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Legalized Marijuana: Water-Efficient Weed Can Be More Than A Pipe Dream

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As the legalization of marijuana continues and customer demand increases, the number of indoor and outdoor plant cultivation sites are also expected to grow.

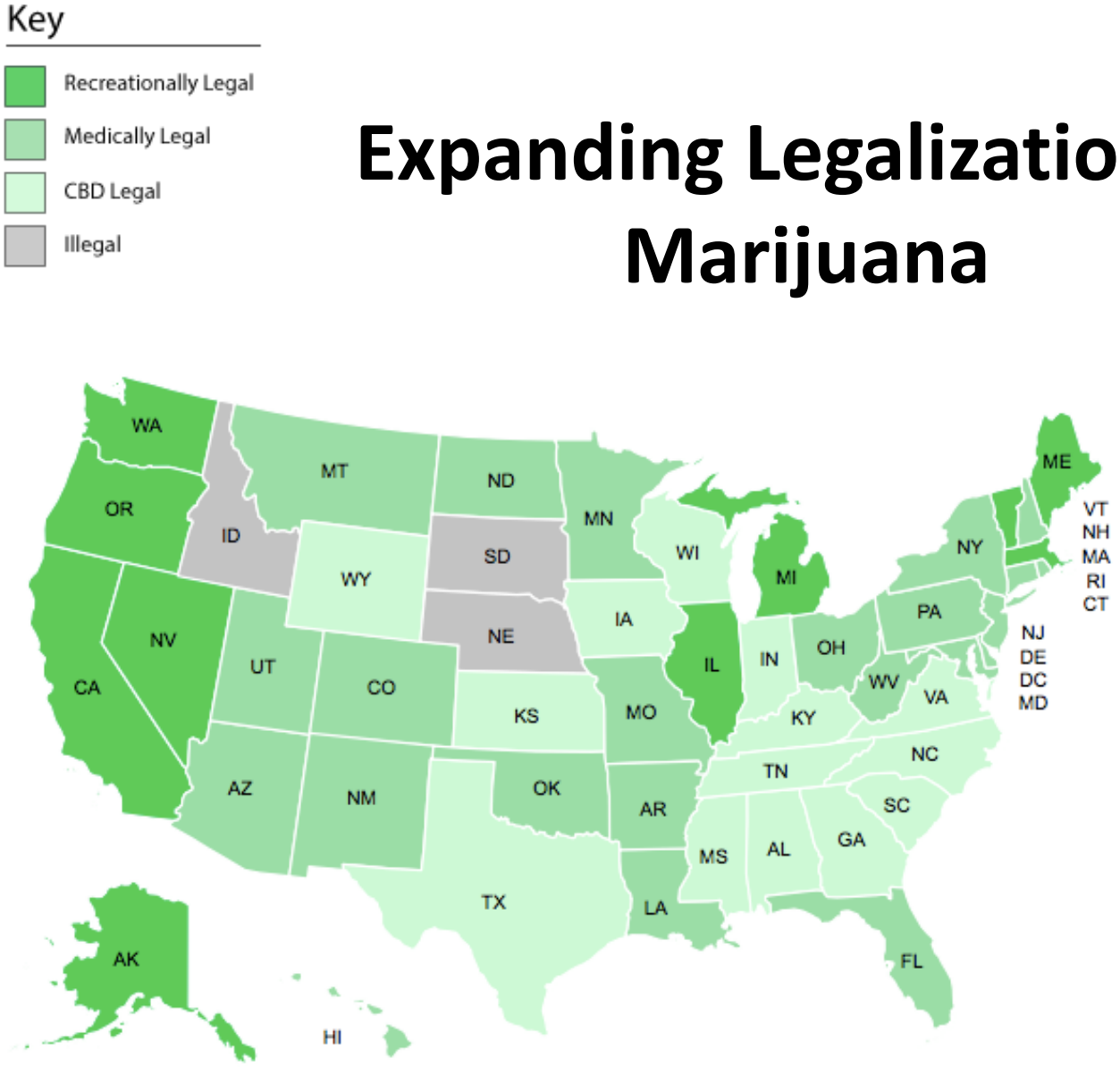
Likewise, we can expect water demands for this commercial and agricultural sector to increase in the years ahead.

