RAINWATER HARVESTING CALCULATOR

This calculator determines the appropriate size for a water reuse cistern based on irrigation and non-potable demand.

Input cell =		User enters value
Default value =		User should only change value if able to provide explanation for adjustment
Calculation cell =		User should not change cell

CALCULATOR

Part I - Calculate Irrigation Demand

1	Turf/Crop Area to be Irrigated	5,000	ft^2
2	Crop Coefficient - Kc	0.8	*cool season grasses = 0.8, warm season grasses = 0.6. See CIMIS website for more information.*
3	Landscape Area to be Irrigated	5000	ft^2
4	Species Factor - k_s	0.5	*<0.1 for very low, 0.1-0.3 for low, 0.4-0.6 for medium, 0.7-0.9 for high. See Part II of Guide (DWR 2000).*
5	Density Factor - k_d	1	*0.5-0.9 for low, 1 for average, 1.1-1.3 for high. See p. 18 of Guide (DWR 2000).*
6	Microclimate Factor - k_{mc}	1	*0.5-0.9 for low, 1 for average, 1.1-1.4 for high. See p. 19 of Guide (DWR 2000).*
7	Landscape Coefficient - K_L	0.5	$K_L = k_s * k_d * k_{mc}$
	Total Irrigation Area	10,000	ft^2
	Average Coefficient	0.65	
8	Irrigation Efficiency	0.90	*Estimated efficiencies are 0.70 to 0.85 for spray, 0.9 for drip, 0.95 for subsurface drip.*
9	Site Location (ETo Zone)	Eastern SF	*Select Western if located in the Richmond, Sunset, or Lake Merced areas of San Francisco*

10	Month	Ave. Monthly Rainfall in/month	Reference Evapotranspiration ETo	Actual Evapotranspiration ET_L	Irrigation Demand			
					ft^3/month	gal/mo	gpd	% of annual
	January	4.56	1.24	0.806	0			
	February	3.85	1.68	1.092	0			
	March	2.91	3.1	2.015	0			
	April	1.41	3.9	2.535	1,040	7,777	259	7%
	May	0.63	4.65	3.0225	2,217	16,582	535	15%
	June	0.22	5.1	3.315	2,865	21,434	714	20%
	July	0.05	4.96	3.224	2,939	21,985	709	20%
	August	0.11	4.65	3.0225	2,699	20,188	651	19%
	September	0.37	3.9	2.535	2,004	14,992	500	14%
	October	1.03	2.79	1.8135	721	5,394	174	5%
	November	2.68	1.8	1.17	0			
	December	4.08	1.24	0.806	0			
	Totals	21.91	39.01	25.36	14,486	**108,353**		

Part II - Calculate Indoor Non-Potable Demand - *water use estimate approach is based on the LEED-NC reference manual (USGBC 2007) and SFPUC (2004) demand estimates*

11	No. of Residential Units	5		
	Persons per Unit	2.1	*typically ranges from 2 to 3, recommend 2.1 for multi-family, 2.7 for single family*	
12	Number of FTEs	0	*Use for commercial and industrial facilities*	
13	Number of Students/Visitors	0	*Use for schools, museums, libraries, etc.*	
14	Number of Retail Customers	0	*Use for retail stores*	
15	Freq. of Residential Toilet Use	5.1	flush/person/day	*Recommend 5.1 for multi-family, 4.8 for single family*
	Freq. of FTE Toilet Use	3.0	flush/person/day	
	Freq. of Student/Visitor Toilet Use	0.5	flush/person/day	
	Freq. of Customer Toilet Use	0.2	flush/person/day	
16	Volume per Flush	1.6	gal/flush	*Recommend 0.8 for ultra low-flow, 1.1 for low-flow, 1.6 for conventional built post-1995, 3.05 for conventional existing facilities built in 1995 or earlier.*
17	Washing Machine Use	0.3	cycles/person/day	*Recommend 0.3 for multi-family, 0.37 for single family*
	Volume per Load	25.0	gal/cycle	*Recommend 15 for ultra-efficient and 35 for conventional (Energy Star 2008, SFPUC 2004)*
18	Other Non-Potable Demand	0.0	gal/day	*Enter any additional non-potable demand, such as cooling water, industrial use, etc.*
19	Daily Reuse Demand	**164**	gal/day	
	Monthly Reuse Demand	**5,001**	gal/month	
	Annual Reuse Demand	**0.06**	MG/yr	

