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IDARA (INSTITUTING WATER DEMAND MANAGEMENT IN JORDAN)

Task 1.4- Perform End Use Analysis

Deliverable 2 – End Use Analysis for Large Consumers – Schools and Universities Audit Report

Final Submitted – October 2011

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IDARA – Water Audits for Large Consumers –Schools and Universities

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1. Background

Jordan is the fourth water poorest country on earth. Demand for water already exceeds Jordan's available water resources. Annual per capita water availability has declined from 3600 cubic meters per year in 1946 to around 145 cubic meters per year in 2008. Water demand is currently estimated at around 1530 MCM versus 870 MCM of water resources. The demand is projected to increase to around 1670 MCM by 2022. The high water shortage has caused a drastic over-abstraction of the groundwater aquifers that are pumped at two folds the safe yield. On the other hand, Jordan's stability, tourism attraction, quality of business and health services make it as a prime regional hub for investment. This challenging situation provides a great opportunity for the introduction of the most effective water demand management tools.

Water Demand Management in Jordan started from the bottom of the pyramid concentrating on educating and convincing the public about the need and benefits of water efficiency, then moved up to work with the institutions to develop water demand management policies, institutionalizing WDM; developing standards, codes and regulations; and introducing technologies and Best Management Practices. Water Audits are one of the tools and Best Management Practices that determine water use patterns for the various consumer categories, and identify water saving opportunities.

Within the scope of Activity 1, "Institutional Capacity for Water Demand Management", IDARA profiled large Institutional and Commercial categories in Amman (Figure 1) and recommended to audit and conduct end use analysis for five of these categories. These IC categories are health facilities, government office buildings, schools and universities, hotels and mosques. This report presents the end use analysis for 14 schools and universities with details about the methodology and approach, assumptions, water use evaluation for each of the audited educational facilities, conclusions and recommendations.

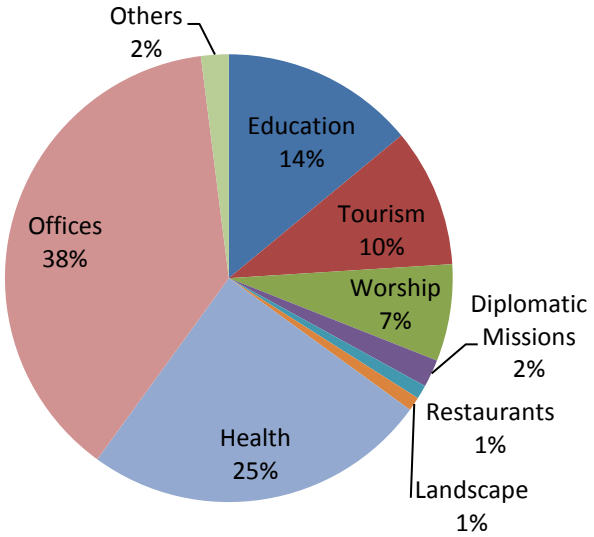

Figure 1: Institutional and commercial billed consumption by Category.

2. Objective

The main objectives of the end use analysis are summarized below:

1. Establish water use patterns in each of the selected facilities.
2. Determine opportunities to reduce water use.
3. Quantify potential savings as a result of adoption of water use efficiency measures.
4. Establish cost and payback for potential measures.
5. Establish Water Use Baseline to obtain realistic estimates of future water demands

3. Approach and Methodology

3.1 Overall Methodology

The water use at schools could reasonably be divided into three categories: plumbing, cleaning, and irrigation use. Some facilities had kitchens, swimming pools, and water softening uses.

The information that was gathered from the audited facilities, including water usage, was tabulated and imputed into a "water model" developed by Water Management, Inc. The "model" is a series of excel spreadsheets that are linked together. The calculations for each facility are based on data gathered from the site audits and from engineering calculations for each of the areas represented. In very broad terms, indoor water use is based on population and flow rates of fixtures; and irrigation use is based on the surface area being irrigated, the evapotranspiration rate for the area, and type of plants.

Performing an audit of water use within a facility requires a number of estimates, based on the site visits and the interviews with the staff, below are the steps followed for each of the audits:

1. Complete an initial survey form prior to the site visit (See Appendix A for a copy of the audit form),
2. Conduct site visit interviews with staff to confirm the information in the survey form and to obtain additional data on levels of activity in individual departments,
3. Collect water use information from both metered use and water purchased from tank trucks, if any.
4. Make measurements and set assumptions prior to site visits.
5. Follow-up questions at the end of the site visit.
6. Input data gathered including water use information and fixture counts into the water model.

3.2 Data Collection

Water Use Data

Gathering potable water use data starts with identifying and recording all water sources such as metered supplies from water utilities, water supplied by wells and similar self supplies sources, and tank truck deliveries. This data was collected as part of the initial survey form sent prior to the visit and was confirmed and modified at the time of the site visit based on information provided at that time. Usage profile for the sanitary fixtures is primarily based on two parameters, which are population and the frequency of use of these fixtures.

3.3 Flow Measurement Collection

Plumbing Fixtures: Faucet and showerhead flow rates were measured using a calibrated flow bag or the "Bucket and Stop Watch" method. Faucets flow rates were taken by turning the valve a quarter turn, and collecting water for five seconds. During this process, water level in the bag was marked reflecting water consumption in liters per minute (lpm).

The vast majority of the toilet fixtures in the audited schools were "Turkish" style, which means they have no tank, flush valve, or button-actuated water delivery system. Instead, users must fill a small bucket (usually 2 liters in volume) and manually clear waste from the floor basin and drain. This water is also used for personal hygiene in place of toilet paper. As such, there is no pre-set "flush volume" related to these fixtures. In order to calculate the water consumed in toilet "flushing" the following information was required, Quantity of water required for clearing solid and liquid waste, whether the user would "flush" the toilet after every use, and how much water is used to wash the basin after evacuation. The measurement of water use in toilets was done either by using a T-5 measuring device that measures actual volume of water flushed or by examining the tank size and observing the actual flush. Where tanks were not accessible or flush valves were used, the volume was estimated based on the make and model of the toilet. Again, a representative sampling of toilets was measured.

In order to calculate the water consumed in toilet "flushing" the following information was required, quantity of water required to clear solid and liquid waste, whether the user would "flush" the toilet after every use, and how much water isused to wash the basin after evacuation. The measurement of water use in gravity style toilets was done either by using a T-5 measuring device that measures actual volume of water flushed or by examining the tank size and observing the actual flush. Where tanks were not accessible or flush valves were used, the volume was estimated based on the make and model of the toilet. Again, measurement of water use in a representative sample of toilets was conducted.

Irrigation: - The irrigation water use estimation was based on local evapotranspiration and rainfall data, vegetation type (shrubs, grass, and trees) and planted area.

Cleaning: A conservative standard is proposed to calculate cleaning water in the audited facilities. Cleaning water was estimated at 0.125 liters per square meter per week. For Turkish toilet cleaning the same number was assumed in daily basis, and for gravity type toilets two flushes per day were allotted for cleaning.

3.4 Auditing Equipment

Following are the auditing equipment used to conduct indoor water use audits:

1. Graduated Cylinder
2. Portable timing device
3. Tape measure
4. T-5 device to measure flush volumes
5. Other equipment as needed

Figure 3: Flow bag used for measurement

Figure 2: T-5 device to measure toilet flush volume

Figure 5: Graduated Cylinder

Figure 4: Ultrasonic Flow meter

4. Assumptions

The following assumptions were developed to calculate the water balance for water uses:

- Unless reported otherwise, staff and students are assumed to use the bathroom once every 2 hours, 95% of staff and visitors will flush the toilet after use. It is also assumed that every other visitor of the facility will use the toilet once.
- It is assumed that 40% of staff, students, and visitors using the toilet will use the bidet or an accompanying hose for 12 seconds per use.
- Unless reported otherwise, 95% of Students and Staff will use lavatory faucets for hand washing after each bathroom use at a rate of 6 seconds per use.
- Kitchen faucet use is assumed specifically at each site and is explained in the appropriate site description.
- Cleaning water is calculated at a rate of 0.125 liters per square meter.

5. Water Use Evaluation

SCHOOLS

Facility 1

Facility Information

The Facility is a 3,600 m^2 government school built in 1972. It houses 50 staff members responsible for 736 students. For 219 days a year staff occupies the building 8 hours daily, and the students for 7 hours. The school has 12 m^3 of above ground, rooftop storage and 10 m^3 of below ground storage (22 m^3 total).

Water Balance and End Use Types

The facility receives water from Miyahuna two days weekly and does not receive extra tanker water. The annual water consumption was estimated at 2,084 m^3.

Two small buildings external to the main classroom building house two public restrooms with "Turkish" style toilets trigger hoses, and faucets. One structure was locked and apparently remains out of service. The other public restroom did not have running water to it and though it was utilized by some students, they were unable to flush the fixtures or wash their hands. To sanitize the bathroom, the maintenance person attaches a hose (without a trigger handle) to a faucet in the science laboratory and washes down the fixtures and floors. As such, a special cleaning consumption value was calculated, estimating that a 19 lpm hose is used 15 minutes per day to clean the bathrooms at this facility. Therefore, the audit team understood that all students and staff utilized the staff bathroom which had one "Turkish" toilet, one gravity tank and bowl toilet, and two faucets. The most important factor, the flush factor, is dramatically reduced in this case, as students are told by their parents to have as little contact with school bathroom facilities as possible. Accordingly, a 20% flush factor for student populations was assumed.

The school has approximately 12 kitchen-style faucets spread over a home economics area, a science laboratory, and two kitchenettes. The average flow rate of these faucets was 11lpm and all were compression style, meaning they are not self-closing. Staff reported there were occasions when students leave faucets running as an act of vandalism.

Water use at the school included irrigation and classroom faucet use. The manually irrigated area is small, consisting mainly of trees and some xeriscape plants that ring the parking lot. A water balance was generated using assumptions typical to an amalgam of secondary school assumptions from the U.S. and Jordan. The results of the end use water balance are illustrated in the Table below.

Table 1: End uses of water at facility 1

Facility 1		
Types	**Avg %**	**m³/year**
Toilets	56%	1,151
Urinals& Bidets	5%	104
Faucets (Kit and Lav)	27%	548
Cleaning	5%	115
Landscape	3%	62
Others	5%	104
Total		**2,084**

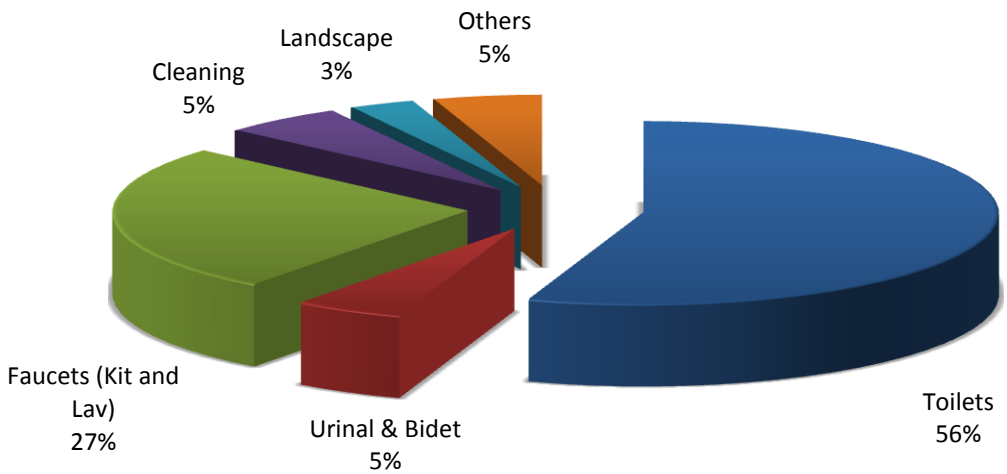

Figure 6: Water use percentages at facility 1.

Recommended Measures

Toilets

Toilets consume the vast majority of water at the facility. The average 4.0 liters per flush (lpf) rate calculated attempts to take into account the significant group of users that would flush "Turkish" fixtures using the spigot and bucket. However, the gravity tanks for both tank and bowl and "Turkish" tank fixtures use an average of 7 liters per flush. These tanks should be retrofitted with 6.0 lpf or less fixed-volume flush mechanisms that prevent an end-user or maintenance worker from adjusting the amount of water delivered. The facility's management could replace the entire fixture (tank for "Turkish" or tank and bowl) depending on the designed flush volume of the bowl, or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. Even though the majority of toilets at the school are "Turkish", dual-flush tanks could still be utilized to save water. The school should consider installing 3L/6L dual flush tanks, especially since the tanks observed were external to the wall and can easily be retrofitted.

Lavatory & Classroom Faucets

Lavatory faucet flow rates in the restrooms in the main school building averaged 8lpm. The audit team calculated slightly lower flow rates for student use (6lpm) to account for bathroom usage outside the main building where there is no running water. Lavatory faucets had strainers, but not flow controls. Installing pressure-compensating, tamper-proof units will help prevent aerator obstruction, increase end user satisfaction, and decrease maintenance issues. The faucets in the public restrooms that are not receiving water service should also be retrofitted with flow controls to ensure efficiency when service resumes.

Facility one has kitchen-style faucets in classroom areas that average 10 lpm. These faucets need to be retrofitted with pressure-compensating, 8.3 lpm flow controls.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	1,151
Bidet consumption per year	104
Lavatory consumption per year	274
Kitchen faucet consumption per year	274
TOTAL DOMESTIC CONSUMPTION	1,803

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	1,093
Bidet consumption per year	104
Lavatory consumption per year	198
Kitchen faucet consumption per year	227
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	1,622

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 181 m^3 per year, which is equivalent to an annual saving of around 9% of the total water use.