In some areas, cannabis industry water demand increases may be substantial.

Overview

- Expanding Legalization of Marijuana
- Growth of U.S. Cannabis Industry
- Water Demands of Cannabis
- Environmental Impacts of Cannabis Industry
- Cannabis Site Water Audit Approach
- Water Efficiency at Cannabis Greenhouse Operations

Expanding Legalization of Marijuana



Source: Wikileaf.com

Cannabis and The Law

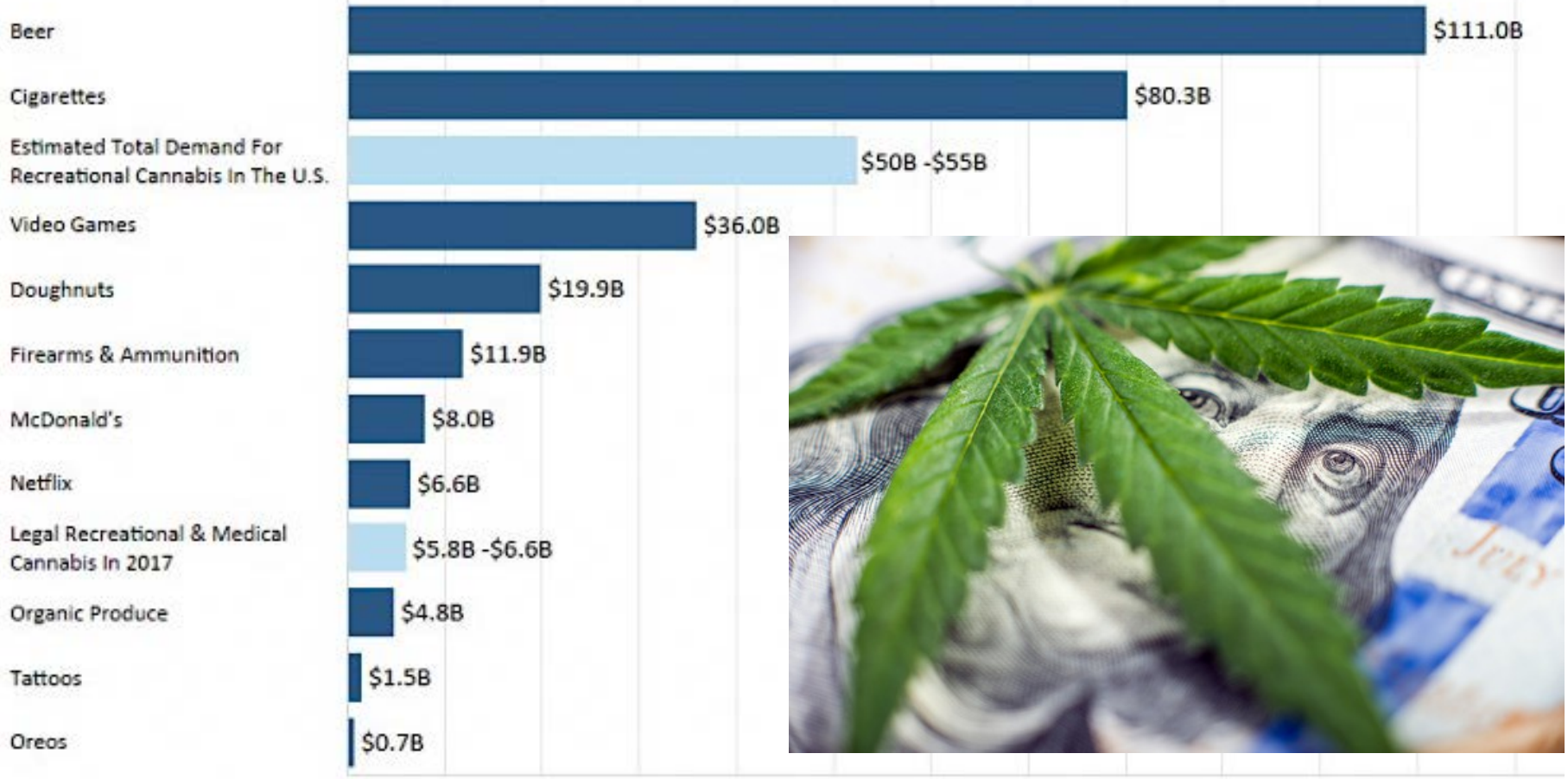
- States: more expected to allow in 2020+
- Feds: marijuana is still largely illegal!
  - Schedule 1 drug classification
    - Dispensary banking issues
  - 2018 Farm Bill legalized hemp and CBD production
  - 2018 FDA approved first cannabis-derived drug
- Ongoing US Drug Enforcement Administration (DEA) Cannabis Eradication Program
  - "The DEA is aggressively striving to halt the spread of cannabis cultivation in the United States…." (more on that soon)

