



BREWERY WASTEWATER & PRETREATMENT

Region 8 Pretreatment Conference | April 30, 2019

Presented by: Scott Schaefer, PE

**Beer is 90
percent water!**



**American Water Works
Association**



Nose →

Body →

← Head



Belly →

AWWA strongly encourages you to drink responsibly.

GREAT WATER = GREAT BEER

WATER QUALITY MATTERS IN THE PRODUCTION OF BEER

WHAT DO YOU NEED TO MAKE GREAT BEER?



WATER



MALT



HOPS



YEAST

BEER IS MADE OF

APPROXIMATELY

90% WATER

MAKING IT ONE OF THE MOST IMPORTANT INGREDIENTS

WATER QUALITY FACTORS AFFECTING BEER:

WATER HARDNESS



HARD WATER
= DARK BEER



SOFT WATER
= PALE BEER

CHLORIDE & SULFATES



HIGHER CHLORIDE
BETTER MALT FLAVORS



HIGHER SULFATES
BETTER HOPS BITTERNESS

BREWERIES IN PERSPECTIVE



VALUE-ADDED AGRICULTURAL PRODUCT

Main Ingredients: Water, Barley, Hops, Yeast

Also: Wheat, Rye, Oats, Maize (corn), Rice, Spices

Dispersion: “Today, 83% of the (US) population lives within 10 miles of a local brewery.”

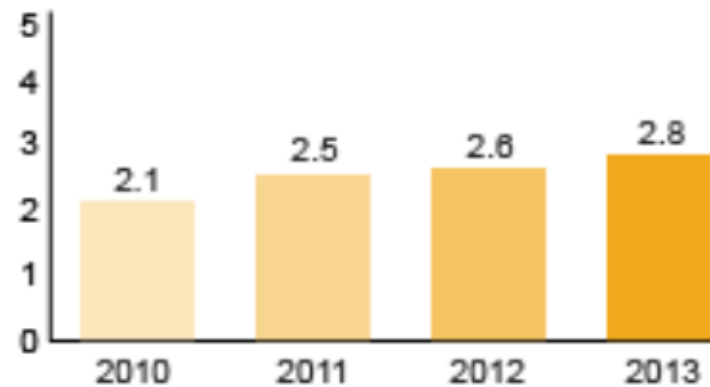
MALTSTERS & BREWERIES



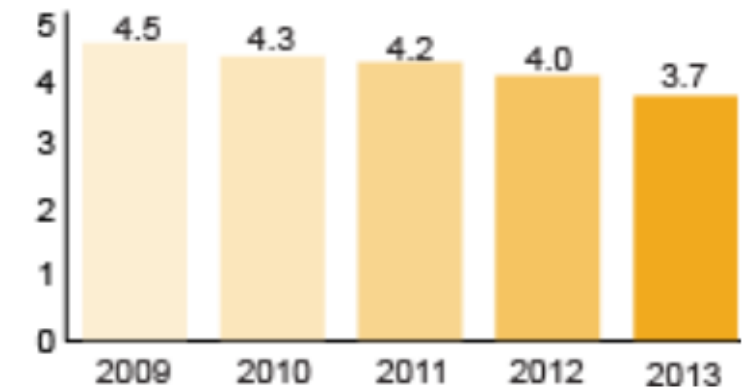
Effects on Wastewater

- **High BOD Loads**
- **Moderate Flows (Relative)**
- **Odor**
 - High Soluble BOD
 - Sulfate
 - Warm

Level assessment score
Water



Water to beer ratio
(hl water/hl beer)