Part III - Calculate Cistern Size Based on Percent Capture

20	Ave. Runoff Coefficient	0.85	*A value of 0.85 is recommended for roofs*
21	Drainage Area	10,000	square ft
22	**Cistern Size**	**10,000**	gallons *Enter cistern size, adjust volume until desired percent capture is met (typically 80%) or until 100% of non-potable demand is met*
	Runoff Captured	48%	
	Non-Potable Demand Met by Rainwater Harvesting	33%	
23	**Additional BMPs Required?**	**Yes**	*If percent capture is less than 80%, additional BMPs will be needed to meet treatment requirements*
24	Cistern Depth	5	ft
	Cistern Surface Area	267	square ft

Assumes cistern is empty at the beginning of September

25	Month	Runoff to Cistern		Non-Potable Demand (gal/mo)			Ending Cistern	Water Captured	Water Reused	Overflow
		ft^3/month	gal/month	Irrigation	Indoor	Total	Volume (gal)	(gal/month)	(gal/month)	(gal/month)
	September	262	1,962	14,992	5,001	19,994	0	1,955	1,955	0
	October	733	5,482	5,394	5,001	10,396	0	5,462	5,462	0
	November	1,902	14,226	0	5,001	5,001	9,172	14,173	5,001	53
	December	2,892	21,634	0	5,001	5,001	10,000	5,830	5,001	15,805
	January	3,231	24,169	0	5,001	5,001	10,000	5,001	5,001	19,167
	February	2,724	20,372	0	5,001	5,001	10,000	5,001	5,001	15,371
	March	2,059	15,404	0	5,001	5,001	10,000	5,001	5,001	10,403
	April	1,000	7,482	7,777	5,001	12,779	4,675	7,454	12,779	0
	May	445	3,329	16,582	5,001	21,584	0	3,316	7,991	0
	June	156	1,167	21,434	5,001	26,435	0	1,163	1,163	0
	July	35	263	21,985	5,001	26,986	0	262	262	0
	August	76	570	20,188	5,001	25,190	0	568	568	0
	Totals	**15,516**	**116,060**	**108,353**	**60,017**	**168,370**		**55,187**	**55,187**	**60,798**

Alternate Part III - Calculate Runoff Captured Based on Available Space

26	Cistern Depth	**5**	ft
	Shape of Cistern	**Rectangular**	Select Circular or Rectangular
	Cistern Length	**15**	ft
	Cistern Width	**15**	ft
27	Cistern Surface Area	225	square ft
	Cistern Volume	1,125	ft^3
	Cistern Volume	8,415	gallons
28	Ave. Runoff Coefficient	0.85	
	Drainage Area	10,000	square ft
29	Runoff Captured	**46%**	
	Non-Potable Demand Met by Rainwater Harvesting	**32%**	

Assumes cistern is empty at the beginning of September

30	Month	Runoff to Cistern		Non-Potable Demand (gal/mo)			Ending Cistern	Water Captured	Water Reused	Overflow
		ft^3/month	gal/month	Irrigation	Indoor	Total	Volume (gal)	(gal/month)	(gal/month)	(gal/month)
	September	262	1,962	14,992	5,001	19,994	0	1,947	1,947	0
	October	733	5,482	5,394	5,001	10,396	0	5,440	5,440	0
	November	1,902	14,226	0	5,001	5,001	8,415	13,416	5,001	809
	December	2,892	21,634	0	5,001	5,001	8,415	5,001	5,001	16,633
	January	3,231	24,169	0	5,001	5,001	8,415	5,001	5,001	19,167
	February	2,724	20,372	0	5,001	5,001	8,415	5,001	5,001	15,371
	March	2,059	15,404	0	5,001	5,001	8,415	5,001	5,001	10,403
	April	1,000	7,482	7,777	5,001	12,779	3,060	7,424	12,779	0
	May	445	3,329	16,582	5,001	21,584	0	3,303	6,363	0
	June	156	1,167	21,434	5,001	26,435	0	1,158	1,158	0
	July	35	263	21,985	5,001	26,986	0	261	261	0
	August	76	570	20,188	5,001	25,190	0	566	566	0
	Totals	**15,516**	**116,060**	**108,353**	**60,017**	**168,370**		**53,521**	**53,521**	**62,383**