Growth of U.S. Cannabis Industry

- Lots of Americans really like it
  - 55+ million use cannabis (est.)
  - 60% support legal pot (est.)
- Multiple medicinal and recreational products
  - Flower/smoke, edibles, topicals, tinctures, pills, beverages
- Global medicinal market $12 billion in 2018
  - Projected $146 billion by 2025
- Illegal market size and growth?
- Local growing operations –and water demands–also expected to increase
  - Indoor greenhouses
  - Will retail pot shops become as common as liquor stores?

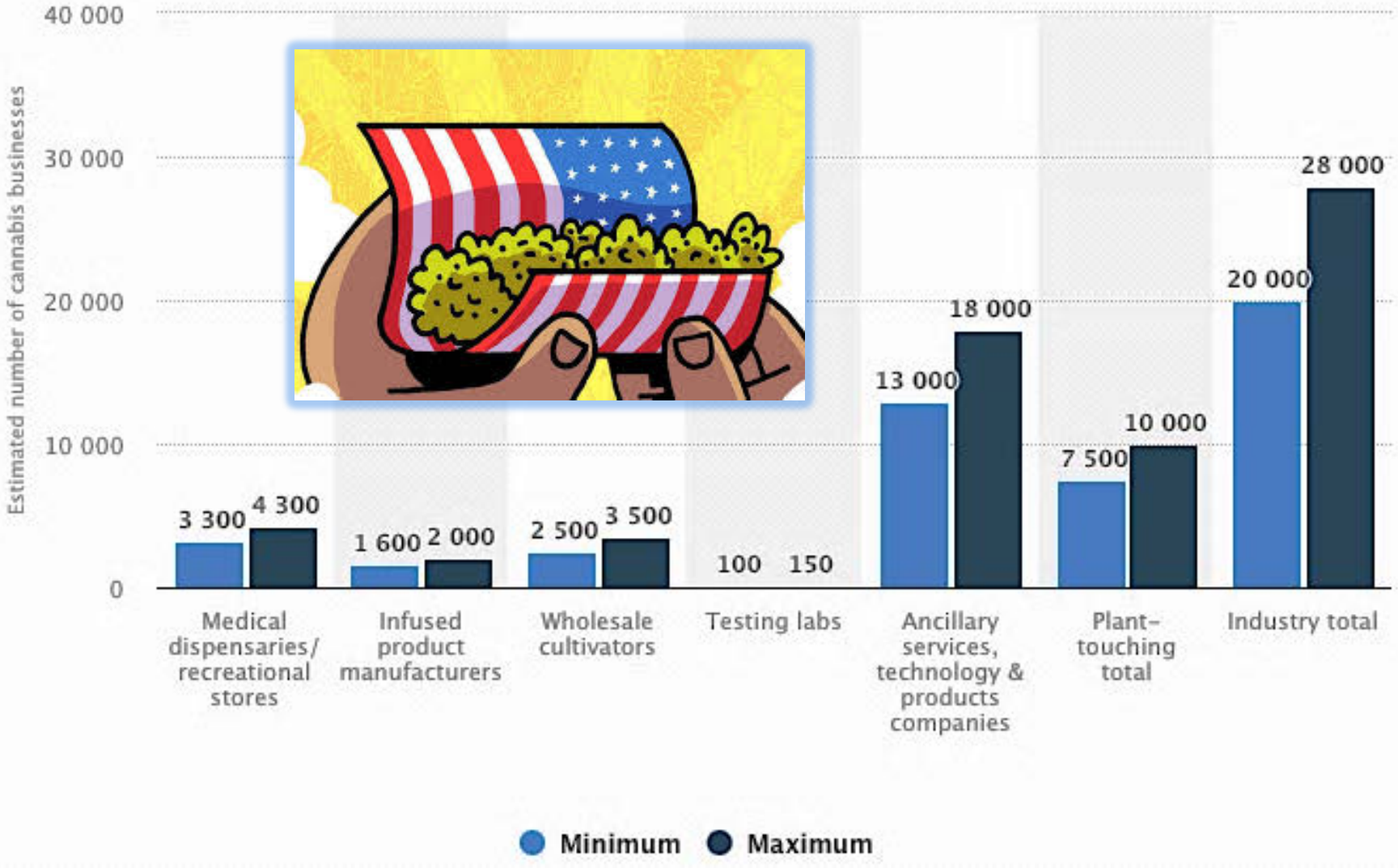
Sources: Marijuana SEO, Grand View Research, Fit Small Research

