

ONE-PAGE PLACE ASSESSMENT: BOULDER, COLORADO

LOCATED IN THE BOULDER CREEK SUBWATERSHED WITHIN THE MISSOURI RIVER WATERSHED

SUN

☐₁

MAR 21 JUN 21 SEP 21 DEC 21

LATITUDE **40.0°**

DEGREES N or S of DUE EAST THE SUN RISES¹

0° 32°N 0° 31°S

DEGREES N or S of DUE WEST THE SUN SETS¹

0° 32°N 0° 30°S

ELEVATION **5,309** FT
1619 m

SOLAR-NOON ALTITUDE ANGLE (ABOVE HORIZON)^{a,1,2}

50° 73° 50° 27°

SOLAR-NOON WINTER-SOLSTICE SHADOW RATIO^b

1 : 2.00 ...AND AZIMUTH^c **0°**

10AM & 2PM WINTER-SOLSTICE SHADOW RATIO^{b,1}

1 : 2.65 ...AND AZIMUTH^{c,1} **29°**

CLIMATE

☐₂

AVERAGE HIGH & LOW TEMPERATURES³

1893 – 2023

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	
°F HIGH	45.2	47.1	53.6	62.0	70.4	80.9	86.5	84.9	77.5	66.2	54.2	46.3	64.6	
°F LOW	20.5	22.2	27.9	35.5	44.1	52.6	58.5	57.4	49.1	38.9	28.8	22.1	38.2	
°C HIGH	7.3	8.4	12.0	16.7	21.3	27.2	30.3	29.4	25.3	19.0	12.3	7.9	18.1	
°C LOW	-6.4	-5.4	-2.3	1.9	6.7	11.4	14.7	14.1	9.5	3.8	-1.8	-5.5	3.4	
RECORD HIGH ³	104° F		40.0° C		JUNE 23, 1954			RECORD LOW ³		-33° F		-36.1° C		JANUARY 17, 1930

WIND

☐₃

MAX SPEED⁵ **147** **237**
MPH km/h

PREVAILING WIND DIRECTION (FROM WHERE) & AVERAGE SPEED⁴

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
	W	W	W, N	W	N	W, SW	N, W	W, SW	W, SW	SW, W	W	W	W
MPH	4.8	5.9	5.6	5.9	4.6	4.4	4.0	4.0	3.6	3.9	4.6	4.8	4.7
km/h	7.7	9.5	9.0	9.5	7.4	7.1	6.4	6.4	5.8	6.3	7.4	7.7	7.6

WATER

☐₄

AVERAGE RAINFALL (GAIN)³

1893 – 2023

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
INCHES	0.61	0.85	1.71	2.66	3.11	1.84	1.80	1.52	1.64	1.47	1.00	0.79	19.14
mm	15.5	21.6	43.4	67.6	79.0	46.7	45.7	38.6	41.7	37.3	25.4	20.1	482.6

AVERAGE PAN EVAPORATION (POTENTIAL LOSS)^{d,6}

1900 – 2005

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
INCHES	0.00	0.00	2.50	4.52	5.42	6.32	6.92	6.07	4.74	3.07	1.48	0.00	41.04
mm	0.0	0.0	63.5	114.8	137.7	160.5	175.8	154.2	120.4	78.0	37.6	0.0	1,042.4

WETTEST YEAR'S RAIN³ **34.15 INCHES** **867 mm** **2013** DRIEST YEAR'S RAIN³ **10.91 INCHES** **277 mm** **1954**

LONGEST PERIOD WITH NO MEASURABLE PRECIPITATION⁷

55 DAYS: SEPTEMBER 27 – NOVEMBER 20, 1934

RAINFALL INCOME^e **222** GPCD

839 lpcd

AREA^{f,8} **26.33** SQ MILES

68.2 km²

POPULATION^{f,8} **108,250**

2020

UTILITY-WATER USE^{g,9} **130** GPCD

492 lpcd

HISTORICAL  DEPTH TO GROUNDWATER^{h,10}  CURRENT

CURRENT GROUNDWATER EXTRACTION  NATURAL GROUNDWATER RECHARGE^{i,11}

WATERGY

☐₅

KWH OF ENERGY USED IN ONE YEAR TO MOVE & TREAT BOULDER'S WATER^{j,12}

3,750,000

TOTEM SPECIES

☐₆

BIRD: Western Burrowing Owl (*Athene cunicularia hypugaea*)