Facility 2

Facility Information

The Facility is an 18,000 m^2 Public Industrial School built in 1952. The building houses 80 staff members responsible for 620 students. For 200 days a year, the staff occupies the building 8 hours daily, and the students for 7 hours. The school has 42 m^3 of above ground, rooftop storage and 50m^3 of below ground storage (92 m^3 total).

Water Balance and End Use Types

The water balance was estimated to be around 2,958 m^3 per year. While the estimated water balance is almost the same as the billed consumption, the audit of the facility was performed while students were out of school, so no usage behavior was observed.

Students and staff at the school commonly use bucket for flushing. This leads to lowering the average flush rates from 8.5-9 lpf to 6 lpf to accommodate this behavior.

The school also has a bank of ablution faucets in the main courtyard, where 20%-40% of the students use for ablution to wash before prayer. Variation in usage regarding these fixtures, or vandalism related to leaving these compression faucets running at 10lpm could significantly impact usage.

Most toilets surveyed were "Turkish" style with tanks and spigots/buckets. The tanks had higher flush rates, upwards of 8-10lpf. However, many teachers and students do not use the tanks to flush the fixtures, but instead bucket flush. A 6lpf flush rate was factored in light of this behavioral information. Lavatory faucets had an extremely low average flow rate of 3.6lpm. This was not due to flow restrictors, as most faucets had only strainers. Water pressure was measured at 0.7 bars on the ground floor. Faucets with hot water are supplied by localized hot water heaters. These units need to be calibrated to conserve energy and prevent scalding.

Figure 7: Turkish toilet

Additional water use at the school includes irrigation. The manually irrigated area is small, consisting mainly of trees and some xeriscape plants that ring the parking lot. Other non-lavatory faucets were found in some classrooms and skills laboratories. The average flow rate of these faucets was 10lpm and all were compression style, meaning they are not self-closing. There was some equipment that uses water for closed loop cooling; make-up water for these closed systems is low and therefore not included in the water balance. The results of the end use water balance are illustrated in the Table below.

Table 2 : End uses of water at facility 2

Facility 2		
Types	**Avg %**	**m³/year**
Toilets	72%	2,082
Urinals & Bidets	1%	50
Faucets (Kit and Lav)	18%	545
Cleaning	7%	208
Landscape	2%	57
Others	1%	16
Total		2,958

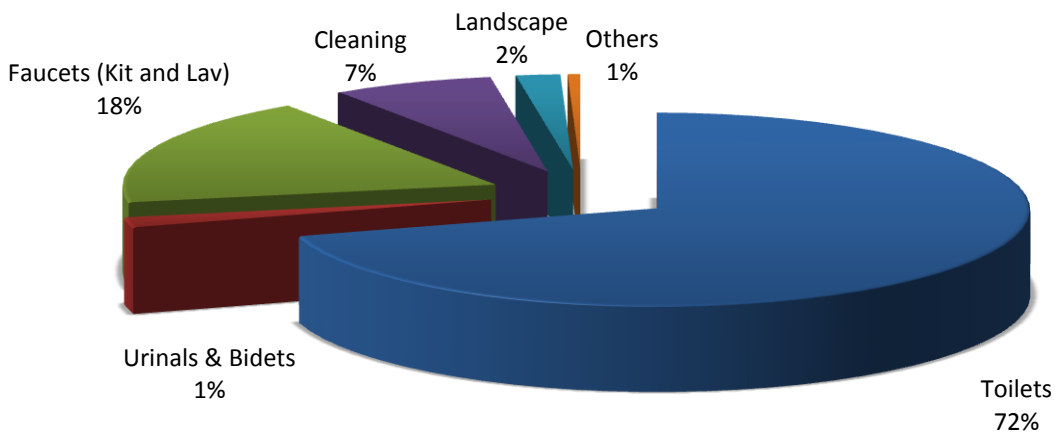

Figure 8: Water use percentages at facility 2

Recommended Measures

School staff informed the audit team that they were concerned the main 50m³ underground storage tank had a leak. Even small leaks to tanks, especially of such a size, can cost thousands of liters of water per year. The facility needs to explore leak detection methods that are cost appropriate. Perhaps the easiest way to test for leakage would be to valve off the tank and take water depth measurements. This will not quantify leak amounts and slight leaks may not visually reveal themselves over a 12 or 24 hour period. The school could meter the pipe leaving the tank to the school and compare that consumption to the utility consumption. Theoretically, the amount of difference would be leaking water. However, there is question that the meter from which the school is billed is not correct, so using that meter to judge leaks is not prudent. Furthermore, small leaks may go undetected by larger water meters that do not record small flows. Ideally, the main site meter should be replaced with a compound meter that will record low flows before attempting to judge leakage.

Toilets

Toilets consume the vast majority of water at the school. The average 6.0 lpf rate calculated by attempts to take into account the significant group of users that would flush "Turkish" fixtures using the spigot and bucket. Make no mistake however, the gravity tanks for both tank and bowl and "Turkish" tank fixtures use an average of 9.5 liters per flush. These tanks should be retrofitted with 6.0lpf or less fixed-volume flush mechanisms that prevent an end-

user or maintenance worker from adjusting the amount of water delivered. The school could replace the entire fixture (tank for "Turkish" or tank and bowl) depending on the designed flush volume of the bowl, or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float.

Even though the majority of toilets at the school are "Turkish", dual-flush tanks could still be utilized to save water. The school should consider installing 3L/6L dual flush tanks, especially since the tanks observed were external to the wall and easily retrofitted.

Kitchen Faucets

These faucets are compression faucets that flow at 9lpm, opened at a quarter. The school should consider installing 8.3 lpm faucet aerators which would result in 8% saving.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m^3/year(Pre Program)	
Toilet consumption per year	2,082
Bidet consumption per year	50
Lavatory consumption per year	126
Kitchen faucet consumption per year	419
TOTAL DOMESTIC CONSUMPTION	2,677

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	1,388
Bidet consumption per year	50
Lavatory consumption per year	158
Kitchen faucet consumption per year	387
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	1,983

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 694 m^3 per year, which is equivalent to an annual saving of around 23% of the total water use.

Facility 3

Facility Information

This facility is a private school which was built in 1995. It has an enrollment of 1,300 students, 50% of which are male. There are 100 staff; 80% teachers and 20% administration. None of the students live on campus; however there are four flats for visitors. The school is in operation for 190 days.

Water balance and End Use Types

Around 18,936 m^3 is consumed on school premises annually. The school is located outside Miyahuna service area. It receives tankers water on a regular basis, about 2 tankers per day with a capacity of 21 m^3 each. In addition the school has nine water harvesting storage tanks /cisterns on campus ranging in capacity between 700 m^3 and 1500 m^3.

The school uses softeners, it was determined that for every 12 m^3 produced from softeners, 4m^3 will be discarded. All softener reject water goes back to the water harvesting storage tanks/cisterns. All landscape is irrigated using harvested rainwater water after mixing with softener reject water. Wastewater collected in septic tanks and hauled by tankers. The school is charged JD 1.67 JD for hauling 1 m^3 of wastewater and JD 2.08 per 1 m^3 of water purchased from tankers. This implies that each m^3 of water costs a total of JD 3.75 JD. There is a full cafeteria that serves 40 full meals for the staff and 200 meals to the children. The meals are served on washable dishes. There are no automatic dishwashers; all dishes are washed by hand. The school has two air cooled chillers. Hot water temperature for faucets and showers was recorded as 54°C. Water is heated by a diesel boiler.

Faucet flow rates were measured at 11.4 lpm for a faucet in kitchen to 6 lpm and 9 lpm flow for 2 faucets in bathrooms. Toilets were 6L wash down units that measured 7 to 7.5 L per flush. Some units could allow for continuous flow if button is held down.

There are two swimming pools at the School, a semi-Olympic pool with a capacity of 900 m^3 (25mx15mx2.5) and a kid's pool with a capacity of 90 m^3. The ambient temperature in pool area is maintained at 25°C; the pools have a separate boiler. Approximately 21 m^3 is added to large pool every 7 to 10 days. There are four 200 liter sand filters for the large pool and one sand filter for the kid's pool. Backwash for sand filters is performed 2 times/week for each of the pool's filters for 5 -10 minutes.

Working up a water balance for the school was difficult because of all of the differing systems that are in place. Irrigation water is listed in the water balance even though this water is harvested from rain water and from the softener and other processes. The results of the end use water balance are illustrated in the Table below.

Table3 : End uses of water at facility 3

Facility 3		
Types	**Avg %**	**m³/year**
Toilets	36%	6,750
Urinals & Bidets	5%	991
Faucets (Kit and Lav)	13%	2,401
Cafeteria	2%	456
Swimming Pool & Jacuzzi	6%	1,050
Softeners /RO/ Filtration	13%	2,478
Landscape	15%	2,850
Cleaning	4%	675
Others	7%	1,286
Total		18,936

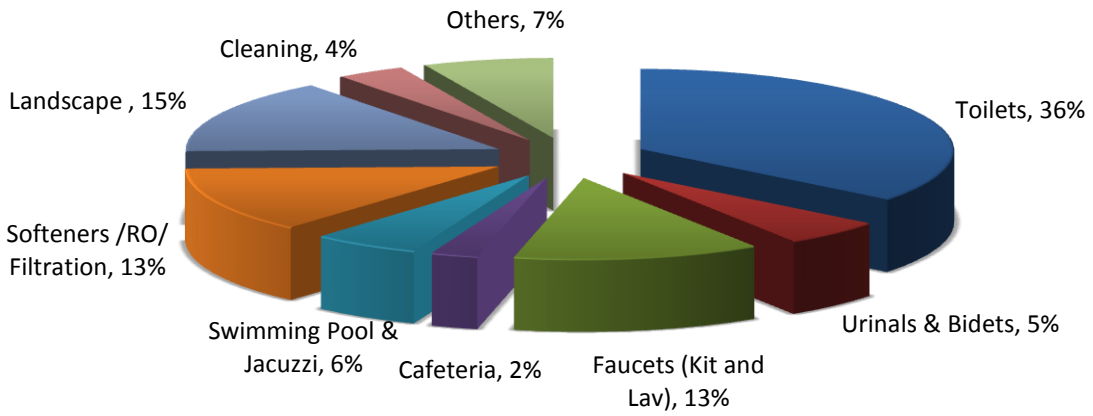

Figure 9: Water use percentages at facility 3

Recommended Measures

Toilets

Toilets consume the vast majority of water at the facility (36%). However, the gravity tanks at the school use an average of 7 liters per flush. These tanks should be retrofitted with 6.0lpf or less fixed-volume flush mechanisms that prevent an end-user or maintenance worker from adjusting the amount of water delivered. To further reduce consumption the installation of 3l/6l flush toilets could be considered.

Lavatory & Kitchen Faucets

Lavatory faucet flow rates in the restrooms in the main school building averaged 7.5lpm. Lavatory faucets had strainers, but not flow controls. Installing pressure-compensating, tamper-proof units will help prevent aerator obstruction, increase end user satisfaction, and decrease maintenance issues. As for the kitchen faucets, the school should consider installing 8.3 lpm faucets. Additionally some savings can be achieved by retrofitting the bidets with 4.5 lpm flow controls.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	6,749
Urinal consumption per year	12
Bidet consumption per year	977
Lavatory consumption per year	2072
Kitchen faucet consumption per year	328
TOTAL DOMESTIC CONSUMPTION	10,141
Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	3,827
Urinal consumption per year	12
Bidet consumption per year	244
Lavatory consumption per year	1,244
Kitchen faucet consumption per year	239
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	5,567

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 4,573 m^3 per year, which is equivalent to an annual saving of 24% of the total water use.

Facility 4

Facility Information

This School is a private school that is located in the city of Amman and is composed of three buildings with the ground surface area totaling 6,000 m². The structure was built in 1974 and has a staff of 208 employees that work 8 hour shifts 210 days a year. The school gets an average of 30 visitors a day and 1,237 students attend the school 190 days per year between the hours of 7am to 3pm.

Water Balance and End Use Types

This facility annual water consumption was estimated at 2,317 m³. The school's bathrooms contain 40 western type toilets that flush at 4.85 liters per flush (lpf). There are 30 hand washing lavatories with an average flow rate of 6.02 lpm. During the walk through of the auditors, it was observed that all the faucets needed aerators. The school has five small drinking fountains running at 0.480 lpm that use a reverse osmosis treatment making 30 liters daily.

The school has a small garden with trees, shrubs, and flowers which is watered with a hose during the summer months for one hour daily and in the winter months twice per week at the rate of 9 lpm. There are 74 m² of turf and 800 m² of flower beds.

The results of the end use water balance are illustrated in the Table below.

Table 4: End uses of water at facility 4

Facility 4		
Types	**Avg %**	**m³/year**
Toilets	55%	1,281
Faucets (Kit and Lav)	13%	302
Cleaning	17%	402
RO/Filtration	7%	151
Landscape	8%	177
Others	0%	5
Total		2,317

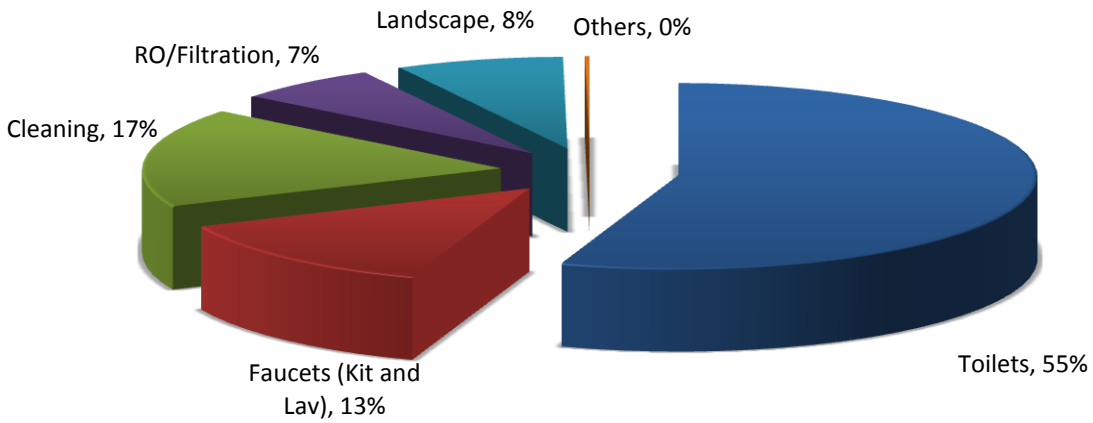

Figure 10: Water use percentages at facility 4

Proposed Measures

Toilets

Even though the facility's toilets are not high consumers of water with an average flow rate of 4.85 lpm, the facility could still reap some savings by installing (3l/6l) dual flush toilets.

