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Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Handbook: Water Evaluation Tools

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FEMP Federal Energy Management Program

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List of Acronyms

CCF	hundred cubic feet
CEWE	comprehensive energy and water evaluations
CoC	cycles of concentration
EISA	Energy Independence and Security Act of 2007
FEMP	Federal Energy Management Program
gpm	gallon per minute
kgal	thousand gallons
O&M	operation and maintenance
TDS	total dissolved solids

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1 Introduction

The Federal Energy Management Program (FEMP) developed the Water Evaluation Tools to assist Federal agencies in conducting comprehensive water evaluations and water use analysis. Three components comprise the online tool:

1. Handbook: Water Evaluation Tools – This document provides general instructions on performing a walk-through water survey to collect the required data for a comprehensive water evaluation and entering data into the online Water Balance Tool.

2. Walk-through data collection forms – Printable forms that provide a format to document the key information during the walk-through survey portion of the water evaluation. These are provided in a PDF format to be filled out during the walk-through and copies of the forms are located at the end of this handbook.

3. Water Balance Tool – This online tool provides an automated method for developing a water balance for a campus.[1] The tool provides an output with the estimated potable water consumption by each end-use and compares the sum of all end-uses to the total potable water supplied to the campus. Data collected during the walk-through survey are entered and stored in the tool. Entered data can be exported to an Excel file. See Section 4, Data Export and Water Balance Results, for more information on the tool's output.

This handbook provides information on the key data that need to be collected during a walk-through survey and explains how to enter the data into the online tool. The following list identifies data that need to be collected:

- General campus information
  - Water supply data
  - Utility information
  - Campus occupancy
- General building information
  - Building occupancy
  - Domestic hot water
- Plumbing fixtures (restrooms, locker rooms, and/or kitchenettes)
- Commercial kitchen
- Cooling towers
- Steam boilers
- Laundry (washing machines)
- Vehicle wash

[1] A campus is defined as a collection of two or more co-located buildings.

- Landscape irrigation
- Other processes such as laboratory and medical equipment

1.1 Statutory Authority for Water Evaluations

Comprehensive water evaluations are required per Section 432 of the Energy Independence and Security Act of 2007 (EISA). EISA directs that comprehensive energy and water evaluations be conducted yearly for approximately 25% of the covered facilities of an agency, with the goal of having all covered square footage evaluated over a four-year period. EISA also encourages agencies to implement identified water-saving measures within two years of the water evaluation.[2] A comprehensive water evaluation is a multi-step process that includes these major elements:

1. Data collection on water using end-uses via a walk-through survey
2. Data analysis using the collected data to estimate water consumption for each end-use, which is then used to formulate a water balance
3. Development of water-efficiency measures with the objective of reducing water use and increasing efficiency.

FEMP developed the Water Evaluation Tools to help federal agencies meet the first two steps in conducting a comprehensive water evaluation at their campuses.

1.2 Tool Background

The Water Evaluation Data Tool, developed in 2018, provides a method for collecting comprehensive water data during building and/or campus walk-through surveys. This FEMP tool focuses on the first step process and supports the completion of water evaluations as part of the comprehensive evaluation requirement.

In 2019, FEMP developed an online Water Balance Tool to compliment the Water Evaluation Tool. The Water Balance Tool provides an automated method for federal agencies to determine potable water consumption, by end-use, of their campuses. This tool focuses on the second step of the comprehensive evaluation process. A water balance compares the total water supply to the volume consumed by water-using equipment and applications; identifies the highest consuming end-uses, which helps to prioritize water-savings opportunities; and may identify operation and maintenance issues that need to be addressed.

These two tools were integrated into one in 2020 to help streamline the data collection and water balance development and support completion of the comprehensive water evaluation. This new tool focuses on potable water consumption for major water consuming equipment at the campus level.

FEMP's Water-Efficiency Best Management Practices[3] provide additional information on these end-uses.

2 Getting Started

The first step is to collect information on the major water-consuming equipment across the campus, called a walk-through survey. The Water Evaluation Tools provides a method and general instructions for collecting comprehensive water data during the survey. This handbook provides descriptions of data that need to be collected and photos of typical fixtures/data collection methods. The information collected during this step is then entered into the Water Balance Tool to develop the water balance.

[2] A copy of EISA 2007 can be found at https://www.sustainability.gov/policy.html
[3] FEMP's Water Efficiency Best Management Practices can be found at https://www.energy.gov/eere/femp/best-management-practices-water-efficiency

2.1 Walk-through Survey

The following section provides general guidance on what is needed before starting the walk-through survey.

2.1.1 General Tips

Consider the following steps in conducting a comprehensive walk-through water survey.

- Identify building(s) to be evaluated. For large campuses where all buildings cannot be surveyed, the buildings selected for evaluation should be representative of the campus' composition.
  - Choose buildings that are expected to have high water use, such as high-occupancy buildings and those with long operating hours and large water-using processes (e.g., cooling towers).
  - Ensure that the following building types are included in the buildings to be surveyed:[4]
    - Lodging, including barracks, dormitories, hotels, and family housing
    - Hospitals and medical/dental clinics
    - Other buildings including offices, maintenance facilities, retail, etc.
- Collect information on these buildings prior to the survey. Include data such as building square footage, use type, construction age, operational characteristics (e.g., occupancy, occupied hours, seasonal variability), and meter data for any end-uses that are sub-metered.
- Print out building floor plan(s) to help locate water-using equipment.
- Create an inventory of all water-using activities before starting the survey. Develop a comprehensive list of equipment types that are covered in the tool (see list above).
- Tap the expertise of others at the facility who have direct knowledge of building water equipment and end-uses to generate a complete inventory.
- Print data collection forms for all water end-uses found on the campus and make sure to bring enough copies during the survey.
- During the walk-through survey, interview occupants to understand any operational problems with the water-consuming equipment and gain insight on potential efficiency measures.
- Take multiple pictures (e.g., overview of room; close ups of equipment, equipment ratings, and nameplates).

2.1.2 Tools Needed for a Walk-Through Water Survey

The equipment listed below is useful in obtaining accurate water-use data during the walk-through portion of an evaluation:

- Infrared temperature sensor/gauge (see Figure 1) for measuring water temperatures
- Metered flow bag (see Figure 2), a plastic bag with graduated lines, for measuring the flow rate of faucets, showerheads, and other nozzles

[4] Within the Water Balance Tool, buildings are divided into three general categories based on different use patterns. Buildings from each of these categories should be included in the walk-through surveys. See Section 3.1.4, Data Collection for Campus Occupancy, for a more information on these building types.

- Watch with a second hand for timing flushes and filling flow bag
- Camera for taking photos of room layouts, water-using equipment and fixtures, and equipment nameplate data
- Clipboard and pen for holding data collection forms and taking notes
- Small towel for drying hands and flow bags.

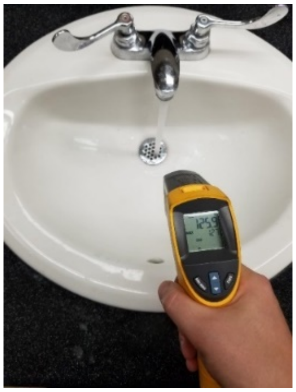

Figure 1. Infrared temperature sensor/gauge

Figure 2. Metered flow bag

2.2 Water Balance Tool

After the walk-through survey information is collected for the major water-consuming equipment across the campus, enter the information into the online Water Balance Tool. The tool is organized in distinct modules listed on the top banner of the tool. The following provides general tips on how to use the Water Balance Tool:

- Make sure to enter the water supply and water end-uses over the same timeframe.
- Carefully enter data in the correct units; units are noted in the far right-hand side of the screen. All water-related units are either gallons or thousand gallons (kgal) that produce the total water end-use estimate in kgal per year (kgal/yr).
- The tool does not automatically calculate water use so be sure to click “Calculate Water Use” after data have been entered or changed.
- Save your information often! At the bottom of each screen, click the save button to store data you have entered. The tool does not automatically save so be sure to save before moving to a new module or exiting the tool.
- The plumbing module can be rolled up to the campus level or done individually by building or location.

3 Data Collection Forms and Tool Entries

The following sections provide a guide for collecting general campus information, using the data collection forms to gather information on specific water end-uses, and entering the data into the online Water Balance Tool.

Data are gathered on the data collection forms for each water end-use by building. Grey cells on the forms indicate information that is not applicable or not needed for a particular fixture or piece of equipment. If only a portion of the equipment is evaluated across the campus, use data to extrapolate to other portions of a large building or to other buildings with the same type of equipment. For this reason, it is important to document when only a portion of a building is evaluated and whether information gathered in one building will be used to estimate water use in similar buildings.

The underlined terms found in Data Collection sections under each end-use indicate specific data entries that are filled out on each form. Note that some collected information will not be used in the tool but may be useful for locating equipment information or analyzing retrofit opportunities (equipment make/model, domestic hot water). The *Data Entry* sections found under each end-use will provide useful information and tips for entering data into the tool.

3.1 General Campus Information

This section discusses general campus information such as campus name, utility information, water supply data, and general campus occupancy. Campus name and water supply year are required to be entered first in the online tool before any other inputs may be completed.

3.1.1 Data Collection for Utility Information

This form collects data on the water utility and costs. This information typically is not collected during the walk-through survey and will likely be provided from the facility manager or gathered from utility bills. Collect the following information:

- Water utility provider
  - Marginal[5] water rate, including units – rate paid for each unit of water provided, being sure to include the units.
    - Determine the rate structure being applied. Utilities may charge residential customers different rates than commercial customers. Visit your utility website to check billing rates and schedules. Common rate structures include:
      - Block rate structures:
        - Inclining – rates increase as water use increases.
        - Declining – rates decrease as water use increases.
      - Flat rate – same cost-per unit is applied to all water use.
    - Determine the marginal per-unit cost of water which is the volumetric cost.
      - Do not include flat fees such as service fees, meter fees, taxes, and late charges, which stay the same no matter the volume used.
- Sewer utility provider
  - Marginal sewer rate, including units
  - Types of energy available – relevant to domestic hot water.
  - Marginal energy rate for each type of energy available, including units

[5] A marginal rate is the amount a consumer would pay (or save) for a single unit of a delivered utility and does not take into account base charges that are not impacted by a change in use. For water, sewer, and liquid fuels, the marginal rate is generally the unit cost, in dollars, of 1,000 gallons (1 kgal) or 100 cubic feet of the delivered or treated commodity. The marginal cost of electricity is dollars per kilowatt-hour.

Currently, this information is not entered into the tool but is used to help estimate water and associated energy costs when evaluating a building for water-efficiency improvements.

3.1.2 Data Collection for Water Supply Data

There is no form for water supply data, which are usually not collected during the walk-through survey. Collect monthly/annual potable water utility bills or water treatment plant/well production data if the water is produced on campus. Make sure to get data for the most current year that has been completed. This information will likely be collected prior to the survey and be provided by the facility manager.

3.1.3 Data Entry for Water Supply Data

Enter water supply data into the general campus module of the tool. This module collects the total water supply data for the campus and establishes a baseline water use that is compared to the sum of the water end-uses in the water balance results.

Annual (calendar year) potable water supply data are entered into the tool. Monthly potable water use for the same time period may be entered as well, if available. These monthly data are plotted to identify any seasonal patterns, such as an increase in water use during summer months for irrigation or cooling applications.

The units used in the tool for annual water supply data are kgal. Be aware that water utility bill data may be in other units such as gallons, million gallons, or hundred cubic feet (CCF). Please make sure to convert to kgal (see Table 1).

Table 1. Kgal conversions

Unit	kgal
1 CCF	0.748
1 gallon	0.001
1 million gallons	1,000

If wastewater is metered and monthly data are available, enter the monthly wastewater discharge for the same time period as the water supply into the tool. This input is not required to develop the water balance. If there is not a meter on the wastewater discharge, the campus may be charged for the same amount of wastewater discharge as potable water use.

Monthly wastewater discharge provides useful insight, as outlined in the scenarios below:

- If some potable water is not being discharged into the wastewater system, such as irrigation or cooling tower uses, a campus could be overcharged for wastewater.
- In the case where monthly potable water supplied to a site is greater than the wastewater discharge during that month, and the difference cannot be accounted for in irrigation or cooling tower uses, the difference may indicate a leak in the distribution system or other system losses. A meter on this system may help reduce wastewater charges.
- If there is a wastewater meter and more water is exiting the system, it could indicate that a campus is being charged for stormwater entering the system. Stormwater management may help reduce these charges.

