report leaks.
- Ensure that the main shut-off valve is in proper working order.
- If possible, use a friction washing component in all cycles, especially if water is not reused.
- Sweep all driveways and impervious surfaces instead of washing.
- Minimize pump head pressures based on manufacturer recommendations.

Some water agencies also incentivize or require the use of reclaimed water systems within car washes. Programs can include rebates or regulations that allow vehicle washes that follow water conservation guidelines greater flexibility to operate during times of drought and water shortage. Examples of such programs are the San Antonio Water System WaterSaver program,[11] the Denver Water Car Wash Certification Program,[12] and the State of Georgia Car Wash Certification requirement.[13]

For further vehicle washing efficiency, follow the operating and maintenance tips specific to each type of vehicle wash system described below.

[10] *Ibid.,* Page 35.
[11] San Antonio Water System (SAWS). WaterSaver Car Wash Program. www.saws.org/conservation/commercial-programs-rebates/watersaver-car-wash-program/.
[12] Denver Water. Car Wash Certification Program. www.denverwater.org/business/services-and-information/car-wash-certification-program.
[13] Georgia Environmental Protection Division. Car Wash Certifications. https://epd.georgia.gov/watershed-protection-branch/water-conservation/car-wash-certifications.

Conveyor Systems

For optimal conveyor system efficiency, consider the following:

- Make sure conveyors are properly calibrated by timing spray nozzles to activate only as the vehicle reaches the spray arch.
- Align spray nozzles properly; they should be oriented parallel to the spray arch.
- If using a water reclamation system, orient blowers so that water is sent back to the water reclamation pit for reuse. Create a dwell time after the final rinse to allow for water to flow back into the reclamation pit.
- Maximize conveyor speed based on manufacturer recommendations.

In-Bay Automatic Systems

For optimal in-bay automatic system efficiency, consider the following:

- Align spray nozzles properly; they should be oriented parallel to the spray arch.
- If using sensors that detect when a vehicle is present, make sure they are properly calibrated. Sensors should activate the spray nozzles only as the vehicle reaches the spray arch.
- If using a reclaim system, create a five-second dwell time before the vehicle exits the bay to allow for water runoff to be collected.
- Maximize wash and rinse cycle speeds based on manufacturer recommendations.

Self-service car wash

Self-Service Car Washes

For optimal self-service car wash efficiency, educate customers on how to efficiently wash their vehicles using less water.

Retrofit Options

Water reclamation systems that treat wash and rinse water from previous wash cycles for use during the next vehicle wash offer the greatest potential water savings for vehicle wash systems (see Figure 1 on the next page for an example of a vehicle wash with a water reclamation system). The degree of water treatment needed depends upon which vehicle washing steps use the reclaimed water. At a minimum, water reclaim systems should separate grit, oil, and grease from wash water. This level of water treatment is enough to

use reclaimed water during the rocker/undercarriage wash stage. Additional treatment, such as oxidation, filtration, membrane filtration, and/or deionization, is necessary for use of reclaimed water during additional vehicle-washing steps. Table 1 below outlines the recommended level of water treatment for reclaimed water use during each phase. Since water quality and road dust varies by region and each car wash reclaim system can be configured differently, the levels of filtration vary by facility.[14]

