9 WATER MANAGEMENT

WATER MANAGEMENT INDICATORS

Table 9. Water Management Indicators for Carnegie Mellon, FY 2004

Report Section	Indicator	Reason	FY2004	Units
Water Supply				
9.1.1	Annual total water use of campus	Indicates water use on campus and any annual change	106,202	kgal/yr
9.1.1	Per capita water use for whole campus	Indicates water use on a per person basis	20.81	gal/person/day
9.1.1	Per square footage use for whole campus	Indicates water use on a building area basis	0.066	gal/sqft/day
9.1.1	Per capita water use for Housing buildings	Indicates water use in Housing buildings only on a per resident basis	41.08	gal/student/day
9.1.2	Total number of buildings on campus	Background Information	60	#
9.1.2	Number of Housing buildings that have individual use data	Indicate the number of Housing buildings that have individual meters for water use data collection	11	#
9.1.2	Number of academic/administrative buildings that have individual meters	Indicate the number of academic/administrative buildings that have individual meters for water use data collection	14	#
9.1.2	Number of PWSA meters	Indicates the number of PWSA meters that can be used for data collection	84	#
9.1.2	Number of internal water meters	Indicates the number of internal (Carnegie Mellon) meters that can be used for data collection	11	#
9.1.2	Meter-to-building ratio	Indicates the number of meters per building	1.6	# meters/# buildings
9.1.3	Per capita use for Housing buildings that have individual meters	Indicates the actual use of water by residents in University Housing	118.78 – 28.84; 64.44	high-low; average gal/student/day
	Westwing		43.8	gal/student/day
	Doherty Apt.		43.6	gal/student/day
	Donner		40.33	gal/student/day
	Fraternities		70.81	gal/student/day
	Morewood		55.96	gal/student/day
	Mudge		45.15	gal/student/day
	Neville		94.74	gal/student/day

Report Section	Indicator	Reason	FY2004	Units
	Roberts Engineering Hall		0.116	gal/sqft/day
	Wean Hall		0.131	gal/sqft/day
	Purnell		0.026	gal/sqft/day
	Warner Hall		0.03	gal/sqft/day
	University Center (UC)		0.092	gal/sqft/day
	407 South Craig		0.0438	gal/sqft/day
	University Technology Development Center (UTDC)		0.0253	gal/sqft/day
	Old student center		0.0274	gal/sqft/day
	Alumni House		0.052	gal/sqft/day
	Bramer		0.0603	gal/sqft/day
	Cyert Hall		0.0322	gal/sqft/day
	Skibo Gym		0.0228	gal/sqft/day
	Mellon Institute		0.0149	gal/sqft/day
	Whitfield Hall		0.0398	gal/sqft/day
9.1.4	Annual total cost of water for whole campus		$675,808	$
9.1.4	Per capita cost of water for whole campus	Cost per person for the campus	$48.34	$/person
9.1.4	Per square foot cost of water for whole campus	Cost per square foot for the campus	$0.15	$/sqft
9.1.4	Price of water per 1000 gallons	Unit cost of water	$7.43	$/kgal
Wastewater				
9.2.1	Annual total wastewater generated	Indicates quantity of wastewater generated	78,797	kgal/yr
9.2.1	Wastewater generated per capita for whole campus	Indicates quantity of wastewater generated per person	15.44	kgal/person/day
9.2.1	Wastewater generated per square foot for the whole campus	Indicates quantity of wastewater generated per square foot	0.049	kgal/sqft/day
9.2.1	Percent of water returned to sewer	Indicates percent of water that is returned to the system	74%	
9.2.2	Annual total cost of wastewater management for whole campus		$218,100.54	$
9.2.2	Per capita cost for whole campus	Cost per person of wastewater management for the campus	$15.60	$/person
9.2.2	Per square footage cost for whole campus	Cost per square foot of wastewater management for the campus	$0.049	$/sqft
9.2.2	Sewer credits earned from cooling towers and lawn sprinklers	Indicates amount of money refunded to the University based on consumptive water use in cooling towers and lawn sprinkler systems	$63,538.25	$
9.2.2	Price of sewage disposal per 1000 gallon	Unit cost of sewage disposal	$2.50	$/kgal
9.2.3	*Amount of wastewater reused*	*Indicates commitment to sewage reduction through reuse*	*FWD*	*Kgal/yr*