Save data entered before leaving this module or the tool.

3.1.4 Data Collection for Campus Occupancy

This data form collects information on occupants, which is necessary to determine water used in plumbing fixtures. Occupancy information is important because population drives water use for plumbing fixtures. The data form collects information on the type of occupants (e.g., residents versus daytime staff) and split of male and female. The percentage of male and female occupants is important because restroom water use differs between genders when urinals are present.

There are five different occupancy groups for which information needs to be collected during the walk-through survey. If an occupancy group does not exist on the campus just ignore any questions regarding that group.

- On-site lodging – Obtain information on total occupancy availability and percent occupied from campus housing offices and/or hotels. This group accounts for individuals who live on the campus in either temporary or permanent lodging, including barracks, dormitories, hotels, and family housing.
- Hospital or clinic staff – Obtain information on staff counts and length of shifts from the hospital/clinic administrative offices. This group accounts for on-site staff members who work in a medical facility, including hospitals and medical or dental clinics.
- Hospital or clinic outpatients – Obtain information on average number of daily clinic visits from the clinic administrative offices. This group accounts for individuals who visit a hospital or clinic that do not require an overnight stay.
- Hospital inpatients – Obtain information on the total number of available hospital beds and average percent occupied from the hospital administrative offices. This group accounts for individuals who require an overnight stay in the hospital.
- Overall campus population – This group accounts for the entire population of the campus. This number should not include hospital or clinic occupancies. On-site lodging occupants are not excluded from this population, since most occupants are assumed to be away from the lodging during the day.

Collect the following information on the applicable occupancy groups that reside at the campus in the collection forms:

- Estimated monthly population in all on-site lodging
- Typical number of days per year hospital/clinics open
- Approximate number of daily staff in all hospitals/clinics
- Overall percentage of hospital/clinic staff that are administrative
- Percentage of all hospital/clinic staff that is male
- Typical length of a hospital/clinic staff shift
- Typical number of hospital/clinic outpatient visits in a day
- Typical length of an outpatient visit
- Typical number of hospital inpatient beds occupied in a day
- Typical daily campus staff population for weekdays, excluding hospital/clinics
- Typical daily campus staff population for weekends, excluding hospital/clinics
- Percentage of overall campus population that is male – Typically estimated based on observations of the water evaluator or provided by the facility/building manager. Subtract percent male occupants from 100% to get percent female occupants.

Use the comments section for any general campus observations or information learned in discussions with facility managers that help to finetune the data entered into the Water Balance Tool.

3.1.5 Data Entry for Campus Occupancy

Enter the information collected during the walk-through survey in the occupancy module of the Water Balance Tool applicable to the occupancy groups that reside at the campus.

Save data entered before leaving this module or the tool.

3.2 General Building Information

In this section, general information on the buildings being evaluated is captured. Note that the online tool allows inputs for multiple buildings when evaluating a campus or installation. General information on the building is important because it provides the basic information to identify the operational patterns and equipment type that can be helpful when extrapolating data across similar building types. For large campuses where all the buildings cannot be evaluated, the buildings being evaluated should be representative of the campus' composition. **Note:** At least one building must be entered for each building type identified as being present on site (on-site lodging, hospital/clinic, other building type).

3.2.1 Data Collection for General Building Information

Collect the following general information on the building. **Note:** This information will need to be entered before information on building-level occupancy or plumbing fixtures is entered; however, all the other modules may be completed in any order.

- Building number/name
- Primary building type – Hotel/motel, barracks/dormitory, family housing, hospital, medical clinic, or other building types. Building type provides important information such as the typical amount of time an occupant spends in the building and typical equipment.
- Building occupants stationary or transient – This information applies only to the "other building types" category. Stationary occupants tend to stay in the building for most, if not all, of the workday. Transient occupants are only in the building for a short period of time like people working out at a gym or shopping at a store. This occupancy pattern is used to estimate the water used in plumbing fixtures for that building.
- Square footage of building – This information is collected from properties prior to the survey but should be verified during the walk-through. Building square footage can be used to extrapolate water survey results over similar buildings.
- Date of construction – Similar to square footage, the construction date is typically not collected during the walk-through but from real property data prior to the survey. The build date provides useful information on the equipment in the building. For example, buildings constructed before 1997 may have higher water consumption toilets and urinals than those built after 1997 because U.S. standards for these fixtures changed after 1997.
- Year of last major water-related renovations
- Types of water renovations completed
- Building address, city, state, and zip code
- Evaluator name

- Date of survey

Use the comments section for general observations such as whether only a portion of the building was evaluated or a portion is a different type from the primary building type

3.2.2 Data Entry for General Building Information

Enter the general building information collected into the general building module of the tool. The building name/number is entered in this module and will be available in a dropdown menu in the occupancy and plumbing modules. The general building module is the only location where building names and numbers can be entered.

Repeat the data entry process until all buildings audited have been input. Enter data for a single building and save before exiting module or the tool.

3.2.3 Data Collection for Building Occupancy

This form collects the necessary information on occupancy used to determine water use of the building. Collect the following occupancy information for **weekdays** and **weekends**:

- Building name and number
- Typical number of building occupants
- Number of days per year building is occupied
- Typical number of occupied hours per day
- Percentage of male occupants (or count of males)

Note: The percentage of male building occupants is typically estimated based on the observations of the water evaluator or provided by the facility/building manager. Subtract percent male occupants from 100% to get percent female occupants.

Use the comments section for any general observations or information learned in discussion with building occupants.

3.2.4 Data Entry for Building Occupancy

Enter the information collected on each building's occupancy into the occupancy module of the tool. Select the corresponding building number from the dropdown list, which provides the building names and numbers that were entered into the general building module. Make sure to select the building name and number that matches the occupancy data being entered.

Repeat the data entry process until occupancy information for all buildings evaluated has been input into this module of the Water Balance Tool. Enter one building at a time and save after each building entry has been completed.

3.2.5 Data Collection for Domestic Hot Water

Documenting information on domestic hot water is important in determining energy use from hot water consumed in end-uses such as faucets and showers, and the potential energy savings that could result from decreased hot water use.

Collect the following information:

- Hot water fuel source – Natural gas, electricity, distillate oil, residual oil, liquid propane gas, steam, other, or none.

- Make and model of water heating equipment – Generally found on the equipment nameplate (see Figure 3). Take a photo of the nameplate.
- Hot water heating efficiency – If not listed on the nameplate, this information can most likely be obtained online by searching the make and model information.
- Hot water heater tank capacity – Find the tank capacity on the nameplate or on the manufacture's website using the make and model information.
- Hot water temperature – Measure with an infrared temperature sensor (Figure 4) at an end-use point such as a faucet or at the hot water outlet of the tank. If a temperature measurement is taken at the tank outlet, make sure to take a reading on bare metal, not insulated piping.

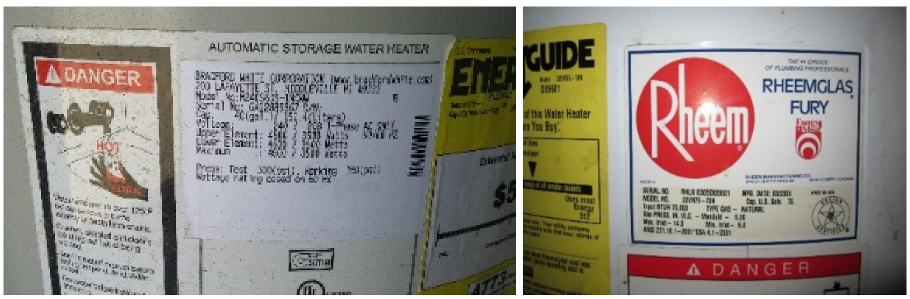

Figure 3. Hot water tank nameplates with make and model

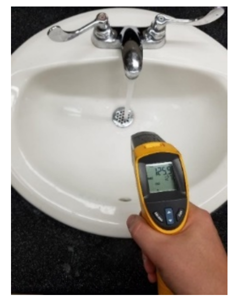

Figure 4. Measuring water temperature

Use the comments section to make note of any general observations, including the presence of tank and piping insulation.

This information is currently not entered into the online tool but can be used to estimate energy savings associated with reduced hot water use when evaluating a building for water-efficiency improvements.

3.3 Plumbing Fixtures

Plumbing fixtures are commonly present in restrooms, locker rooms, and kitchenettes. Fixtures include toilets, urinals, faucets, and showerheads. The following information describes the data collected for plumbing fixtures, how these data are entered into the plumbing fixture module of the Water Balance Tool, and general information and tips for gathering the information.

For large buildings with multiple restrooms, evaluating at least 10% of a building's plumbing fixtures is recommended. Ensure that the restrooms evaluated in the building are a representative sample of the plumbing fixtures. For example, if wings of the building were built at different times, make sure to survey a selection of restrooms from all wings.

3.3.1 Data Collection for Plumbing Fixtures

Collect the following general information for spaces containing plumbing fixtures. This information will help identify the location of spaces after the survey.

- Plumbing area type – Restroom, locker room, kitchenette
- Restroom/locker room type – Male, female, unisex

3.3.1.1 Toilets and Urinals

There are two primary types of toilets, tank and flush valve. There are also two types of urinals, flush valve and non-water. The following information provides a brief overview of these fixtures that assist in completing the data collection form.

***Tank toilets* –** Tank toilets (see Figure 5) operate in one of two ways: gravity or pressure assisted. Gravity tank toilets send water via gravity from the tank into the bowl by releasing a flapper valve between the tank and the bowl. Pressure-assisted tank toilets (see Figure 6) contain a vessel inside the tank filled with pressurized air. When the toilet is flushed, the pressurized air pushes the water into the bowl at a high velocity to create the flush.

Figure 5. Tank toilet

Figure 6. Pressure-assisted tank toilet

***Flush valve toilets and urinals* –** Flush valve toilets and urinals send pressurized water directly from the supply line through a valve and into the bowl to create the flush. There are also two types of flush valves. Diaphragm flush valves (see Figure 7) have a rubber gasket, or diaphragm, that separates the upper and lower chambers in the valve housing. When the toilet is flushed, the diaphragm gasket flexes, moving water through the valve and into the bowl. In a piston flush valve (see Figure 8), the valve houses a piston that separates the upper and lower chambers in the valve housing. This valve housing has a smaller diameter than the diaphragm valve. When the toilet is flushed, the piston lifts, allowing water to flow from the inlet pipe under the piston and into the bowl.

Figure 7. Diaphragm flush valve

Figure 8. Piston flush valve

Non-water urinals – Non-water urinals (see Figure 9) have no flushing mechanism and use no water to flush waste down the drain line. The fixtures use a cartridge containing liquid that prevents odors from permeating the restroom. When using the building-by-building method to determine an average flush rate, including non-water urinals for determining average flush rate in a building is at the user's discretion, considering the presence of non-water urinals in both assessed facilities and the overall campus.

Collect the following information for toilets and urinals. Currently, only a portion of this information is entered into the plumbing fixture module of the online tool. However, this information, is used when evaluating savings potential for potential plumbing retrofits so it is a best practice to collect it during the walk-through survey.

Figure 9. Non-water urinal

- Count of fixtures
- Primary fixture type – Toilet only
  - Tank (gravity or pressure assisted)
  - Flush valve
- Fixture type
  - Flush valve toilet/urinal (diaphragm or piston (see description above)
- Fixture mounting
  - Toilet – Note whether the toilet bowl is wall mounted (Figure 10), floor mounted (Figure 11), or floor mounted with rear discharge. Floor-mounted with rear discharge is bolted to the floor *and* the wall, with the discharge outlet facing toward the wall. The type of fixture mounting is important because future replacement fixtures should discharge to the same locations as existing fixtures.
  - Urinal – Note whether the urinal is floor-mounted (Figure 12) or wall mounted (Figure 13).