Annual U.S. Cannabis Sales Vs. Other Industries & Goods



Source: Brewers Association, Alcohol & Tobacco Tax & Trade Bureau, Entertainment Software Association, Goldstein Research, IBIS World, Netflix, Nielsen, Nabisco

Number of cannabis businesses in the U.S. as of 2017



Source: Statista.com, https://www.statista.com/statistics/596641/us-cannabis-businesses-number/

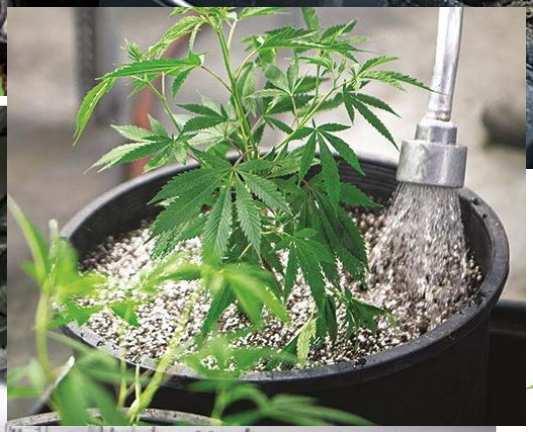
Cannabis Superstore and Entertainment Complex

Planet Water Feature

The sophisticated 18-foot outdoor water feature uses vibrant LED lights with fog to create a glowing effect which can be seen from the 65,000 hotel rooms that look directly onto the Superstore location.

