Public Utilities

Breweries

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Salt Lake City Corporation

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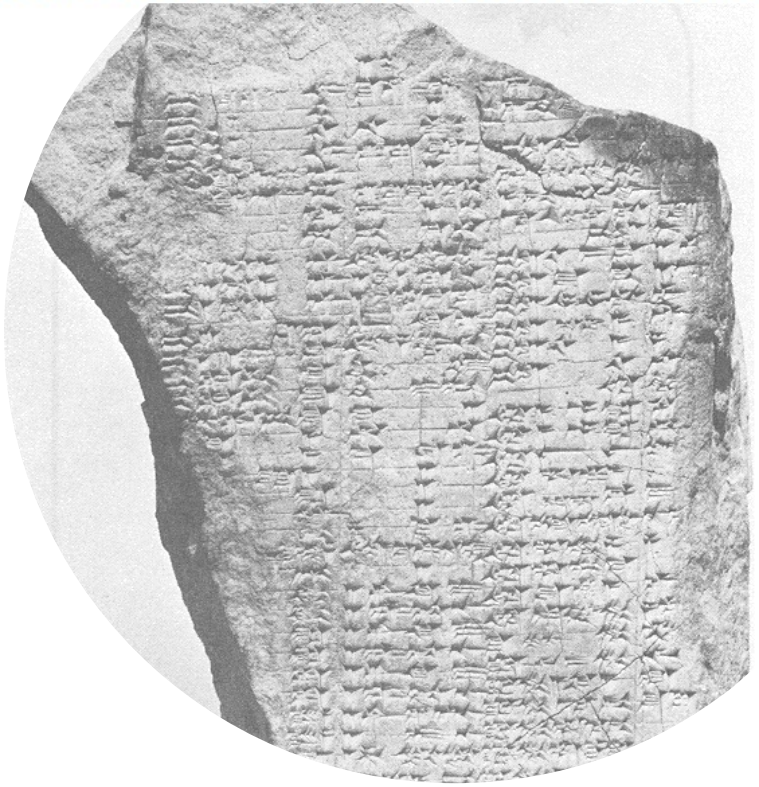
History of Brewing

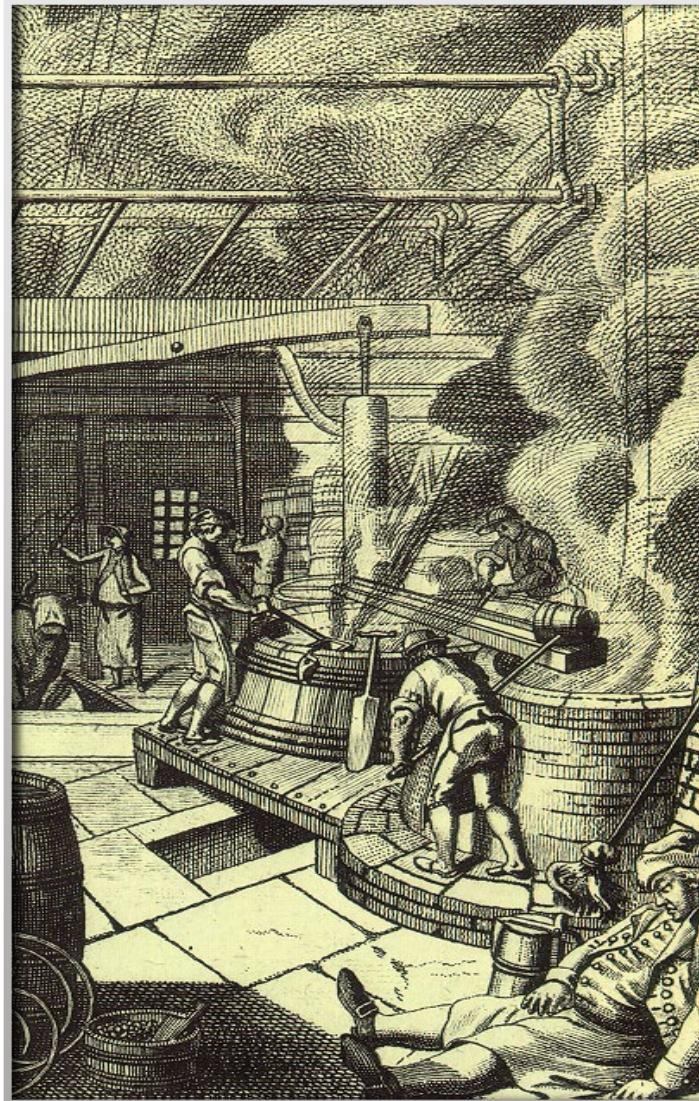
- Sumeria (4000 BC) Sikaru
- Egypt (3000 BC) Zythum
- India (2000 BC) Sura
- China (2000 BC) Kiu
- Sumerian beer recipe
  - 3000 BC
- Resembled liquid bread:
  - Barley and emmer
  - Spices / fruits
  - No hops
- Safe, nutritious, and exhilarating beverage



Man has been making beer since the dawn of civilization. Where grain was grown, beer was made

Definition of Beer

AN ALCOHOLIC BEVERAGE PRODUCED BY THE FERMENTATION OF SUGAR-RICH EXTRACTS DERIVED FROM CEREAL GRAINS OR OTHER STARCHY MATERIALS.



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Domestic Beer

Beer from the good ole USA

Craft Brewers

- A craft brewer is a small and independent brewer
- Innovation. Craft brewers interpret historic styles with unique twists and develop new styles that have no precedent
- Craft beer is generally made with traditional ingredients like malted barley; interesting and sometimes non-traditional ingredients are often added for distinctiveness
- Craft brewers tend to be very involved in their communities through philanthropy, product donations, volunteerism and sponsorship of events
- Craft brewers have distinctive, individualistic approaches to connecting with their customers
- Craft brewers maintain integrity by what they brew and their general independence, free from a substantial interest by a non-craft brewer