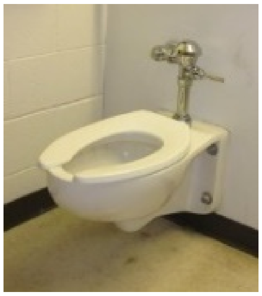

Figure 10. Wall-mounted toilet

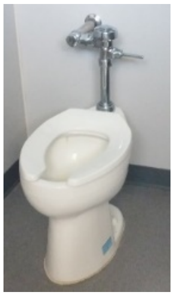

Figure 11. Floor-mounted toilet

Figure 12. Floor-mounted urinal

Figure 13. Wall-mounted urinal

- Operation type
  - Toilet – Manual (Figure 14), dual flush (Figure 15), sensor (note that sensor only applies to flush valve toilets)
  - Urinal – Manual or sensor

Figure 14. Manual flush valve

Figure 15. Dual flush system

- Urinal discharge tube diameter – The discharge tube is the pipe (¾″ or 1¼″ diameter) that connects the flush valve to the fixture. A thin pipe denotes a ¾″ diameter tube (as shown in Figure 13).

- Rated flush rate
  - Tank – Generally given in gallons per flush stamped either on the china near the bowl or inside the tank itself.
  - Flush valve toilet or urinal – Typically found stamped either on the china near the bowl or on the flush mechanism just under the lever.
- Measured average flush time for flush valve toilet and urinal.
  - The actual flush rate of a flush valve toilet and urinal is estimated by counting the number of seconds from the time the lever is actuated until the valve closes.
  - The flush rate is the time to complete a flush calculated using the following equation:

$$\text{Flush volume (gallons per flush)} = [\text{Time to flush (sec)} - 1]/2$$

Note: For tank toilets, it is not necessary to collect flush times as they flush a set volume of water. The actual flush rate can only be determined by measuring the volume of water in the tank, which is difficult to do during a walk-through survey. Therefore, the rated flush rate marked on the toilet is used to estimate water consumption for tank toilets. ***However, lift the tank top and note whether the water is over the marked level inside, leaking over the overflow tube, or continously running.***

Use the comments section to make notes of any general observations. Include long flush times for flush valve toilets and urinals, which may indicate an eroding or incorrectly sized gasket inside the flush valve. Also document if tank toilets run longer than expected, which may indicate the tank flapper is not sealing properly.

3.3.1.2 Faucets

Most buildings have public faucets and/or private faucets. Public faucets are intended to be used in high-traffic public areas and are generally found in restrooms. Public faucets should not have a flow rate in excess of 0.5 gallons per minute (gpm).[6] Private faucets are intended to be used in lower traffic areas, primarily breakrooms or kitchenettes, and are required to have a flow rate no greater than 2.2 gpm.[7] High-efficiency private faucets are not to exceed 1.5 gpm.[8]

Collect the following information for faucets in the data collection form. Currently, only a portion of this information is entered into the plumbing module of the online tool but can be used when evaluating savings for potential plumbing retrofits.

- Total count of faucets in the use area
- Primary fixture type (with aerator or without aerator) – Note any non-threaded faucet encountered in the comments. The vast majority of faucets either have an aerator attached or have threads to which an aerator can be attached, which controls the flow of water coming out of the fixture. In rare instances, faucets may have no aerator and no threads. Typically, these are old faucets that require whole-fixture replacement.
- Fixture operation – Manual, sensor, or metered.

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[6] Standard based on American Society of Mechanical Engineers A112.18.1/Canadian Standards Association B125.1 Plumbing Supply Fittings
[7] Federal standards 10 CFR 430.32(o)
[8] EPA WaterSense Specification: https://www.epa.gov/watersense/bathroom-faucets

  - Manual faucets may have either two handles, one each for hot and cold water, or a single handle that mixes hot and cold water before it exits the faucet.
  - Sensor faucets operate by sensing when an object is in front of the faucet and opening a valve to allow water to flow.
  - Metered faucets, also called self-closing faucets, are activated by the user. Once activated a pre-set amount of water is dispensed and then the valve automatically closes.
- <u>Rated flow rate</u> – This value is stamped on the faucet (see Figure 16) where water exits into the basin and is generally provided in gpm.
- <u>Measured average flow rate</u> – Measure the faucet flow rate by using the metered flow bag (see Figure 17) by turning the faucet on to the maximum flow and capturing the flow for 5 seconds (using a stopwatch). Then hold the bag top with two hands and read the gpm according to the graduated lines on the metered flow bag. Note that if there are hot and cold handles, both should be open.

Figure 16. Faucet flow rating

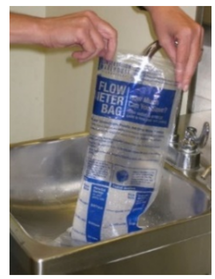

Figure 17. Metered flow bag

3.3.1.3 Showerheads

There are four general categories of showerheads: threaded fixed (Figure 18), handheld (Figure 19), wall mounted (Figure 20), and gang-type (Figure 21).

- Threaded showerheads are the most common type. These heads can be removed or replaced by simply unscrewing the existing showerhead and attaching a new one.
- Wall-mounted showerheads are mounted either directly to the wall or are included in a box that also contains the water controls. These showerheads cannot be unscrewed from the pipe coming from the wall; instead the whole fixture must be replaced where it attaches to the plumbing distribution system. These types of showerheads are typically more expensive to retrofit than threaded style showerheads but are less common.
- Gang showers consist of multiple showerheads on a single stand or "tree." Note the number of heads on the tree and the rated flow rate of the individual heads.

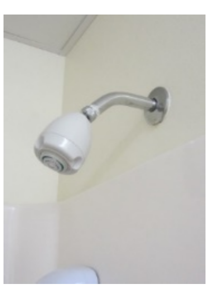

Figure 18. Threaded fixed showerhead

Figure 19. Threaded handheld showerhead

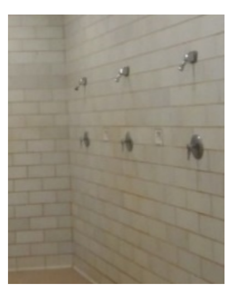

Figure 20. Wall-mounted showerhead

Figure 21. Gang shower

Collect the following information for showerheads. Currently, only a portion of this information is entered into the online tool but can be used when evaluating savings for potential plumbing retrofits.

- <u>Count of showerheads in the use area</u>
- <u>Primary fixture type</u> – Threaded fixed, threaded handheld, wall mounted, or gang.
- <u>Rated flow rate</u> – Typically provided in gpm and often marked in the center or around the outside of the showerhead.
- <u>Measured average flow rate</u> – Using the same technique as faucets, measure showerhead flow rate using a metered flow bag by turning the showerhead on to maximum flow and capturing the flow for 5 seconds. Hold the top of the bag with two hands and read the gpm. Note that if there are separate hot and cold handles, open both. When encountering a gang shower, measure the flow rate of 50% of the attached heads and make a note of how many heads are present on the tree.
- <u>Percentage of building occupants that use showers on weekdays and weekends</u> – In order to estimate water used by showering, it is critical to determine how frequently the showers are used. Interview the building manager and/or occupants to get a sense for how often occupants shower. In cases where there is uncertainty, request a best estimate. While not ideal, it is possible that no estimate will be provided. In these instances, consider the shower state. The presence of janitorial equipment in the shower stall, for example, likely means it is not used at all, whereas the presence of bathing items (soap, shampoo, etc.) means the shower is likely used with some regularity.

When performing restroom, locker room, and/or kitchenette surveys, use the comments section to make notes of any general observations and any problems such as leaks or broken equipment.

3.3.2 Data Entry for Plumbing Fixtures

There are two options for entering plumbing fixture data into the plumbing module of the tool: 1) campus-wide or 2) building by building. First, use the slide bars in the plumbing module to indicate which option is being used. The following information provides tips on which is the most appropriate option. However, for both approaches enter the estimated total population for each building category on the campus. (See Section 3.1.4 for information on the building types—on-site lodging, hospitals/clinics, and general campus buildings.)

3.3.2.1 Data Entry with Campus-Level Plumbing Information

This option uses typical fixture data and occupancy at the campus level (entered in the occupancy module) to estimate water used in plumbing fixtures across the campus. This is most applicable when the walk-through surveys do not cover a representative sample of restrooms across the campus. Use the slider bars to indicate if on-site lodging and hospitals or clinics are present on the campus. The typical fixture rates are entered into the tool separately for each building type, and the flush and flow rates should be representative of all the buildings in that group. Determine typical rates by observation during walk-through surveys or by using documented equipment information when available. When entering fixture information for the overall campus, make separate entries for each building type present on the campus.

Calculate water use once all the data have been entered for one of the building types and save progress before leaving the module or tool.

3.3.2.2 Data Entry with Building-Level Plumbing Information

This option is most applicable when the walk-through surveys evaluate a variety of building types that include a good representation of the plumbing fixtures and buildings types on the campus. When the building-by-building method is selected for plumbing data entry, select buildings one at a time from a dropdown menu created from the general building inputs tab. Enter fixture information only for the building selected. If the building has fixtures with differing flow and/or flush rates, the user can decide if it is best to use an average based on the fixtures evaluated or specific information for the fixture most common to the building.

In order to estimate the water use for buildings on campus that were not individually evaluated, the Water Balance Tool uses flow and flush rates determined from population-weighted averages based on buildings within each category that were audited. The population-weighted flow and flush rate values are then applied to the occupancy that is not accounted for in the audited buildings.

Repeat the data entry process until plumbing information for all evaluated buildings has been input into the plumbing module. Users are encouraged to calculate water use once all the data have been entered for a single facility and save progress before leaving the module or tool.

3.4 Commercial Kitchen

Commercial kitchens are typically found in dining facilities, hospitals, or administrative buildings and contain a variety of water-using equipment. This module collects data on commercial kitchens, either as standalone facilities or integrated into a larger building such as a hospital.

3.4.1 Data Collection for Commercial Kitchen

Use this form to collect information on the average number of meals served per day along with equipment that is used to estimate water use in the Water Balance Tool. The form also provides a way to document important information on kitchen equipment that can inform efficiency ideas such as operation and maintenance improvements and retrofit/replacement options, which can be used later in the evaluation process.

Collect the following general information for each commercial kitchen.

- Unique name identifier – The tool allows for multiple commercial kitchens to be entered; therefore, a unique name must be identified for each facility (such as building name/number).
- Average number of daily meals prepared during weekday (M-F) – Collect these data from purchase records or by interviewing the kitchen manager and/or staff.
- Number of weekdays per week meals prepared
- Number of weeks (M-F) commercial kitchen is operating per year
- Average number of meals prepared per weekend day
- Number of weekend days per week meals prepared
- Number of weekends the commercial kitchen is operating per year

For commercial dishwashers, collect the following information (if there is more than one type of dishwasher, enter the predominant type):

- Count of number of dishwashers
- Dishwasher type
  - Batch dishwasher (see Figure 22) runs a single load of dishes at a time. A dishrack is loaded into the dishwasher, its hood is lowered, and the washing cycle begins.
  - Continuous dishwashers use a moving track that circulates while the machine is running. Conveyor-type dishwashers (see Figure 23) move racks loaded with dishes through the machine.

Flight-type dishwashers (see Figure 24) have pegs on the conveyor belt that allow dishes to be loaded directly onto the conveyor and does not require dishracks.

Figure 22. Batch dishwasher

Figure 23. Conveyor-type dishwasher

Figure 24. Flight-type dishwasher

- Note whether equipment is ENERGY STAR rated – Yes or no.
- Rated flow rate – Collect for continuous dishwashers only, document the model number from the equipment nameplate during the walk-through and download the associated specification sheet from the manufacturer's website to determine this flow rate.
- Batch water use – Collect for batch dishwashers only, document the model number from the equipment nameplate during the walk-through and download the associated specifications sheet from the manufacturer's website to determine the water use per batch.
- Make and model of equipment – Collect this information and download the associated specification sheet from the manufacturer's website for any data not readily available in the field.
- Hours operated per day/loads per day – Document the hours operated for continuous machines or number of loads per day for batch machines.

Pre-rinse spray valves (see Figure 25) are the fixtures used to remove food residue from dishes before they are loaded into a dishwasher. Collect the following information:

Figure 25. Pre-rinse spray valve

- Count of pre-rinse spray valves
- Equipment type – Note whether equipment is WaterSense labeled or not.
- Rated flow rate – Typically provided in gpm and often marked in the center or around the outside edge of the pre-rinse spray valve.
- Measured average flow rate – Determine using a metered flow bag by squeezing the pre-rinse spray valve handle to achieve the maximum flow and capturing the flow for 5 seconds. Hold the top of the bag with two hands and read the gpm.
- Hours operated per day – Ask staff the estimated time the pre-rinse spray valve is actually operating.

