ONE-PAGE PLACE ASSESSMENT: PETALUMA, CALIFORNIA

LOCATED IN THE TOMALES-DRAKE BAYS SUBWATERSHED WITHIN THE CALIFORNIA WATERSHED

CLIMATE ⚐1

AVERAGE HIGH & LOW TEMPERATURES[1] — 1893 – 2012

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
°F HIGH	56.9	61.3	64.3	67.8	72.2	78.1	81.8	81.7	81.4	75.8	65.8	57.6	70.4
°F LOW	37.6	40.2	41.5	43.3	46.4	49.8	51.3	51.5	50.6	47.0	41.3	38.1	44.9
°C HIGH	13.8	16.3	17.9	19.9	22.3	25.6	27.7	27.6	27.4	24.3	18.8	14.2	21.3
°C LOW	3.1	4.6	5.3	6.3	8.0	9.9	10.7	10.8	10.3	8.3	5.2	3.4	7.2

RECORD HIGH[1]: 110° F | 43.3° C | *June 2, 1960*

RECORD LOW[1]: 16° F | -8.9° C | *December 14, 1932*

SUN ⚐2

LATITUDE: 38.2°

ELEVATION: 11 FT / 3.4 m

	MAR 21	JUN 21	SEP 21	DEC 21
DEGREES N or S of DUE EAST THE SUN RISES[2]	0°	31°N	0°	30°S
DEGREES N or S of DUE WEST THE SUN SETS[2]	0°	31°N	0°	30°S
SOLAR-NOON ALTITUDE ANGLE (ABOVE HORIZON)[a,2,3]	52°	75°	52°	28°

SOLAR-NOON WINTER-SOLSTICE SHADOW RATIO[b]: 1 : 1.85 ...AND AZIMUTH[c]: 0°

9AM & 3PM WINTER-SOLSTICE SHADOW RATIO[b,2]: 1 : 3.64 ...AND AZIMUTH[c,2]: 42°

WIND ⚐3

MAX SPEED[4]: 71 MPH | 114 km/h

PREVAILING WIND DIRECTION (FROM WHERE) & AVERAGE SPEED[4]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
	N	NW	W	W	W	W	W	W	W	W	NW	N	
MPH	7	8	11	11	13	13	11	11	10	10	8	7	10.0
km/h	11	13	18	18	21	21	18	18	16	16	13	11	16.1

WATER ⚐4

AVERAGE RAINFALL (GAIN)[1] — 1893 – 2012

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
INCHES	5.33	4.57	3.25	1.58	0.63	0.20	0.02	0.06	0.24	1.28	2.96	4.78	24.90
mm	135.4	116.1	82.6	40.1	16.0	5.1	0.5	1.5	6.1	32.5	75.2	121.4	632.5

AVERAGE PAN EVAPORATION (POTENTIAL LOSS)[d,5] — 1955 – 1977

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
INCHES	1.42	2.09	3.87	5.70	7.74	9.34	9.34	8.27	6.75	4.65	2.25	1.46	62.88
mm	36.1	53.1	98.3	144.8	196.6	237.2	237.2	210.1	171.5	118.1	57.2	37.1	1,597.2

WETTEST YEAR'S RAIN[1]: 45.93 INCHES | 1,167 mm | *1998*

DRIEST YEAR'S RAIN[1]: 8.98 INCHES | 228 mm | *1976*

LONGEST PERIOD WITH NO MEASURABLE PRECIPITATION[6]: 174 DAYS: *May 1 – October 21, 1987*

RAINFALL INCOME[e]: 289 GPCD / 1,095 lpcd

AREA[f,7]: 14.38 SQ MILES / 37.2 km²

POPULATION[f,7]: 58,921 *2012 est.*

UTILITY-WATER USE[g,8]: 119 GPCD / 450 lpcd

HISTORICAL: 12.2 FT | 3.7 m | *1953*

DEPTH TO GROUNDWATER[h,9]: 40.6 FT | 12.4 m | *1983* RECENT

CURRENT GROUNDWATER EXTRACTION < NATURAL GROUNDWATER RECHARGE[i,8,10]

WATERGY ⚐5

% of ANNUAL CA ELECTRICITY CONSUMPTION USED FOR WATER-RELATED PURPOSES[j,11]: 19%

TOTEM SPECIES ⚐6

PLANT: Marsh sandwort *(Arenaria paludicola)* MEGAFAUNA: Tule elk *(Cervus canadensis nannodes)* [12]

AMPHIBIAN: California red-legged frog *(Rana draytonii)* BIRD: California clapper rail *(Rallus longirostris obsoletus)*

FISH: Steelhead trout *(Oncorhynchus mykiss)* MAMMAL: American badger *(Taxidea taxus)* CRUSTACEAN: California freshwater shrimp *(Syncaris pacifica)*

FOR MORE INFORMATION & HOW TO APPLY IT

⚐**1.** For more CLIMATE information, see the introduction, chapters 1, 2, & 4, and appendix 5 of *Rainwater Harvesting for Drylands and Beyond (RWHDB), Volume 1, 2nd Edition*

⚐**2.** For more SUN information, see chapters 2 & 4 and appendices 5 & 7

⚐**3.** For more WIND information, see chapters 2 & 4 and appendices 5 & 9

⚐**4.** For more WATER information, see the introduction, chapters 1–4, and appendices 1–5

⚐**5.** For more WATERGY information, see chapters 2 & 4 and appendix 9

⚐**6.** For more TOTEM SPECIES information: the ethics, principles, and strategies throughout *RWHDB* help us shift from a negative to a positive impact on these species and their habitats and ecosystems, on which our quality of life also depends.