Reference: MillerCoors



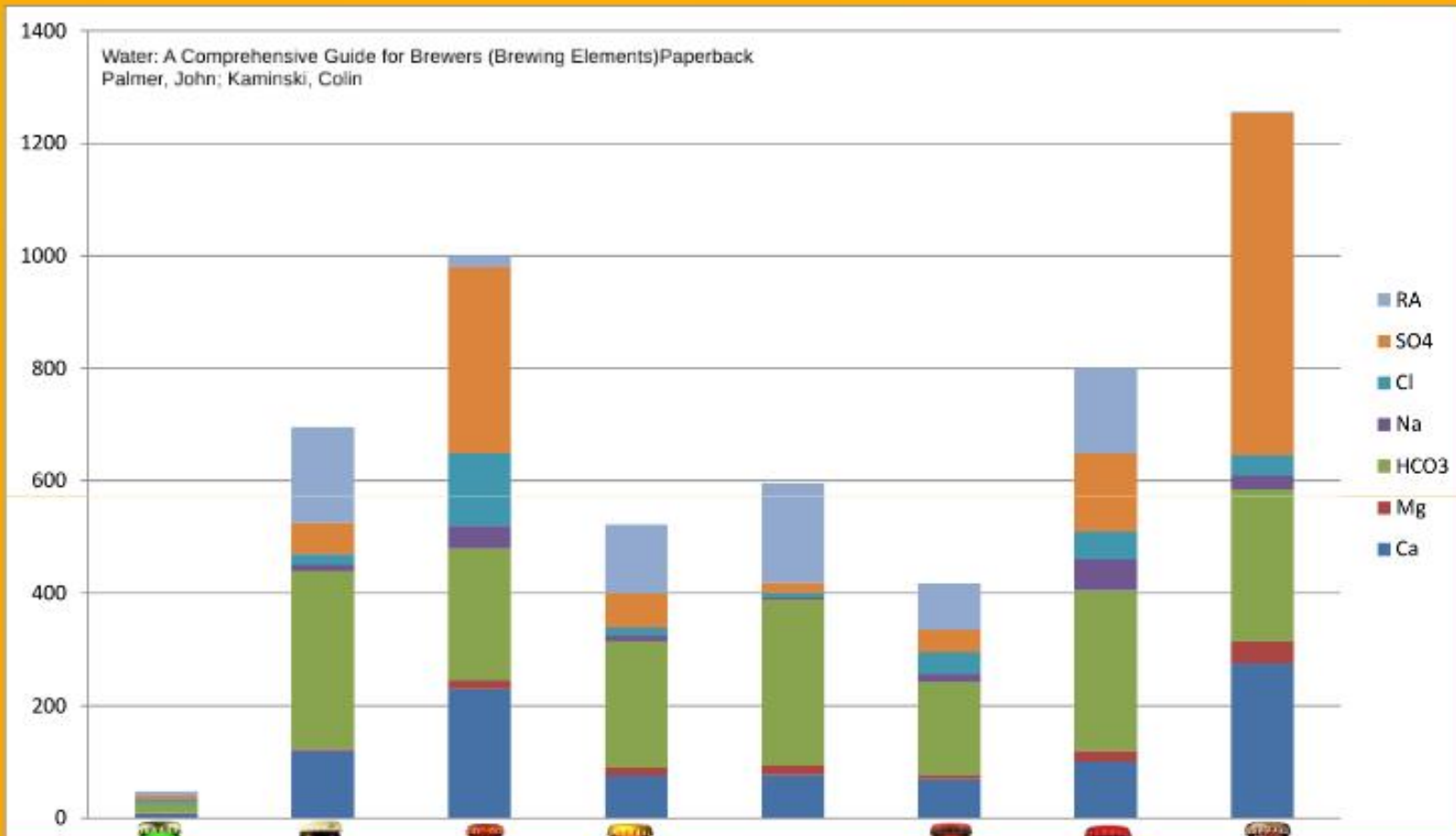
WATER COSTS

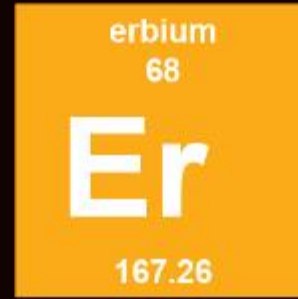
Brewery wastewater disposal is generally more costly than source water



Regional Water Quality







Water Quality

"The Chemistry"

Calcium Magnesium Chlorine
Chloride Chloramines **pH**
Hardness Phosphates
Sulfate Alkalinity





Full R.O.

BREWING PROCESS

"the science behind making beer"

Mash Tun



Kettle



Fermentor



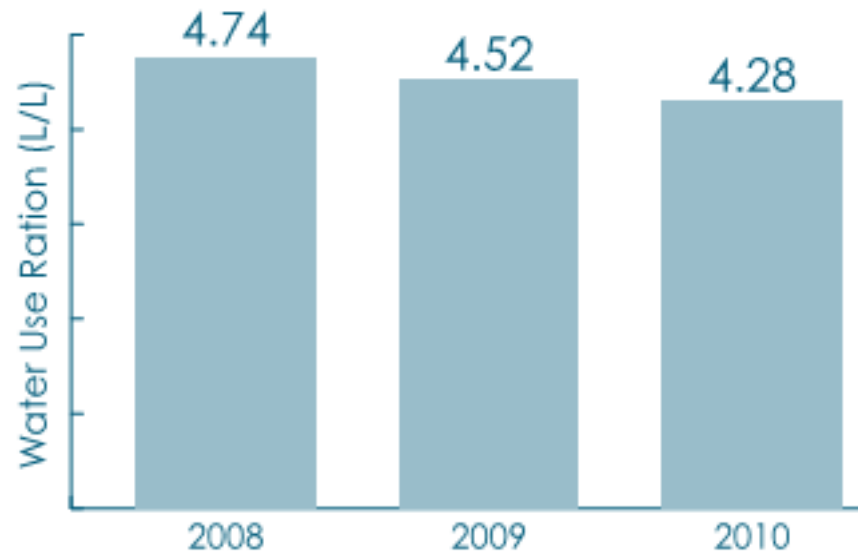
Keg!