For hand wash faucets collect the following information:

- Count of faucets in the commercial kitchen
- Equipment type – Manual, sensor, or metered (See Section 3.3.1.2 for more information).
- Rated flow rate – Generally stamped on the faucet where water exits into the basin.

- Measured average flow rate – Determine using a metered flow bag by turning the faucet on to the maximum flow and capturing the flow for 5 seconds. Hold the top of the bag with two hands and read the gpm. Note that if there are separate hot and cold handles, both should be open.

Prep sink faucets (Figure 26) and/or pots/pans washing sink faucets are used to fill pots and defrost frozen food and are not typically used for hand washing. Collect count information on prep sink faucets.

Figure 26. Prep sink faucets

- Count of prep and/or pots/pans sink faucets in the commercial kitchen.

Food steamers are used in commercial kitchens to cook foods. Cooking is done either with steam, circulating hot air, or a combination of steam and hot air. Collect the following information on food steamers:

- Count of food steamers
- Equipment type
  - Boiler-based food steamers are connected to a central boiler that runs hot water through the equipment continuously while it is running. In addition, a supply of cold water is needed at the drain to temper water before it enters the sewer system. Boiler-based systems can be identified by the presence of an incoming water line in addition to an outlet to the drain.
  - Connectionless food steamers are self-contained, with an internal water reservoir and heat source to create the steam needed for cooking. Connectionless equipment is generally drained at the end of the day and refilled the next day. Connectionless systems can be identified by the presence of a pan under the unit that serves as the water reservoir. Note, connectionless food steamers are much more water and energy efficient than boiler-based steamers.
- Equipment is ENERGY STAR rated – Yes or no.
- Rated flow rate (for boiler-based food steamers) – Determine by looking up the model number on the manufacturer's website.
- Batch water use (for connectionless food steamers) – Determine by looking up the model number on the manufacturer's website.
- Make and model of each food steamer
- Hours operated per day
- Loads cooked per day

For ice machines, collect the following information (if there is more than one type of ice machine, enter the predominant type):

- Count of ice machines
- Equipment type
  - Water-cooled ice machines typically run water through the system to reject heat and then discharge the water to the drain, known as a "single-pass" or "once-through" system. A water-cooled system

is typically noted with "W" in the model number. In addition, typically a water-cooled machine has a discharge water line that can be seen underneath the unit.

  – Air-cooled ice machines use a typical refrigerant cycle to discharge heat from the unit and are much more water efficient. Note, all ENERGY STAR ice machines are air cooled. An air-cooled ice machine is often denoted by an A in the model number and can also be identified by looking for refrigerant information on the nameplate (see Figure 27).

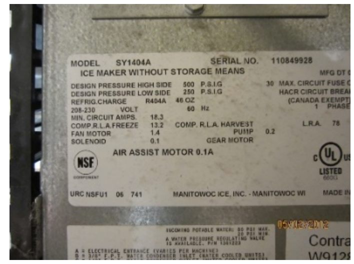

Figure 27. Air-cooled ice machine

- Equipment is ENERGY STAR rated – Yes or no.
- Makes and model numbers of ice machines
- Hours operated per day – For ice machines that are integrated into a beverage dispenser, record the estimated hours the machine is actively in use.
- Loads per day – Record when ice is moved from the ice machine to be used elsewhere.

When performing a commercial kitchen survey, use the comments section to make notes of any general observations and also note any problems such as leaks or broken equipment, or operational observations such as pre-rinse spray valves running continually.

3.4.2 Data Entry for Commercial Kitchen

On the Commercial Kitchen module within the Water Balance Tool, check the box "My campus has commercial kitchen facilities?" Enter each commercial kitchen separately.

First select if the commercial kitchen is a standalone facility or is incorporated into another building. For both options, enter a unique identifier for the commercial kitchen, such as a building name or number. If the commercial kitchen is a standalone facility, the Water Balance Tool will ask if the water use is metered. When metered data are used, ensure the data entered are for the same year as the water supply data. For standalone commercial kitchens that are not metered, and for those incorporated into another building, input information collected during the walk-through survey. Using the information collected during the walk-through survey, the Water Balance Tool uses an indexing method to estimate the water use per meal served as high, medium, or low. Not all changes to equipment information will have an impact on the water use determined by the tool.

Calculate water use once all data have been entered for a single facility and save progress before leaving the module or tool.

3.5 Cooling Towers

Cooling towers (see Figure 28) dissipate heat to the ambient air from recirculating water used to cool chillers, air conditioners, and other process equipment.[9] The following information describes the data to be collected during a cooling tower walk-through survey. Some of the information can be gathered by looking at the key components of the system, including the cooling tower(s), chillers and heat exchangers, and piping configuration and pumps. However, most of the information listed below will need to be

Figure 28. Example of a cooling tower

[9] For more information on cooling towers, go to FEMP's Cooling Tower Best Management Practices: https://www.energy.gov/eere/femp/best-management-practice-10-cooling-tower-management.

gathered from control systems connected to the cooling system and/or from interviews with the facility operations and maintenance staff.

3.5.1 Data Collection for Cooling Towers

If the campus has cooling towers that are metered, document the location and information on who is responsible for the meter so the data can be requested at a later time. Annual makeup water use must be entered in the tool in kgal. (**Note:** Record the same year as the water supply data.) For cooling towers that are not metered, collect the information needed to estimate water use.

- Unique name identifier – The tool allows for multiple cooling towers to be entered; therefore, a unique name must be identified for each facility (such as building name/number associated with the facility).
- Process the cooling tower is used for – Identify the process the cooling tower serves, such as comfort cooling (heating, ventilation, and air conditioning [HVAC]), process load, or other.
- Total tonnage rating of chillers associated with the cooling system – Obtain the system tonnage from the nameplate on the chiller system or from the manufacturer's specifications.
- Typical operating cycles of concentration of the system – Ask the operator whether the system operates under a set number of cycles of concentration (CoCs). CoC is the ratio of the concentration of dissolved solids in the blowdown water compared to the makeup water, which is approximately equal to the ratio of volume of makeup to blowdown water. CoC is an important parameter in understanding how efficiently the system runs.[10]
- Cooling season start date and end date – Ask the system operator when the cooling season starts and ends for the system.
- Typical number of hours system operates per day – Record the number of hours the system typically runs per day during the operating season. It is important to gather information on the operating time because it is used to determine what percentage of a full year (8,760 hours) the system operates, a key to estimating cooling tower water consumption. Operational information can be gathered from operating logs or connected controls systems. If logs are not available, an estimate of the percent full-load cooling hours can be determined as described in Section 3.5.2.
- Typical percent of capacity used during the cooling season – Estimate the percent of total capacity that the system utilizes, on average, throughout the cooling season.

When performing a cooling tower survey, use the comments section to make note of any general observations as well as any problems such as broken or poorly maintained equipment.

3.5.2 Data Entry for Cooling Towers

On the Cooling Towers module within the Water Balance Tool, check the box "My campus has cooling towers?" Enter a unique identifier for the first cooling system being entered. If the system is metered, enter the annual makeup water volume. If the system is not metered, input the data collected for the cooling tower system.

If CoC is unknown it can be estimated by using information on the water quality being delivered to the system. Table 2 and Table 3 show the relationships between CoC and total dissolved solids (TDS) in parts per million (ppm) or conductivity in micromhos per centimeter, respectively.

[10] Find information on COCs and estimating methods in the FEMP Cooling Tower Factsheet: https://www.energy.gov/sites/prod/files/2013/10/f3/waterfs_coolingtowers.pdf.

Table 2. Determining CoC from water quality – TDS

TDS (ppm)	CoC
200	8.4
300	5.6
400	4.2
500	3.4
600	2.8
700	2.4
800	2.1

Table 3. Determining CoC from water quality – conductivity

Conductivity (micromhos/cm)	CoC
350	9.6
500	6.7
650	5.2
800	4.2
950	3.5
1100	3.0
1250	2.7
1400	2.4
1550	2.2

The Water Balance Tool uses operational information (days and hours in operation and utilized capacity) to determine the percent full-load cooling hours of the system. This is a calculation of the total hours in operation divided by the total number of hours in a full year (8,760). If operational information was collected during the walk-through survey, the user will answer “yes” to the question “Are operational parameters (days and hours in operation) known?” and input the cooling season start date, cooling season end date, average hours operated per day, and the estimated percent of total capacity utilized during the cooling season from the evaluation form. If operational information was not available, make an estimate of the full-load cooling hours based on the climate zone where the cooling system is located and the type of building utilizing the cooling.

Figure 29 shows the ASHRAE climate zones and Table 4 provides the percent load cooling hours for hospitals and all other buildings based on information in ASHRAE. To determine the percent of full-load cooling hours to be entered into the tool, identify the climate zone the campus is located in from Figure 29. Table 4 can then be used to select the percent full-load cooling hours based on the type of building the cooling tower is serving.

Repeat the data entry process until all cooling tower systems have been input into the Water Balance Tool. Calculate water use once all data have been entered for a single facility and save progress before leaving the module or tool.

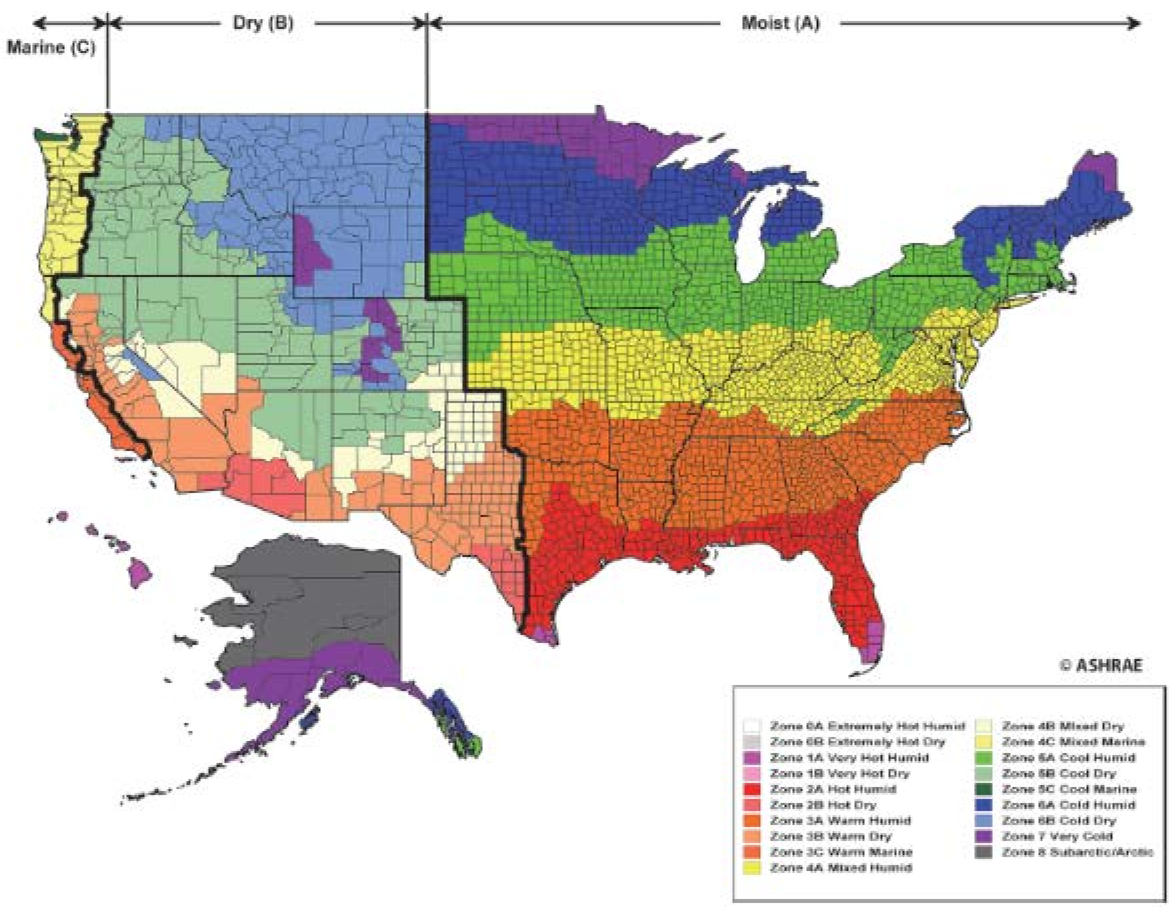

Figure 29. ASHRAE climate zones

Table 4. Percent load cooling hours

Climate Zone	Hospitals	Other Buildings
1A	46%	26%
2A	35%	20%
2B	30%	17%
3A	27%	14%
3B	31%	14%
3C	37%	17%
4A	22%	11%
4C	26%	9%
5A	17%	8%
5B	20%	9%
6A	12%	5%
6B	10%	4%
8B	5%	2%

For more information on cooling towers:

- FEMP Best Management Practice: https://www.energy.gov/eere/femp/best-management-practice-10-cooling-tower-management
- FEMP Cooling Tower Factsheet: https://www.energy.gov/sites/prod/files/2013/10/f3/waterfs_coolingtowers.pdf

3.6 Steam Boilers

Steam boilers (see Figure 30) are commonly used in large heating systems, institutional kitchens, or facilities where large amounts of process steam are used and are commonly found in building mechanical rooms. This equipment consumes varying amounts of water depending on system size and the amount of condensate returned. Steam boiler systems often include a softener system, placed upstream of the boiler. The purpose of the softener is to remove hardness from the boiler feedwater, generally via ion exchange using resin beads. The softener system is preprogrammed to regenerate after providing a specific volume of water. Regeneration is a process that cleans the resin beads by flushing out collected solids and drawing in fresh brine (saturated saltwater) to recharge the resin beads.