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Import Beer

Made almost anywhere but Canada or the USA

Beer Statistics

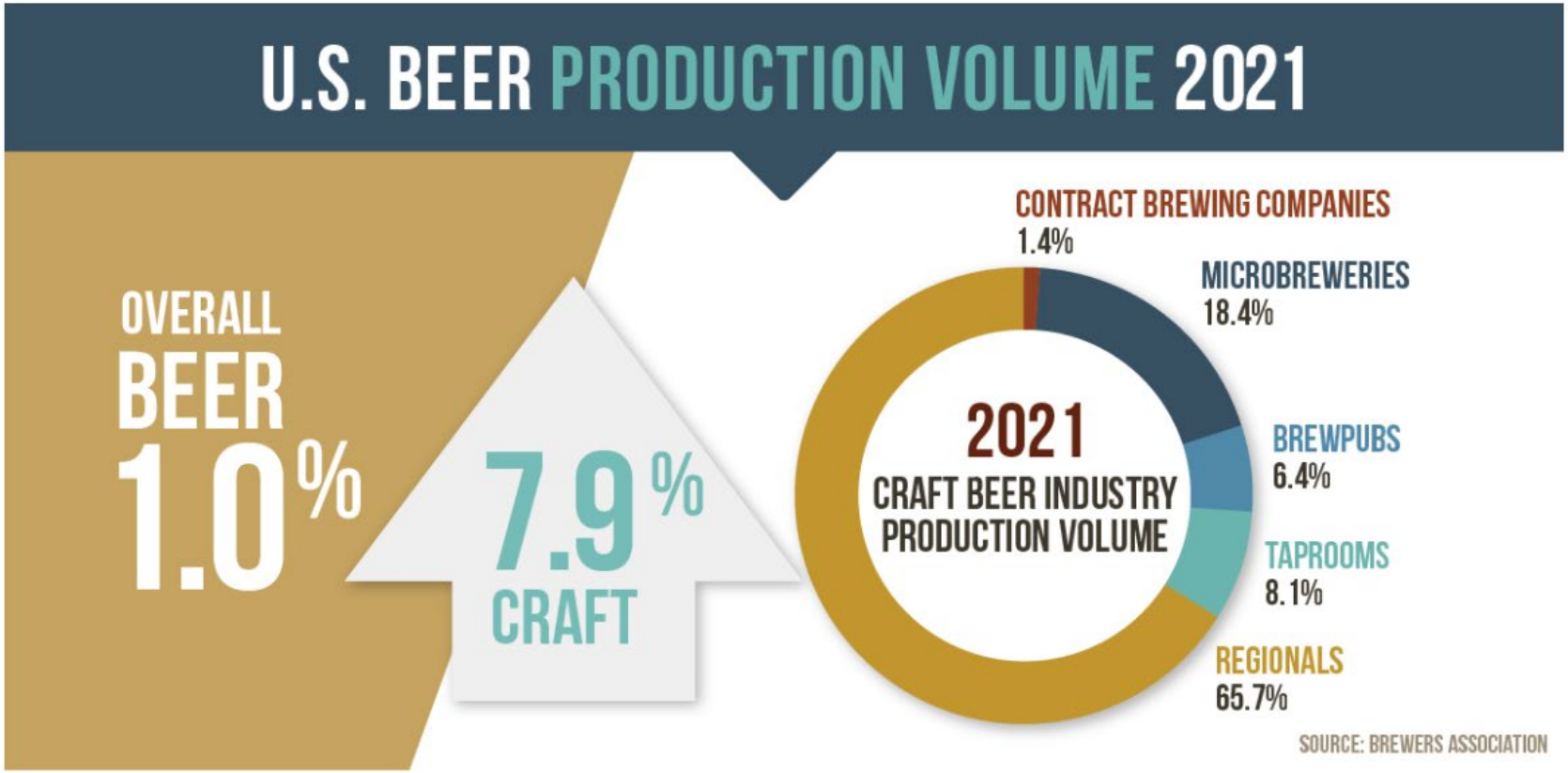
Recent U.S. Brewery Count

	2015	2016	2017	2018	2019	2020	2021	2020 to 2021 % Change
Craft	**4,803**	**5,713**	**6,661**	**7,618**	**8,419**	**8,905**	**9,118**	**4.4%**
Regional Craft Breweries	178	186	202	230	240	220	223	1.4%
Microbreweries	2,684	3,319	3,956	4,518	1,917	1,898	1,886	-0.6%
Taprooms					3,091	3,471	3,708	6.2%
Brewpubs	1,941	2,208	2,503	2,870	3,171	3,302	3,307	0.2%
Large/Non-Craft	44	67	106	104	111	120	129	7.5%
Total U.S. Breweries	**4,847**	**5,780**	**6,767**	**7,722**	**8,530**	**9,025**	**9,247**	**2.5%**

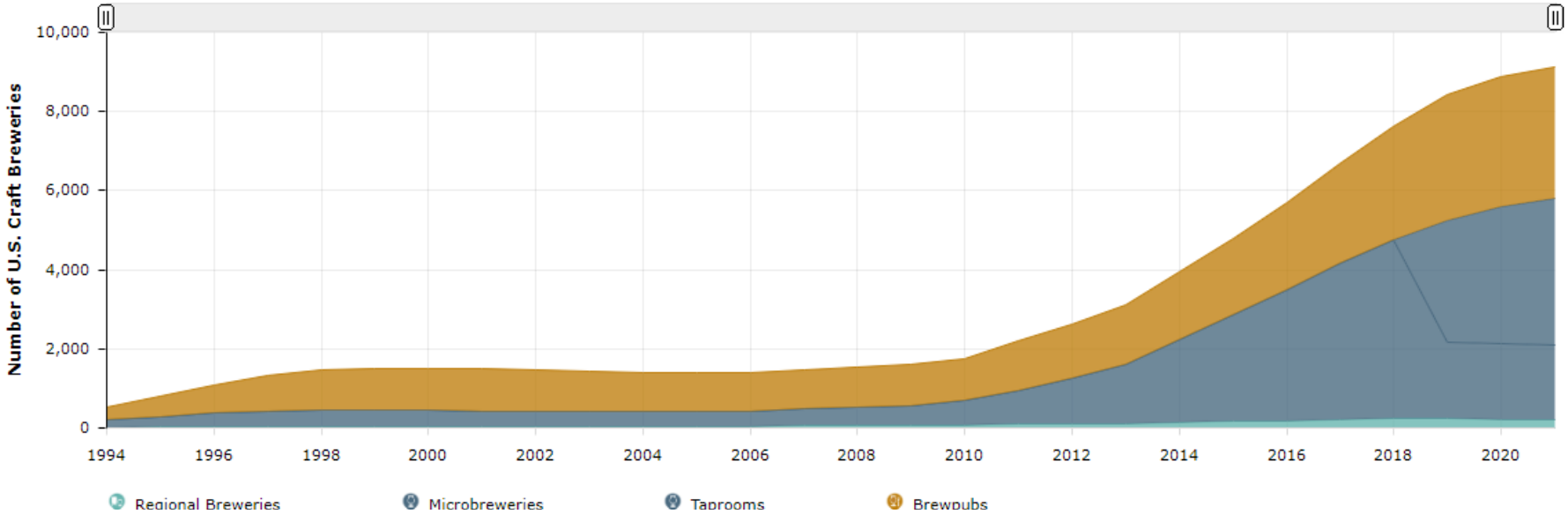
Sales Data


U.S. BEER SALES VOLUME 2021
BREWERS ASSOCIATION
OVERALL BEER 1.0%
187,637,077 BBLS
7.9% CRAFT
24,489,945 BBLS
8.5% IMPORT BEER
39,408,756 BBLS
OVERALL BEER MARKET
$100.2 BILLION
CRAFT BEER MARKET
$26.8 BILLION
21% DOLLAR GROWTH
CRAFT
13.1% SHARE
(24,489,945 BBLS)
IMPORT
21.0% SHARE
(39,408,756 BBLS)
OTHER DOMESTIC
65.9% SHARE
(123,889,486 BBLS)
SOURCE: BREWERS ASSOCIATION