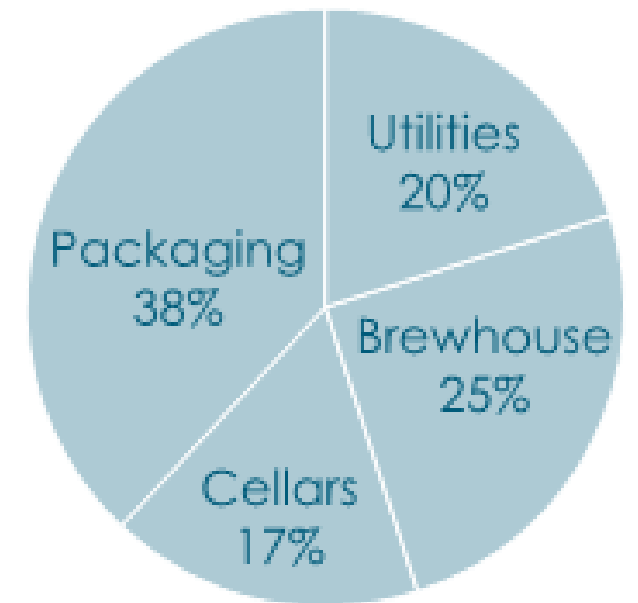


WATER QUANTITIES

Approximately 70% of incoming water becomes effluent



WATER USE



Reference: Brewers Association



WATER QUANTITIES

- **Larger = More Water Efficient**
- **Miller-Coors-Milwaukee – 2018 Alliance for Water Stewardship – Gold**

New Belgium – 3.5:1 water use goal

#4 Craft Brewery in US (~900k BPY)

Miller-Coors Water Goals

Year	Water Ratio
2016	3.2
2020	3.0
2025	2.8



MARKET SEGMENT-BASED

- **Brewpub: <15k BPY, >25% on-site sales**
- **Microbrewery: <15k BPY, >75% off-site sales**
- **Regional Brewery: >15k BPY, <6M BPY**
- **Large Brewery: >6M BPY**