Report Section	Indicator	Reason	FY2004	Units
9.2.4	*Number of wastewater discharges monitored for flow*	*Indicates commitment to quantity reduction*	*FWD*	#
Stormwater				
9.3.1	Runoff generated for a 30-min- 2-year return frequency storm	Indicates amount of water that runs off campus after the indicated storm	0.48	inches
9.3.1	Percent of rainfall that runs off as stormwater	Indicates amount of rainfall runoff that does not infiltrate or is not captured by a detention basin	54	%
9.3.2	Stormwater retention capacity	Indicates the capacity for stormwater retention, a measure that will help prevent sewer system overflows	10,000	gal
9.3.2	Number of rainwater storage systems	Indicates the number of rainwater storage systems used to stagger releases and help prevent sewer system overflows	1	#
9.3.2	Number of stormwater mitigation systems	Indicates the total number of stormwater detention and retention systems on campus	3	#
9.3.3	*Amount of stormwater storage for reuse*	*Indicates commitment to reduction of stormwater released to the sewer system through reuse*	*10,000*	*gal*
9.3.4	*Number of stormwater discharges monitored for quality*	*Indicates commitment to stormwater quality*	*0*	#

WATER MANAGEMENT INDICATORS RATIONALE

The way Carnegie Mellon University uses water and returns it to the ecosystem is important for a number of reasons. While water is relatively abundant in the region, Pittsburgh has one of the highest prices for public water supply in the country[75]. Water conservation saves not only water and money, but the energy and chemicals used to treat the water before it is used by the consumer. The City of Pittsburgh has a combined-overflow sewer system that collects stormwater and sewage in the same pipes for treatment. When too much water is brought into the system the pipes overflow by design into streams and rivers along which the sewers run to prevent the treatment plants from being overwhelmed and sewer system backups into homes and commercial buildings. This results in untreated sewage entering the streams and rivers, elevating levels of pathogenic bacteria (such as fecal coliform and e. coli) as well as introducing other contaminants such as motor oil washed off of the roads or chemicals washed off of lawns into the ecosystem. This can cause immediate health dangers to people who wish to use the rivers as recreation, and can create more subtle problems in the form of more complicated water treatment to the 90% of Allegheny County that uses the Monongahela, Allegheny, Ohio and Youghiogheny Rivers as a source of drinking water[76]. It is estimated that about 0.5 inches of rain will cause an overflow event[77], although some sources note that as little as 0.1 inches[78] of rain will suffice. This is because during dry weather as much as 50 to 60 percent of water carried through the combined sewer overflow pipes and treated before discharge is stormwater or groundwater[79], leaving a reduced capacity in the best of conditions for treatment of sewage.

9.1 Water Use

9.1.1 Annual Water Use

The annual quantity of clean water used from the public water supply by Carnegie Mellon University is measured by a series of indicators that compare the water use to campus size and number of people in the campus community. The total quantity of water used is an indicator that

[75] U.S. Water News Online. "Pittsburgh, Penn. leads the country in price of water" February 2000. http://www.uswaternews.com/archives/arcsupply/tpitpen2.html. Accessed 22 January 2005.
[76] Three Rivers Wet Weather Demonstration Program, "Allegheny County Sewer Related Facts and Figures." http://www.3riverswetweather.org/f_resources/facts_sheet.pdf. Accessed 22 January 2005.
[77] Three Rivers Second Nature, "Swimming the River City: Water Quality and Human Contact" http://3r2n.cfa.cmu.edu/Year1/reports/social/SwWater.htm. Accessed 22 January 2005.
[78] Ibid, Footnote 76.
[79] Ibid, Footnote 76.