Lavatory & Kitchen Faucets

Faucet flow rates can be reduced by retrofitting lavatory faucets with pressure-compensating 4.5 lpm flow controls, the facility could also save energy costs associated with hot water production and boiler operation. In addition, the bidets at the school should be retrofitted with 4.5 lpm flow controls.

Irrigation

The school should consider the installation of a smart irrigation system and controller. Automating irrigation based on soil moisture sensor monitoring and weather data will reduce consumption. During the rainy winter months, the soil moisture sensors will prevent the controller from watering already moist soil.

Potential domestic savings

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	1,281
Lavatory consumption per year	302
TOTAL DOMESTIC CONSUMPTION	1,583

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	1,057
Lavatory consumption per year	225
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	1,282

Based on the above calculation, if the school implements the above recommended domestic measures it will save around 300 m^3 of water per year, which is equivalent to 13% of the total water use.

Facility 5

Facility Information

This school is a public school which was built in 1950 and has a built area of 2,482 m². The total surface area of the school's property is 3,876 m². The school has 50 employees that work 8 hours a day, 194 days a year, and has 1,100 students of varying ages that occupy the school for 6 hours a day, 194 days a year. There is also an average of 10 visitors to the school each day.

Water Balance and End Use Types

The annual water consumption was estimated at 1,218 m³. The school's bathrooms are primarily equipped with Turkish-style toilets that flush at 6 lpf, but there is also one western-style toilet used by staff that flushes around 4.0 lpf. There are 6 hand washing lavatories that operate at 4.4 lpm. There are also 12 hand hose faucets with 4.2 lpf flow rates.

Figure 11: Ablution faucet at facility five

The school has one kitchen break room that is used to make tea, coffee, and small snacks. It is equipped with one kitchen sink that is used to clean any dishes. The school uses two small reverse osmosis systems to provide clean water for drinking fountains and for the kitchen.

Figure 12: Kitchen sink at facility five.

Outdoor, the school has some landscaping—95 m²—that is irrigated manually by a hose with a flow rate of lpm.

The results of the end use water balance are illustrated in the Table below.

Table 5: End uses of water at facility 5

Facility 5		
Types	**Avg %**	**m³/year**
Toilets	67%	817
Faucets (Kit and Lav)	12%	152
Cleaning	4%	44
RO/Filtration	1%	12
Landscape	13%	160
Others	3%	33
Total		**1,218**

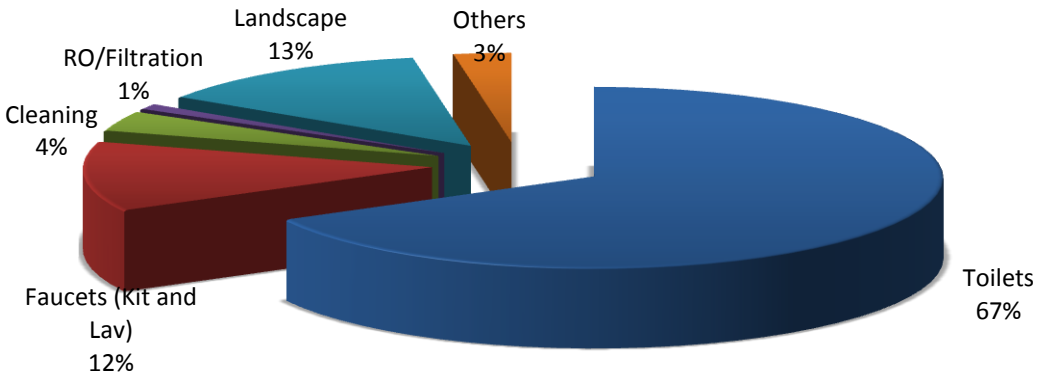

Figure 11: Water use percentages at facility 5

The school's fixtures are already low flow, and therefore no retrofit measures are recommended

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Facility 6

Facility Information

The School is a private school that is composed of one building with a surface area of 1,500 m^2. The structure was built twenty years ago and has 100 employees that work 8 hours a day, 240 days a year. The school gets an average of 100 visitors a day, and has 3,200 students enrolled in classes.

Water Balance and End Use Types

The annual water consumption was estimated at 14,043 m^3. The school's bathrooms contain 12 western type toilets that flush at 6 liters per flush (lpf). There are 12 urinals on site that flush using 1.5 liters per flush. There are also 20 hand washing lavatories that operate at 1.5 lpm. Water filters are used for drinking water, which produces no reject and are reported to produce approximately 20 m^3 for the facility each day. The school has one swimming pool with a volume of 6 m^3. The pool's filtration system is set to automatically backwash when it registers a pressure drop.

The results of the end use water balance are illustrated in the Table below.

Table 6: End uses of water at facility 6

Types	Avg %	m3
Toilet	71%	10,050
Urinal & Bidet	1%	169
Faucets (Kit and Lav)	5%	637
Cleaning	8%	1,057
Pool Evaporation	6%	780
Pool Backwash	9%	1,350
Total		14,043

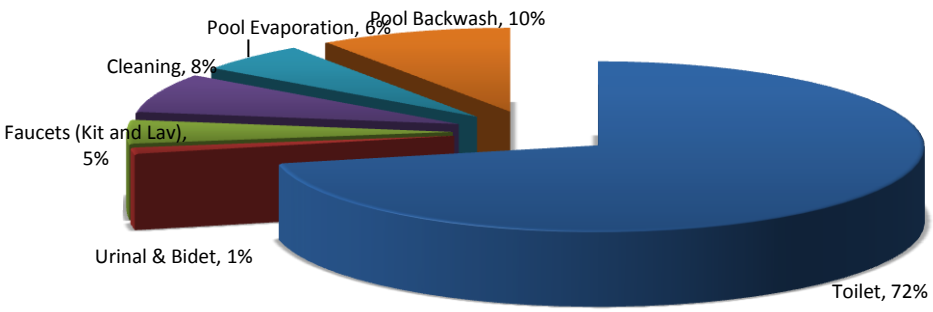

Figure 13 : Water use percentages at facility six

Proposed Measures

Toilets

Toilet tanks should be retrofitted with 3L/ 6L dual flush systems. The resulted savings could reach up to 33% per fixture.

Urinals

Urinals flush at a rate of 1.5 lpf, these units should be retrofitted with 1.0 lpf mechanisms.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	10,050
Urinal consumption per year	169
Lavatory consumption per year	637
TOTAL DOMESTIC CONSUMPTION	10,856

Building Domestic Subtotals - Consumption m^3/year(Post-Program)	
Toilet consumption per year	6,700
Urinal consumption per year	113
Lavatory consumption per year	637
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	7,450

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 3,406 m^3 per year, which is equivalent to 24% of the total water use.

Facility 7

Facility Information

This facility is a public school that is composed of 3 buildings. Each building has a surface area of 3,500 m^2. The total surface area of the school property is 19,500$m^{2.}$. The school was built in 1949, however there have been several upgrades including the current construction of a new bathroom. The facility has 60 employees that work 8 hours a day, 190 days a year. The school gets an average of 30 visitors a day and has 1,370 students enrolled in classes.

Water Balance and End Use Types

The annual water consumption was estimated at 727 m^3. The school's bathrooms contain 36 Turkish type toilets that are flushed using 2 liter buckets. There are 20 hand washing lavatories that operate at 4.8 lpm. The school's floor surfaces are cleaned three times a week, using approximately 2m^3 of water each week.

The school has an irrigation system installed using approximately 2m^3 of water each week, four months of the year, to maintain 6,000 m^2 of landscaping that primarily contains trees.

The results of the end use water balance are illustrated in the Table below.

Table 7: End use of water at facility 7

Facility 7		
Types	**Avg %**	**m^3/year**
Toilet	67%	484
Faucets (Kit and Lav)	22%	162
Cleaning	11%	80
Total		**727**

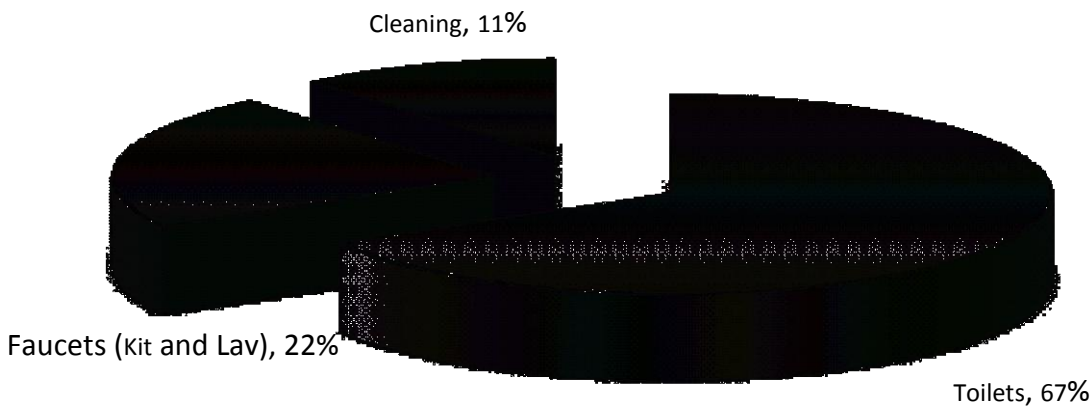

Figure 14: Watr use percentages at facility 7

The school is already equipped with low flow fixtures, and therefore no measures are recommended.

Facility 8

Facility Information:

The facility is a girls' school composed of one, three-floored, building with a surface area of 1,038m². The school was built four years ago, and has 42 employees that work 8 hours a day, 198 days a year. The school gets an average of 20 visitors a day and has 657 students enrolled in classes.

Water Balance and End Use Types:

The annual water consumption was estimated at 863 m³. The school's bathrooms contain 15 Turkish type toilets that are flushed using 2 liter buckets, and 2 western type toilets that flush using 6.1 liters per flush (lpf). Each toilet is equipped with its own spray hose. There are also 11 hand washing lavatories that operate at 3.5 liters per minute. According to staff, the school's floors are mopped once a day. The school has one break room for coffee, tea, and small meals, where all dishes are washed by hand.

The school has very little landscaping, which is watered manually by bucket. During the summer, approximately twenty-five 12 liter buckets are used to accomplish any watering.

The results of the end use water balance are illustrated in the Table below.

Table 8 : End uses of water at facility 8

Facility 8		
Types	**Avg %**	**m³/year**
Toilets	61%	523
Faucets (Kit and Lav)	17%	148
Cleaning	17%	147
Others	5%	45
Total		**863**

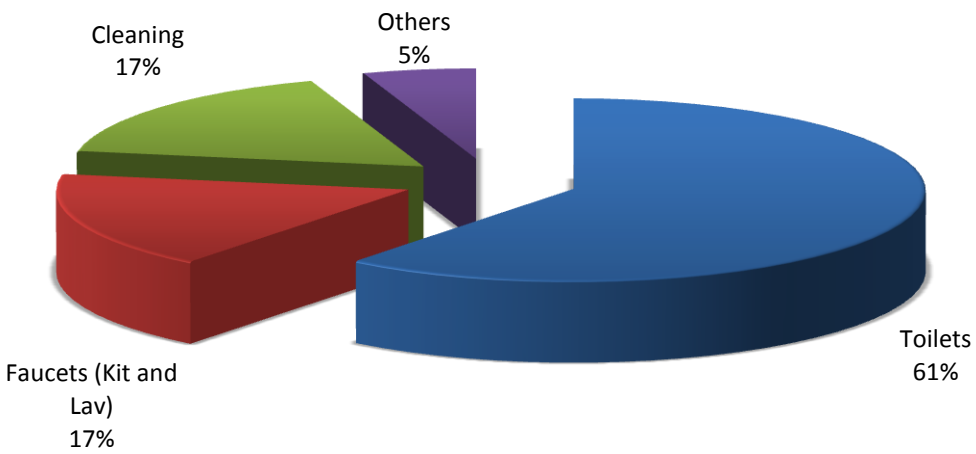

Figure 14: Water use percentages at facility 8

The school is already equipped with low flow fixtures, and therefore no retrofits are recommended.

UNIVERSITIES

Facility 9

Facility Information:

The University is located south of Amman on the way to Queen Alia International Airport. It is open all year round and has approximately 8,000 students.

Water Balance and End Use Types:

Average annual water use at the University is approximately 102,200 m^3. All of the water is produced from one well that pumps 35 m^3/hour for 8 hours a day. The well water is clean and does not require any reverse osmosis or other treatments.