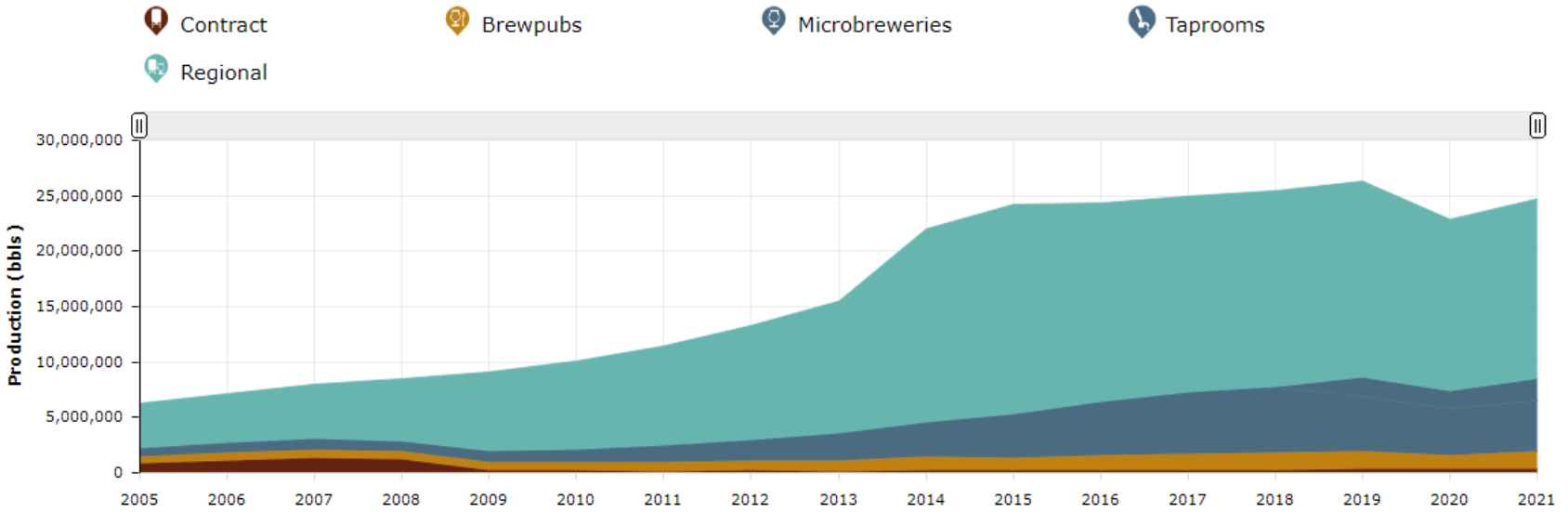
Production Data



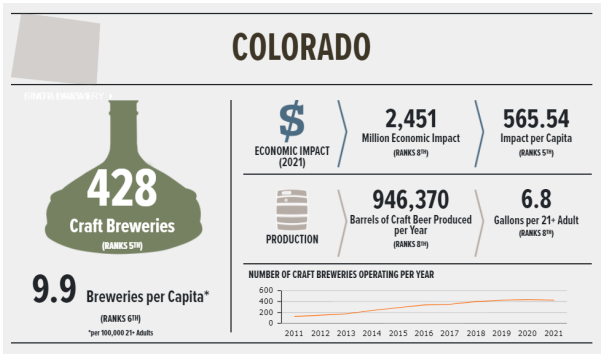
U.S. Craft Brewery Count by Category

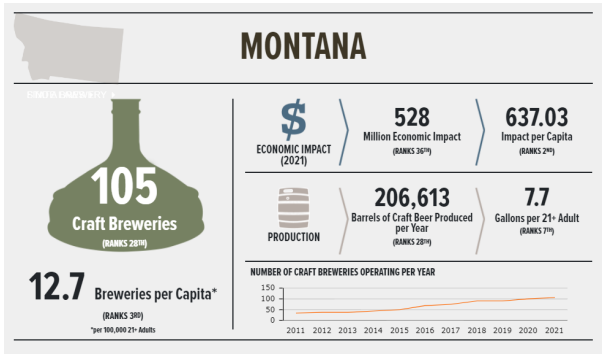


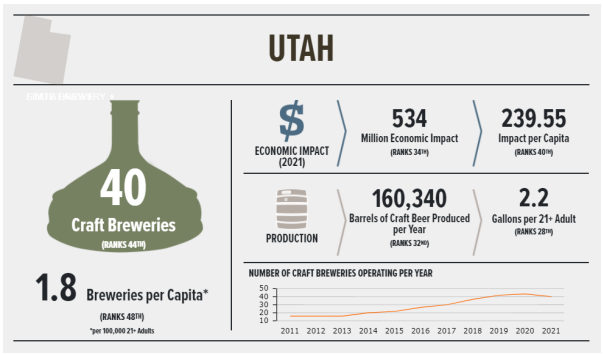
Historical Craft Brewery Production by Category

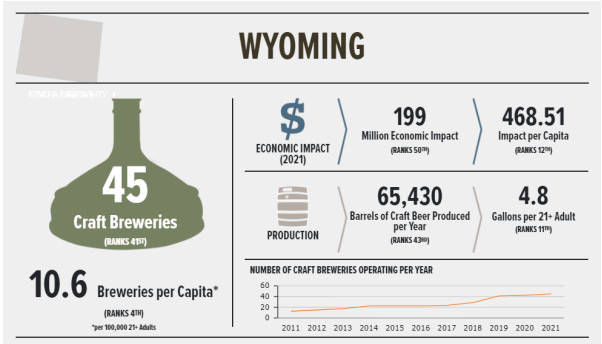


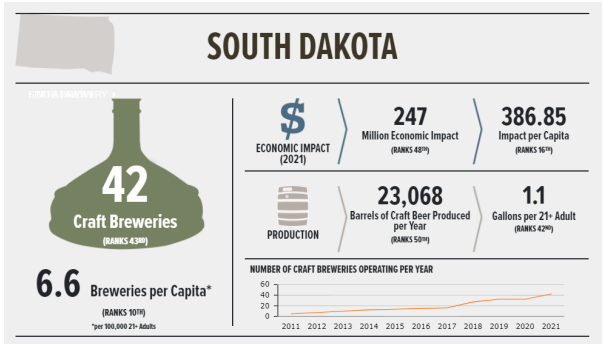
1 barrel = 31 US gallons

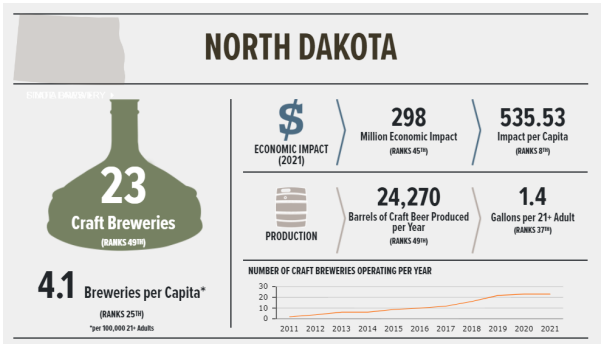












Statistics By State

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Terms

- **Yeast** - During the fermentation process, yeast converts the natural malt sugars into alcohol and carbon dioxide gas
- **Hops** - the flowers (also called seed cones or strobiles) of the hop plant *Humulus lupulus.* They are used primarily as a bittering, flavoring, and stability agent in beer, to which, in addition to bitterness, they impart floral, fruity, or citrus flavors and aromas
- **Wort** - The bittersweet sugar solution obtained by mashing the malt and boiling in the hops, which becomes beer through fermentation
- **Trub** - Wort particles resulting from the precipitation of proteins, hop oils and tannins during the boiling and cooling stages of brewing
- **Grist** - Ground malt and grains ready for mashing
- **Lautering** - The process of separating the sweet wort (pre-boil) from the spent grains in a lauter tun or with other straining apparatus
- **Malt** - Processed barley that has been steeped in water, germinated and later dried in kilns for the purpose of stopping the germination and converting the insoluble starch in barley to the soluble substances and sugars in malt
- **BBLS** – beer barrels = 31 gals

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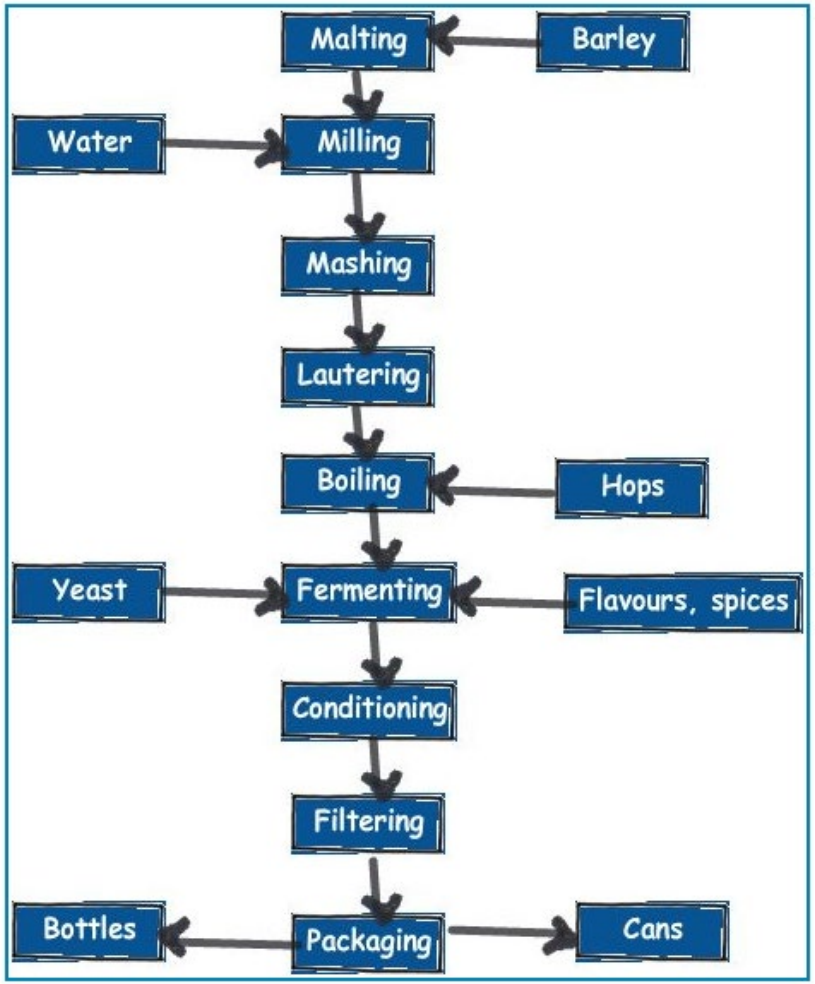
Brewing Process

- Step 1: Malting
- Step 2: Milling
- Step 3: Mashing
- Step 4: Lautering
- Step 5: The boil
- Step 6: Fermentation
- Step 7: Conditioning
- Step 8: Filtration
- Step 9: Packaging



Malting

- The conversion of carbohydrates to dextrin and maltose takes place in three steps
  - Soaking known as steeping
  - Germination to sprout
  - Heating or kilning