BREWERY SIZES



BREWERY ASSOCIATION

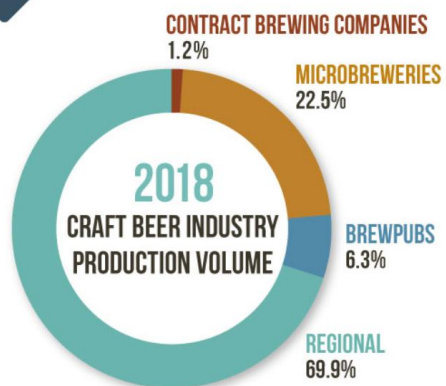
MARKET SEGMENT-BASED

U.S. BEER PRODUCTION VOLUME 2018

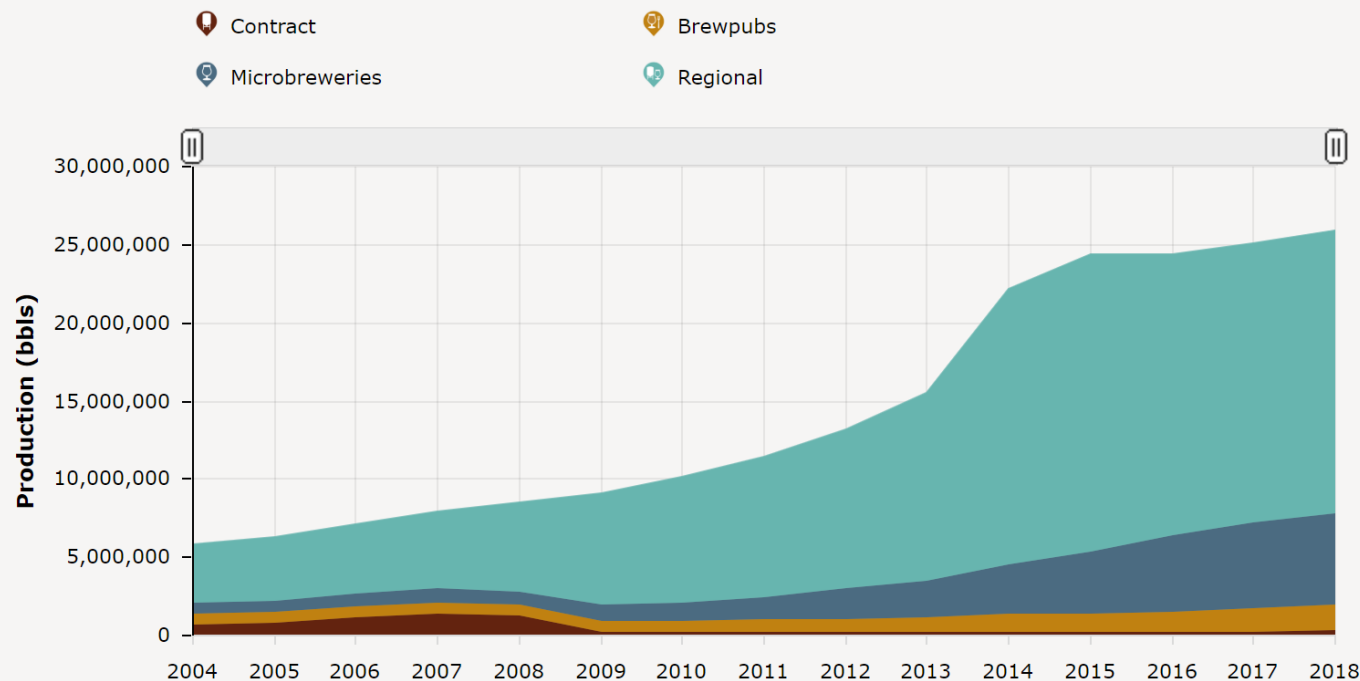
OVERALL BEER
-0.8%

3.9%
CRAFT

SOURCE: BREWERS ASSOCIATION, BOULDER CO



Historical Craft Brewery Production by Category



1 barrel = 31 US gallons

Reference: Brewers Association

BREWERY SIZES



SUI Trigger – 25,000 gpd

MARKET SEGMENT-BASED

	Barrel Per Year	Daily Effluent (gallons) by Water Use Ratio			
		3	4	5	6
Microbrewery	15,000	-	3,700	5,000	6,200
Regional Brewery	100,000	16,100	24,600	33,100	41,600
Regional Brewery	500,000	80,700	123,000	166,000	208,000
Regional Brewery	1,000,000	161,000	246,000	331,000	-
Regional Brewery	4,000,000	645,000	985,000	-	-
Large Brewery	6,000,000	968,000	1,480,000	-	-

BREWERY WASTEWATER CONCENTRATIONS



HIGH LOADS!

“RAW” BREWERY WASTEWATER

PARAMETER	TYPICAL RANGE
Water to beer ratio	4 - 10 liter/liter
Wastewater to beer ratio	1.3 - 2 liter/liter lower than water to beer ratio
Biochemical Oxygen Demand (BOD)	600 - 5,000 ppm
Chemical Oxygen Demand (COD)	1,800 – 5,500 ppm
Nitrogen	30 - 100 ppm
Phosphorus	30 - 100 ppm
pH	3 - 12
Total Suspended Solids (TSS)	200 – 1,500 ppm

BREWERY WASTEWATER CONCENTRATIONS



HIGH LOADS!

Main Areas Of Wastewater Generation

SOURCE	OPERATION	CHARACTERISTICS
Mash Tun	Rinsing	Cellulose, sugars, amino acids. ~3,000 ppm BOD
Lauter Tun	Rinsing	Cellulose, sugars, spent grain. SS ~3,000 ppm, BOD ~10,000 ppm
Spent Grain	Last running and washing	Cellulose, nitrogenous material. Very high in SS (~30,000 ppm). Up to 100,000 ppm BOD
Representative Sampling is Difficult!		
Storage tanks	Rinsing	Beer, yeast, protein. High SS (~4,000 ppm). BOD ~80,000 ppm
Filtration	Cleaning, start up, end of filtration, leaks during filtration	Excessive SS (up to 60,000 ppm). Beer, yeast, proteins. BOD up to 135,000 ppm
Beer spills	Waste, flushing etc	1,000 ppm BOD
Bottle washer	Discharges from bottle washer operation	High pH due to chemical used. Also high SS and BOD, especially thru load of paper pulp.
Keg washer	Discharges from keg washing operations	Low in SS (~400 ppm). Higher BOD.
Miscellaneous	Discharged cleaning and sanitation materials. Floor washing, flushing water, boiler blow-down etc.	Relatively low on SS and BOD. Problem is pH due to chemicals being used.