Figure 15: External Landscape at the University

Figure 15: The University Soccer Field

Much of the green spaces at the University that are watered, are irrigated from reclaimed water from the onsite wastewater treatment plant. In addition, a considerable amount of fresh potable water is used from July to the end of September for irrigation purposes. Many ornamental plants can be found on the grounds of the campus. All of this requires a great deal of water. It is estimated that approximately 30-80 m^3 of reclaimed water is available daily for reuse from the waste water treatment. However during the summer months an additional 100 – 130 m^3 of "fresh water" is needed for irrigation purposes. Much of the landscaping on the campus is new and therefore needs additional watering. Once the landscape is established, this watering is anticipated to be reduced

Currently a new soccer stadium is being built. At the time of the audit, the turf had not yet been installed. It is estimated that an additional 50m3 /day of water will be needed in the summer to water this turf. This will also have to come from potable water supplies.

Figure 17: Existing Toilet at the University

Domestic fixtures appeared in good condition; however in many of the restrooms audited, Toilets had used significantly more water than necessary. The toilet fixtures observed by the audit team were tank and bowl and most had an accompanying trigger hose for bidet usage. Toilets observed had flush towers and ball float mechanisms that dispensed an average of 7.5 lpf. A few of the newer sections of the campus had dual flush (3L/6L) toilets.

Lavatory faucets operated at a wide range of flow rates from 4 lpm to as high as 15 lpm. The majority of the faucets flowed at rates in excess of 8 lpm.

The results of the end use water balance are illustrated in the Table below.

Table 9: End uses of water at facility 9

Facility 9		
Types	**Avg %**	**m³/year**
Toilets	33%	34,067
Urinals & Bidets	3%	2,926
Faucets (Kit and Lav)	6%	5,877
Ablution Faucets	5%	4,800
Showers	10%	9,856
Cleaning	9%	9,520
Landscape	29%	29,589
Others	5%	5,564
Total		**102,200**

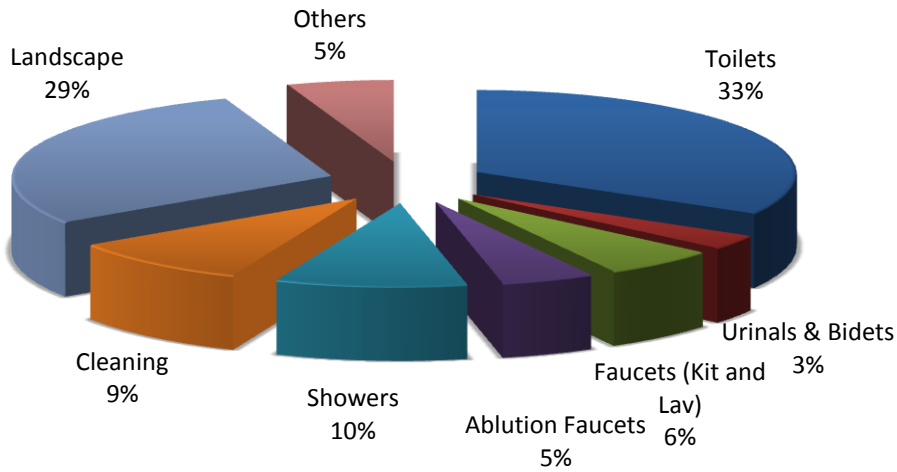

Figure 16: Water use percentages at facility 9

Recommended Measures

Toilets

Domestic fixtures appeared in good condition; however in many of the restrooms audited, Toilets had used significantly more water than necessary. The toilet fixtures observed by the audit team were tank and bowl and most had an accompanying trigger hose for bidet usage. Toilets observed had flush towers and ball float mechanisms that dispensed an average of 7.5 lpf. A few of the newer sections of the campus had dual flush (3L/6L) toilets. These tanks should be retrofitted with 3L/6L dual flush tanks or single flush 6lpm toilets.

Faucets

Lavatory faucets operated at a wide range of flow rates from 4 lpm to as high as 15 lpm. The majority of the faucets flowed at rates in excess of 8 lpm. These numbers are far too high and should be reduced through the application of pressure-compensating flow controls. Some of the lavatory faucets had no strainers or flow controls. Installing pressure-compensating, tamper-proof will achieve significant savings. In addition, the Bidets should be retrofitted with pressure-compensating, 4.5 lpm flow controls.

Showers

Showerheads should be retrofitted with less or equal to 7.6 lpm flow restrictors (aerators)

Landscaping

A good idea would be to install a subsurface drip irrigation system, especially that the lawn system is not yet installed .This would reduce water usage requirements by 60-80%. High water consumption landscape, especially grass areas need to be replaced by water-wise vegetation applying xeriscaping principles.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m³/year (Pre Program)	
Toilet consumption per year	34,067
Urinal consumption per year	15
Bidet consumption per year	2,910
Lavatory consumption per year	5,242
Shower consumption per year	9,856
Kitchen faucet consumption per year	635
TOTAL DOMESTIC CONSUMPTION	52,726
Building Domestic Subtotals - Consumption m³/year (Post-Program)	
Toilet consumption per year	17,625
Urinal consumption per year	15
Bidet consumption per year	727
Lavatory consumption per year	3,211
Shower consumption per year	6,810
Kitchen faucet consumption per year	278
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	28,666

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by approximately 24,060 m^3 per year, which is equivalent to an annual saving of around 24% of the total water use.

Facility 10

Facility Information

The University was established in 1991and its campus lies on a lot of 300,000 m^2. The University was originally composed of two buildings but later expanded to include eleven buildings. In addition to classroom buildings there are two large cafeterias, a library and an administration office building. The University has 7,000 students and 700 staff and employees. Seventy percent of the students are males.

Water Balance and End Use Types

The annual water consumption was estimated at 98,915 m^3**.** The well of the University is 350 meters deep and the pump is at 312 meters. The production rate of the well was 25 m^3 per hour and later dropped down to 7m^3 per hour. This low output had forced the University to increase the hours that the well is pumping to 16 hours per day and has also increased its reliance on tanker water and water from Miyahuna.

The reservoir for the University holds 400m^3, and to increase the storage capacity most of the buildings have roof top tanks. This has resulted in a pressure drop in the network system and the fixtures, since the system is not pressurized. It is roughly estimated that the total capacity of all of the roof top tanks is 50 m^3.

Figure 19: Roof Top Tanks at the University

Some water (70m^3) is reclaimed from the onsite wastewater treatment plant for irrigation of the soccer field. The soccer field is the only green space at the University that is piped to receive reclaimed water. As a result other green spaces at the University must rely on potable water as its source for irrigation water. This is estimated to be an additional 70m^3 of water during the summer (approximately 120 days).

Figure 20: Two of the many green spaces at the University that require potable water for irrigation

Figure 17: Soccer field and wastewater treatment plant, reclaimed water is piped from plant to field for irrigation

Domestic fixtures appeared in good condition; however in many of the restrooms audited, Toilets had used significantly more water than necessary. The toilet fixtures were tank and bowl and most had an accompanying trigger hose for bidet usage. Many Toilets exceeded 8 lpf. The majority of the faucets flowed at rates in excess of 7 lpm. Most shower flows exceed 10 lpm.

The results of the end use water balance are illustrated in the Table below.

Table 10: End uses of water at facility 10

Facility 10		
Types	**Avg %**	**m³/year**
Toilets	40%	39,122
Urinals & Bidets	3%	3,414
Faucets (Kit and Lav)	11%	11,311
Ablution Faucets	7%	7392
Showers	6%	5,852
Cleaning	4%	3,912
Irrigation	23%	23,014
Others	5%	4,898
Total		98,915

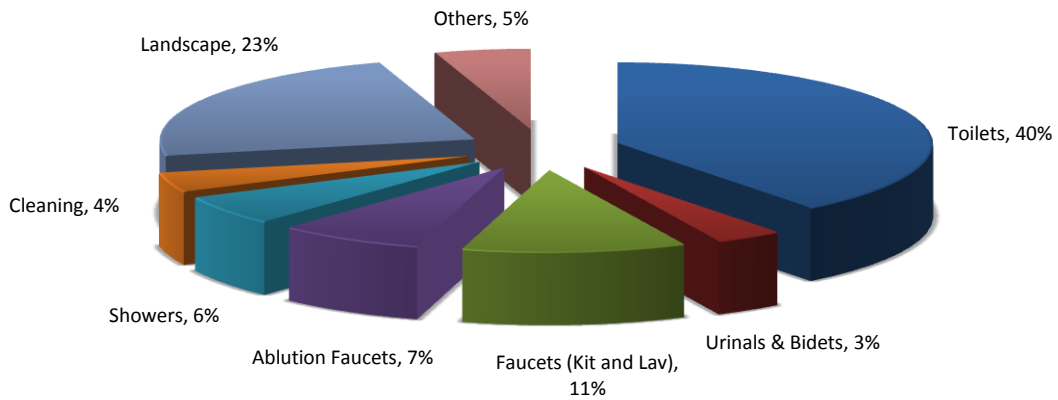

Figure 18: Water use percentages at facility 10

Recommended Measures

Faucets

The faucets flows are far too high and should be reduced through the application of pressure-compensating flow controls. Some of the lavatory faucets had no strainers or flow controls. The faucets and bidets at the facility should be retrofitted with pressure-compensating flow controls with less or equal than 4.5 lpm. Kitchen faucets flow rates were very high, with an average 18.9 lpm; savings will exceed 50% of kitchen faucet water use by retrofitting them with 8.3 lpm kitchen faucet aerators.

Toilets

Toilets had a higher consumption than what is recommended. Retrofit the 7.5 lpf toilets with 3L/6L dual flush or single flush 6lpm toilets.

Showers

Showerheads should be retrofitted with less or equal to 7.6 lpm flow restrictors (aerators). The existing average shower flow rates for students are around 11 lpm; savings can reach up to 30% of shower consumption if those showers were retrofitted.

Landscaping

High water consumption landscape, especially grass areas need to be replaced by water-wise vegetation applying xeriscaping principles.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m³/year (Pre Program)	
Toilet consumption per year	39,121
Urinal consumption per year	17
Bidet consumption per year	3,396
Lavatory consumption per year	10,879
Shower consumption per year	5,852
Kitchen faucet consumption per year	430
TOTAL DOMESTIC CONSUMPTION	59,698

Building Domestic Subtotals - Consumption m³/year (Post-Program)	
Toilet consumption per year	20,265
Urinal consumption per year	133
Bidet consumption per year	849
Lavatory consumption per year	6,669
Shower consumption per year	4,043
Kitchen faucet consumption per year	189,
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	32,150

Based on the calculations, if the facility implements the recommended domestic measures it will reduce consumption by 27,548 m^3 per year, which is equivalent to an annual saving of 28% of the total water use.

Facility 11

Facility Information

The University was established in 1991. There are 17 buildings on campus. One of the buildings is an all-female dormitory that houses 116 women during the school year and 85-90 women in the summer semester. Other buildings on campus include administrative buildings, a mosque, a cafeteria, convenience stores and a sports complex.

Water Balance and End Use Types:

The annual water consumption was estimated at 16,270 m³**.** Domestic fixtures in the classroom buildings appeared in good condition; however in many of the restrooms audited the flow rates of the faucets were much higher than they should be. Each of the classroom buildings and many of the other buildings have portable Reverse Osmosis (RO) for each of the bubble coolers units. These units can reject a considerable amount of water and it is estimated that there are approximately 100 of these units on campus. However when the campus was audited it was learned that many of these units had been turned off and therefore it was not believed that these units were commonly being used.

The dormitory of the university is located on the lower section of the campus where the water pressure is higher. There are approximately 30 bathrooms in the building. Each bathroom is for the use of 4 women and has a toilet, 2 sinks and a shower. There are small areas on each floor with kitchen facilities. Hot water is turned on only once a day for 4-6 hours in the evening. Efficient front load washing machines are located in the basement. It is estimated that 300 loads of laundry are washed each week – with each load using approximately 20 liters of water. The dormitory faucets observed had aerators removed and the showerheads did not have any restriction. The majority of lavatory and kitchen faucets flow observed have high flows exceeding 10 lpm. Likewise, most toilets operate at more than 8 lpf, and showers have excessively high flows.

Figure 23: Women's Dormitory

The results of the end use water balance are illustrated in the Table below.

Table 11: End uses of water at facility 11

Facility 11		
Types	**Avg %**	**m³/year**
Toilets	35%	5,679
Urinals & Bidets	2%	289
Faucets (Kit and Lav)	5%	872
Showers	11%	1,762
Cleaning	41%	6,682
Com. Kitchen	5%	811
Others	1%	175
Total		**16,270**

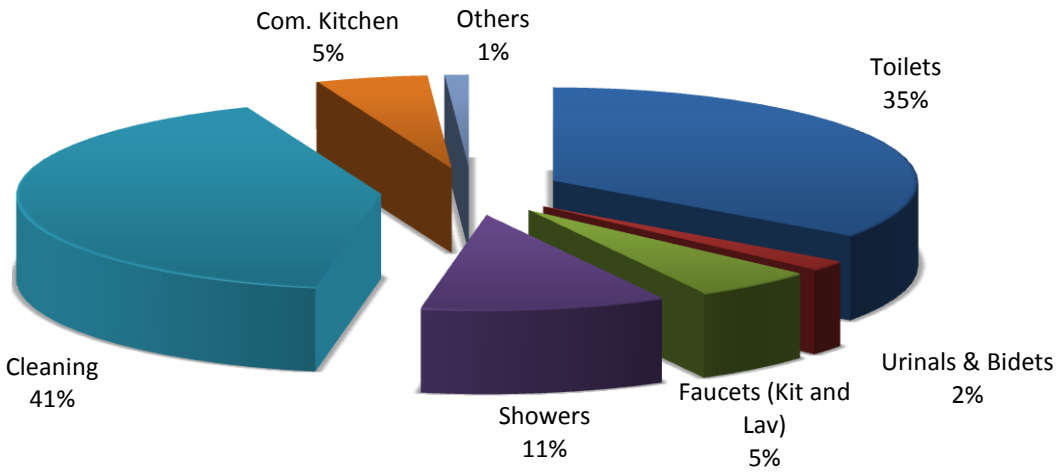

Figure 19: Water use percentages at facility 11

Recommended Measures

Lavatory and Kitchen Faucets

The Bidets and faucets' flows should be reduced through the application of pressure-compensating flow controls. Some of the lavatory faucets had no strainers or flow controls. The faucets should be retrofitted with pressure-compensating flow controls with less or equal than 4.5 and 8.3 lpm for lavatory/bidets and kitchens, respectively.