Milling

- Beginning in the brew house, different types of malt are crushed together to break up the grain kernels to extract fermentable sugars to produce a milled product called grist
- The malt is mixed with water to complete the conversion of starches to sugar. The grain is milled to create the proper consistency to the malt
- This crucially important step can make or break a beer before it has even begun

Mashing

- Once the grain has been milled, it is added to a large vessel called the mash tun and mixed with hot water to form the mash
- The heat from the water (referred to as liquor in breweries) activates the enzymes within the barley. Enzymes convert the starches released during the malting stage, into sugars that can be fermented

Lautering

- To begin the lautering process, the liquid containing the sugar extracted during mashing is separated from the grains. It is then generally termed as wort and is transferred to a vessel with a false-bottom called a lauter tun, where wort is drained away from the hulls and barley grist
- Water is added during lautering to extract even more of the fermentable sugars from the grain. This is known as sparging

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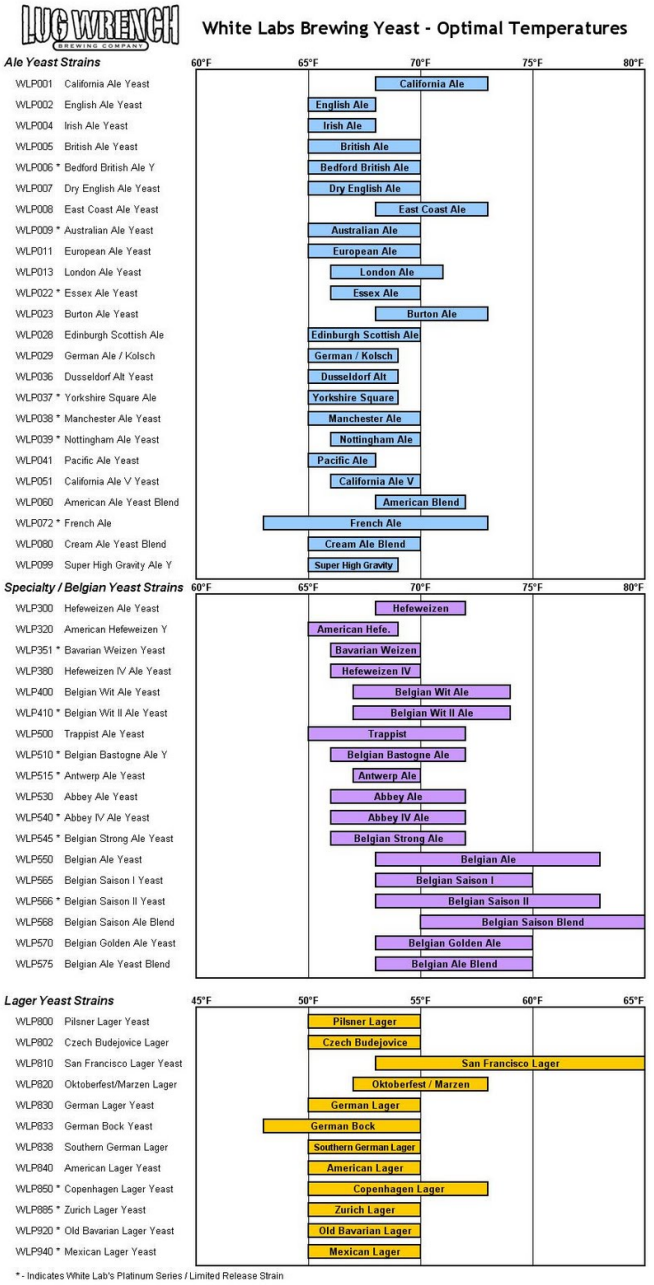
Boil/Hops

Wort is collected in a vessel called a kettle, where it is brought to a controlled boil before the hops are added. Hops are added during this stage for flavor and aroma to balance the sweetness of the malt

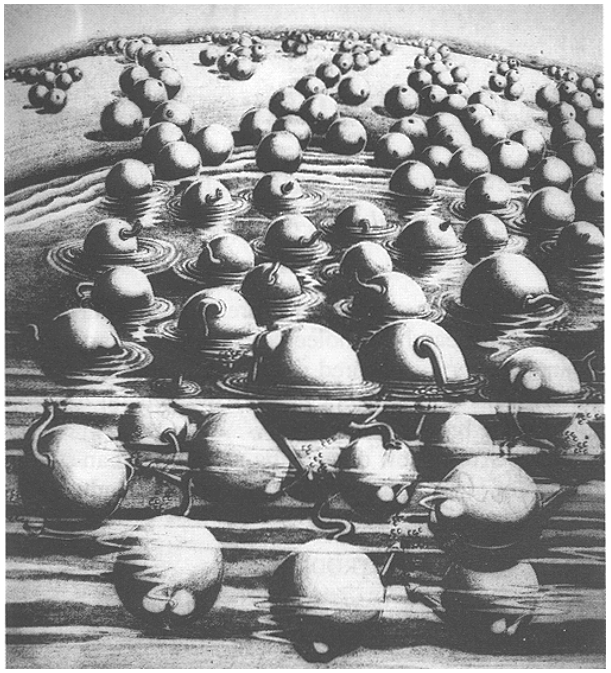
Fermentation

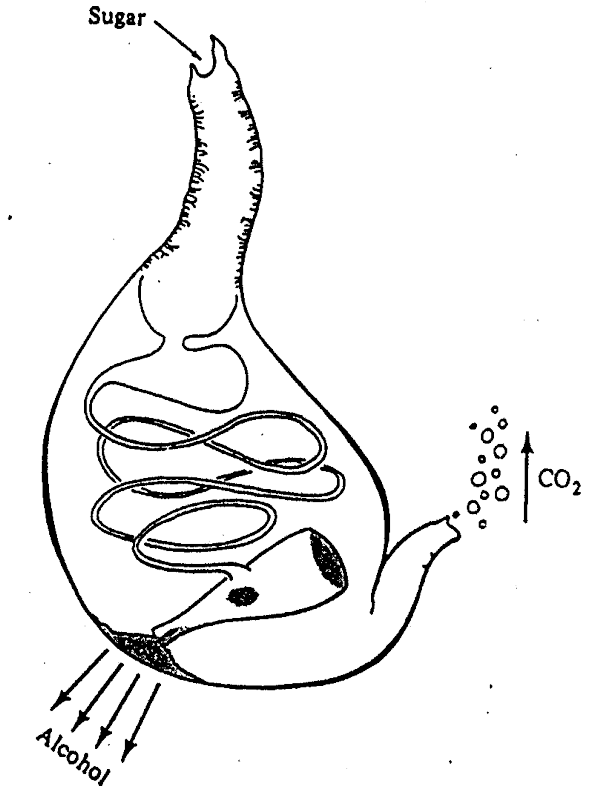
To start the fermentation, yeast is added during the filling of the vessel. Yeast converts the sugary wort into beer by producing alcohol, a wide range of flavors, and carbon dioxide (used later in the process to give the beer its sparkle).



Yeast

….small animal which sips sugar through its snout and excretes alcohol from its gut and carbonic acid from its urinary organ





Conditioning

- Fermented beer contains suspended particles, lacks sufficient carbonation, lacks taste and aroma, and less stable.
- Conditioning reduces the levels of these undesirable compounds to produce a more finished product

Filtering

Filtration helps remove excess yeast and solids, like hops or grain, remaining in the beer. Filtering is the process which produces the clear, bright and stable beer

Packaging

Packaging is the process of putting the finished beer into vessels for distribution

- Bottles
- Cans
- Kegs

Brewery Production

Brewery
Annual Production = 10,000 bbls/yr
Daily Production (250 days/yr) = 40 bbls/day
Water Usage = 8 bbl/bbl
Wastewater/Water Ratio = 0.6
Wastewater Flow = 6,000 gal/day
BOD Loading (8,000 mg/L) = 400 lb/day
TSS Loading (2,000 mg/L) = 100 lb/day
N Loading (125 mg/L) = 6 lb/day

Residential
Wastewater Flow (4 person household) = 240 gal/day
BOD Loading (200 mg/L) = 0.4 lb/day
TSS Loading (250 mg/L) = 0.5 lb/day
N Loading (50 mg/L) = 0.1 lb/day

Equivalent number of residences to one 10,000 bbls/yr brewery based on BOD loadings = 1,000 homes

Wastewater

- Elevated sugar
- Elevated alcohol
- Elevated solids
- Elevated temperature
- Variable pH
- Elevated phosphorus

Wastewater Generation

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
Boil Kettle	Dewatering	Nitrogenous residue. BOD ~2,000 ppm
Whirlpool	Rinsing spent hops and hot trub	Proteins, sludge and wort. High in SS (~35,000 ppm). BOD ~85,000 ppm
Fermenters	Rinsing	Yeast SS ~6,000 ppm, BOD up to 100,000 ppm
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.