Water Demands of Cannabis

- Historically illegal crop
  - Limited water demand and other statistics
- Cannabis plant water use–estimates vary widely
  - Indoor: 2.3 GD/plant (widely quoted by industry)
  - Outdoor: 6 GD/plant (Cal. Fish & Wildlife, 2018)
  - 3 to 8 GD/plant
- Many factors influence plant water demand
  - Indoor or outdoor cultivation, irrigation, soil, plant growth stage and strain
- Irrigation
  - Indoor: single emitter/plant
  - Outdoor: drip, rainfall
- Total volume required to produce 1 pound of finished flower
  - Many estimates: 100-200 gallons, 480 gallons, and 900 gallons



▲ Section grower Corey Evans walks between flowering marijuana plants at the Canopy Growth facility in Smiths Falls, Ontario, Canada. Photograph: Chris Wattie/Reuters

Colorado Study: Indoor, Greenhouse, And Outdoor Farm Sites

- Grow cycles ranged from 105 to 149 days
  - Example: 112 day indoor grow cycle
    - 10 days in clone
    - 39 days vegetative state
    - 63 days in flower

Table 9. Summary of Resource Consumption Data from all Sources

Source	Facility Type	Electricity Consumption Rate (kWh/lb. of flower)	Water Consumption Rate (gal/lb. of flower)
Anonymous	Indoor	1,256	184
The Clinic (Historical)	Indoor	1,202	564
The Clinic (Current)	Indoor	1,136	564
Midwest Ranch	Greenhouse	236	91
Pot Zero	Outdoor	1.75*	968*
Scientific Literature	Mix	2,600-3,259	—
Median	—	1,202	564

** A kWh and gal respectively per lb. of total useable product (102 pounds of flower and 887 pounds of trim)*

Source: The Cannabis Conservancy, Energy Use in the Colorado Cannabis Industry, Fall 2018.

DEA 2018 Cannabis Eradication

- 2,820,170 plants (indoor and outdoor)
- 316,632 lbs. bulk processed flower

Est. 317 MG to 1.6 BG water demands in 2018?

2018 FINAL DOMESTIC CANNABIS ERADICATION/SUPPRESSION PROGRAM STATISTICAL REPORT

State	Total Eradicated Outdoor Grow Sites	TOTAL Cultivated Plants Outdoor	Total Eradicated Indoor Grow Sites	TOTAL Cultivated Plants Indoor	Total Cultivated Plants (Outdoor & Indoor)	Bulk Processed Marijuana (Pounds)	Number Of Arrest	Assets Seized (Value)	Weapon Seizure
Alabama	35	3,846	3	440	4,286	120	28	$279,003.00	44
Alaska	0	0	1	319	319	60	0	$0.00	0
Arizona	34	21,395	6	2,384	23,779	53,519	236	$850,533.00	21
Arkansas	19	393	0	0	393	3,971	31	$3,500.00	41
California	889	1,396,824	516	411,695	1,808,519	145,221	1,196	$4,675,753.00	817
Colorado	13	12,427	114	34,001	46,428	6,039	64	$1,259,720.00	43
Connecticut	34	262	24	587	849	298	81	$469,437.60	114
Florida	25	3,690	20	539	4,229	116	17	$7,690.00	1
Georgia	91	6,573	37	10,598	17,171	3,199	177	$1,340,194.00	134
Hawaii	24	1,928	13	102	2,030	146	10	$60,700.00	14
Idaho	2	38	1	0	38	2,328	43	$84,402.00	8
Illinois	13	1,096	7	93	1,189	2	7	$5,273.00	15
Indiana	223	27,448	113	3,693	31,141	7,822	448	$1,502,521.60	160
Iowa	4	78	5	151	229	18	14	$70,290.00	16
Kansas	3	85	1	19	104	10,300	544	$137,267.00	40
Kentucky	614	416,719	65	1,357	418,076	2,108	507	$471,180.41	73
Louisiana	11	220	21	700	920	1,638	102	$420,211.00	62
Maryland	68	426	209	1,572	1,998	3,675	200	$3,787,388.00	268
Massachusetts	0	0	0	0	0	44	0	$0.00	0
Michigan	189	6,711	95	7,024	13,735	1,693	146	$1,814,768.00	188
Minnesota	0	0	1	1,433	1,433	0	2	$127,000.00	0
Mississippi	27	69,527	3	21	69,548	881	65	$32,461.00	20
Missouri	25	14,753	18	349	15,102	1,330	66	$268,441.00	75
Montana	0	2	1	34	36	2,731	41	$10,316.00	0
Nebraska	23	140	31	12	152	9,011	277	$867,150.00	20
Nevada	2	24	18	2,759	2,783	82	11	$158,849.00	8
New Hampshire	0	0	1	50	50	1	2	$0.00	3
New Jersey	1	10	5	110	120	40	7	$16,000.00	8
New Mexico	2	76	0	0	76	232	1	$6,889.00	0
New York	139	4,239	66	2,120	6,359	1,229	146	$2,910,016.79	26
North Carolina	39	1,623	3	333	1,956	49	14	$725,450.00	2
Ohio	574	22,473	32	4,231	26,704	440	93	$26,072.00	96
Oklahoma	14	123	1	28	151	3,772	126	$360,036.00	9
Oregon	4	587	12	22,594	23,181	18,602	22	$1,295,033.00	92
Pennsylvania	1	301	3	323	624	2,580	0	$0.00	0
South Carolina	7	269	2	166	435	127	25	$60,833.00	64
Tennessee	420	56,136	0	0	56,136	1	19	$25.00	1
Texas	11	46,894	28	2,318	49,212	811	42	$105,928.00	41
Utah	3	149	1	0	149	5,794	174	$0.00	64
Virginia	73	1,933	11	507	2,440	900	147	$127,171.86	93
Washington	44	30,351	48	81,487	111,838	14,220	198	$25,455,108.00	46
West Virginia	126	67,105	7	940	68,045	237	43	$172,832.00	28
Wisconsin	21	4,963	75	1,060	6,023	1,320	137	$2,071,577.99	105
Wyoming	0	0	0	0	0	6,328	123	$36,047.00	2
Total	**3,847**	**2,221,837**	**1,618**	**598,333**	**2,820,170**	**316,632**	**5,632**	**$52,308,982.25**	**2,862**