Toilets

The toilet fixtures observed were tank and bowl, most of them had an accompanying trigger hose for bidet usage. Many of the toilets in the newer buildings were already retrofitted with dual flush toilets. A few toilets were found to be leaking and or out of adjustment but were minimal. These tanks should be retrofitted with 3L/6L dual flush tanks.

Showers

Showerheads should be retrofitted with less than or equal to 7.6 lpm flow restrictors (aerators)

Urinals

Urinals flush at a rate of 2.0 lpf, these units should be retrofitted with 1.0 lpf mechanisms.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m³/year (Pre Program)	
Toilet consumption per year	5,679
Urinal consumption per year	106
Bidet consumption per year	182
Lavatory consumption per year	771
Shower consumption per year	1,762
Kitchen faucet consumption per year	101
TOTAL DOMESTIC CONSUMPTION	8,602

Building Domestic Subtotals - Consumption m³/year (Post-Program)	
Toilet consumption per year	3,441
Urinal consumption per year	53
Bidet consumption per year	91
Lavatory consumption per year	462
Shower consumption per year	669
Kitchen faucet consumption per year	83
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	4,801

Based on the above calculations, if the facility implements the recommended domestic measures it will reduce consumption by 3,801 m^3 per year, which is equivalent to an annual saving of 23% of the total water use.

Facility 12

Facility Information

This facility is a private university that is composed of 15 buildings. Each building has a surface area of 327,000m^2 with a total surface area of 94,000m^2. . The structure was built twenty years ago and has 940 employees that work 8 hour shifts 190 days a year. The school has 10,500 students enrolled in classes.

Water Balance and End Use Types

The University receives water from its own Water Well that flows 220 cubic meters per day. The annual water consumption was estimated at 14,346 m^3.

The University's bathrooms contain 218 western type toilets that flush at 6 lpf. 280 "Turkish" style toilets with tanks are in use at this site with an average flow rate of 6 lpf. This location has 3 urinals that flush at 2 lpf; however they are only used for special events as they remain behind the locked doors of the theater. There are 37 bidets that have an average flow rate of 5 lpm. There are 481 hand washing lavatories that operate at 4.5 lpm. 3 of 5 of the lavatory faucets are missing aerators. There are a total of 120 Lab sinks with 9 sink per lab; they are not frequently used--possibly twice a week for 2 min. In addition, it is important to note that roughly 80% of those enrolled in the University practice ablution.

Figure20: Turkish Toilets

The university has a kitchen that produces a daily average of 150 meals daily. All the meals are served on disposable plates. Being that there are few meals prepared by the school, they want to shut down all kitchens. Most of the food is prepared by food vendors on campus. There are five different food vendors. The vendors rent small stands from the University. All their water is from the schools water supplies. There are two kitchen sinks in the kitchen that hold roughly 32 liters daily; the faucets both run at 8.4 lpm. The kitchen has a medium sized dishwasher that is run 12 times per day. However, before dishes are put in the dishwasher they are sprayed down with a 5.7 lpm pre-rinse nozzle. In addition, the kitchen has a medium sized ice machine and medium sized freezers that are both air cooled. The University uses water filters to clean the drinking water, which produces no reject. The University is reported to have 74 filters throughout facility. For irrigation, the University has a drip sprinkler system installed. It runs 2 times for 2 hrs per day at 2 times/ week to water the 65,000 m^2 of beds. The beds contain flowers, trees, and shrubbery that appear to be in fair condition.

The results of the end use water balance are illustrated in the Table below.

Table 12: End uses of water at facility 12

Facility 12		
Types	Avg %	**m³/year**
Toilets	33%	4733
Urinals & Bidets	2%	241
Faucets (Kit and Lav)	7%	1023
Showers	12%	1762
Cleaning	46%	6587
Total		14,346

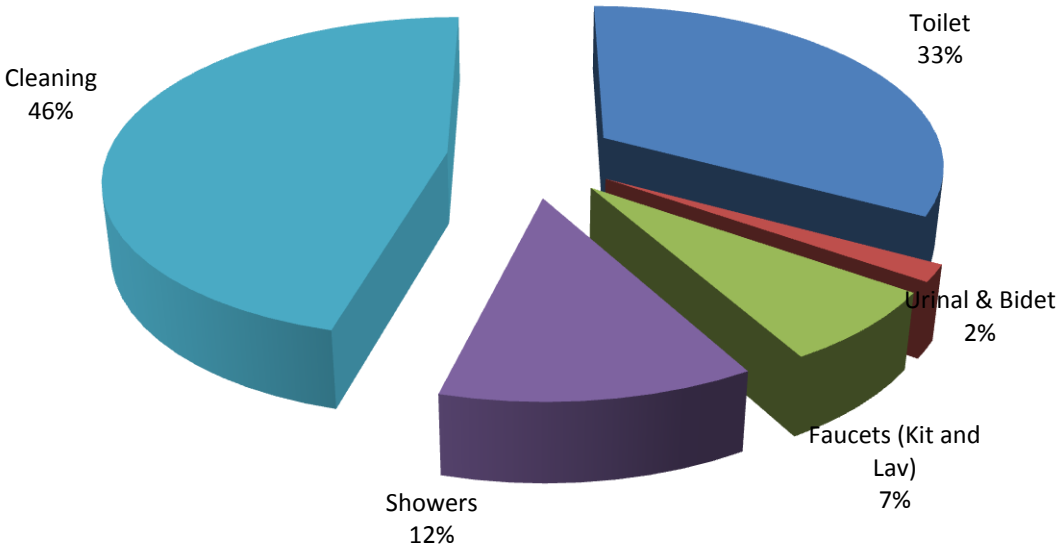

Figure 21: Water use percentages at facility 12

Proposed Measures

Toilets

Retrofit the 7.5 lpf toilets with 3L/6L dual flush or single flush 6lpm toilets.

Faucets

The bidets and faucets flows should be reduced through the application of pressure-compensating flow controls. Some of the lavatory faucets had no strainers or flow controls. The faucets should be retrofitted with pressure-compensating flow controls with less or equal than 4,5 and 8.3 lpm for lavatory/bidets and kitchens, respectively.

Showers

Significant savings can be achieved by retrofitting shower heads at the University. Showerheads should be retrofitted with less or equal to 7.6 lpm flow restrictors (aerators)

Urinals

Urinals flush at a rate of 2.0 lpf, these units should be retrofitted with 1.0 lpf mechanisms.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m³/year (Pre Program)	
Toilet consumption per year	4,732
Urinal consumption per year	88
Bidet consumption per year	152
Lavatory consumption per year	922
Shower consumption per year	1,762
Kitchen faucet consumption per year	101
TOTAL DOMESTIC CONSUMPTION	7,759

Building Domestic Subtotals - Consumption m³/year (Post-Program)	
Toilet consumption per year	2,868
Urinal consumption per year	44
Bidet consumption per year	76
Lavatory consumption per year	553
Shower consumption per year	669
Kitchen faucet consumption per year	83
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	4,294

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 3,465 m³ per year, which is equivalent to 24% of the total water use.

Facility 13

Background Information

This University has 17 buildings, four of which are student dormitories. Each building has a surface area of 61,868m^2 and the university's total surface area is 173,000m^2. . The university was built in 1990, however there were several upgrades made to several of the school's bathroom facilities in 2009. The university has 650 employees that work 8 hours a day, 310 days a year. The school gets an average of 75 visitors a day and has 6,500 students enrolled in classes 240 days a year.

Water Balance and End Use Types

The University receives water from Miyahuna in addition to 43 m^3 per day from a ground well located on site. The annual water consumption was estimated at 32,359 m^3.

The University's bathrooms contain 301 western type toilets that flush at 4.6 liters per flush (lpf). There are also 60 urinals in use at this site with an average flow rate of 2lpf. The total showerhead count is 64 with an average flow rate of 6.6lpf. There are 325 hand washing lavatories that operate at 7.6lpm. There are a total of 12 kitchen sink faucets with flow rates of 5.7lpm. The university has four laboratories, each equipped with one faucet. In addition, it is important to note that roughly 10% of those enrolled in the University practice ablution, and there are 12 ablution sinks located on campus with flow rates of 6lpm.

The university's dormitories are equipped with kitchenette units, each with one faucet with flows of 5.4 liters per minute (lpm). There are a total of 79 of these kitchenettes. In addition, the university has 12 cafeterias that produce a daily average of 500 meals daily. Roughly 90% of the meals are served on disposable plates. Being that there are few meals prepared by the school, they want to shut down all kitchens. Most of the food is prepared by food vendors on campus. Each cafeteria kitchen has two kitchen sinks equipped with one pre-rinse sprayer, one hand sink, and dishwasher. However, it is important to note that due to the amount of disposable dishware used; primarily only pots and pans are washed in the kitchen. The University's dormitories are equipped with 14 non-automatic washing machines and 26 automatic washing machines. All the machines run an average of 5 loads a day, 7 days a week. The non-automatic machines use approximately 15 liters of water per load, while the automatic machines use approximately 20 liters of water per load. The university therefore uses an estimated 1,225 liters of water each week in laundry processes. The University's floor surfaces are cleaned daily. According to staff interviewed during the survey, the university uses approximately 100 liters of water for each of the 13 buildings each week.

The University has an irrigation system installed, which uses approximately 140m^3 of water each day to maintain 21,000m^2 of landscaping. Roughly 500m^2 of the landscaping is turf. The University has one swimming pool with a volume of 1,500m^3 and a surface area of 350m^2. The pools filtration system is backwashed daily for 4 minutes at a rate of approximately 6 liters per minute (lpm). The backwashing is controlled by a timer. Additionally, it is important to note that the university replaces the water in the pool every four months. There are also four Jacuzzis located on campus, two large spas and two smaller spas. The larger Jacuzzis are 7 m^2, and the smaller Jacuzzis are 3 m^2. In addition there are two steam baths, each 12 m^2, which are used 3 days a week.

The University withdraws 140 m^3 of well water during a 4 hour period each day. The university also uses a water softening system for its swimming pool, which is backwashed using 2 m^3, two times each week.

The results of the end use water balance are illustrated in the Table below.

Table 13: End uses of water at facility 13

Facility 13		
Types	**Avg %**	**m^3/year**
Toilets	45%	14,617
Urinals & Bidets	1%	440
Faucets (Kit and Lav)	25%	7954
Showers	9%	2,883
Cleaning	5%	1,514
Com. Kitchen	11%	3,500
Laundry	0%	98
Pool Evaporation	3%	910
Pool Backwash, Decorative Fountains	0%	9
Others	1%	435
Total		32,359

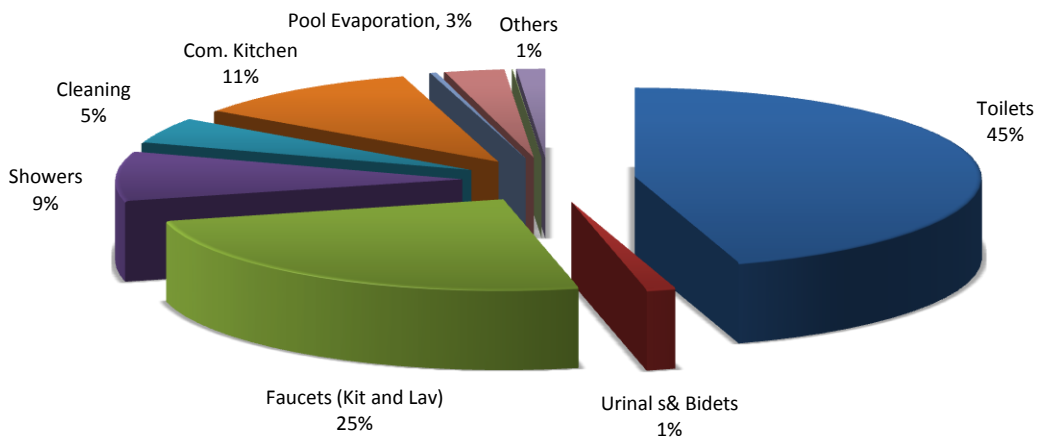

Figure 22: Water use percentages at facility 13

Proposed Measures:

Toilets

Though the university already has low flow toilets, in order to further reduce consumption, the school could consider installing dual-flush toilets. While 3L/6L dual-flush models exist, it is recommended that the university ensures its drainage plumbing infrastructure will operate adequately with such a flow reduction. Many systems were designed to operate with much higher flush rates and accordingly, obstructions can occur, especially in commercial facilities where users are apt to flush a wider variety of materials than in residential settings.

Lavatory & Kitchen Faucets

Faucet flow rates are high compared to the standards and other IC audit results. By retrofitting lavatory faucets with pressure-compensating 4.5lpm flow controls, the facility could achieve significant savings.

Urinals

Urinals flush at a rate of 2.0 lpf; these units should be retrofitted with 1.0 lpf mechanisms.

Irrigation

High water consumption landscape, especially grass areas need to be replaced by water-wise vegetation applying xeriscaping principles.