Pretreatment/BMPs

- pH neutralization
- Solids management
- Biological treatment
- Water conservation

Containment of concern	Side Streaming	Screening	Settling/ equalization	Chemical Addition	Biological treatment
BOD	X		X		X
TSS	X	X	X	X	X
pH			X	X	X

pH control

- Flow equalization
- Chemical addition

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pH BMPs

- Install totes, tanks, or containers to adjust pH of individual waste streams
- Install sufficiently sized tank to collect wastewater from all brewery operations for neutralization
- Provide a mechanical mixer to promote neutralization
- Reuse and recycle chemicals wherever possible
- Train employees on pH management

Solids Management

- Side streaming
- Screening
- Sedimentation

Side Streaming

Side streaming is collecting high strength, concentrated wastes at the source and setting it aside for disposal or repurpose

- Possible sources:
  - Spent grain
  - Trub
  - Spent yeast
  - Lauter plate rinsing
  - Hop back rinsing
  - Fermenter bottoms
  - Returned beer in kegs
  - Fermenter blow off
  - Beer in hoses or pipes

Co-product	Source	Attributes	Possible uses
Spent Grain	Lauter Tun	High Carbohydrate, protein	Cattle Feed
Sweet Water	Lauter Tun	High Carbohydrate	Animal Feed
Spent Hops	Brew Kettle	High Carbohydrate	Animal Feed, Soil amendment
Trub	Whirlpool Tank	High Carbohydrate	Cattle Feed
Spent Yeast	Tank Bottoms	High Protein	Animal Feed, Distillation
Spent DE	Filtration	Porous Silica	Soil amendment
Ullage	Racker	Ethanol	Distillation

Solids BMPs

- Install screens, filters or baskets on all floor drains and trenches
- Prevent spent yeast, grains, hops and trub from entering the sewer
- Use the correct gauge screen to maximize solids removal and install screens that are easy to access and service
- Dewater collected solids and dispose offsite
- Collect spent yeast slurry for offsite disposal or beneficial reuse. If possible, reuse yeast for multiple generations
- Collect used filter media
- Control solids at the source
- Train employees on solids management practices

Biological treatment

- Anaerobic
- Aerobic

Comparison Of Two Pre-Treatment Options

	AEROBIC TREATMENT	ANAEROBIC TREATMENT
CONS	Higher energy use	80+% COD reduction
	Generates biomass (sludge) requiring disposal	
	High operating costs	
	Larger Footprint	
PROS	99+% BOD reduction	Provides renewable energy (biogas) and low biomass
		Low operating costs
		Smaller Footprint
		Capital equal or slightly lower than aerobic

Water Conservation BMPs

- Monitor water usage by installing water meters in various areas of operations
- Set water saving goals
- Use dry cleaning procedures before wet cleaning
- Use water efficient equipment, such as high-pressure nozzles, clean in place systems and water brooms
- Find alternatives to water cooled chilling equipment

Typical Reductions In Water Use

Water saving measure	Possible application	Typical reduction in process use (%)
Closed loop recycle	Fermentor cooling	>90
Cleaning-in-place (CIP)	New CIP set	60
Re-use of wash water	Cask washer	50
Countercurrent rinsing	CIP set	40
Good housekeeping	Hose pipes	30
Cleaning-in-place	Optimisation of CIP set	30
Spray/jet upgrades	Cask Washer	20
Brushes/squeegees	Fermentor cleaining	20
Automatic shut-off	Pump cooling water	15