MAMMAL: North American Beaver (*Castor canadensis*)

AMPHIBIAN: Northern Leopard Frog (*Lithobates pipiens*)

FISH: Greenback Cutthroat Trout (*Oncorhynchus clarki stomias*)

PLANT: Bell's twinpod (*Physaria bellii*)

INSECT: Hunt's Bumble Bee (*Bombus huntii*)

REPTILE: Common Garter Snake (*Thamnophis sirtalis*)¹³

FOR MORE INFORMATION & HOW TO APPLY IT

- ☐ 1. For more SUN information, see chapters 2 & 4 and appendices 5 & 7 of *Rainwater Harvesting for Drylands and Beyond (RWHDB), Volume 1, 2nd Edition*
- ☐ 2. For more CLIMATE information, see the introduction; chapters 1, 2, & 4; and appendix 5
- ☐ 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.

BOULDER 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 $x = 1 \div \text{tangent}(90 - (\text{latitude} + 23.44))$.
- 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. 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 checking pan-evaporation rates for your area. If pan-evaporation rates exceed rainfall rates, you are in a dryland environment, where evaporation-reducing strategies such as mulch, windbreaks, shading, and covered water storage are very important.
- e. Calculated in situ w/ average rainfall, area, & population
- f. City proper
- g. All-sector indoor & outdoor usage for 2022 (incl. residential, municipal, commercial, industrial, institutional, and unaccounted-for water) per interpretation of data made in consultation with information from City of Boulder 2016 Water Efficiency Plan, p. 34; boulder.colorado.gov/media/9063/download?inline, accessed 6/18/2023
- h. Relevant depth to groundwater in Boulder unavailable through our usual USGS source; "The City of Boulder does not use groundwater to meet municipal demand and thus does not track depth to groundwater or groundwater extraction rates."
- i. Information not readily available; see note h
- j. This figure does not likely include the energy used to move water from the Western Slope over the Continental Divide for Boulder's consumption. "Boulder's water delivery system is largely gravity fed. The city used approximately 3.75 million kWh in 2022 for water treatment and delivery. Water delivery to two treatment plants and through the distribution system moves through eight hydroelectric facilities, which generated 41 million kWh in 2022."

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

BOULDER PLACE-ASSESSMENT REFERENCES

- 1. Rainwater Harvesting for Drylands & Beyond, Vol 1, or esrl.noaa.gov/gmd/grad/solcalc, accessed 6/17/2023
- 2. RWHDB Vol 1, or Mar 21 = $90 - \text{latitude}$, Jun 21 = $90 - (\text{latitude} - 23.44)$, Sep 21 = $90 - \text{latitude}$, Dec 21 = $90 - (\text{latitude} + 23.44)$
- 3. Boulder station (#050848), wrcc.dri.edu/my, accessed 6/17/2023
- 4. Custom Wind Rose Plots, CO_ASOS, Boulder Municipal Airport 2010–2023, 8-bin, mesonet.agron.iastate.edu, accessed 6/18/2023
- 5. Boulder wind info, psl.noaa.gov/boulder/wind.html, accessed 6/18/2023
- 6. Average Pan Evaporation Data by State, Colorado, Fort Collins; wrcc.dri.edu/Climate/comp_table_show.php?stype=pan_evap_avg, accessed 6/17/2023
- 7. Number of Consecutive Days Precipitation < 0.01, Boulder station (#050848); scacis.rcc-acis.org, accessed 6/17/2023
- 8. QuickFacts: Boulder city, Colorado; United States, www.census.gov/quickfacts, accessed 6/17/2023
- 9. Boulder's Annual and Per Capita Treated Water Use, 1983–2022, Fig. 2 in Rozaklis and Associates report dated 1/17/2023; image provided in email communication dated 6/28/2023 from Robby Glenn, Senior Civil Engineering Project Manager, City of Boulder
- 10., 11., & 12. Email communication from City of Boulder Utilities Department Deputy Director Chris Douville, dated 6/29/2023
- 13. Mammal, fish, and reptile species for Denver per Jason Gerhardt, Real Earth Design, via email 2/4 & 2/5/2012; Bird, amphibian, plant, and insect species for Boulder per Rella Abernathy, Senior Ecologist, City of Boulder, via email 6/28/2023