can be compared yearly to measure increase or decreases in water used. Other indicators are calculated in order to present the annual water use on different scales of measurement. The per capita use of water in Housing buildings is calculated in order to find the average use of a student living in the various residence halls each day. Similarly, the per capita use of water for the entire campus is calculated, but it should be noted that this value will differ significantly from the per capita Housing use, as students in residential housing use water for longer periods of time and for more intensive uses (i.e. showering) than the rest of the campus community. The annual water use indicator is also calculated per square foot of built infrastructure for the entire campus. This value is calculated in order to account for total building area increases due to construction.

9.1.2 Water Meters

There are two major types of meters available for tracking the use of water at Carnegie Mellon. One type is meters placed by the Pittsburgh Water and Sewer Authority (PWSA), and the other is internal meters installed on campus by the University. The number of each of these meters on campus are two indicators of the level of accuracy of information for water use. Using the total number of meters on campus, a meter-to-building ratio can be calculated to indicate the amount of metering coverage there is at Carnegie Mellon. It should be noted that while the meter-to-building ratio is greater than one, this does not mean that each building has a meter. A number of buildings have more than one meter and some meters may track water flow through more than one building.

9.1.3 Annual Water Used by Buildings with Metering Data

While the majority of buildings on the Carnegie Mellon campus do not have metering information, for those that do it is possible to calculate more exactly the annual water use. One use of the metering data is to calculate the average daily use per student in Housing buildings. Figure 9-1 shows the different range in water use at metered Housing buildings at Carnegie Mellon. Note that New House is a LEED Silver Certified building and as such has water saving measures implemented.

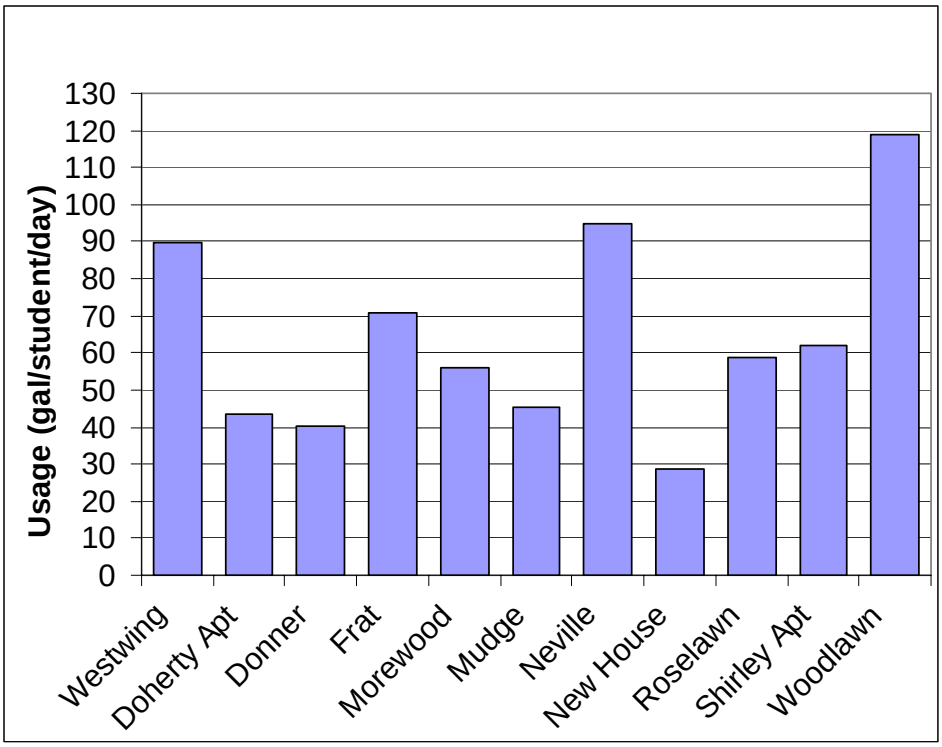

Figure 9-1. Average Daily use of Water at Metered Housing Buildings at Carnegie Mellon, FY2004.