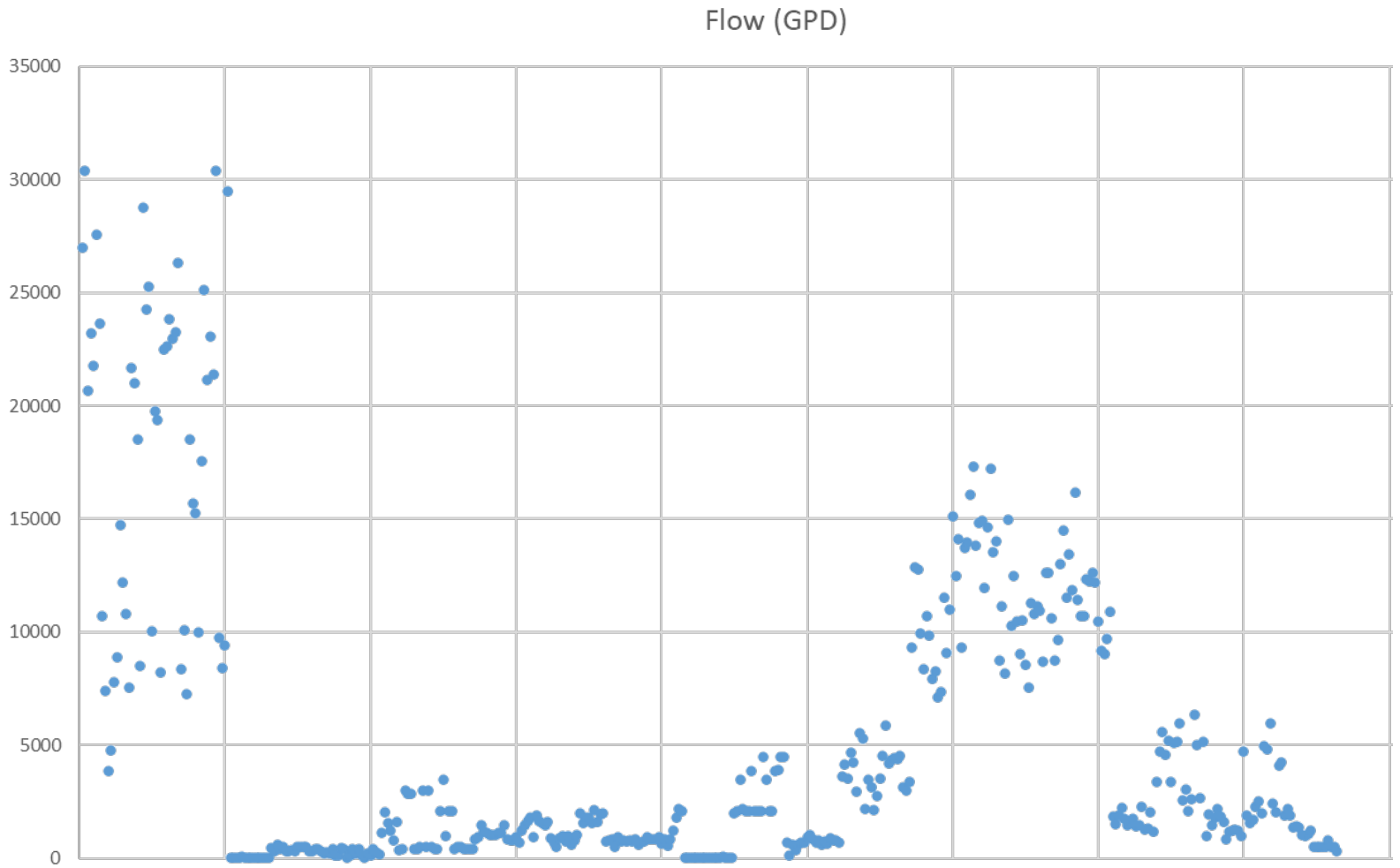
Pitfalls

- Slug discharge
- Out of speck product
- CIP wastewater
- Yeast, hops, trub

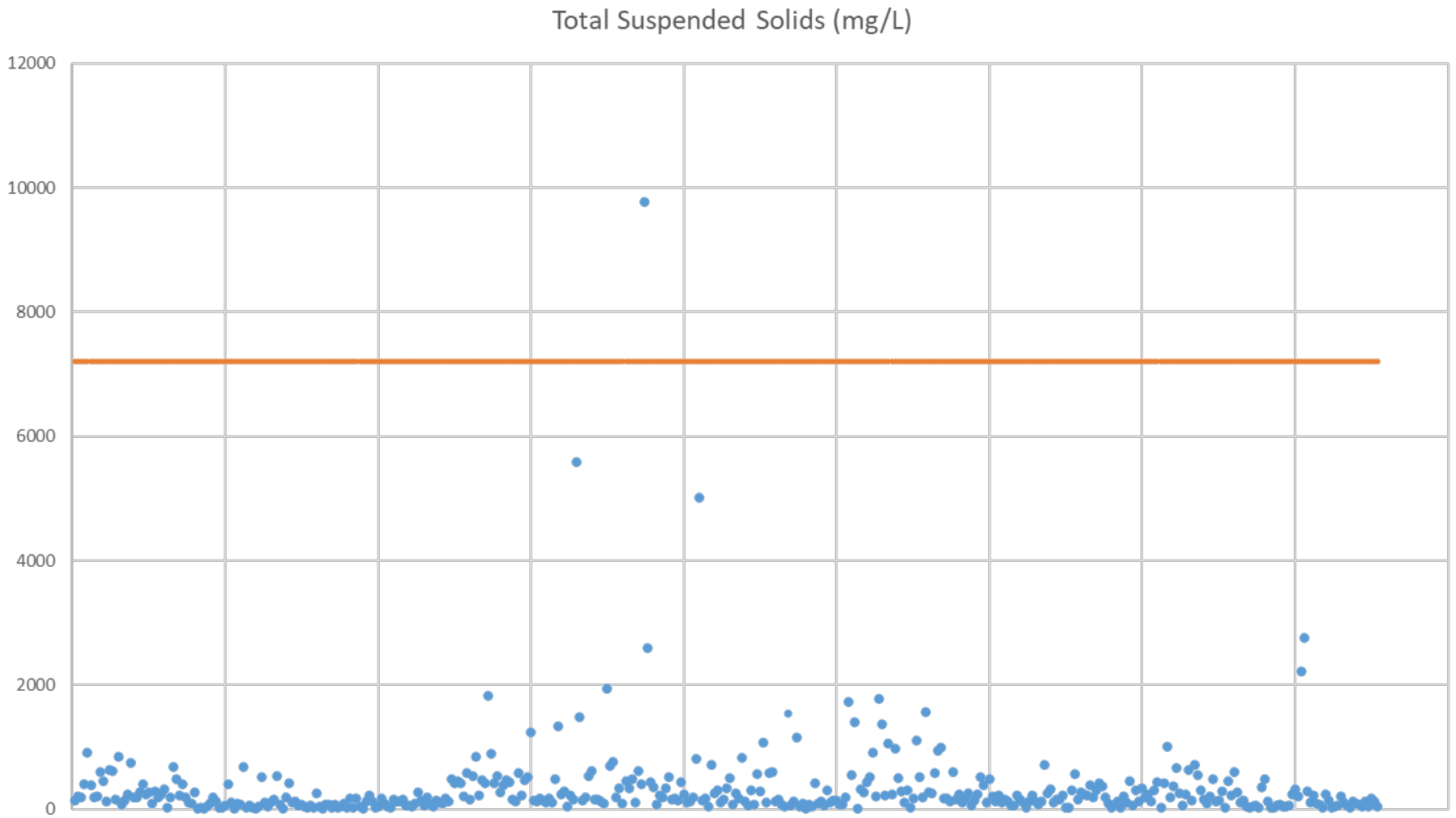
Salt Lake City

- 13 breweries
- Many breweries struggle with wastewater discharge limits
- BOD
- TSS
- pH
- TP (where local limits are appliable)