Pool

The school has an outdoor swimming pool. The sand filter for the pool utilizes a set timer to handle blowdown. The school should install pressure-based automated regulation in order to increase the efficiency of the blowdown process. The school needs to automate this process, based on pressure differentials on either side of the filter to eliminate unnecessary backwashing. Chemical and physical pool covers also warrant consideration to cut down evaporative loss.

Proposed Domestic Savings:

Building Domestic Subtotals - Consumption m^3/year (Pre Program)	
Toilet consumption per year	14,616
Urinal consumption per year	439
Lavatory consumption per year	7,358
Shower consumption per year	2,882
Kitchen faucet consumption per year	595
TOTAL DOMESTIC CONSUMPTION	25,893

Building Domestic Subtotals - Consumption m^3/year (Post-Program)	
Toilet consumption per year	12,710
Urinal consumption per year	219
Lavatory consumption per year	4,357
Shower consumption per year	3,319
Kitchen faucet consumption per year	866
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	21,473

Based on the above calculations, if the facility implements the recommended measures it will reduce consumption by 4,420 m^3 per year, which is equivalent to 14% of the total water use.

Facility 14

Facility Information

This facility is a private university that is composed of 16 buildings. The university's total surface area is 64,718m^2. The university was built in 1989, however there have been several upgrades made to the school, the most recent of which took place in 2009. The university has 669 employees that work 8 hours a day, 200 days a year. The school gets an average of 200 visitors a day and has 5,507 students enrolled in classes 200 days a year.

Water Balance and End Use Types

The annual water consumption was estimated at 15,459 m^3. The University's bathrooms contain 382 western type toilets that flush at approximately 6.6 liters per flush (lpf), 15 Turkish type toilets flushing at 6.2lpf, and 70 flush valve toilets flushing at 11lpf, though 30% of the toilets observed had of leaks varying degrees. There are also 20 urinals in use on campus with average flow rates of 2lpf. The total showerhead count is 6 with an average flow rate of 20lpf. There are 360 hand washing lavatories that operate at 7.5lpm, though many of the faucets are in poor condition and approximately 90% are missing aerators. It is also important to note that an estimated 30% of the university's occupants practice ablution, and the school is equipped with 6 ablution sinks with flow rates of 6.2lpf for this purpose. The University's floor surfaces are cleaned daily. According to staff interviewed during the survey, all bathrooms are mopped 3 times a day, while all classrooms and hallways are mopped once a day.

The university's kitchen produces an average of 370 meals daily. Roughly 68% of the meals are served on disposable china. The kitchen is equipped four small water-cooled refrigerators, four air-cooled ice machines, and an air-cooled freezer. The kitchen has 16 basin sinks with 16 liter capacities that are filled an average of six times a day. There are also 4 hand sinks with flow rates of 4.2 liters per minute (lpm). The kitchen floors are mopped twice each day and hosed down once a week. In addition, it is important to note that during the survey it was observed that meats were left to thaw in sinks with water left running.

The University has an irrigation system installed, which is used to water approximately 7,500m^2 of turf landscaping at the school's stadium. The results of the end use water balance are illustrated in the Table below.

Table 14: End uses of water at facility 14

Facility 14		
Types	**Avg %**	**m^3/year**
Toilets	31%	4,733
Urinals & Bidets	2%	241
Faucets (Kit and Lav)	7%	1023
Showers	23%	3,524
Cleaning	5%	747
Landscape	31%	4,845
Others	2%	346
Total		15,459

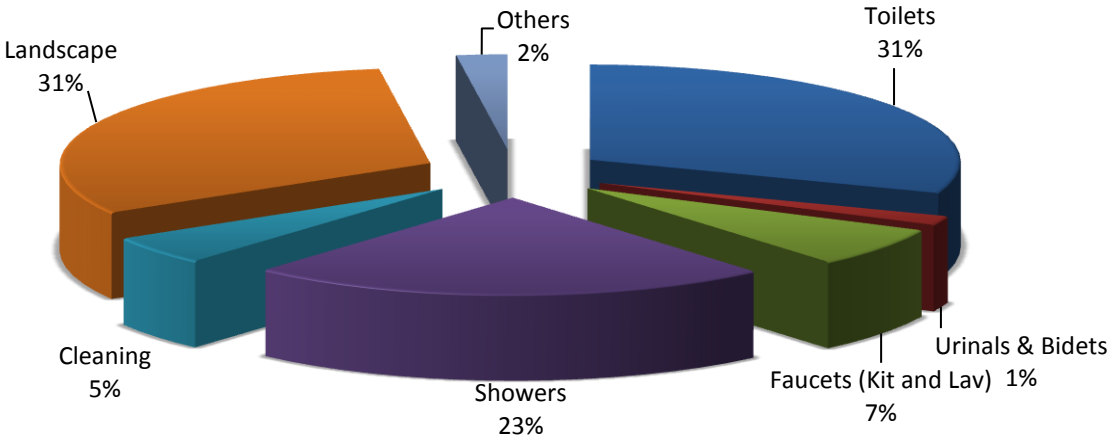

Figure 23: Water use percentages at facility 14

Proposed Measures

Toilets

Toilet tanks should be retrofitted with 6.0 lpf or less fixed-volume flush mechanisms that prevent an end-user or maintenance worker to adjust the amount of water delivered. The University can choose to replace the entire fixture (depending on the designed flush volume of the bowl, or swap out the adjustable ball/tower float in the existing tank for a fixed-volume tower float. To further reduce consumption, the school should consider installing 3L/6L dual-flush toilets.

Lavatory & Kitchen Faucets

Faucet flow rates are high compared to industry standards and other IC audit results. By retrofitting lavatory faucets with pressure-compensating less or equal 4.5 lpm flow controls, the facility could achieve significant savings. Additionally it is recommended to install less or equal 8.3 lpm kitchen aerators.

Showerheads

As discussed above, retrofitting these units with pressure compensating, less or equal 7.6lpm shower heads can reduce shower consumption per fixture at by over 50%. Installing more efficient showerheads that aerate water as it passes through the head should also improve customer satisfaction, providing more pressure than the existing units that generate a deluge stream. This is an inexpensive measure that will save considerable water and energy.

Urinals

Urinals flush at a rate of 2.0 lpf, these units should be retrofitted with 1.0 lpf mechanisms.

Irrigation

High water consumption landscape, especially grass areas need to be replaced by water-wise vegetation applying xeriscaping principles.

Potential Domestic Savings

Building Domestic Subtotals - Consumption m³/year (Pre Program)	
Toilet consumption per year	4,733
Urinal consumption per year	88
Bidet consumption per year	152
Lavatory consumption per year	922
Shower consumption per year	3,524
Kitchen faucet consumption per year	101
TOTAL DOMESTIC CONSUMPTION	9,520

Building Domestic Subtotals - Consumption m³/year (Post-Program)	
Toilet consumption per year	2,869
Urinal consumption per year	44
Bidet consumption per year	77
Lavatory consumption per year	553
Shower consumption per year	1,339
Kitchen faucet consumption per year	83
TOTAL DOMESTIC CONSUMPTION POST-PROGRAM	4,965

Based in the above calculations, if the facility implements the recommended measures it will reduce consumption by 4,555 m^3 per year that is around 29 % of savings of the total water use.

5.2 Water Use Baseline

The water use baseline for each end use (faucets, toilets, irrigation, cleaning, bidets…) was determined based on the average percentages of each facility type, and presented respectively for schools and universities in figure 29 and 30. These figures show that the highest water at the audited schools occurs at toilets (61%), followed by faucets (16%), cleaning (9%), landscape (5%), Softeners (3%), and urinals and bidets (2%). For the audited universities the major water also takes place at toilets (36%), followed by cleaning (18%), faucets (15%), landscape (14%), showers (12%), and urinals and bidets (2%).

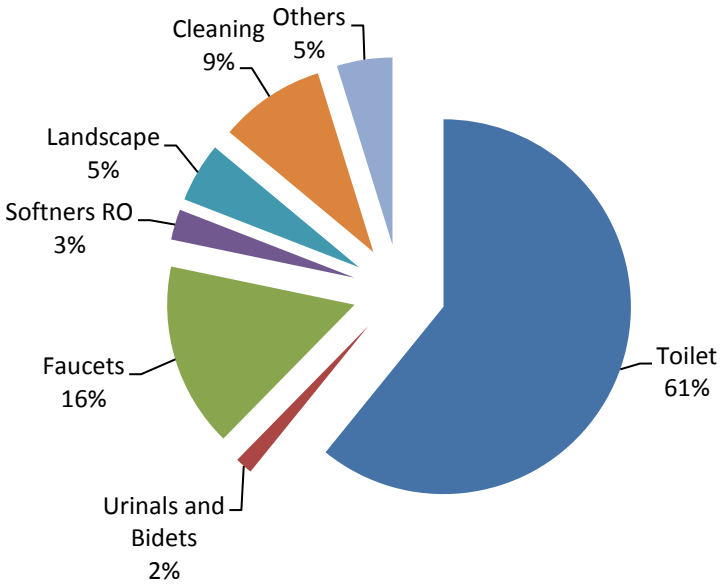

Figure 29: Baseline water use for Schools

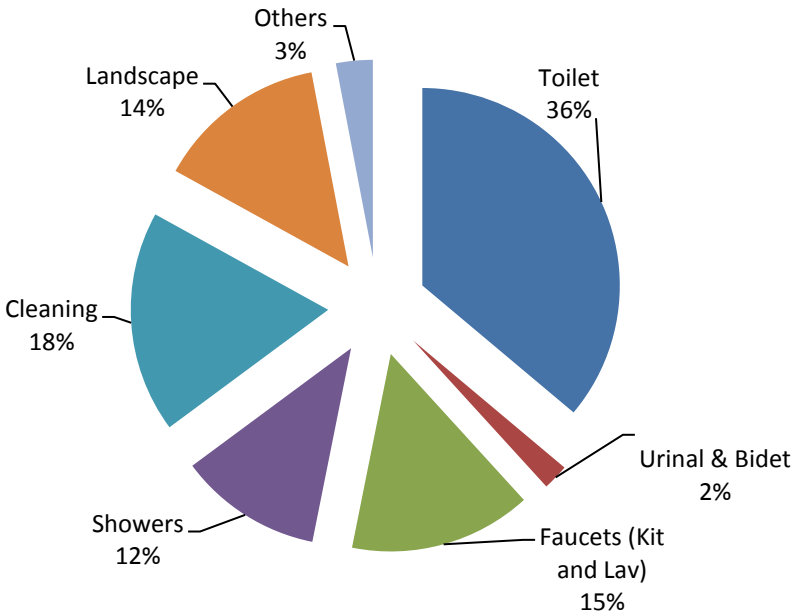

Figure 30: Baseline water use for Universities

5.3 Cost Effectiveness Calculation

Cost effectiveness was conducted for the audited facilities based on the potential savings resulting from the adoption of the recommended measures, and the cost of water and wastewater based on the commercial tariff (1.56 JD/m^3). However, the three universities that were audited had private wells and the cost of water was calculated for each university based on the reported pumped water cost. The interest rate used for the calculation is 7% and the present value of the water saved was calculated based on the initial cost and the life time of the fixture. Cost of energy, which is embedded in the cost of water, was estimated at around 4.25 JD/m^3.

The savings (JD/Year) was calculated as follows = Number of uses per day (for example, number of flushes per day) x amount of saving per use (m^3) x number of days facility occupied per year x cost of water per m^3.

Cost of Retrofit = Number of fixtures at the facility x Cost of replacing existing fixture.

Cost effectiveness calculations for retrofit of toilets and faucets are presented in Tables 15 and 16 respectively for the audited schools and universities that have water saving potential. The cost of the fixture and its installation was estimated at JD150, JD25, and JD2.5 for toilet, toilet trim, and faucet aerator; respectively. The life time is 20 years for the toilet and 5 years for the faucet aerator and toilet trim. The toilet trim replacement is given as an option for users in case the toilet replacement is not cost-effective. Cost analysis for fixtures without installation, assuming that it is done by the facility staff, is also presented.

For schools, Table 15 shows that the faucets retrofit is the most cost effective with a payback period, with installation, ranging from approximately 1.7 month for facility one to 4.3 months for facility four. Without installation, the payback period drops to 10 days for facility one and 25 days for facility four. Toilets replacement is only cost effective for facility six and facility three where the payback period with installation is around 4 months for the former and 2.5 years for the latter. With no installation, the payback period is 2.6 months for facility six and 2.0 years for facility three. On the other hand, replacement of the toilet trim is highly feasible with a payback period with installation varying from approximately 20 days for facility six to 2.3 years for facility four.

For universities, Table 16 indicates that the faucets retrofit is also the most cost effective with a payback period, with installation, ranging from approximately 22 days for facility ten to 14.4months for facility eleven. Without installation, the payback period drops to 4.5 days for facility nine and 2.8 months for facility eleven. Toilets replacement is only cost effective for facility ten where the payback period with installation is around 1.5 years, and approximately 1.0 year with no installation. On the other hand, replacement of the toilet trim is feasible for all the audited universities.

Cost analysis is also carried out for showers at the universities where retrofitting of shower heads including cost of installation is highly cost effective with a payback period less than one month as illustrated in Table 16.