Another indicator calculates the annual average water use per square foot for metered academic or administrative buildings. Figure 9-2 shows the range of water used by the metered academic and administrative buildings at Carnegie Mellon.

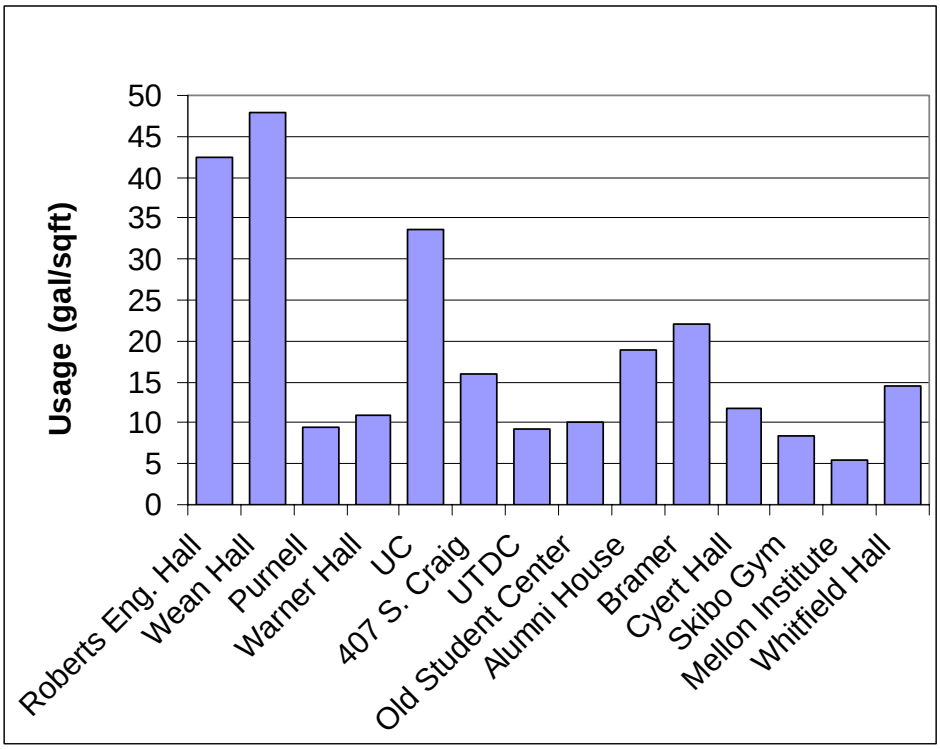

Figure 9-2. Average Daily use of Water at Metered Academic and Administrative Buildings at Carnegie Mellon, FY2004

9.1.4 Cost of Water Used

The annual cost of water used at Carnegie Mellon is an indicator that will reflect both changes in water use, but also changes in the price of water. This indicator can also be rephrased as the annual cost of water per square foot. The unit cost of water purchased by Carnegie Mellon can be used to indicate changes in water consumption that may result after a change in price.

9.2 Wastewater Generation and Disposal

9.2.1 Annual total wastewater generated

The total amount of wastewater generated indicators how much wastewater Carnegie Mellon contributes to the Pittsburgh sewer system. This indicator is manipulated in order to obtain the total wastewater generated per capita for the entire campus and the total wastewater generated per square foot for the entire campus. Also, the fraction of supplied water used that is returned to the sewer indicates loss that occurs during water use. Neither the Allegheny County Sanitary Authority (Alcosan) nor the University monitors wastewater flows on campus. The amount of wastewater generated is estimated by Alcosan as a fraction of water use.

9.2.2 Cost of Wastewater

The annual cost of wastewater treatment at Carnegie Mellon indicates changes in generation and management on campus. This indicator can be restated in two ways: the cost per capita and the cost per square foot for the entire University. Also, the unit cost of sewage disposal indicates changes in the market.