Link: https://www.dea.gov/sites/default/files/2019-08/FY2018%20Program%20Stats%20For%20Website%20%232.pdf

Environmental Impacts of Cannabis Industry

- Water
  - Demand impacts on local supply source(s)
  - Water quality impacts
- Chemicals
  - Fertilizers, pesticides, herbicides, fungicides
  - Maintenance
- Wastewater/Sewer
- Energy
  - Artificial lighting
- Plastics and solid waste
  - Indoor growing trays
  - Irrigation drip lines, emitters, stakes
- Stream diversions, dewatering
  - Legal and illegal growing operations

Cannabis Site Water Audit Approach

1. **Data collection** (meter data–water, sewer, energy and chemical use, plant stains and inventory by growth cycle, irrigation methods and practices, costs)
2. **Facility tour** (plumbing layout, HVAC system, RO system, etc.)
3. **Measurements and site data analysis**
   - Water balance, condensate quality and quantity
4. **Identify problem areas** (leaks, waste, equipment, etc.)
5. **Identify short- and long-term efficiency and reuse options, alternative sources**
   - Greenhouse BMPs
   - Cannabis industry benchmarks and goals, e.g., gal/day/plant
   - Condensate reuse est. 2-6 cycles (partial plant water demand)
6. **Cost-effectiveness analysis**
7. **Report: Findings and recommendations**