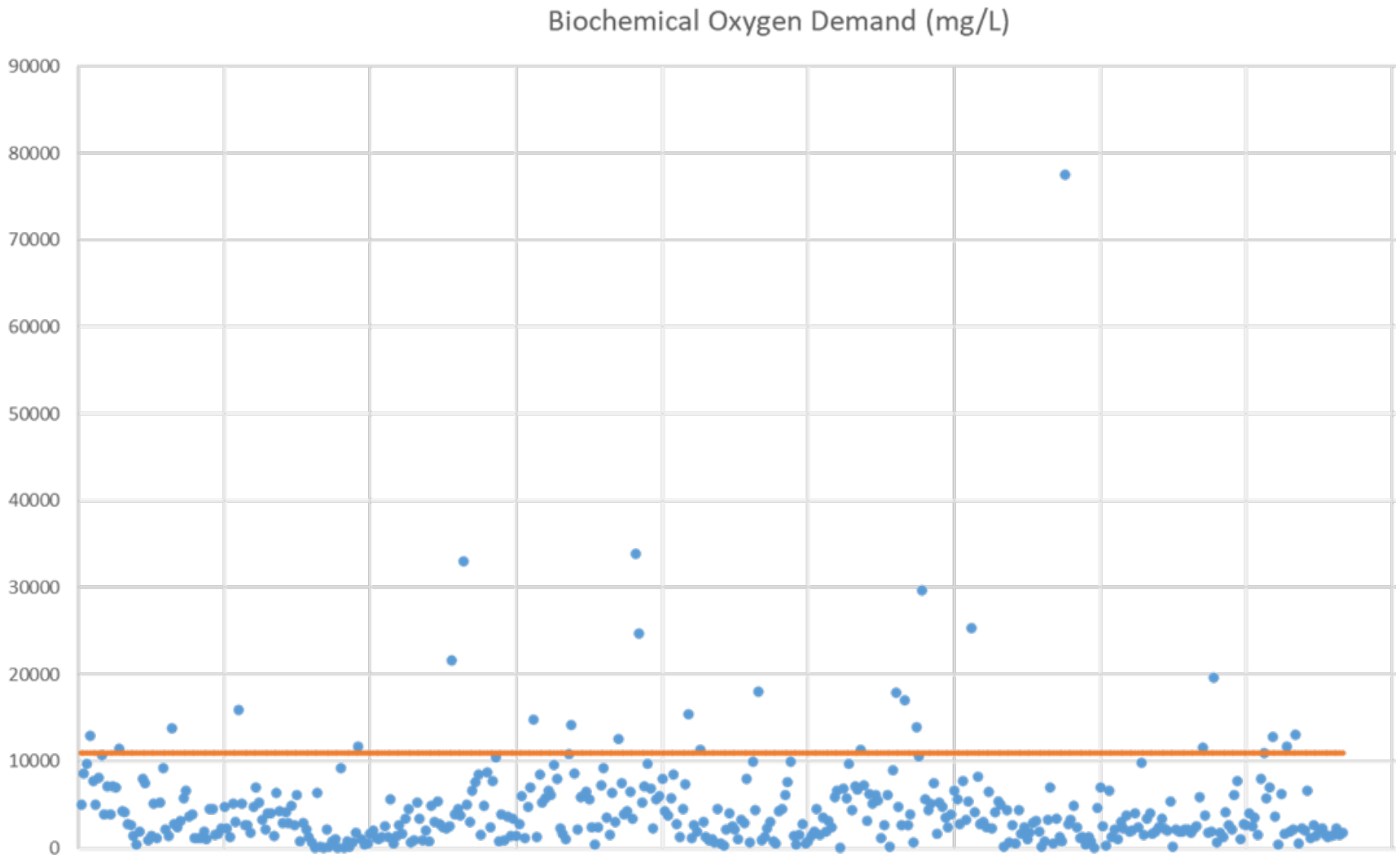
Wastewater Characteristics: Flow



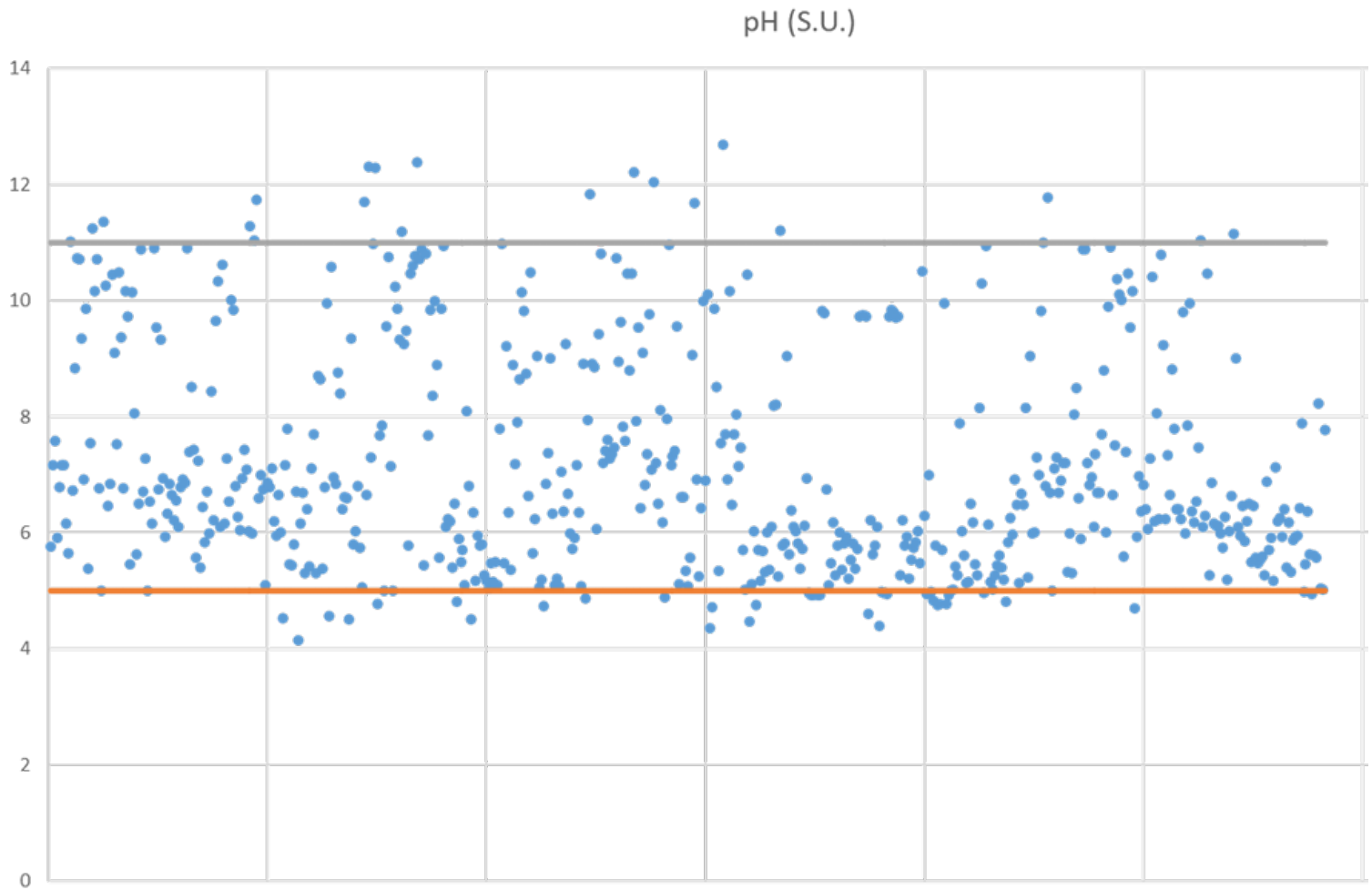
Wastewater Characteristics: TSS



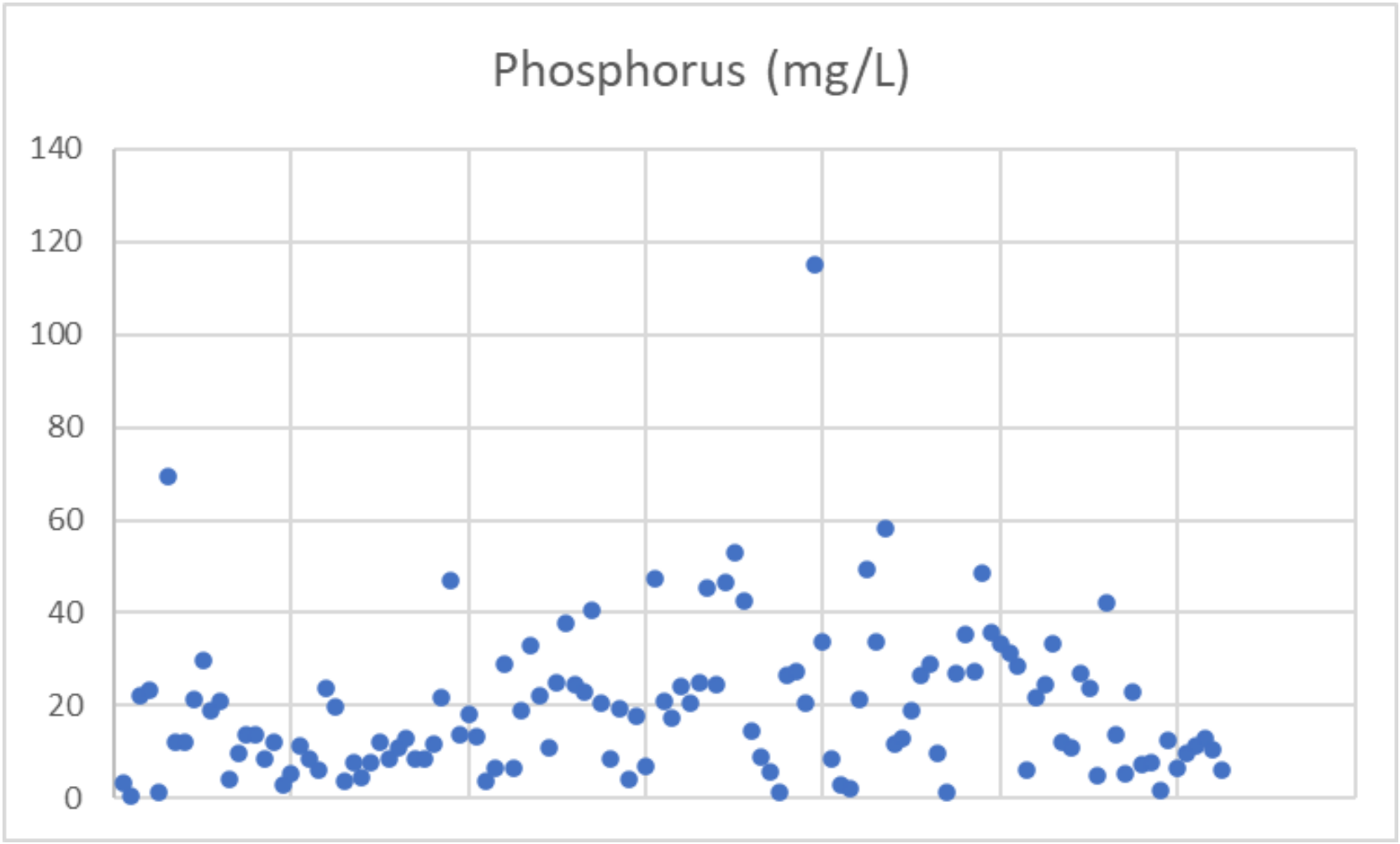
Wastewater Characteristics: BOD



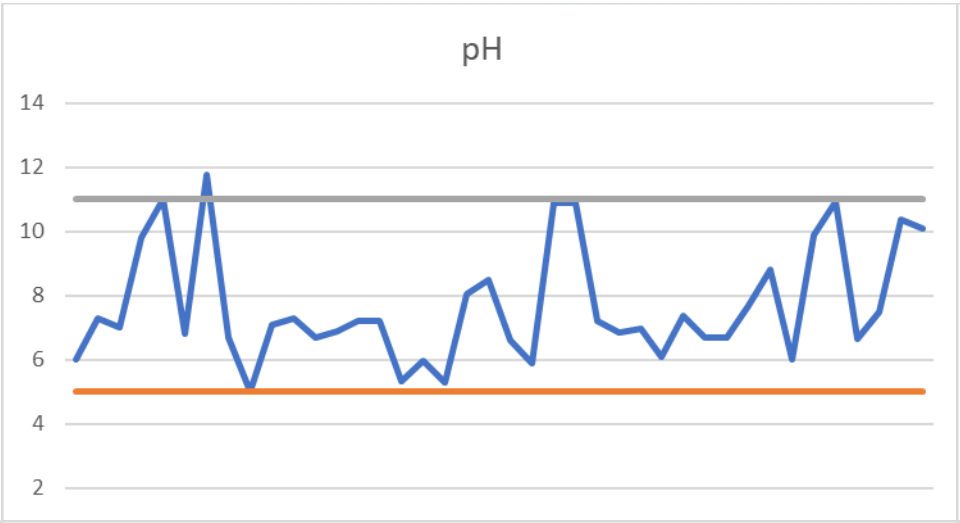
Wastewater Characteristics: pH

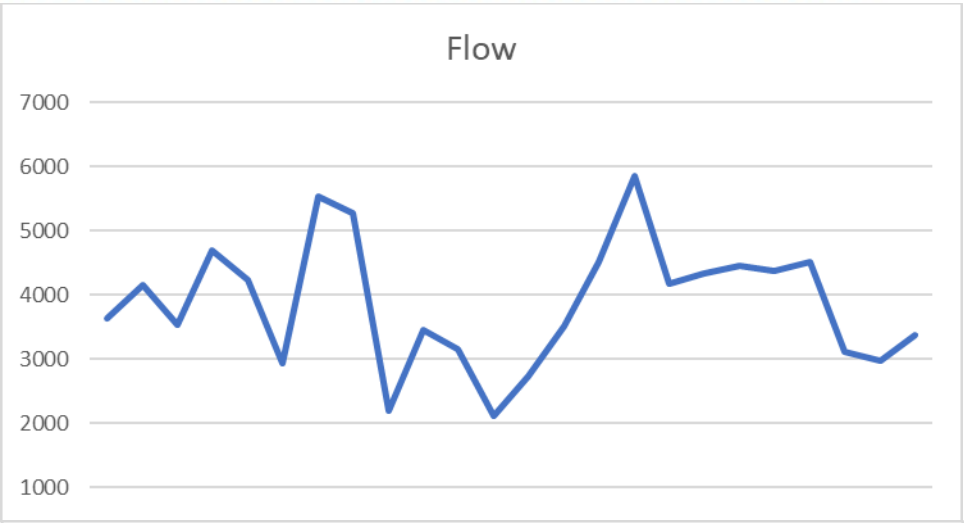


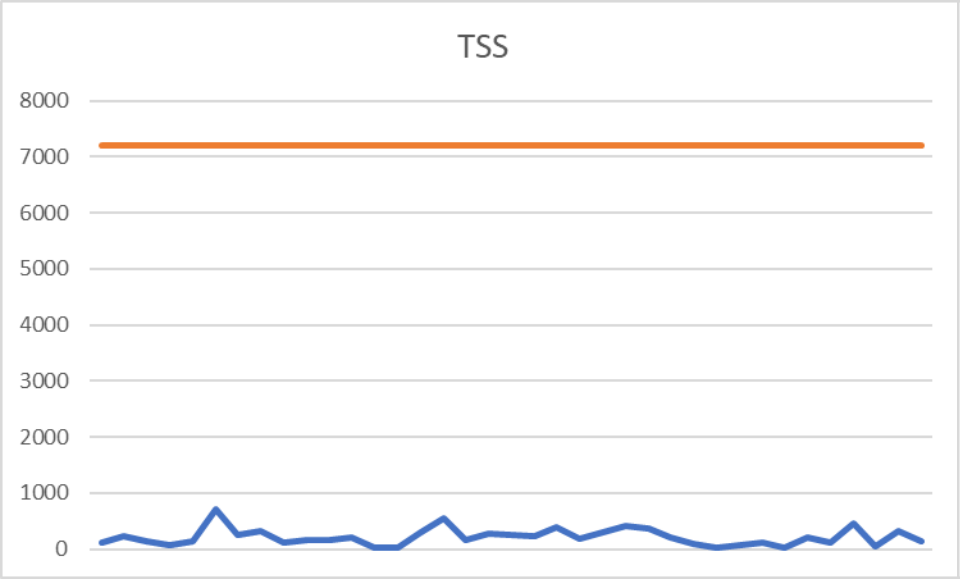
Wastewater Characteristics: Phosphorus

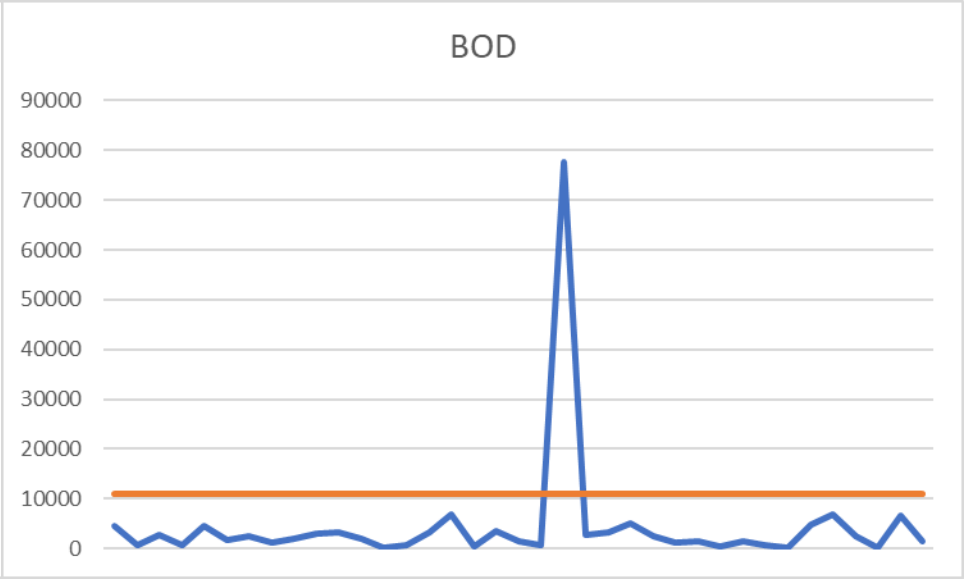


Brewery A – Overview









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Brewery A – Compliance

It all started with a phone call…

Brewery A - Compliance

Brewery A – Compliance

An investigative sample was collected with the following analytical results:

Pollutant	Result	Limit
BOD	77,500 mg/L	10,000 mg/L
COD	104,000 mg/L	20,000 mg/L

Brewery A – Cease and Desist Order

ORDER