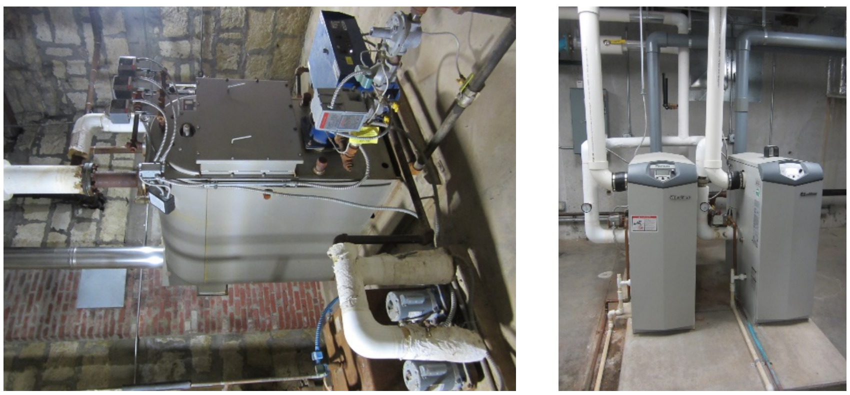

Figure 30. Steam boilers

There are two general methods for estimating water use in steam boilers, which impacts the type of data collected in the data collection form. First, choose the method to estimate water use:

1. Performance of a softener system – This method is used if the steam boiler system includes a water softener
2. Steam generation rate – This method is used when there is no water softener included in the system.

3.6.1 Data Collection for Steam Boilers

If the campus has steam boilers that are metered, document the location and information on who is responsible for the meter so the data can be requested at a later time. Annual makeup water use must be entered in the tool in kgal. (**Note:** Record the same year as the water supply data.) For steam boilers that are not metered, collect the information in the data collection form, which is needed to estimate water use based on the type of system. For both methods of estimation, operational parameters such as operating hours per week and number of weeks in operation can typically be obtained from the facility manager.

Collect the following information for steam boilers using the softener method:

- <u>Unique name identifier</u> – Record a unique name for each system (such as building name/number associated with the system).

- Amount of water used between regenerations – Determine this information from manufacturer's literature, by contacting the manufacturer directly, or by asking the facility manager.
- Number of times the system regenerates weekly – Determine this information from maintenance logs, other recorded information, or from the facility manager.
- Number of weeks per year the system operates – Determine this information from maintenance logs, other recorded information, or from the facility manager.

Collect the following information for steam boilers using the steam generation rate method:

- Unique name identifier – Record a unique name for each system (such as building name/number associated with the system).
- Steam generation rate – Determine the amount of steam generated by the system, measured in pounds per hour (also monitored as the flow rate). Typically this value is logged and tracked to verify the system is supplying the necessary amount of steam and can be obtained from maintenance logs or the facility manager.
- Percent of condensate returned – This is the percentage of the overall steam generation rate, which is likely tracked either by facility staff or as part of a building control system. For institutional facilities, a typical condensate return rate is 80%. If there is a condensate return system in place, but you do not know the return rate, use a default of value of 80%.
- Typical operating cycles of concentration – CoCs are generally set as part of the system maintenance and can be supplied by the facility manager. CoC refers to the ratio of TDS of the discharge water being purged from the steam boiler to the fresh supply water feeding the system.[11] If CoC is not known, it can be estimated using water quality. Refer to Table 2 and Table 3 in Section 3.5.
- Typical number of hours the system operates per week
- Typical number of weeks per year the system operates

When performing a steam boiler survey, use the comments section to make note of any general observations as well as any problems such as broken or poorly maintained equipment.

3.6.2 Data Entry for Steam Boilers

On the Steam Boilers module within the Water Balance Tool, check the box "My campus has steam boilers?" Enter a unique identifier for the first steam boiler system being entered. If the system is metered, enter the annual makeup water volume. If the system is not metered, answer the question "Does the system have a softener or water conditioning system?" If the answer is yes, input the data collected for the softener method. Enter data collected for the steam generation rate method if the answer is no.

Repeat the data entry process until all steam boiler systems have been input. Calculate water use once all data have been entered for a single steam boiler system and save progress before leaving the module or tool.

3.7 Laundry

Laundry facilities are commonly found in barracks, hotels, medical facilities, and residential buildings, or can be standalone facilities. Data can be obtained during a visual inspection of the equipment during the walk-

[11] A single COC refers to the TDS of water in a system (assuming fresh supply water). As steam evaporates from a steam system, it leaves any dissolved solids behind. If the system water is completely evaporated and replaced with new freshwater, the supply water will bring its own COC of TDS and accumulate the residual TDS from the evaporated water, thus reaching two COCs.

through survey and gathered from the building occupants, laundry operators, or staff members that manage the buildings. Data collection sheets and data entries in the tool account for two types of washing machines:

- Single-/multi-load machines
  - Single-load machines (see Figure 31) are residential-style washing machines that wash approximately 12 to 20 pounds of laundry per load.
  - Multi-load machines are larger capacity and wash up to 80 pounds of laundry per load. Although multi-load washers are considered industrial, because they are rated based on tub capacity and water factor, inputs are included with single-load machines.
- Industrial washers
  - Washer extractors (see Figure 32) are machines that use centrifugal force to remove water and detergent from the clothes. These washers can have capacities ranging from 30 to 800 pounds of laundry per load.
  - Tunnel washers are continuous-batch washers where the laundry moves through a series of compartments. These types of washers are used in very large, institutional operations (e.g., hospitals, prisons). Tunnel washer capacities are around 2,000 pounds of laundry per hour.

Figure 31. Single-load washing machines

Figure 32. Industrial washers

3.7.1 Data Collection for Laundry

The following is the information to collect during the walk-through survey for entry into the Water Balance Tool.

3.7.1.1 Single-load and Multi-load Washer

When multiple machines are present in a single location, a portion of the machines may be surveyed and the data averaged, or all machines may be surveyed. For these types of machines, collect the following information:

- <u>Unique name identifier</u> – Record a unique name for each system (such as building name/number associated with the system).
- <u>Estimated number of people that use the washing machines each weekday</u> – Interview facility manager for typical facility occupancy during weekdays.
- <u>Estimated number of people that use the washing machines each weekend</u> – Interview facility manager for typical facility occupancy during weekends.
- <u>Estimated loads of laundry per person, per week, weekday</u> – Interview facility manager or occupants to estimate the typical number of loads per week.

- Estimated loads of laundry per person, per week, weekend – Interview facility manager or occupants to estimate the typical number of loads per weekend.
- Weeks per year machines are operated

Single-load machines are divided into two categories: ENERGY STAR and non-ENERGY STAR. ENERGY STAR machines are identified with a label on the machine. Collect the following information on ENERGY STAR and non-ENERGY STAR machines:

- Count of washing machines in each category
- Are non-ENERGY STAR washing machines predominately top loading or front loading
- Make and model number of machines – Locate this information on a sticker either at the top edge on the back of the washer, inside the door on front loaders (Figure 33), or at the top of the wash bin on top loaders (Figure 34).

Figure 33. Front-loading washing machine

Figure 34. Top-loading washer

- Capacity of machines – Determine the volume of the machine, measured in cubic feet, from the nameplate or the manufacturer's website using the model number.
- Water factor of machines – Determine by looking up the model number on the manufacturer's website. Water factor is the gallons per cycle per volumetric capacity of the machine, measured in gallons/cycle/cubic foot. Front- and top-loading machines with capacities greater than 1.6 cubic feet and less than 8.0 cubic feet are eligible to earn ENERGY STAR[12] certification. The maximum federal standard water factor for front-loading machines is 5.5 gallons/cycle/cubic feet and 8.5 gallons/cycle/cubic feet for top-loading machines. Washing machines are required to have a lower water factor to be eligible for the ENERGY STAR label, as shown in Table 5.

Table 5. Energy Star washing machine integrated water factors

Washer Type	ENERGY STAR Criteria (March 2015 through February 2018)	ENERGY STAR Criteria (as of February 2, 2018)
Residential front-loading (>2.5 cubic feet)	≤3.7 gallons/cycle/cubic foot	≤3.2 gallons/cycle/cubic foot
Residential top- loading (>2.5 cubic feet)	≤4.3 gallons/cycle/cubic foot	≤4.3 gallons/cycle/cubic foot
Residential (≤2.5 cubic feet)	≤4.2 gallons/cycle/cubic foot	≤4.2 gallons/cycle/cubic foot
Commercial front loading	≤4.5 gallons/cycle/cubic foot	≤4.0 gallons/cycle/cubic foot

[12] ENERGY STAR criteria change periodically. Information for machines manufactured prior to 2015 is available in the archived versions of the Energy Star Clothes Washers Program Requirements at https://www.energystar.gov/products/appliances/clothes_washers/partners

When performing a laundry room survey use the comments section to make notes of any general observations and also note any issues such as leaks or broken equipment.

3.7.1.2 Industrial Washer

Industrial washers, such as washer extractors and tunnel washers, are often found in facilities with large washing needs (e.g., hospitals, hotels, prisons).

Collect the following information on industrial washer laundry use:

- Unique name identifier – Record a unique name for each system (such as building name/number associated with the system).
- Estimated weight of laundry washed per week (lbs.) – Interview the facility manager to estimate the typical weight of laundry washed per week.
- Weeks per year machines operate – Interview the facility manager to get this information.
- Count of washing machines
- Make and model number of machines – Find this information on a sticker located on the machine.
- Estimated water use per pound of laundry (gal) – Look up the model number on the manufacturer's website. If the information is not available the following can help estimate values.
    - Typical water extractors use 3 to 4 gallons of water per pound of laundry, but if water recycling capabilities exist, water use may be less than 2.5 gallons per pound. Older models may use more water (e.g., 3.5 gallons/lb.), where newer models tend to use less (e.g., 2.0 to 2.5 gallons/lb.).
    - Tunnel washers use approximately 2 gallons of water per pound of laundry.[13] The water use per pound accounts for water that is recycled, as recycling is a design element in tunnel washers.
- Percentage of water recycled/reused – Record the average percent of water recycled/reused by the washer. Some washers may reclaim water during the cycles and reuse it during the next use. This reduces the amount of overall freshwater use of the system. Ask the staff who may know how much the system recycles or look on the equipment (e.g., nameplate) during the walk-through survey. Information on the equipment may be used to obtain the specification of the unit on the manufacturer's website.

When performing a laundry room survey use the comments section to make notes of any general observations and also note any issues such as leaks or broken equipment.

3.7.2 Data Entry for Laundry

On the Laundry (Washing Machines) module within the Water Balance Tool, check the box "My campus has laundry facilities?" Next, identify the type of washing machines, single-/multi-load or industrial. Enter a unique identifier for the facility, such as a building name or number. Input information collected during the walk-through survey for each laundry system separately. For a location with multiple washing machines, users may find it easier to average the collected data for ENERGY STAR and non-ENERGY STAR machines.[14] Calculate water use once all data have been entered for a single facility and save progress before leaving the module or tool.