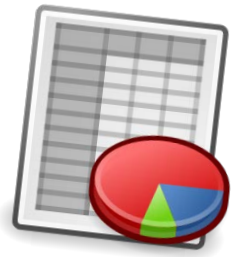
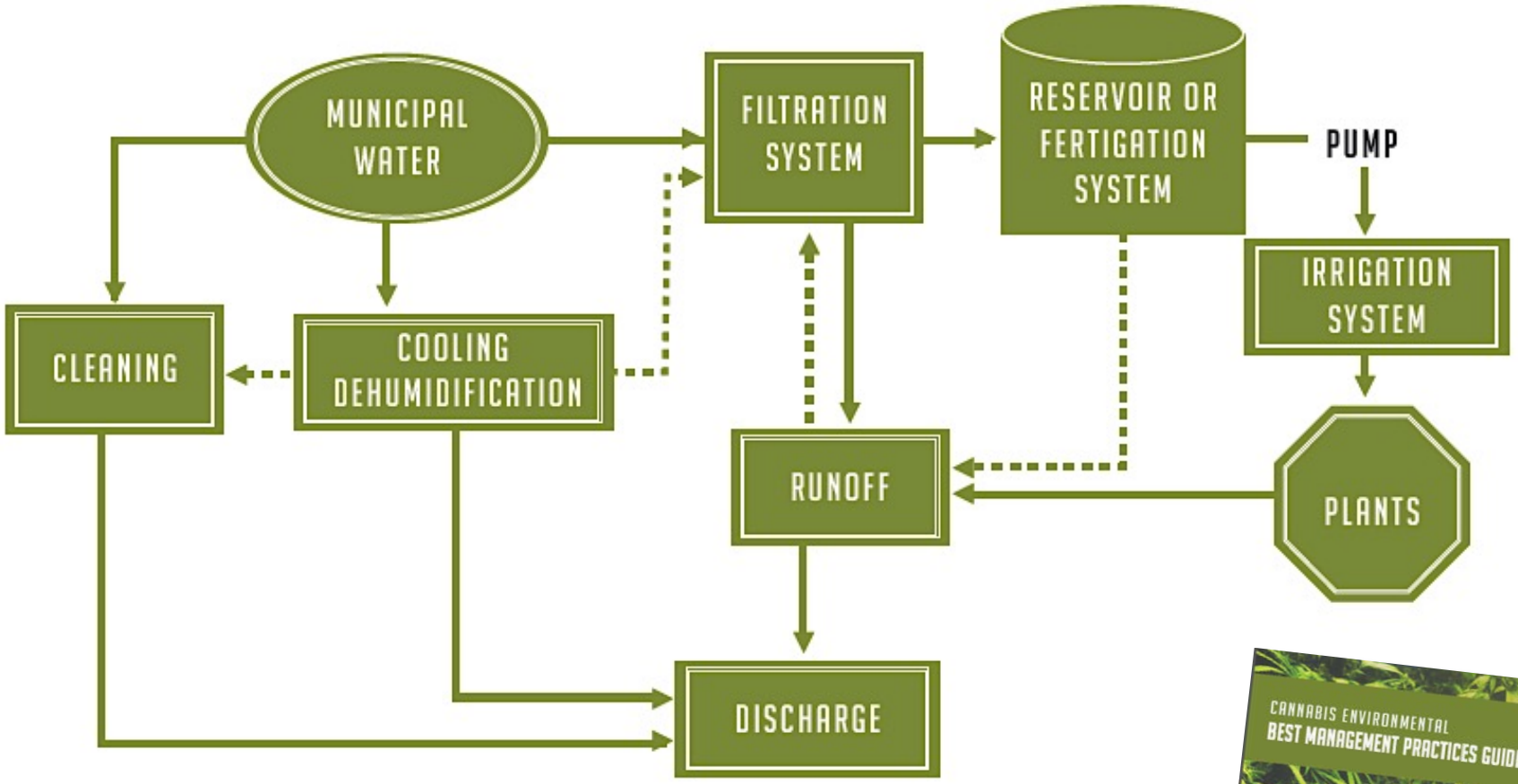
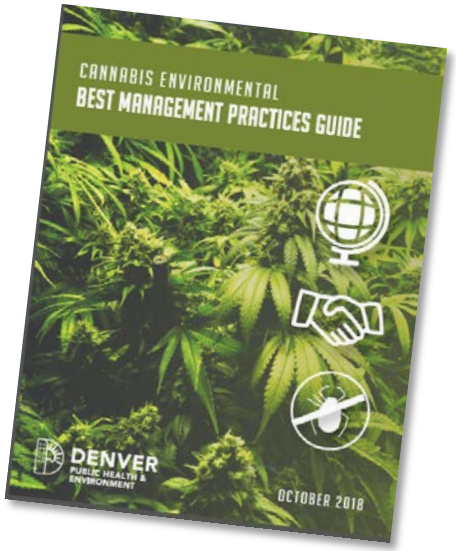
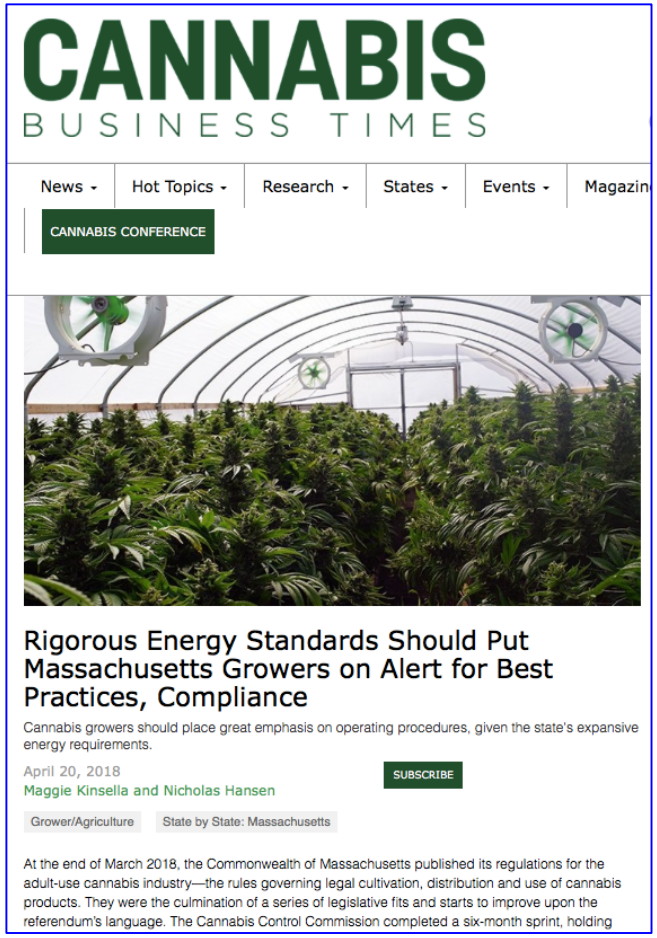