Figure 1. Vehicle Wash Water Reclamation System

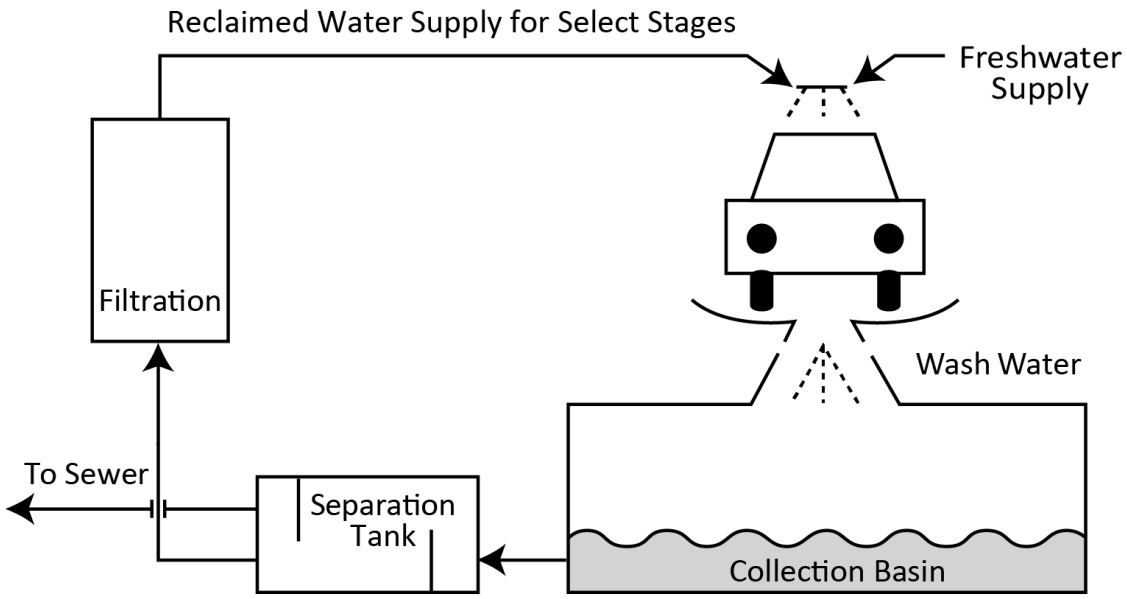


Table 1. Recommended Level of Treatment for Reclaim Systems

Wash Stage	Self-Service	In-Bay Automatic	Conveyor	
			Friction	Frictionless
Pre-soak	N/A	Filtration	Filtration, reverse osmosis or deionization	Filtration, reverse osmosis or deionization
Wash	N/A	Filtration	Separation, filtration	Filtration
Rocker Panel/ Undercarriage	N/A	Filtration	Separation, filtration	Filtration, reverse osmosis or deionization
First Rinse	N/A	Filtration	Filtration	Filtration
Wax and Sealers	Reverse osmosis	Reverse osmosis	Reverse osmosis or deionization	Reverse osmosis or deionization
Final Rinse	Reverse osmosis	Reverse osmosis	Reverse osmosis or deionization	Reverse osmosis or deionization

[14] Brown, Chris 2000, *op. cit.*, Pages 29-30.

If considering a water reclamation retrofit, be sure to evaluate the feasibility of the installation. The ability to install additional piping and water treatment equipment will determine whether a reclamation system retrofit is appropriate. Industry experts recommend taking the following into account when designing a reclamation system:[15]

- Nature of the contamination to be treated
- Concentration of the contaminants
- Volume of water used per day
- Flow rate per minute of different processes in the professional car wash
- Chemicals and procedures used in the wash or rinse process
- Discharge limits (if applicable)
- Intended use of the reclaimed water and the desired quality for its use

Water reclamation systems require additional maintenance to clean filters and other system components. Cleaning and finish products should be compatible with the system filters.[16] Water reclamation systems can be retrofitted with existing conveyor or in-bay automatic vehicle washing systems, but they are not recommended for retrofit with self-service vehicle washing.

For additional retrofit options to reduce water use, consider the following retrofit options for each wash type:

Set Your Threshold

When retrofitting a vehicle wash to save water or constructing new vehicle washes, limit freshwater consumption to 35 to 40 gallons (132 to 151 liters) per vehicle in conveyor systems and in-bay automatic systems, respectively. All nozzles in self-service car washes should flow at no more than 3.0 gallons (11.4 liters) per minute. Consider the operation and maintenance, retrofit, and replacement options in this document to help achieve these maximum water use thresholds.

Conveyor Systems

When retrofitting a conveyor system, consider the following:

- Limit fresh water consumption to 35.0 gpv (132 lpv).[17]
- For conveyor systems that utilize frictionless washing, consider installing friction washing components to use during the wash cycles.
- If a reverse osmosis treatment system is installed for use with a water reclamation

[15] *Ibid.*, Page 21.
[16] Koeller and Company and Chris Brown Consulting. October 2006. *Evaluation of Potential Best Management Practices—Vehicle Wash Systems*. Prepared for the California Urban Water Conservation Council. Pages 5-7. https://calwep.org/wp-content/uploads/2021/03/Vehicle-Wash-Systems-PBMP-2006.pdf.
[17] Texas Water Development Board. 2018. *Best Management Practices for Commercial and Institutional Water Users*. Page 54. www.twdb.texas.gov/conservation/BMPs/CI/index.asp.

system or to supply spot-free rinse water, capture reject water and reuse it during wash cycles.

- Install check valves to prevent backflow wherever possible.