WATER REDUCTION

- **Single Pass Cooling – convert to closed loop**
- **Beer Filtration**
 - **High water use:** Rotary, Diatomaceous Earth, Plate and Frame
 - **Lower water use:** Cross-flow membranes, ceramic membranes
- **Clean In Place system**
- **Pump Seals**
- **Chase Water**



LOAD REDUCTION

- **Spent Grains management**
- **Trub Disposal**
- **Yeast Disposal – Physical Separation**
 - **40% protein = Animal Feed (or Vegemite)**





POTENTIAL TREATMENT OPTIONS

- **pH Neutralization**
 - Batch tank
- **Temperature Limits**
- **Solids Removal**
 - Filtration or Settling
- **BOD Removal**
 - **Biological:** Anaerobic and Aerobic
 - **Example:** UASB – 100k to 200k BPY Regional Brewery



METROPOLITAN COUNCIL ENVIRONMENTAL SERVICES (MCES)

INDUSTRIAL DISCHARGE PERMIT

General Permit - Microbreweries and Brewpubs

- **General Permit**
- **“No Sampling” Accepted Strength – 5,930 mg/L COD**
- **Optional Sampling by Brewery**
- **Best Management Practices (BMPs)**

Water Restrictions

Drought In CA



Sierra Nevada reduces water use 30%



Bear Republic builds \$4MM WWTF to reuse water for cleaning



Lagunitas Brewing - EcoVolt MBR for energy and reuse water for cleaning

WASTEWATER TO BREW



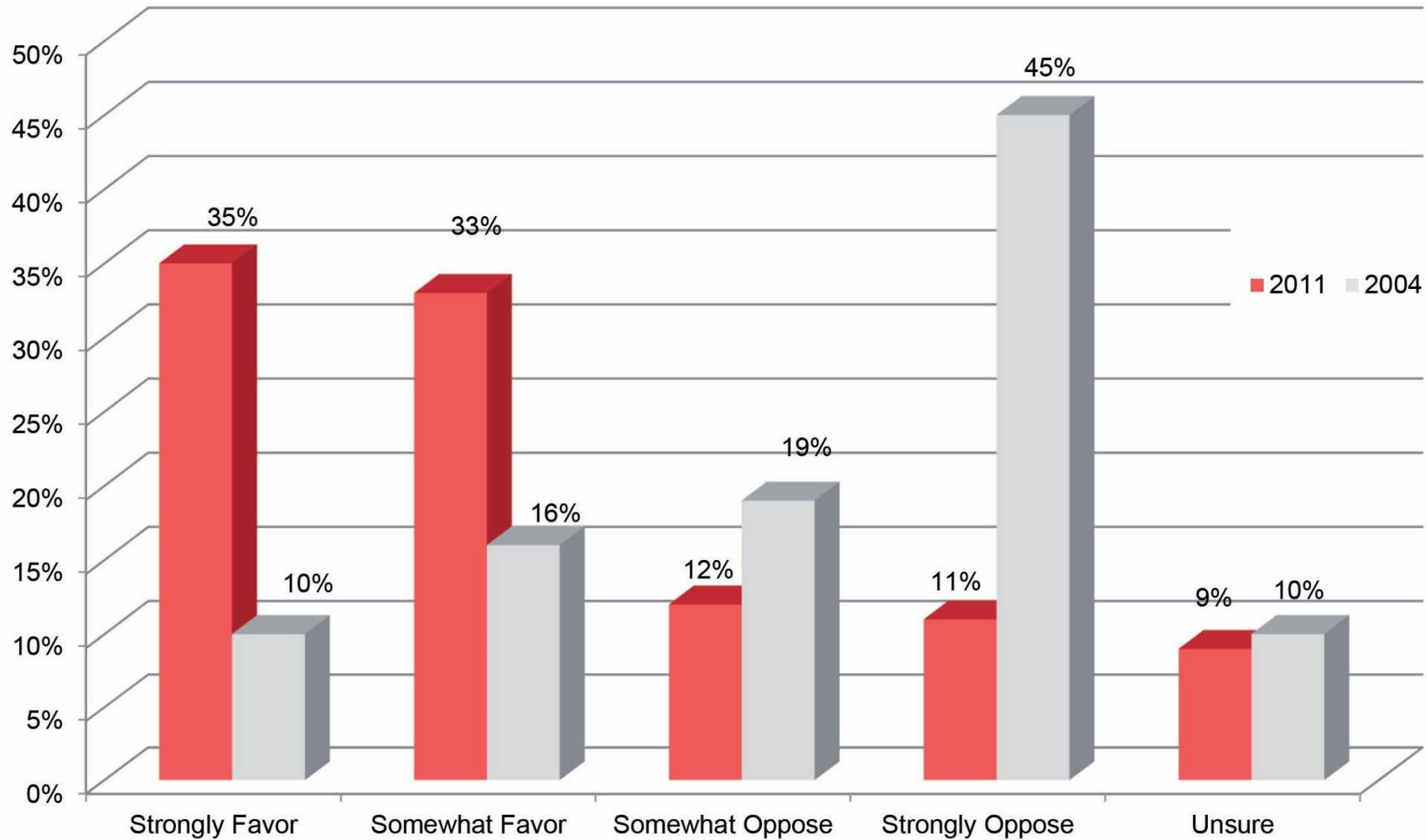