PETALUMA PLACE-ASSESSMENT NOTES

a. The solar-noon altitude angle (a.k.a., solar-noon elevation angle) refers to the number of degrees the sun is located above the equator-facing horizon at solar noon on the given date. In the northern hemisphere, the equator-facing horizon is to the south. In the southern hemisphere, the equator-facing horizon is to the north.

b. The solar-noon winter-solstice shadow ratio is the object's height : length of object's shadow cast on December 21 at noon (the longest noontime shadow of the year). The ratio is 1 : x, where x = 1 ÷ tangent (90 - (latitude + 23.44)).

c. Azimuth is the angle formed between a reference direction (here, due south) to the point on the horizon directly below a given object. Solar noon is the time on any day when the sun's azimuth is 0°. The 9 am & 3 pm winter-solstice azimuth indicates the sun's deviation, in degrees, east/west of due south at those times (–/+ 3 hours from solar noon) on December 21.

d. The nearest weather station to Petaluma with available pan-evaporation data is Duttons Landing near Napa County Airport. Due to differences between the 2 locations' climatological conditions, Petaluma's actual pan-evaporation rates will vary from those given. An evaporation pan holds water whose depth is measured daily as water evaporates. These data allow us to determine evaporation rates at a given location. Compare average rainfall (water gain) to potential water loss via evaporation by looking up pan-evaporation rates for your area. According to one definition, if pan-evaporation rates exceed rainfall rates, you are in a dryland environment. Another definition states that drylands are "land areas where the mean annual precipitation is less than two thirds of potential evapotranspiration (potential evaporation from soil plus transpiration by plants), excluding polar regions and some high mountain areas which meet this criterion but have completely different ecological characteristics" (Greenfacts.org). The higher the ratio of potential evaporation to rainfall, the more important evaporation-reducing strategies such as mulch, windbreaks, shading, and covered water storage become.

e. Calculated in situ w/ average rainfall, area, & population

f. City proper

g. The report cited in ref. 8 states, "The gpcd values for 2009 and 2010 likely impacted by the Temporary Impairment, rate increases, hydrologic factors, poor economy, and other elements." The 5-year running gpcd for 2010 was 137 (ref. 10).

h. Well ID # USGS 381603122391101 005N007W20B002M, Latitude 38°16'03", Longitude 122°39'11". This is the only well found in Petaluma with historical data. It is located on N McDowell Blvd near Corona Rd.

i. The total annual natural recharge volume (and corresponding safe yield) for the northern Petaluma groundwater basin was estimated to be around 40,000 acre-feet by the Department of Water Resources in June 1982 (ref. 10). The City of Petaluma uses groundwater only as emergency supply. In 2006 no groundwater was pumped for the City from the Petaluma Valley 2-1 Basin. In 2010, the City received 1,007 acre-feet from this basin (ref. 8).

j. This 2005 statistic includes energy consumption for supply & treatment, ag use, end-users & wastewater.

CREDITS: Brad Lancaster, Resource concept, oversight **|** **Megan Hartman,** Resource creation, research

PETALUMA PLACE-ASSESSMENT REFERENCES

1. Petaluma Fire Station (#04826), wrcc.dri.edu, accessed 4/16/2014

2. Rainwater Harvesting for Drylands & Beyond, Vol 1, or esrl.noaa.gov/gmd/grad/solcalc, accessed 4/16/2014

3. RWHDB Vol 1, or Mar 21 = 90–latitude, Jun 21 = 90–(latitude–23.44), Sep 21 = 90–latitude, Dec 21 = 90–(latitude+23.44)

4. Almanac: Historical Information, www.myforecast.com/bin/climate.m?city=12061, accessed 4/16/2014

5. California Monthly Average Pan Evaporation, www.wrcc.dri.edu/htmlfiles/westevap.final.html#CALIFORNIA, accessed 4/16/2014

6. Steve Anderson, Forecaster, National Weather Service, San Francisco Bay Area office, via phone 4/16/2014

7. Census.gov, accessed 4/16/2014

8. City of Petaluma 2010 Urban Water Management Plan, cityofpetaluma.net/wrcd/pdf/2010_uwmp_final.pdf, accessed 4/16/2014

9. Groundwater Levels for California, nwis.waterdata.usgs.gov/ca/nwis/gwlevels, accessed 4/17/2014

10. 4.8 Hydrology and Water Quality, cityofpetaluma.net/cdd/pdf/ewpeir/4.8_hydrology-water-quality.pdf, accessed 4/17/2014

11. California Energy Commission Final Staff Report on California's Water-Energy Relationship, 2005, www.energy.ca.gov, accessed 4/17/2014

12. Bird, crustacean, fish, mammal, & megafauna species selected by Brock Dolman of OAEC's WATER Institute, via email, 4/16/20