Table 15: Cost effectiveness calculations for Schools

		Quantity of Equpment in Facility	Efficient Use Rate		Existing Average Use Rate	Unit of Use Per day	No of Days Equipment Used per Year	Life of Equipment (years)	Incremental Cost for Efficient Equipment (JD)	Total Incremental Cost for Efficient Equipment (JD)	Unit Cost of Replacing Existing Equipment (JD)	Total Cost of Replacing Existing Equipment	Estimated Water Savings per Day (liters)	Water Savings per Year (cubic meters)	Perecnt Hotwater	Weighted Price of Water	Value of Water and Wastewater Savings per Year (JD) Incl. Energy	Present Value of Water Saving Over Life of Measure (JD) (Incl. Energy)	Payback for Replacing Inefficient Equipment without installation (Months)	Payback for Replacing an Existing Equipment with installation (Months)
Facility no. 1	Toilet (3l/6l)	12	4	ave. liters per flush	6	153	190	20	100	1,200	150	1,800	306	58	0%	1.56	90.70	1,813.97	158.77	238.15
	Toilet Trims	12	4	ave. liters per flush	6	153	190	5	20	240	25	300	306	58	0%	1.56	90.70	453.49	31.75	39.69
	Faucet Aerators	12	4.5	lpm	6.23	232	190	5	0.5	6	2.5	30	401.36	76	30%	2.84	216.19	1,080.96	0.33	1.67
	Total for All Equipment									6		30						1,081		
Facility no. 2	Toilet (3l/6l)	36	4	ave. liters per flush	6	1789	194	20	100	3,600	150	5,400	3,578	694	0%	1.56	1,082.85	21,656.92	39.89	59.84
	Toilet Trims	36	4	ave. liters per flush	6	1789	194	5	20	720	25	900	3,578	694	0%	1.56	1,082.85	5,414.23	7.98	9.97
	Total for All Equipment									#REF!		#REF!						#REF!		
Facility no. 3	Toilet (3l/6l)	82	4	ave. liters per flush	7.1	4963	190	20	100	8,200	150	12,300	15,380	2,922	0%	1.56	4,558.73	91,174.64	21.58	32.38
	Toilet Trims	82	4	ave. liters per flush	7.1	4963	190	5	20	1,640	25	2,050	15,380	2,922	0%	1.56	4,558.73	22,793.66	4.32	5.40
	Faucet Aerators	100	4.5	lpm	7.6	1425	190	5	0.5	50	2.5	250	4,358	828	30%	2.84	2,347.25	11,736.24	0.26	1.28
	Total for All Equipment									9,890		14,600						125,705		
Facility no.4	Toilet (3l/6l)	40	4	ave. liters per flush	4.9	1348	190	20	100	4,000	150	6,000	1,180	224	0%	1.56	349.60	6,992.08	137.30	205.95
	Toilet Trims	40	4	ave. liters per flush	4.9	1348	190	5	20	800	25	1,000	1,180	224	0%	1.56	349.60	1,748.02	27.46	34.32
	Faucet Aerators	30	4.5	lpm	6.1	256	190	5	0.5	15	2.5	75	404	77	30%	2.84	217.87	1,089.37	0.83	4.13
	Total for All Equipment									4,815		7,075						9,829		
Facility no.6	Toilet (3l/6l)	12	4	ave. liters per flush	6	6980	240	20	100	1,200	150	1,800	13,960	3,350	0%	1.56	5,226.62	104,532.48	2.76	4.13
	Toilet Trims	12	4	ave. liters per flush	6	6980	240	5	20	240	25	300	13,960	3,350	0%	1.56	5,226.62	26,133.12	0.55	0.69
	Urinals	12	1	lpm	1.5	470	240	20	80	960	120	1,440	235	56	0%	1.56	88	1,760	130.9	196.4
	Total for All Equipment									2,400		3,540						132,425		

Table 16: Cost effectiveness calculations for Universities

		Quantity of Equpment in Facility	Efficient Use Rate		Existing Average Use Rate	Unit of Use Per day	No of Days Equipment Used per Year	Life of Equipment (years)	Incremental Cost for Efficient Equipment (JD)	Total Incremental Cost for Efficient Equipment (JD)	Unit Cost of Replacing Existing Equipment (JD)	Total Cost of Replacing Existing Equipment	Estimated Water Savings per Day (liters)	Water Savings per Year (cubic meters)	Perecnt Hotwater	Weighted Price of Water	Value of Water and Wastewater Savings per Year (JD) Incl. Energy	Present Value of Water Saving Over Life of Measure (JD) (Incl. Energy)	Payback for Replacing Inefficient Equipment without installation (Months)	Payback for Replacing an Existing Equipment with installation (Months)
Facility no. 9	Toilet (3l/6l)	250	4	ave. liters per flush	7.8	15572	280	20	100	25,000	150	37,500	58,722	16442	0%	1.56	25,650	512,995	11.70	17.54
	Toilet Trims	250	4	ave. liters per flush	7.8	15572	280	5	20	5,000	25	6,250	58,722	16442	0%	1.56	25,650	128,249	2.34	2.92
	Faucet Aerators	300	4.5	lpm	7.4	2521	280	5	0.5	150	2.5	750	7,253	2,031	30%	2.84	5,757	28,787	0.31	1.56
	Showers	50	7.6	lpm	11.0	3200	280	5	0.5	25	2.5	125	10,880	3,046	30%	2.84	8,637	43,183	0.03	0.17
	Total for All Equipment					36865				150		750						28,787		
Facility no. 10	Toilet (3l/6l)	300	4	ave. liters per flush	7.7	26665	190	20	100	30,000	150	45,000	99,247	18857	0%	1.56	29,417	588,337	12.24	18.36
	Toilet Trims	300	4	ave. liters per flush	7.7	26665	190	5	20	6,000	25	7,500	99,247	18857	0%	1.56	29,417	147,084	2.45	3.06
	Faucet Aerators	300	4.5	lpm	7.3	7801	190	5	0.5	150	2.5	750	22,155	4209	30%	2.84	11,934	59,669	0.15	0.75
	Showers	50	7.6	lpm	11.0	2800	190	5	0.5	25	2.5	125	9,520	1,809	30%	2.84	5,128	25,640	0.06	0.29
	Total for All Equipment					63931				36,150		53,250						795,090		
Facility no. 11	Toilet (3l/6l)	378	4	ave. liters per flush	6.6	4303	200	20	100	37,800	150	56,700	11,188	2238	0%	1.56	3,491	69,812	129.95	194.92
	Toilet Trims	378	4	ave. liters per flush	6.6	4303	200	5	20	7,560	25	9,450	11,188	2238	0%	1.56	3,491	17,453	25.99	32.49
	Faucet Aerators	420	4.5	lpm	7.5	514	200	5	0.5	210	2.5	1,050	1,542	308	30%	2.84	874	4,372	2.88	14.41
	Showers	50	7.6	lpm	20.0	441	200	5	0.5	25	2.5	125	5,465	1,093	30%	2.84	3,098	15,492	0.10	0.48
	Urinals	100	1	lpm	2	267	200	20	80	8,000	120	12,000	267	53	0%	1.56	83	1,666	1152.4	1728.6
	Total for All Equipment					73051				45,570		67,200						91,636		
Facility no.12	Toilet (3l/6l)	498	4	ave. liters per flush	6.6	3585	200	20	100	49,800	150	74,700	9,321	1864	0%	1.56	2,908	58,163	205.49	308.24
	Toilet Trims	498	4	ave. liters per flush	6.6	3585	200	5	20	9,960	25	12,450	9,321	1864	0%	1.56	2,908	14,541	41.10	51.37
	Faucet Aerators	481	4.5	lpm	7.5	615	200	5	0.5	241	2.5	1,203	1,845	369	30%	2.84	1,046	5,231	2.76	13.79
	Shower heads	18	7.6	lpm	20	441	200	5	0.5	9	2.5	45	5,465	1093	50%	3.69	4,027	20,137	0.03	0.13
	Urinals	50	1	lpm	2	221	200	20	80	4,000	120	6,000	221	44	0%	1.56	69	1,379	696.1	1044.2
	Total for All Equipment					8225.7				60,010		88,398						98,072		
Facility no.13	Toilet (3l/6l)	301	4	ave. liters per flush	4.6	11157	280	20	100	30,100	150	45,150	6,806	1906	0%	1.56	2,973	59,455	121.50	182.25
	Toilet Trims	301	4	ave. liters per flush	4.6	11157	280	5	20	6,020	25	7,525	6,806	1906	0%	1.56	2,973	14,864	24.30	30.38
	Faucet Aerators	428	4.5	lpm	7.7	3399	280	5	0.5	214	2.5	1,070	10,717	3001	30%	2.84	8,507	42,536	0.30	1.51
	Urinals	60	1	lpm	2.0	769	280	20	80	4,800	120	7,200	784	220	0%	1.56	343	6,852	168.1	252.2
	Total for All Equipment					33938.7				36,334		53,745						116,855		
Facility no.14	Toilet (3l/6l)	382	4	ave. liters per flush	6.6	3585	200	20	100	38,200	150	57,300	9,321	1864	0%	1.56	2,908	58,163	157.63	236.44
	Toilet Trims	382	4	ave. liters per flush	6.6	3585	200	5	20	7,640	25	9,550	9,321	1864	0%	1.56	2,908	14,541	31.53	39.41
	Faucet Aerators	360	4.5	lpm	7.5	615	200	5	0.5	180	2.5	900	1,845	369	30%	2.84	1,046	5,231	2.06	10.32
	Shower heads	6	7.6	lpm	20	881	200	5	0.5	3	2.5	15	10,924	2185	50%	3.69	8,051	40,256	0.00	0.02
	Urinals	80	1	lpm	2.0	218	200	20	80	6,400	120	9,600	222	44	0%	1.56	69	1,388	1107.0	1660.5
	Total for All Equipment					8666				46,023		67,765						118,191		

6. Conclusion

Based on the end-use analysis study of the educational facilities, following are the conclusions:

1. The major water uses at the audited schools are toilets (61%), faucets (16%), cleaning (9%), Landscape (5%), Softeners (3%), and Urinals and bidet (2%).
2. The major water uses at the audited universities are toilets (36%), cleaning (18%), faucet (15%), landscape (14%), showers (12%), and Urinals and bidets (2%).
3. Three out of the eight audited schools use water efficiently and do not currently require retrofitting. The remaining five schools have potential water saving from domestic water use ranging from 9% to 24% of the total annual water use. Three of the schools have a potential saving of approximately equal or more than 20%.
4. All the audited universities need to apply water efficiency practices. The range of potential water saving from the domestic water from 14% to 29%, and exceeds 20% for five out of the six universities.
5. Retrofitting faucets is proven to be economically feasible for both the audited schools and universities; the payback period in most cases is less than five months and it can be as low as approximately three weeks.
6. Replacing inefficient showerheads at the audited universities is highly cost effective with a payback period ranging from few days to 1.5 months.
7. Replacing inefficient toilets is cost effective only for three schools and two universities. However, replacing toilet trims or flushing system is found to be generally cost effective.
8. Landscape irrigation is highly inefficient in most of the audited schools and universities which have watered landscape. Most of the irrigation is done manually through a hose with obvious wastage of water.
9. Two of the audited schools and one university have swimming pools. Potential water saving at swimming pools can be reached by improving backwashing practices and reducing evaporation.

7. Recommendations

Based on the end-use analysis study, following are the recommendations for the schools and universities,

1. Install WSDs for all faucets that use more than 4.5 lpm. Tamper proof pressure compensating flow controllers should be considered.
2. Replacing toilets is only recommended when economically feasible; otherwise retrofitting toilet trims should be practiced.
3. In office buildings where there is an intensive use of RO systems, it is recommended to use systems that have a 1:1 product to reject ratio.
4. Use backwashing and evaporation reduction best practices to improve water use efficiency in swimming pools.
5. Provide regular maintenance and repair for all plumbing fixtures including toilet flushing valves and faucets, and leak detection via dye testing.
6. In the case of universities and schools with large landscape areas, it is recommended to use non-conventional water resources for irrigation, such as rainwater harvested from roof tops and treated waste water. High water consumption landscape, especially grass areas need to be replaced by water-wise vegetation applying xeriscaping principles.
7. Conduct awareness programs targeting schools and universities students to increase their knowledge of how to use water more efficiently in their facilities.
8. Conduct regular water audits at schools and universities to identify areas of water saving, and develop and implement water efficiency programs.