NEW TONIGHT

STONE BREWING USES WASTEWATER TO BREW BEER
LIBERTY STATION



POTABLE REUSE – PUBLIC ACCEPTANCE





POWERED BY AMERICAN WATER



drinking water

REITER

12 FL OZ
AMERICAN WATER
11.500L 40

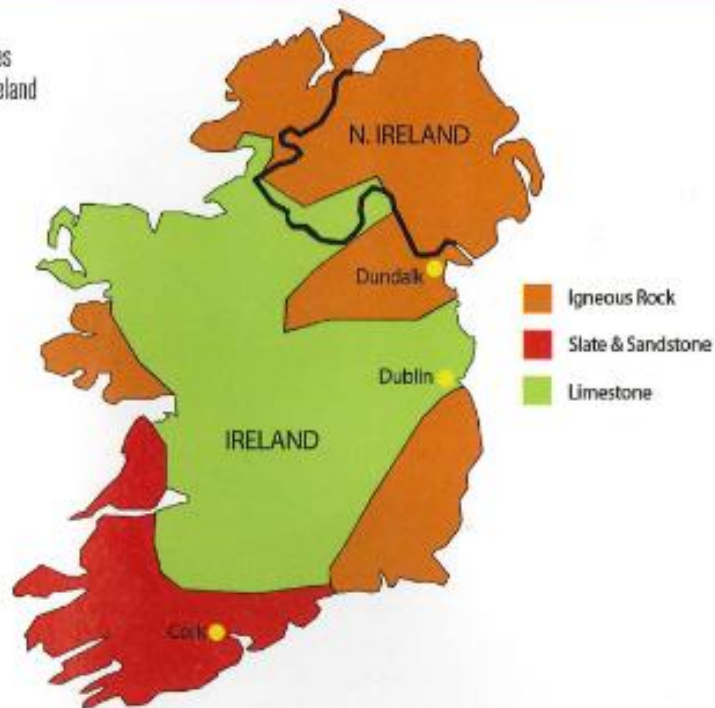


Brewery – Wastewater & Pretreatment **QUESTIONS?**



IRELAND

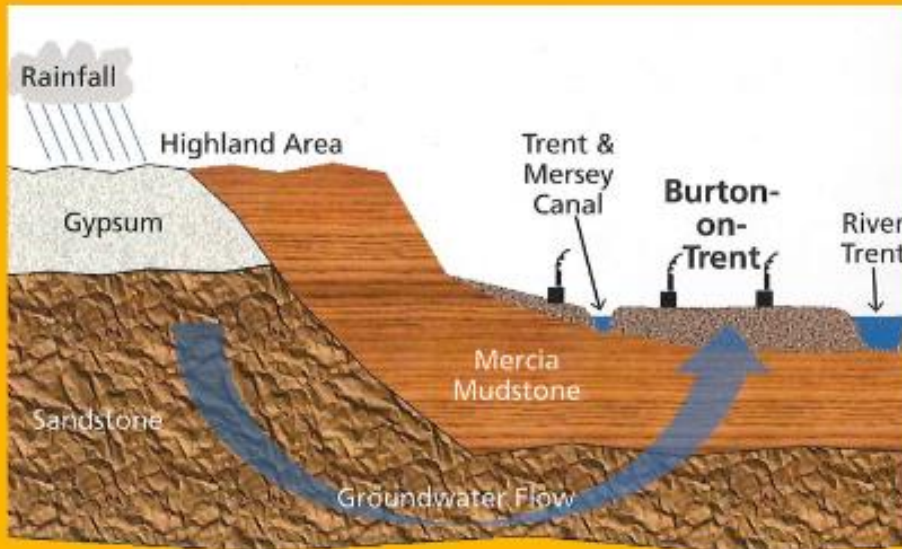
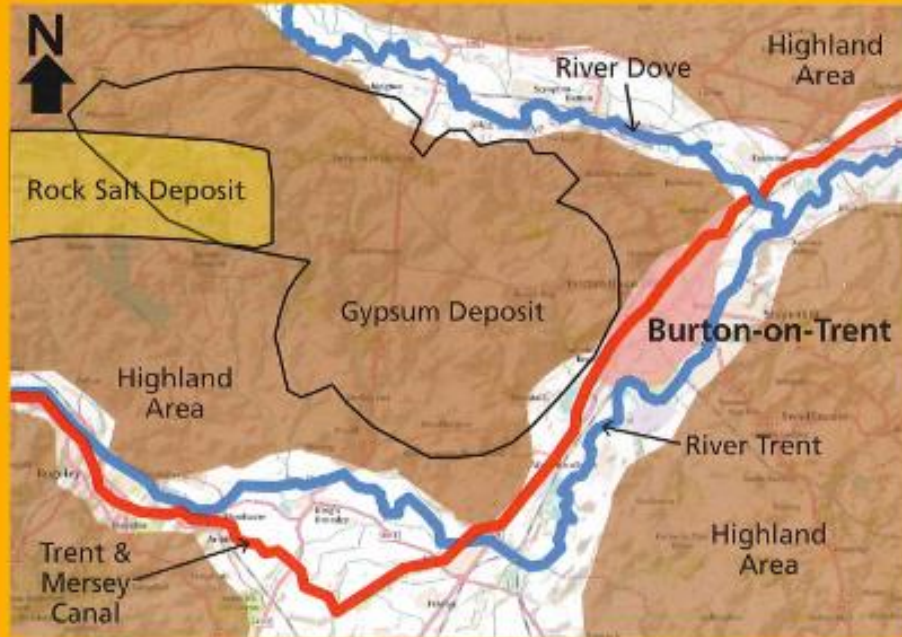
Map 1:
Major Rock Types
Found Across Ireland



Map 2:
Water Supplies for
Brewing Cities



ENGLAND



Retrieved from Zymurgy Magazine

BAVARIA

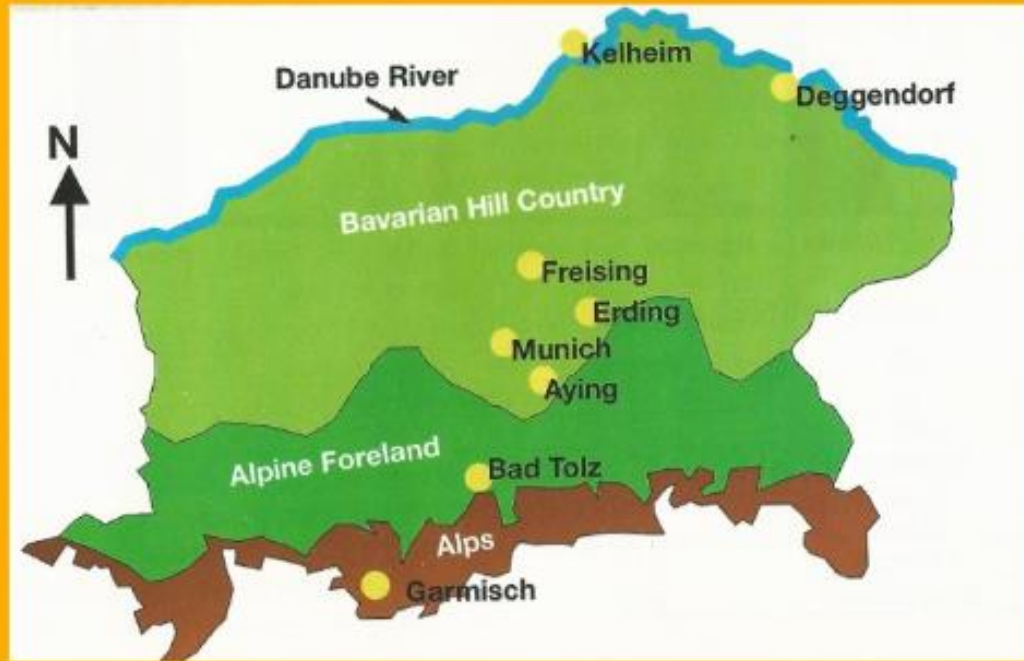
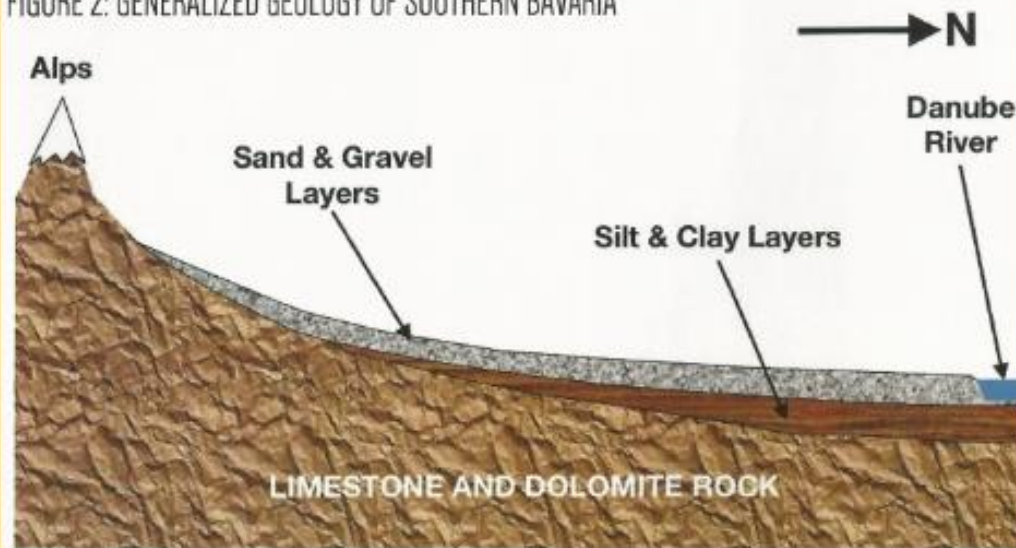