[13] Gallon per pound of laundry from the Alliance for Water Efficiency.
[14] Entering information for each individual machine would require that an estimate of the loads washed in that particular machine were known.

3.8 Vehicle Wash

These data are collected for four types of vehicle wash systems and vehicles that are washed. These wash systems may be standalone facilities or associated with other buildings such as gas stations or vehicle maintenance facilities. The following information provides a summary of each wash system type and data that are collected during the evaluation and then entered into the tool. The data may be obtained by interviewing the system operators or on the equipment (e.g., nameplates) during the walk-through survey.

3.8.1 Data Collection for Vehicle Wash

The following is the information to collect during the walk-through survey for entry into the Water Balance Tool.

3.8.1.1 Individual In-bay Automated Vehicle Wash

Individual in-bay automated washing equipment (see Figure 35) moves around a stationary vehicle. These systems can come with and without water recycling capability. If the campus has in-bay systems that are metered, document the location and who is responsible for the meter so the data can be requested at a later time. Annual water use must be entered in the tool in kgal. (**Note:** Record the same year as the water supply data.)

Figure 35. In-bay automated vehicle wash

Collect the following information for individual in-bay automated vehicle wash systems that are not metered:

- <u>Unique name identifier</u> – The tool allows for multiple vehicle wash systems to be entered; therefore, a unique name must be recorded for each system (such as building name/number associated with the system).

- <u>Average number of vehicles washed per week</u> – Ask the staff responsible for the system.

- <u>Total number of weeks per year vehicles are washed</u> – Ask the staff responsible for the system.

- <u>Estimated water use per vehicle (gpv)</u> – Ask the staff how much water the system uses per vehicle or look on the equipment (e.g., nameplates) during the walk-through survey. Equipment nameplate information may be used to obtain the specification of the unit on the manufacturer's website. In-bay systems typically use approximately 45 gallons per vehicle (gpv)[15] (ranges from 30 to 60 gallons). If the gpv is not known for this system, 45 gpv is a good default value to use in the tool.

- <u>Percentage of water recycled/reused</u> – Record the average percent of water recycled/reused by the system. Some wash systems may reclaim water during the wash cycle and reuse it during the next use. This reduces the amount of overall freshwater use of the system. Ask the staff how much the system recycles or look on the equipment (e.g., nameplates) during the walk-through survey. Information on the equipment may be used to obtain specifications on the manufacturer's website.

3.8.1.2 Conveyor-type Friction Washing or Frictionless Washing Vehicle Wash

Conveyor-type wash systems move the vehicle along a path, washing it as it moves through the system. There are two types of conveyor systems: friction and frictionless. Friction washing is when washing equipment touches the vehicle and frictionless is when only water and cleaning liquids touch the vehicle. If the campus has friction/frictionless systems that are metered, record the annual water use in kgal. (**Note:** Record the same year as the water supply data.)

[15] Brown, Chris 2017. *Water Use in the Professional Car Wash Industry*.

Collect the following information for conveyor-type wash systems that are not metered:

- Unique name identifier – The tool allows for multiple vehicle wash systems to be entered; therefore, a unique name must be recorded for each system (such as building name/number associated with the system).
- Average number of vehicles washed per week – Ask the staff responsible for the system.
- Total number of weeks per year vehicles are washed – Ask the staff responsible for the system.
- Estimated water use per vehicle (gpv) – Ask the staff how much water the system uses per vehicle or look on the equipment (e.g., nameplates) during the walk-through survey. Information on the equipment may be used to obtain specifications on the manufacturer's website. Friction and frictionless systems typically use approximately 66 gpv and approximately 85 gpv,[16] respectively. These values may be used as default if the information is unknown.
- Percentage of water recycled/reused – Record the average percent of water recycled/reused by the system. Some wash systems may reclaim water during the wash cycle and reuse it during the next use. This reduces the amount of overall freshwater use of the system. Ask the staff how much the system recycles or look on the equipment (e.g., nameplates) during the walk-through survey. Information on the equipment may be used to obtain specifications on the manufacturer's website.

3.8.1.3 Self-service Wash Pad: Open Hose or Pressure Washer

Self-service wash pads are areas where vehicles are washed, either using a handheld open hose or pressure washer (see Figure 36 and Figure 37). An open-hose system may be similar to a garden hose with or without a nozzle. A pressure washer is a system in which the water enters under low pressure and is sprayed out of a nozzle at a higher pressure. Information not obtained from a visual inspection of the equipment will need to be gathered from the vehicle wash operator or facility manager.

Figure 36. Pressure washer and nozzle (wand)

Figure 37. Pressure washer rating and manufacture's information

Collect the following information for open-hose and/or pressure-washer vehicle wash systems:

- Unique name identifier – The tool allows for multiple vehicle wash systems to be entered; therefore, a unique name must be recorded for each system (such as building name/number associated with the system).
- Average number of vehicles washed per week – Note the type of vehicles washed such as large trucks or tracked vehicles. The type of vehicle can help when estimating the amount of wash time, which is needed to estimate water use.
- Total number of weeks per year vehicles are washed

[16] Brown, Chris 2002. *Water Use in the Professional Car Wash Industry*. Prepared for International Carwash Association.

- Approximate wash time per vehicle (minutes) – Ask the staff for a general estimate of the wash time per vehicle, which is typically 20–30 minutes. Cars and wheeled vehicles generally take less time to wash than tracked vehicles.

- Flow rate of hose (gpm) (open hose only) – Measure the flow rate using the metered flow bag by turning the hose on to the maximum flow and capturing the flow for 5 seconds. After this, hold the bag top with two hands and read the gpm (see Section 2.1.2 for how to use a flow bag). If the flow rate is high enough to overflow the bag in 5 seconds, the linked online calculator computes the flow rate based on hose diameter, pressure, and hose length: http://irrigation.wsu.edu/Content/Calculators/Residential/Garden-Hose-Flow.php

- Nozzle manufacturer (pressure washer only) – Record information found on the nozzle.

- Nozzle rating (pressure washer only) – Record the nozzle rating (gpm) on handle of wand; it is not recommended to measure with a flow bag as the water is under high pressure,

- Manufacturer and model number (pressure washer only) – Find on a label on the pressure washer. If the nozzle rating is not provided, use the pressure washer information on the equipment to obtain specifications on the manufacturer's website. This should provide the rated flow rate.

3.8.1.4 Large Vehicle Wash Facilities

Large vehicle wash facilities can be common at campuses with tactical operations such as military installations (commonly referred to as a central vehicle wash facility as shown in Figure 38). These systems are used where it is not feasible to use the previously described washing systems such as for semi-trucks, tracked vehicles, or aircraft. These vehicles may have additional cleaning requirements and require treatment of the wastewater. If the campus has large wash systems that are metered, record the annual water use in kgal. (**Note:** Use the same year as the water supply data.)

Collect the following information for large vehicle wash systems that are not metered:

- Unique name identifier – The tool allows for multiple vehicle wash systems to be entered; therefore, a unique name must be recorded for each system (such as building name/number associated with the system).

- Average number of vehicles washed per week – Ask the staff responsible for the system.

- Total number of weeks per year vehicles are washed – Ask the staff responsible for the system.

- Estimated water use per vehicle (gpv) – Ask the staff how much the water system uses per vehicle or look on the equipment (e.g., nameplates) during the walk-through survey. Information on the equipment may be used to obtain specifications on the manufacturer's website.

- Percentage of water recycled/reused – Record the average percent of water recycled/reused by the system. Some wash systems may reclaim water during the wash cycle and reuse it during the next use. This reduces the amount of overall freshwater use of the system. Ask the staff how much water the system recycles or look on the equipment (e.g., nameplates) during the walk-through survey. Information on the equipment may be used to obtain specifications on the manufacturer's website.

Figure 38. Central vehicle wash facility

When performing a vehicle wash survey, use the comments section to make notes of any general observations and any problems with such as leaks, broken equipment, and missing nozzles.

3.8.2 Data Entry for Vehicle Wash

On the Vehicle Wash module within the Water Balance Tool, check the box "My campus has vehicle wash facilities?" Enter each vehicle wash into the tool separately. Next, enter a unique identifier for the vehicle wash, such as a building name or number. For in-bay automated, conveyor, and facilities for large vehicles, identify if the water use is metered. If metered data are used, ensure that the data entered are for the same year as the water supply data. Finally, enter the information recorded during the facility walk-through into the tool.

Calculate water use once all data have been entered for a single facility and save progress before leaving the module or tool.

3.9 Landscape Irrigation

Landscape irrigation can be found throughout campus grounds such as around buildings, golf courses, ball fields, and parks. Landscape irrigation can potentially be a high-water-use activity, depending on factors such as how much irrigated landscape exists, condition of the system, and irrigation management (e.g., amount and timing of the water applied).

Use the data collection forms to gather data on irrigated areas such as building landscape, ball fields, parks, and golf courses. Information not obtained from a visual inspection of the equipment and irrigated grounds will need to be gathered from the grounds or building manager and the staff that irrigates and manages the grounds.

3.9.1 Data Collection for Landscape Irrigation

Collect the following information during the walk-through survey for entry into the Water Balance Tool. The tool allows for multiple landscape areas so break large areas into multiple sub-areas based on landscape type. Note that some of the information collected will not be used in the Water Balance Tool but may be useful for locating equipment information or analyzing retrofit opportunities.

- Landscape irrigation area description – Describe the area, including general information on locations and types of plant. Some areas will not be associated with a building, and this description will help identify the irrigated landscape area.

- Water use metered – If the campus has landscape irrigation areas that are metered, document the location and who is responsible for the meter so the data can be requested at a later time. Annual water use must be entered in the tool in kgal. (**Note:** Record the same year as the water supply data.)

For irrigation areas that are not metered, collect the following information needed to estimate water use.

- Landscape area type – Select the landscape type that best describes the area (e.g., landscape around a building, athletic field, golf course, parade field, park, family housing).

- Water supply type – Identify the type of water that supplies the irrigation system. This can typically be provided by the ground's manager. Knowing the water source of the irrigation is important in the water balance analysis and can help identify potential alternative sources of water.

  – Potable – Water from freshwater sources that is safe to drink, such as surface water or groundwater.

  – Non-potable – Water from freshwater sources that is not safe to drink, such as surface water or groundwater.

- Alternative – Water that is not from freshwater sources, such as rainwater harvesting, graywater, condensate capture.

Irrigation start and end months will provide the growing season of the landscape and identify how long irrigation water is applied.

- Month irrigation start – Identify the month when landscape irrigation is typically started.
- Month irrigation end – Identify the month when landscape irrigation is typically shut down for the season.

Turfgrass or mixed beds – Identify the general type of landscaping (areas can be broken into multiple sub-areas depending on landscape type):

- Turfgrass – Landscape areas consisting of grass such as ballfields and parks (see Figure 39).
- Mixed beds – Landscape areas consisting of a variety of plantings such as shrubs, trees, and turf (see Figure 40). If a mixed bed has more than 50% turf, fill out separate survey forms for the turf area and mixed bed area.

Figure 39. Turfgrass landscape

Figure 40. Mixed bed landscape

Mixed beds – Record the following information on the data collection form:

- General level of supplemental irrigation needed by the mixed bed area – Select irrigation needs based on the predominant type of plants in the mixed bed.
  - Low – Plants are native or well adapted/drought tolerant to the specific area and do not require much water over the growing season to stay healthy.
  - Moderate – Plants that require some additional water to stay healthy over the growing season and are not native or adaptive to the area.
  - High – Plants that need ample supplemental water to stay healthy.
- Mixed bed plant density – Identify the density level of plantings that best matches the following types (if the area has more than one type, choose the predominant type).
  - Low – Sparsely planted landscape (see Figure 41).
  - Moderate – Full coverage, but predominantly one vegetation type (see Figure 42).
  - High – Mix of plant types that are compactly planted covering the whole landscape (see Figure 43).

Figure 41. Low-density mixed bed

Figure 42. Medium-density mixed bed

Figure 43. High-density mixed bed

- Mixed bed level of protection/exposure (microclimate) – Identify how exposed the plants are to heat, wind, and sunlight using three categories (if the area has more than one, choose the predominant type).
  - Protected – Area shaded from sunlight and protected from wind and heat gain.
  - Open – Area in an open, flat field.
  - Intense exposure – Area exposed to high heat and/or windy conditions.