In-Bay Automatic Systems

When retrofitting in-bay automatic systems, consider the following:

- Limit fresh water consumption to 40.0 gpv (151 lpv).[18]
- For in-bay automatic systems that utilize frictionless washing, consider installing friction washing components to use during the wash cycles.
- If a reverse osmosis treatment system is installed for use with a reclaim system or to supply spot-free rinse water, capture reject water and reuse during wash cycles.
- Install check valves to prevent backflow wherever possible.
- Install laser sensors to evaluate the length of the vehicle being washed and adjust the washing procedure to the specific length of the vehicle.
- Limit water consumption during the rocker panel/undercarriage cycle to 12.0 gallons per cycle (45.4 liters per cycle).

Self-Service Car Washes

When retrofitting self-service car washes, consider the following:

- Limit the nozzle flow rate to 3.0 gallons per minute (gpm) (11.4 liters per minute [lpm]).[19]
- Install check valves to prevent backflow wherever possible.
- If towel ringers are installed, use a positive shut-off valve.

Replacement Options

Due to the high capital costs involved with replacing a vehicle wash system, first implement all efficient operation and maintenance procedures and perform any retrofits available to optimize the efficiency of the system. Retrofitting an existing vehicle wash system with a water reclamation system can yield the most potential for water and operational cost savings. Water reclamation systems are appropriate for conveyor and in-bay automatic vehicle washing. When designing a new vehicle washing facility, consider one that incorporates the features described in the earlier “Retrofit Options” section.

[18] *Ibid.*
[19] *Ibid.*

Savings Potential

Water savings can be achieved by installing a water reclamation system for conveyor or in-bay automatic vehicle wash facilities. Studies by the ICA found that facilities using reclamation systems were able to fulfill a significant portion of their water needs from reclaimed water. The actual values found in the field depend on which cycles are plumbed to use reclaimed water.
To calculate facility-specific water savings and payback, use the following information.

Current Water Use

To estimate the current water use of an existing vehicle wash system, identify the following information and use Equation 1 below:

- Water use per vehicle: This can be determined based on metered water use. If the facility does not have a meter, manufacturers estimate that conveyor and in-bay automatic washes use an average of 75.0 gpv and 55.0 gpv (284 lpv and 208 lpv) of fresh water, respectively.[20]
- Number of vehicles washed per day.
- Days of facility operation per year

Equation 1. Water Use of Vehicle Wash System (gallons or liters per year)

= Water Use per Vehicle x Vehicles Washed x Days of Facility Operation

Where:

- Water Use per Vehicle: Gallons or liters per vehicle
- Vehicles Washed: Number of vehicles washed per day
- Days of Facility Operation: Days per year

Water Savings

The data collected in ICA's studies indicates that vehicle wash facilities can reduce their fresh water use from 50 percent to as high as 83 percent by using a water reclamation system.[21,22] Manufacturers should be able to give an estimate for their equipment packages. To calculate water savings that can be achieved from retrofitting an existing vehicle wash system, identify the current water use (as calculated using Equation 1 above) and use Equation 2 on the next page.

[20] Brown, Chris 2000, *op. cit.*, Page 16.
[21] *Ibid*.
[22] Brown, Chris 2018, *op. cit.,* Page 5.

Equation 2. Water Savings From Vehicle Wash System Retrofit (gallons or liters per year)

= Current Water Use of Vehicle Wash System x Savings

Where:

- Current Water Use of Vehicle Wash System: Gallons or liters per year
- Savings: Percent

Payback

To calculate the simple payback from the water savings associated with the vehicle wash system retrofit, consider the equipment and installation cost of the retrofit water reclamation system, the water savings as calculated using Equation 2 above, and the facility-specific cost of water and wastewater.

Additional Resources

Brown, Chris. 2000. *Water Conservation in the Professional Car Wash Industry*. Prepared for the International Carwash Association (ICA).

Brown, Chris. September 2002. *Water Use in the Professional Car Wash Industry*. Prepared for the ICA.

Brown, Chris. 2018. *Water Use, Evaporation and Carry Out in Professional Car Washes*. Prepared for ICA. www.carwash.org/resources (see Environmental Resources)

East Bay Municipal Utility District (EBMUD). 2008. *WaterSmart Guidebook: A Water-Use Efficiency Plan Review Guide for New Businesses*. Pages WASH1-6. www.ebmud.com/water/conservation-and-rebates/commercial/watersmart-guidebook.

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