FIGURE 2: GENERALIZED GEOLOGY OF SOUTHERN BAVARIA

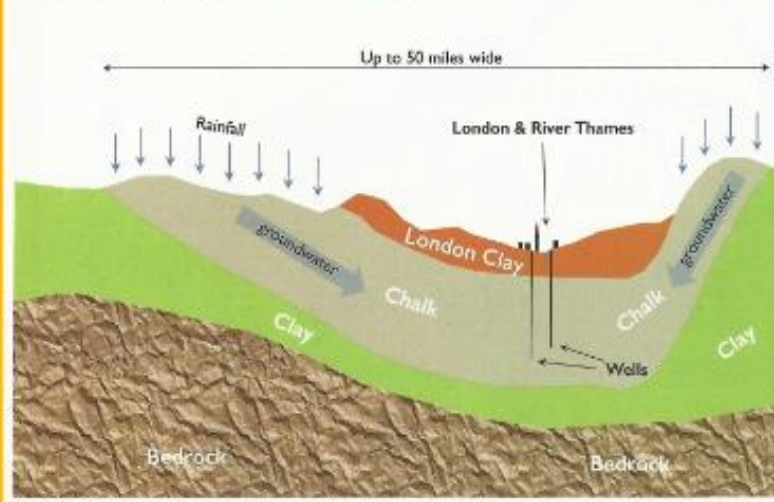


LONDON

FIGURE 1: SOUTHEAST ENGLAND GEOGRAPHY AND GEOLOGY



FIGURE 2: GEOLOGIC CROSS-SECTION OF THAMES VALLEY



Why Ales? Why not Lager?



It's the water. Tucson has natural groundwater similar to the Burton in England.

- Very Hard Water
- Carbon Filtering/
Chlorine Removal



Built alongside the natural spring near the Red River Trail.

"It is a water like no other, unique in its ability to refresh." Armond DuPont (founder) noted "Though seemingly impossible, a year-round frost forms at the base of this amazing spring."

1860



Along the banks of the Cottonwood River next to an artesian spring

Provides exceptionally pure water



Bad Habit Brewing

- Remove Chlorine



Beaver Island

- Remove Chlorine
- Soften for Cleaning

Water



Extensive Water Research

Source: Mountain Water
(City of Missoula)

Treatment:

Carbon Filter
Add Minerals to Style



Breweries Are Helping Austin Coffee Shops During Boil Water Notice

Black Star Co-op, Blue Owl Brewing, and other Texas breweries are coming to the aid of local businesses

by [Nadia Chaudhury](#) | Updated Oct 24, 2018, 10:48am CDT

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Clean water at St. Elmo | [St. Elmo Brewing Company/Facebook](#)

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