Turfgrass – Identify the following information on the data collection form:

- Type of turfgrass – See Table 6 for examples of turfgrass season types. [17]

Table 6. Examples of turfgrass season type

Turfgrass Type	Season Type
Annual bluegrass	Cool
Annual ryegrass	Cool
Colonial bentgrass	Cool
Creeping bentgrass	Cool
Hard fescue	Cool
Highland bentgrass	Cool
Kentucky bluegrass	Cool
Meadow fescue	Cool
Perennial ryegrass	Cool
Red fescue	Cool
Rough-stalked	Cool
Tall fescue	Cool
Bermuda grass	Warm
Buffalo grass	Warm
Kikuyu grass	Warm
Seashore paspalum	Warm
St. Augustine grass	Warm
Zoysia grass	Warm

[17] Sources: California Department of Water Resources. 2000. A Guide to Estimating Irrigation Water Needs of Landscape Planting in California – The Landscape Coefficient Method and WUCOLS III. https://water.ca.gov/LegacyFiles/wateruseefficiency/docs/wucols00.pdf; University of Florida, Irrigation Research, Southwest Florida Water Management District. 2009. *Turfgrass Crop Coefficients Website, Institute of Food and Agricultural Sciences Extension*. https://abe.ufl.edu/faculty/mdukes/

- Cool-season grass – Thrives in cooler climates, generally requires more water than warm-season grass to thrive, and has dark green, thin blades that are densely packed (see Figure 44).
- Warm-season grass – Better suited for hot summers, generally more drought tolerant, and has lighter green, thick blades that are less densely packed (see Figure 45).

Figure 44. Cool-season grass

Figure 45. Warm-season grass

For both mixed beds and turfgrass, collect the following information on the data collection form:

- General appearance/condition of the landscape – Determine the best match of the landscape's appearance to the following descriptions (if the walk-through survey is not during the growing season, obtain this information from the grounds or building manager).
  - Stressed – Landscape appearance is not a priority and may be under-watered at times during the growing season.
  - Average – Landscape is kept green but not lush throughout the growing season.
  - High quality – Landscape is kept green and lush during the entire growing season.
- Soil type – Record landscape area general soil type. Ask the grounds manager or search online for the soil type of the general region.
  - Sandy – Soil will not form a ball.
  - Loam – Rich soil that is a combination of sand and clay; soil will form a well-shaped ball that will break apart easily.
  - Clay – Soil will form a well-shaped ball that does not break apart easily.
- Landscape area size – Estimate the square footage of landscape area. This information may not be obtained during the walk-through, but can be estimated using online mapping tools (e.g., Google maps), provided the landscape boundaries are understood.

Irrigation equipment information and operation and maintenance – Collect the following data on the irrigation equipment to determine how well the system is maintained and how efficiently it irrigates the landscape. Additional information is provided below on how this information can be used in subsequent steps of a water evaluation.

- Irrigation equipment type – Identify the type of sprinkler head. There are three main types that can be identified either visually while the sprinklers are running or by asking the staff.
  - Rotor – Delivers water in a rotating stream (Figure 46). Typical for large irrigated areas.
  - Spray – Delivers water in fan shaped pattern (Figure 47). Typical for small landscape beds.

- Micro-spray and drip – Small emitters that deliver water at lower pressures directly to the root zone of the plant (Figure 48). Typical for small landscape beds.
- Manual – Water delivered with hoses, nozzles, and/or aboveground sprinklers (Figure 49).


Figure 46. Rotor-type sprinkler head


Figure 47. Spray-type sprinkler


Figure 48. Micro-spray/drip irrigation


Figure 49. Manual watering equipment

- Irrigation controls
  - Manual – The irrigation system is manually controlled, with the grounds manager determining the irrigation schedule.
  - Clock – The irrigation system is controlled via a clock or timer.
  - Smart water application technologies – The irrigation system is controlled automatically based on weather and soil conditions that precisely schedule watering based on actual needs of the plants.

Note any observations on irrigation efficiency and system operation.[18]

- Puddles observed in and around the landscape area – Note if there are many, few, or no puddles in and around the landscape, which may be caused by overwatering or uneven watering by the irrigation system.
- Runoff observed in and around the landscape area – Note runoff in and around the landscape area during or directly after irrigation.
- Sprinkler head leaks observed – Note if there are many, few, or no leaks from the irrigation equipment. These may be observed as water seeping from sprinkler heads.
- Broken equipment observed – Note any broken landscape equipment including missing sprinkler heads that cause a geyser (spraying large amounts of water not commensurate with the other heads) or malfunctioning valves that do not shut off the zone so the irrigation system continues to run.
- Impervious surfaces being watered – Note surfaces such as sidewalks and roadways being watered by irrigation system.

When conducting an irrigation survey, use the comments section to make notes of general observations. Also note grounds maintenance practices such as how often systems are checked for leaks and operational issues.

3.9.2 Data Entry for Landscape Irrigation

On the Landscape Irrigation module within the Water Balance Tool, check the box "My campus has landscape irrigation?" Enter each landscape irrigation area into the tool separately. Calculate water use once all data have been entered for a single area and save progress before leaving the module or tool.

[18] These observations are best determined by observing the irrigation system in operation. Request the irrigation system be turned on by the grounds maintenance staff during the walk-through survey.

Enter a unique identifier for the landscape irrigation area, such as a building name or number the landscape is associated with. Areas can be broken into multiple sub-areas if both turfgrass and mixed beds are present and it may help to include “turf” or “beds” in the identifier. However, if the landscape area is dominated by one type, just enter information for the dominant landscape type.

Information collected on the irrigation equipment and operation and maintenance, such as leaking sprinkler heads or watering impervious surfaces, is used by the Water Balance Tool to estimate a system’s efficiency. System efficiency is an expression of what portion of the irrigation water consumed is actually used by the turfgrass and plants. Efficiency is based on the type of irrigation equipment installed as well as the maintenance and scheduling of the system. A perfect system, operating at 100% efficiency, would have no leaks, losses, or waste. But no system is 100% efficient; for example, water is lost though runoff, leaks, and evaporation. Efficiency can also be affected by poor maintenance, such as broken sprinkler heads or pipes, or caused by scheduling problems such as watering during windy periods. Based on the qualitative information collected during the walk-through survey and input into the tool, the efficiency of each landscape irrigation system is estimated.

Enter the zip code where the irrigated landscape is located. The zip code is used to access evapotranspiration data for that area. Together with the data collected during the walk-through survey, this provides the necessary information to estimate irrigation using the evapotranspiration method.[19] This method calculates the amount of water needed to maintain a healthy landscaped area for a given location based on the amount of water transpired from the plants and evaporated from the soil, or evapotranspiration.[20]

Calculate water use once all data have been entered for a single facility and save progress before leaving the module or tool.

3.10 Other Processes

The Other Processes category allows users to account for individual water processes that are not included in the other categories. Examples include laboratory and medical equipment such as disinfection/sterilizing equipment, vacuum systems, glassware washing equipment (see Figure 50), and vivarium equipment. Additional miscellaneous water-using equipment includes water purification systems (see Figure 51), water softening equipment, and small evaporative cooling equipment (“swamp coolers”). These types of equipment may be found in a variety of facilities but are especially common in laboratories, clinics, and hospitals. Annual water use for these processes should be determined individually but will appear in the Water Balance Tool results combined as “other processes.” Find information on water used by this equipment on nameplates or from manufacturer literature using the equipment make and model.

Figure 50. Glassware washing equipment

Figure 51. Water purification system

[19] For other methods to estimate irrigation use (irrigation audit method), see the [Irrigation Associations website](https://www.irrigation.org).

[20] For a more precise method to estimate irrigation use (irrigation audit method), see the Irrigation Associations website at https://www.irrigation.org/IA/Resources/Technical-Resources/Irrigation-Auditing/Audit-Guidelines/IA/Resources/Audit-Guidelines.aspx?hkey=d3af0807-efe0-4779-a31f-c6011b23c6d3

3.10.1 Data Collection for Other Processes

This form collects data for two types of processes:

Batch process – A specified volume of water is used each time a process is completed such as laboratory glassware washing. For batch processes, collect the following information.

If the system is metered, document the location and who is responsible for the meter so that data can be requested at a later time. Annual makeup water use must be entered in the tool in kgal. (**Note:** Record the same year as the water supply data.)

If the system is not metered, collect:

- Unique name identifier – Record a unique name for each system (such as building name/number associated with the system).
- Typical number of batches per week – Obtain by interviewing staff responsible for the equipment.
- Number of weeks per year the system operates – Obtain by interviewing staff responsible for the equipment.
- Water use per batch (gallons) – Located on the equipment nameplate or from the manufacturer's website using the model information.
- Percentage of water recycled in the system – Obtain from facility staff or manufacturer's information (look up the model number on the manufacturer's website).

Continuous process – Water continually flows through the equipment such as steam sterilizers. For continuous process equipment, collect the following information.

If the system is metered, document the location and who is responsible for the meter so that data can be requested at a later time. Annual makeup water use must be entered in the tool in kgal. (**Note:** Record the same year as the water supply data.)

If the system is not metered, collect:

- Unique name identifier – Record a unique name for each system (such as building name/number associated with the system).
- Typical number of hours per week the process operates – Obtain by interviewing staff responsible for the equipment.
- Number of weeks per year the system operates – Obtain by interviewing staff responsible for the equipment
- Typical water flow rate – Located on the equipment nameplate or from the manufacturer's website using the model information.
- Percentage of water recycled in the system – Obtained from facility staff or manufacturer's information (look up the model number on the manufacturer's website).

3.10.2 Data Entry for Other Processes

On the Other Processes module within the Water Balance Tool, check the box "My campus has other water-consuming processes that are not already covered?" Select the type of process that data will be entered for (batch or continuous). Enter a unique identifier for each process, such as a process description. Enter the information collected during the walk-through survey or obtained from manufacturer's literature. The tool allows multiple entries for both batch and continuous processes so enter each process separately. Calculate water use once all data have been entered for a single process and save progress before leaving the module or tool.

4 Water Balance Results

After collecting and entering all the data for a campus, the tool generates a water balance.

The water balance results provide a bar graph and a pie chart that shows the total volume of water used annually for each end-use. In addition, the bar chart shows the amount of “unknown” water use. This value is the difference between the total water supplied to the campus and the sum of the end-uses. This discrepancy is due, in part, to the assumptions the user makes in rolling up values in the tool. For example, the tool requests a single entry for faucet flow rate in a building, but if the user encountered a wide range of faucet flow rates during the walk-through, a typical or average value that best represents overall faucet flow rate must be entered according to the user’s discretion. If there is a high degree of variability across multiple end-use categories, the expected margin of error for the estimated water use is likely to be much higher. Users should approach the water balance with an expectation for a margin of error. If the unknown component exceeds the expected margin of error, it could indicate accounting errors in water supply data, water leaks, etc.

If the unknown is greater than 20% of the total water supply, do the following:

- Revisit the inputs entered in the tool to make sure they are reasonable estimates of actual water use. Look for entries that make a big impact on the water use such as the number of occupants, number of loads, and number of meals.
- Check the water supply data to make sure the correct units were entered.

If after checking the end-use inputs and water supply data there is still a large unknown portion of water use, the campus may have a high leak rate in the distribution system. Performing a leak detection survey is a recommended next step. Go to FEMP's Best Management Practice on Distribution System Leak Detection and Repair to find information on getting started.

If the sum of the end-uses is greater than the total water supplied to the campus, the data entries need to be revisited.

- Look for entries that make a big impact on the water use such as the number of occupants, number of loads, and number of meals. Have any of these entries been overestimated? Start with the end-uses that are the biggest consumers.
- Check the units. Have you entered any data that may be in the wrong units?
- If the campus has a master meter that measures the total water supplied to the campus, has it been calibrated recently? The total water supply may be underestimated if the meter is out of calibration. Contact the water utility to see if they can provide you with a calibration report.
- Once the entries have been revised, rerun the tool and see if the water balance has improved.

5 Next Steps

Using the results from the Water Balance Tool, the next step in the comprehensive water evaluation process is to assess ways to increase efficiency and reduce water use through operation and maintenance improvements and retrofit and replacement of existing equipment. Use FEMP’s best management practices as a starting place for operations and maintenance improvements, as well as retrofit and replacement ideas. A retrofit/replacement analysis is performed to determine whether upgrading to higher efficiency fixtures or equipment is cost effective. Use data collected in the walk-through surveys, such as actual flow and flush rates, occupancy patterns, and utility rates, coupled with other available data including replacement fixture/equipment costs and labor rates to determine the water and cost savings of efficiency upgrades.