Figure 3: Water Flow for Cannabis Cultivation Facilities





Source: City of Denver, Public Health and Environment, Cannabis Environmental BMP Guide, 2018



Water Application Methods for Indoor Cannabis

Hand watering requires little equipment and expense initially, but the amount of applied water varies greatly. Much larger potential for water being wasted through either over application or by missing plant roots.

Wick systems employ a reservoir that provides water and nutrients to a plant via capillary action through wicking material. Option for seedlings and newly vegetating plants.

Flood Tables utilize large, shallow tables that flood and provide a layer of water and/or nutrients to plants growing in hydroponic mediums. Large amounts of water are used but the water can often be recycled and used again after treatment via filtration and cleaning.

Drip watering directly to each plant. Water volume can be controlled directly or on an automated schedule and virtually eliminates excess water waste and runoff.

Source: Commonwealth of Massachusetts, Cannabis Control Commission, Guidance on Best Management Practices for Water Use, April 4, 2019.

Water Efficiency at Cannabis Greenhouse Operations
Emerging Standards and Practices

- Leaks
- Filtration-carbon
- Irrigation-drip, wick, flood tables, hand watering
  - Drip and spray nozzle sizing
- Irrigation schedules
- Water recycling: runoff, condensate
- Piping, sediment filters, holding tanks
- Green cleaning products
- Maintenance practices
- Staff education and training

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