Another indictor is the amount of sewer credits earned from cooling towers and lawn sprinklers. This value is determined based on metering. Alcosan's estimate of the amount of wastewater discharged to the sewers is reduced by the amount of water supply that is evaporated in the cooling towers or infiltrated into the ground via the sprinkler system.

9.2.3 Amount of wastewater reused

Wastewater could be reused at Carnegie Mellon instead of discarding it after one use. The amount of water diverted for reuse through gray-water or dark-water systems (including using water from public sinks for lawn irrigation) indicates the success of this initiative. This is a forward-leaning indicator because gray- or dark-water systems have not been implemented at Carnegie Mellon.

9.2.4 Number of wastewater discharges monitored for flow

Wastewater generation on campus could be managed better with more information about amounts generated in different parts of campus. The number of wastewater discharges monitored is a forward-leaning indicator because at this time no laterals or sewers on campus are monitored for water flow.

9.3 Stormwater Indicators

9.3.1 Runoff Generated at Carnegie Mellon

In order to estimate how much runoff the university contributes to the sewer system after a storm and the effects of different land use in runoff generation, a 30-minute storm with two year return frequency is used as the reference storm event. This implies a 30-minute storm intensity (in/hr) that occurs once every two years.[80] Pittsburgh is considered in Region 2 of Pennsylvania[81] and the storm used has a total rainfall of 0.9 inches in 30 minutes. The amount of water that runs

[80] 1992. Linsley, Franzinei, Freyberg, and Tchobanoglous. Water Resources Engineering, Fourth Edition. McGraw-Hill. p. 141.

[81] May 1986, Pennsylvania Department of Transportation and Federal Highway Administration. "Field Manual of Pennsylvania Department of Transportation Storm Intensity-Duration-Frequency-Intensity Charts PDT-IDF" http://www.dot.state.pa.us/hh/FieldManual.pdf. Accessed 22 January 2005.

off the campus indicates the impact to the city sewer system that Carnegie Mellon. As noted before, as little as one-tenth of an inch of rainfall can cause the combined sewers in Allegheny County to overflow untreated into the rivers[82]. The runoff modeling includes identifying subbasins on the Carnegie Mellon campus (there are a total of 22) and calculating how much water will run off from each basin to obtain a campus total runoff value. This calculation considers the area and type of land use in each sub-basin.

9.3.2 Stormwater Management and Reuse

One way to prevent a large volume of stormwater from entering the public sewer system at one time is to detain it, or to slow its travel. There are two detention systems at Carnegie Mellon: under the Purnell Center there are underground detention pipes that slow the speed of traveling water towards the sewer system and during heavy rainfall the dry wells at the north end of the Morewood parking lot serves as a temporary detention basin.

Stormwater can be used at Carnegie Mellon instead of directing to the Pittsburgh sewer system, preventing the use of clean and treated water for tasks such as irrigation or flushing of toilets. A simple way to capture runoff from the Carnegie Mellon campus for reuse and to prevent it from entering the public sewer system is to use stormwater retention basins. The number of stormwater detention and storage tanks and basins and the capacity of these areas are indicators of the capacity for retaining stormwater on campus. Currently, there is a stormwater retention basin in the newly constructed CIC building that stores 10,000 gallons of stormwater for later reuse (in fluch toilets) or release. Some reuse may require the development of gray-water systems, however some, such as irrigation, do not and require only sufficient stormwater capacity.

9.3.3 Number of stormwater discharges monitored for quality

Considering the certainty of combined sewer overflows reaching the local rivers, monitoring stormwater discharges for water quality may help assess the direct impact of Carnegie Mellon on the region's watersheds. The number of stormwater discharges that are monitored for water quality is a forward-leaning indicator that identifies which discharges are monitored, the parameters for which they are monitored, and any violations for surface water discharge

[82] Ibid, Footnote 76.