8. Appendices

8.1 Appendix A

Audit Survey Form

Date: _____ التاريخ: Auditor: _____ المحقق/ المدقق:

Name of facility: إسم المنشأ:

Operational Company Name:_____ إسم الشركة التشغيلية

Address: _____ العنوان:

Manager name: _____ إسم مدير المنشأ Telephone: _____ الهاتف

FAX: _____ الفاكس

e-mail address: _____ البريد الإلكتروني

Date facility built: _____ تاريخ بناء المنشأ

Census and occupancy data based on daily averages for year (answer where applicable):

- Number of buildings the facility is composed of_____ عدد المباني التي تتكون منها المنشأة
- Total area of each building:_____ المساحة الإجمالية لكل مبنى
  1.
  2.
- Number of faculties _____ عدد الكليات
- Number of staff :_____ عدد الموظفين; % Male _____ نسبة الذكور
- Number of students: _____ عدد الطلاب; % Male _____ نسبة الذكور
  - % of students that live on campus: _____ نسبة الطلاب الذين يعيشون في الحرم الجامعي أوالمدرسة
- Average number of visitors per day: _____ متوسط عدد الزائرين في اليوم
- Number of days per year operational: _____ عدد أيام الإشغال سنوياً

يرجى الحصول على المخططات التالية:

1. **التمديدات الصحية ومخططات الطوابق المختلفة**

Engineering drawings (Plumbing drawings and floor plans)

2. **مخططات المساحة الخارجية المزروعة**

Irrigation drawings (irrigation engineering drawings, if available, otherwise site maps including general landscaping information

ACTIVITY AND EQUIPMENT CHECKLIST (check or fill in all that are applicable)

❑ Main Kitchen Operations عمليات المطبخ الرئيسية

عَدد الوجبات المقدمة في اليوم الفطور _____ الغداء_____ العشاء_____غير ذلك _____

- No. of meals/day served Breakfast: ____, Lunch: ____ Dinner:__ Other: ____

عَدد الوجبات المقدمة في الصحون _____ عِدّد (أدرج) الوجبات المقدمة في الصحون القابلة للإتلاف_____

- Number of meals served on china___ Number served on disposable ware_____

❑ FOOD SERVICE ITEMS بنود خدمات الطعام

- Water cooled refrigeration equipment معدات التبريد التي تعمل بإستخدام المياه المبردة
- Water cooled ice makers معدات صنع الثلج التي تعمل بإستخدام المياه المبردة
- Air cooled ice makers (Including remote head units) معدات صنع الثلج التي تعمل بإستخدام الهواء المبرد (وتشمل وحدة التحكم عن بعد)
- Freezers الفريزرات
- Steam tables طاولات بخار
- Boilerless Steamer مبخرة بدون مرجل لتوليد البخار
- Boiler type Steamer مولدات بخار بإستخدام المراجل
- Combination ovens الأفران التجميعية
- Steam kettles غلايات البخار
- Garbage grinders (disposers) مطاحن القمامة (والتخلص منها)
- Dish Washer/Ware-washer غسالات أطباق
- Three compartment sinks مجلى بثلاثة مصارف
- Pot soaker مجلى لنقع الطناجر
- Pulper مستأصل اللب
- Sluice trough to garbage grinder (disposal) حوض صغير لطحن القمامة
- Pre-rinse spray with shutoff رشاش ما قبل الشطف مع قاطع للتيار الكهربائي أتوماتيكي
- Confectionary faucet – (ice cream scoop sink & faucet) صنبور حلويات – (صنبور و حوض للمثلجات)
- Faucets drip حنفيات تنقيط
- Thaw meat in sink إذابة اللحوم المجمدة في أحواض الجلي
- Water left running الصب المتواصل للمياه
- Kitchen floors hosed down at end of day ترك خرطوم المياه على أرضية المطبخ عند الشطف
- Other غيرها

_____

❑ WATER TREATMENT معالجة المياه

- Water Softener جهاز تنقية المياه من الشوائب
- Reverse Osmosis جهاز تنقية المياه من الأملاح باستخدام التناضح العكسي
- Water Stills أجهزة تقطير المياه
- Ultra-pure Water System نظام للتنقية القصوى للمياه
- Other غيرها

❑ LABORATORY EQUIPMENT أدوات المختبر

- Vacuum autoclaves without water tempering device
- Vacuum autoclaves with water tempering device
- Gravity autoclaves without water tempering device
- Gravity autoclaves with water tempering device
- Air cooled compressors (no water use)
- Water cooled and sealed air compressors

❑ MECHANICAL EQUIPMENT المعدات الميكانيكية

- Air conditioned facility – tons _____ مكيفات الهواء – السعة بالطن
- Cooling towers – tons_____ أبراج تبريد –السعة بالطن
- Contract for cooling water treatment إتفاقية لمعالجة المياه المستخدمة في التبريد
- Contract specifies cycles of concentration for cooling tower إتفاقية تحدد دوائر التركيز لبرج التبريد

  - أنظمة التبريد والتدفئة بإستخدام وحدة تبريد وتدفئة مركزي مغلقة
- Closed loop chilled/hot water system for heating and cooling

  - جمع وإعادة استخدام مبردات الهواء بأبراج التبريد لأغراض الري
- Collect and reuse air conditioner condensate for irrigation of cooling towers

  - أبراج تحتوي على عداد لقياس كميات المياه المضخوخة لبرج التبريد بهدف تعويض الفاقد
- Towers equipped with a makeup meter

- Towers equipped with bleed off or blowdown meters
- Towers equipped with conductivity controllers

❑ RESTROOM ROOMS الحمامات

- Number of toilets _____ عدد المراحيض
  - التدفق (لتر /الدفقة) (إختر واحدة مما يلي)

  6 لتر /الدفقة 13.25 لتر /الدفقة أعلى من 13.25 لتر /الدفقة
- Litters per flush (circle one) 6.0 lpf 13.25 lpf Over 13.25 lpf

- Number of urinals _____ عدد المبولات
- Litters per flush (circle one) 3.8 lpf 7.6 lpf Over 7.6 lpf لتر بالدفقة (إختر واحدة مما يلي)

- Number of showers _____ عدد الدوشات
- Shower flow rate _____ lpm معدل تدفق الدوش _____ لتر/ دقيقة

- Number of hand washing lavatories عدد المغاسل (لغسل اليدين)
- Flow rate of aerators _____ lpm معدل تدفق أجهزة الإشباع بالهواء (لتر/ دقيقة)

- Other water using fixtures or appliances أي تركيبات أو قطع أخرى تستخدم للمياه

_____

❑ LOCKER ROOMS

- Number of toilets _____ عدد المراحيض
- Litters per flush (circle one) 6.0 lpf 13.25 lpf Over 13.25 lpf لتر بالفورة (إختر واحدة مما يلي)
- Number of urinals _____ عدد المبولات
- Litters per flush (circle one) 3.8 lpf 7.6 lpf Over 7.6 lpf لتر بالفورة (إختر واحدة مما يلي)
- Number of showers _____ عدد الدوشات
- Shower flow rate _____ lpm معدل تدفق الدوش _____ لتر/ دقيقة
- Number of hand washing lavatories عدد المغاسل (لغسل اليدين)
- Flow rate of aerators _____ lpm معدل تدفق أجهزة الإشباع بالهواء (لتر/ دقيقة)
- Clothes washer غسالات الملابس
- Hot tub or Jacuzzi أحواض ساخنة أو جاكوزي

Other water using fixtures or appliances أي تركيبات أو قطع أخرى تستخدم للمياه

_____

❑ LANDSCAPE المساحات الخارجية

- Landscape irrigation ري الحدائق(غير المساحات المخصصة للرياضة)

  - جدول الري – عدد المرات بالأسبوع _____ عددالدقائق لكل منطقة _____
  - Irrigation schedule – use per week _____ minutes per zone _____

  - مساحة المرج (متر مربع):____ __مساحة الأحواض (مثل أحواض الزهور) - متر مربع _____
  - Square meters of turf: _____ Square meters of beds: _____
  - Type of turf: _____ نوع المرج
  - Installed sprinkler system (Yes) (No) نظام ري بالرشاشات؟ (نعم) (لا)
- Managed by Landscape Company (Yes) (No) تديرهُ شركة مختصة؟ (نعم) (لا)
- Condition of irrigation system :_____ وضع نظام الري

- Type of plant material: _____ نوع النباتات المزروعة
- Soil depth: _____ عمق التربة
- Opportunity for rainwater harvesting: _____هل هناك فرصة لتخزين مياه الأمطار

  - هل هناك إستخدام للمياه غير الصالحة للشرب لري المزروعات _____
- Opportunity for non-potable sources of irrigation water _____
  _____

❑ SWIMMING POOLS, THERAPY POOLS AND SPAS برك سباحة، برك علاج، ومنتجعات إسترخاء علاجية

- Water meter on makeup هل يوجد عداد لقياس المياه المفقودة من البركة
- Total volume _____الحجم الكلي, Surface area:___ _____مساحة السطح
- Heated pool; temperature_____ درجة حرارة البرك المدفأة

  - ما هي ميكانيكية سحب المياه من البركة لتنظيف الفلاتر؟ هل يتم تفعيلها عند إنخفاض الضغط أي بدون استخدام المؤقت؟ __
- Backwash set by pressure drop and not timer _____
  - هل يتم إعادة استخدام هذه المياه لري المزروعات_____
- Backwash water reused for irrigation_____
  - هل يتم تغطية البرك الساخنة عندما لا تكون مستخدمة منعاً للتبخر_____
  -

❑ Hot tubs covered when not in use to prevent evaporation___

❑ DECORATIVE FOUNTAINS AND WATER FEATURES ديكورات النوافير ومعالم مائية اخرى مع التصوير

- Describe decorative fountains _____ وصف موجز للنوافير إن وجدت
- Describe ponds, streams, etc. _____...وصف للجداول ، برك تجمع المياه وما الى ذلك
- Describe other features _____وصف المعالم الاخرى

المصارف الخارجية و التنظيف (مواقف سيارات، مباني، مناطق القمامة والنفايات، وما الى ذلك)

❑ OUTSIDE WASHDOWN AND CLEANING (parking lot, building, dumpster area, etc.)

- Pressure washer used (Yes) (No) هل يتم استخدام آلة غسيل تعمل بالضغط (نعم) (لا)
- Garden hose used (Yes) (No) هل يتم استخدام خرطوم مياه حديقة (نعم) (لا)

  - إذا كان الجواب على البند السابق نعم، هل الخرطوم معد بفوهة إغلاق (nozzles) (نعم) (لا)
- Shut-off nozzles on hose, if hose used (Yes) (No)

  - هل يمكن استبدال أعمال التنظيف الخارجية التي تستخدم المياه بأدوات التكنبس أو النفخ (للاوراق مثلاً) (نعم) (لا)

- Can sweeping & blowing substitute for outdoor cleaning? (Yes) (No)

- هل يوجد لديكم معدات لغسل السيارات أو المركبات (نعم) (لا)
- Car or vehicle washing equipment? (Yes) (No)

Other outdoor uses: _____ غيرها من الاستخدامات الخارجية

❑ LAUNDRY FACILITIES منشآت الغسيل

- Number washers available for use _____ عددالغسالات المتوفرة للاستعمال
- Number of loads washed per month _____ ما هو عدد الأحمال في الشهر
- On Premise Commercial Laundry Equipment هل يتم استخدام معدات غسيل لأغراض تجارية في الموقع
  a. Capacity (Kilo) for each _____ القدرة الاستيعابية للغسالة (كيلو)

  عدد الأحمال للملابس ذات الأوساخ الخفيفة لكل يوم _____
  b. Number of loads per day for lightly soiled items _____

  عدد الاحمال ذات الأوساخ الثقيلة لكل يوم _____
  c. Number of loads per day for heavily soiled items _____

  يوجد إعادة تدوير للمياه أو هل يتم استخدام معدات للمعالجة بالأوزون (نعم) (لا)
  d. Water recycle or ozone equipment used (yes) (No)

❑ CLEANING AND OTHER INDOOR USES التنظيف والإستخدامات الداخلية الأخرى

- نظافة الخزائن التي يحتفظ فيها بمواد وأدوات التنظيف ووضع أحواض الغسيل من حيث النظافة _____ _____
- Janitorial closet or sink condition:_____

- عدد المرات التي يتم فيها المسح في اليوم _____ مصدر المياه الخاصة بالمسح_____ إستخدام الخرطوم العادي للشطف _____
- Moping/Day: _____ Source of mop water:__ _____ Hose down: _____

- إذا كان الخرطوم هو المستعمل ، هل يوجد عليه فوهة رشاش (نعم) (لا) وما هو مقدار التدفق _____ لتر / دقيقة
- Does hose have spray nozzle (yes) (no) – what is flow rate ____ litter per minute

- هل هو من النوع الذي يستخدم أنبوب معقم مائي (نعم) (لا)
- Floor cleaning machine (wet vacuum type) (yes) (no)
- Water broom (yes) (no) هل يوجد مكنسة تستخدم المياه (نعم) (لا)

TOTAL WATER USAGE

Total Metered Water Use:

Main Meter Units (thousands of liters, cubic meters, etc.) _____

وحدات العداد الرئيسي (الاف الليترات، مترات مكعبة، إلخ) _____

Amount for last year: الكمية للسنة الماضية

January كانون الثاني	**February شباط**	**March اذار**	**Q1 (total)**
April نيسان	**May أيار**	**June حزيران**	**Q2 (total)**
July تموز	**August اب**	**September أيلول**	**Q3 (total)**
October تشرين الأول	**November تشرين الثاني**	**December كانون الأول**	**Q4 (total)**

Water purchased from private sources المياه التي تم شراؤها من مصادر خاصة

Main Meter Units (thousands of liters, cubic meters, etc.) _____

وحدات العداد الرئيسي (الاف الليترات، مترات مكعبة، إلخ) _____

Amount for last year: الكمية للسنة الماضية

January كانون الثاني	**February شباط**	**March اذار**	**Q1 (total)**
April نيسان	**May أيار**	**June حزيران**	**Q2 (total)**
July تموز	**August اب**	**September أيلول**	**Q3 (total)**
October تشرين الأول	**November تشرين الثاني**	**December كانون الأول**	**Q4 (total)**

Other water sources **مصادر المياه الأخرى**

Main Meter Units (thousands of liters, cubic meters, etc.) _____

وحدات العداد الرئيسي (الاف الليترات، مترات مكعبة، إلخ) _____

Amount for last year: **الكمية للسنة الماضية**

January كانون الثاني	**February شباط**	**March اذار**	**Q1 (total)**
April نيسان	**May أيار**	**June حزيران**	**Q2 (total)**
July تموز	**August اب**	**September أيلول**	**Q3 (total)**
October تشرين الأول	**November تشرين الثاني**	**December كانون الأول**	**Q4 (total)**

List Sources: _____ **عدد المصادر**

8.2 Appendix B

List of Organizations and Firms that participated in the Audits:

- Water Demand Management Unit (WDMU) of the Ministry of Water and Irrigation (MWI)
- Water Authority of Jordan (WAJ)
- Northern Governorates Administration (NGWA)
- Miyahuna
- Aqaba Water Company (AWC)
- Royal Scientific Society (RSS)
- National Energy Research Center (NERC)
- JUST University
- Consolidated Consultants (CC)
- Center for Engineering Consultancy (CEC)
- ME POWER
- Orient for Engineering Consultancy and Design
- ECO Consult
- Energy Management Services (EMS)
- Green Tech for Sustainable Environment
- Inter-Disciplinary Research Consultant (IDRC)
- Total H2O
- Engicon