FEMP developed these resources on water efficiency and water management to assist in this step of the evaluation process:

- Streamlined operation and maintenance guidelines for common water-using equipment: https://www.energy.gov/eere/femp/technical-operations-and-maintenance-guidelines-common-water-equipment
- Water Project Screening Tool: https://www.energy.gov/eere/femp/water-efficiency-federal-buildings-and-campuses
- Water-efficiency best practices: https://www.energy.gov/eere/femp/best-management-practices-water-efficiency
- Technologies that offer opportunities for significant water savings potential: https://www.energy.gov/eere/femp/water-efficient-technology-opportunities

The Environmental Protection Agency's WaterSense program developed "WaterSense at Work" discusses a variety of water-efficiency best practices.

Resources for more information

FEMP has developed resources for developing a water balance:

- General methods for determining water use of unmetered major water-consuming equipment: https://www.energy.gov/eere/femp/estimating-methods-determining-end-use-water-consumption
- Information on developing a water balance: https://www.energy.gov/eere/femp/developing-water-management-plan

6 Walk-Through Data Collection Forms

The following pages contain the forms discussed throughout the instructions.

WATER EVALUATION DATA COLLECTION FORM

General Building Information		
		Comments
Building number and name		
Primary building type (circle the most appropriate building type)	Hotel/Motel Barracks/Dormitory Family Housing Hospital Medical Clinic Other Building Type	
Building occupants stationary or transient (only needed if "Other Building Type" selected above) (circle) (Stationary -e.g., office workers working a full work day; Transient - e.g., people working out at a gym, customers shopping at a store)	Stationary / Transient	
Square footage of building		
Date of construction (year)		
Year of last major water-related renovations		
List types of water-related renovations		
Building address		
City, State, Zip Code		
Evaluator name		
Date of survey		

Building Occupancy			
Building number and name			
	Weekday	**Weekend**	**Comments**
Typical number of building occupants			
Number of days per year building is occupied			
Typical number of occupied hours per day			
Percentage of occupants that are male			

Building Domestic Hot Water		
Building number and name		
		Comments
Hot water fuel source (circle)	Natural Gas / Electricity / Distillate Oil / Residual Oil / LPG (Propane) / Steam / Other / None	
Make and model of water heating equipment		
Hot water heating efficiency*		
Hot water heater tank capacity (gallons)*		
Hot water temperature (°F)		

***This may not be available during the onsite evaluation but may be obtained online using the water heater make and model.**

WATER EVALUATION DATA COLLECTION FORM

Campus-Wide Occupancy

		Comments
Estimated monthly population in all on-site lodging		
Typical number of days per year hospital/clinics open		
Approximate number of daily staff in all hospitals/clinics		
Overall percentage of hospital/clinic staff are administrative		
Percentage of all hospital/clinic staff are male		
Typical length of a hospital/clinic staff shift		
Typical number of hospital/clinic outpatient visits in a day		
Typical length of an outpatient visit		
Typical number of hospital inpatient beds occupied in a day		
Typical daily campus staff population for weekdays, excluding hospital/clinics		
Typical daily campus staff population for weekends, excluding hospital/clinics		
Percentage of overall campus population are male		

Utility Information		
		Comments
Water utility provider		
Marginal water rate,* including units		
Sewer utility provider		
Marginal Sewer rate,* including units		
Types of energy available - relevant to domestic hot water		
Marginal energy rate for each type available, including units		

***Utility rates may not be available during onsite evaluation. Site's point of contact may need to be contacted for this information.**

WATER EVALUATION DATA COLLECTION FORM

Plumbing Fixtures - Restrooms, Locker Rooms and/or Kitchenettes

Building number and name					
Location of plumbing fixtures:				**Restroom type:**	Male / Female / Unisex
	Toilets	**Urinals**	**Faucets***	**Showers**	**Comments**
Count of fixtures					
Primary fixture type (circle)	Tank (Gravity) / Tank (Pressure Assisted) / Flush Valve		With Aerator / Without Aerator	Threaded Fixed / Handheld Wall Mount/ Gang	
Flush valve only - Primary flush valve type (circle)	Diaphragm / Piston	Diaphragm / Piston / Non-water			
Flush valve only - Fixture mount type (circle)	Floor Mount / Wall Mount / Floor with Rear Discharge	Floor Mount / Wall Mount			
Operation type (circle)	Manual / Sensor/ Dual Flush	Manual / Sensor	Manual / Sensor / Metered		
Urinal only - Discharge tube diameter (check)		¾"____; 1¼"____			
Rated flush rate - gallons per flush (gpf)					
Rated flow rate - gallons per minute (gpm)					
Flush valve only - Average flush time (sec)					
Measured average flow rate (gpm)					
Percentage of occupants showering daily, weekdays					
Percentage of occupants showering daily, weekends					

***This includes faucets located in bathroom, locker room and/or kitchenettes.**

WATER EVALUATION DATA COLLECTION FORM

Commercial Kitchen

Building number and name

Unique name identifier for this commercial kitchen facility		
Is water use metered?	Yes* / No	

	Weekday	Weekend
Average numbers of meals prepared per day		
Number of days per week meals prepared		
Number of weeks commercial kitchen is operating per year		

	Dishwashing Machine	Pre-Rinse Spray Valve	Handwashing Faucets	Prep Sink Faucets or Pots/Pans Washing Sink Faucets	Food Steamer	Ice Machine	Comments
Count of fixtures or equipment							
Equipment Type (circle)	Continuous / Batch	Standard Flow / WaterSense Labeled	Manual / Sensor / Metered		Boiler-Based / Connectionless	Air-Cooled / Water-Cooled	
Equipment is ENERGY STAR (circle the appropriate answer)	Yes / No				Yes / No	Yes / No	
Rated flow rate - gallons per minute (gpm)							
Batch water use (gallons per cycle)							
Measured average flow rate - gallons per minute (gpm)							
Make of equipment							
Model number of equipment							
Hours operated per day							
Loads per day							

***Collect meter data for a full year**

WATER EVALUATION DATA COLLECTION FORM

Cooling Tower

Building number and name

Unique name identifier for this cooling tower		**Comments**
For what process is the cooling tower used? (Circle)	Comfort Cooling (HVAC) / Process Load / Other	
Is makeup water use metered? (circle)	Yes* / No	
Total tonnage of chillers associated with the cooling system		
Typical operating cycles of concentration of the system		
Cooling season start date		
Cooling season end date		
Typical number of hours system operates per day		
Typical percent of capacity utilized over the cooling season		
***Collect meter data for a full year**		

WATER EVALUATION DATA COLLECTION FORM

Steam Boilers			
Building number and name			
Unique name identifier for this steam boiler system			
Is the steam boiler water use metered?	Yes* / No		
	Softener or Water Conditioning System		**Comments**
	Yes	No	
Amount of water used between regenerations (gal)			
Number of times the system regenerates in 1 week			
Number of weeks per year the system is operating			
Steam generation rate (lb./hr.)			
Percentage of condensate that is returned			
Typical operating cycles of concentration of the system			
Typical number of hours the system operates per week			
Typical number of weeks per year the system is operating			
***Collect meter data for a full year**			

WATER EVALUATION DATA COLLECTION FORM

Laundry - Single/Multi-Load Washing Machines

Building number and name			
Unique name identifier for these machines			
Estimated number of people that use the washing machines each week			
Estimated loads of laundry per person per week, weekdays			
Estimated loads of laundry per person per week, weekends			
Weeks per year machines are operated			
	ENERGY STAR Machines	Non-ENERGY STAR Machines	Comments
Count of washing machines			
Top loading or front-loading machines			
Make of washing machines			
Model of washing machines			
Typical capacity of washing machines cubic feet*			
Water factor of washing machines gallons/cycle/cubic feet*			
*This may not be available during the onsite evaluation but may be obtained online using the washing machine make and model.			

WATER EVALUATION DATA COLLECTION FORM

Laundry - Industrial Washing Machines

Building number and name		
Unique name identifier for these machines		
Estimated weight of laundry washed per week (lbs)		**Comments**
Weeks per year machines are operated		
Count of washing machines		
Make of washing machines		
Model of washing machines		
Estimated water use per pound of laundry (gal)*		
Percentage of water recycled/reused*		
***This may not be available during the onsite evaluation but may be obtained online using the washing machine make and model.**		

WATER EVALUATION DATA COLLECTION FORM

Vehicle Wash - Open Hose/Pressure Washer

Building number and name			
Unique name identifier for vehicle wash			
	Open Hose	Pressure Washer	Comments
Average number of vehicles washed per week			
Total number of weeks per year vehicles are washed			
Approximate wash time per vehicle (minutes)			
Flow rate of open hose - measured average flow rate gallons per minute (gpm)			
Nozzle manufacturer			
Nozzle rating - (gpm)			
Manufacturer			
Model number			

WATER EVALUATION DATA COLLECTION FORM

Vehicle Wash

Building number and name					
Unique name identifier for this vehicle wash facility					
Is the water use metered?	Yes* / No	Yes* / No	Yes* / No	Yes* / No	
	Individual Automated In-Bay	**Friction Conveyor**	**Frictionless Conveyor**	**Large Vehicle**	**Comments**
Average number of vehicles washed per week					
Total number of weeks per year vehicles are washed					
Estimated water use per vehicle (gpv)					
Percentage of water recycled/reused (if any)					
***Collect meter data for a full year**					

WATER EVALUATION DATA COLLECTION FORM

Landscape Irrigation

Building number and name (if landscape is associated with a building)			
Landscape irrigation area description (unique name identifier such as where it is located)			
Is water use metered? (circle)	Yes* / No		
	Turfgrass	**Mixed Beds**	**Comments**
Landscape area type (circle)	Landscape Around Building / Athletic Field / Golf Course / Parade Field / Park / Family Housing / Other		
Water supply type (circle)	Potable / Non-potable / Alternative		
Month irrigation starts			
Month irrigation ends			
General level of supplemental irrigation needed by the mixed bed (circle)		Low / Moderate / High	
Density the mixed bed area planted (circle the appropriate answer)		Low / Moderate / High	
Level of protected/exposed of the mixed bed area (microclimate)? (circle)		Protected / Open / Intense Exposure	
Turf species (circle)	Cool Season / Warm Season		
General appearance/condition of the landscape (circle)	Stressed / Average / High Quality	Stressed / Average / High Quality	
Soil type (circle)	Sandy / Loam / Clay	Sandy / Loam / Clay	
Landscape area size in square feet			
Irrigation equipment type (circle)	Rotor /Spray / Micro-spray / Drip / Manual	Rotor /Spray / Micro-spray / Drip / Manual	
Type of irrigation controls (circle)	Manual /Clock / Smart Water Application Technologies	Manual /Clock / Smart Water Application Technologies	
Puddles observed in and around the landscape area (circle)	Many/Few/None	Many/Few/None	
Runoff observed in and around the landscape area (circle)	Yes/No	Yes/No	
Sprinkler heads leaks observed (circle)	Many/Few/None	Many/Few/None	
Broken equipment observed (circle)	Yes/No	Yes/No	
Impervious surfaces being watered (e.g., sidewalks or parking lots)	Yes/No	Yes/No	
***Collect meter data for a full year**			

WATER EVALUATION DATA COLLECTION FORM

Batch Processes (such as laboratory glassware washing)

Building number and name

Batch Processes description (unique name identifier)					**Comments**
Is the batch process water use metered? (circle)	Yes* / No	Yes* / No	Yes* / No	Yes* / No	
Typical number of batches per week					
Number of weeks per year the batch process runs					
Water use for one batch (gal)					
Percentage of the water that is recycled/reused, if any					
***Collect meter data for a full year**					

WATER EVALUATION DATA COLLECTION FORM

Continuous Processes (such as tempering water for steam sterilizers)

Building number and name					
Continuous Processes description (unique name identifier)					**Comments**
Is the continuous process water use metered? (circle)	Yes* / No	Yes* / No	Yes* / No	Yes* / No	
Typical number of hours per week the continuous process runs					
Number of weeks per year the continuous process runs					
Typical flow rate (gpm)					
Percentage of the water that is recycled/reused, if any					
***Collect meter data for a full year**					

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