INSTRUCTIONS

Part I - Calculating Irrigation Demand

1	Enter the square footage of the area to be irrigated that is covered by turfgrass or crops. Note: 1 acre = 43560 ft^2.
2	Enter the crop coefficient for your site. Cool season grasses= 0.8, warm season=0.6. See the CIMIS website if more information is needed. Link to CIMIS
3	Enter the square footage of the landscaped area to be irrigated. If no landscaped area, skip to Step 8. Note: 1 acre = 43560 ft^2.
4	Enter species factor based on type of plants used. See *A Guide to Estimating Landscape Planting Needs in California* (Guide) (DWR 2000) for more info. Link to Guide
5	Enter density factor based on plant coverage. Full coverage of one vegetation type is considered average. See *Guide* for more info.
6	Enter microclimate factor based on site's exposure to sun and wind. Open-field without extraordinary winds or heat inputs is considered average (e.g., a park).
7	The landscape coefficient is calculated here. It is a product of the species, density, and microclimate factors.
8	Enter irrigation efficiency. Generally ranges from 0.7 to 0.95, with subsurface drip being the most efficient and spray irrigation the least efficient. Current San Francisco regulations require
9	Select whether the site is located in western or eastern San Francisco. Sites located in the foggier western half of the city will have lower evapotranspiration values.
	Other conditions not included in the Sizer may also effect irrigation water demand, such as soil salt concentration, soil evaporation rate, trees in turf, etc. If you feel these special conditions
10	The monthly irrigation demand is calculated in the table. Reference evapotranspiration rates are from CIMIS (DWR 2005).

Part II - Calculating Indoor Non-Potable Demand

11	Enter the number of residential units at the site and the average people per unit. People per unit typically ranges from 2 to 3.
12	For commercial and industrial sites, enter the number of full-time equivalents (FTEs) located on site. An 8-hr/day occupant has an FTE of 1.
	Part-time occupants have an FTE = # hrs per day/8 hrs.
13	For facilities such as schools, museums, and churches, enter the number of students or visitors
14	For retail buildings, enter the number of customers.
15	The default values for toilet flushes per day are given here. These values are based on the LEED-NC reference manual (USBGC 2007) and SFPUC demand estimates (SFPUC 2004).
16	Enter the gallons per toilet flush. Recommended values based on LEED and SFPUC are 0.8 for ultra low-flow, 1.1 for low-flow, 1.6 for conventional post-1995 construction, 3.05 for
17	Enter the washing machine loads and gallons per load. The default loads per day is 0.3. Gallons per load ranges from 15 gallons for ultra-efficient to 35 for conventional.
18	Enter any additional non-potable demand in gallons per day. This includes industrial uses such as cooling or process water.
19	The indoor non-potable demand is calculated here.

Part III - Calculate Cistern Size to Meet Desired Percent Capture

20	Enter the runoff coefficient for the area draining to the cistern. A value of 0.85 is recommended for roofs.
21	Enter the square footage of the area draining to the cistern.
22	Enter a volume for the cistern. Adjust the volume until the desired percent capture is met (typically at least 80%) or when 100% of non-potable demand is met.
23	If the cistern cannot capture the required percentage of annual runoff (typically at least 80%), then additional BMPs will be needed to manage runoff from the drainage area.
24	Enter the depth of the cistern to find the surface area covered by the cistern.
25	The estimated monthly runoff captured and reused by the cistern is shown in the table.

Alternate Part III - Calculate Runoff Captured by Cistern Based on Available Area (Note: if percent capture is <80%, additional BMPs will be necessary)

26	Enter depth, shape, and length/diameter of the cistern.
27	The surface area and volume of the cistern are calculated here.
28	Enter the runoff coefficient and square footage of the area draining to the cistern. A value of 0.85 is recommended for roofs.
29	The runoff percent capture and the percent of non-potable demand are calculated here.
30	The estimated monthly runoff captured and reused by the cistern is shown in the table.

References

California Department of Water Resources (DWR). 2005. *CIMIS Reference Evapotranspiration Zones* . http://wwwcimis.water.ca.gov/cimis/pdf/CimisRefEvapZones.pdf

San Francisco Public Utilities Commission (SFPUC). 2004. Water Use Estimates. Source files: "householdcons.xls", "nonresconsump.xls".

University of California Cooperative Extension and California Department of Water Resources (DWR). 2000. *A Guide to Estimating Landscape Planting Needs in California* .

United States Green Building Council. 2007. *LEED New Construction v2.2 Reference Manual.* Third Edition October 2007.

Part I calculates the monthly irrigation demand, Part II calculates the indoor non-potable demand, and Part III sizes the cistern.