Taking these Findings into consideration, the Permittee shall cease and desist the disposal of non-permitted substances including but not limited to cleaning solutions and filtered and unfiltered beer to facility floor drains.

Pursuant to Title 17 of the City's Ordinance and the Permit, IT IS HEREBY ORDERED that the Permittee comply with the following requirements:

1. The Permittee shall cease and desist the disposal of non-permitted substances, including but not limited to cleaning solutions and filtered and unfiltered beer into facility floor drains.

2. Non-permitted substances shall be hauled and disposed offsite at an appropriate disposal facility. Disposal manifests for non-permitted substances shall be submitted quarterly with Permit required Periodic Compliance Reports.

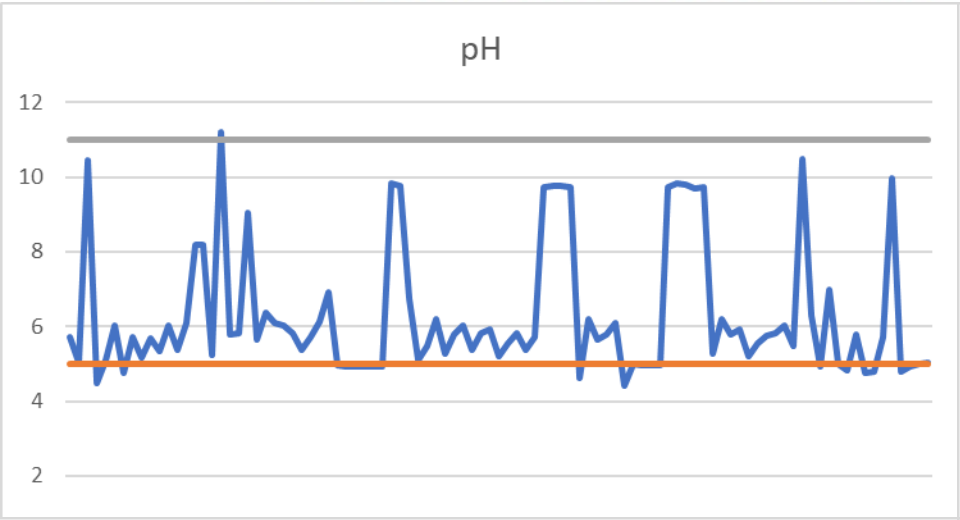
3. All non-domestic wastewater discharges to the POTW shall pass through the onsite pH neutralization system prior to discharge.

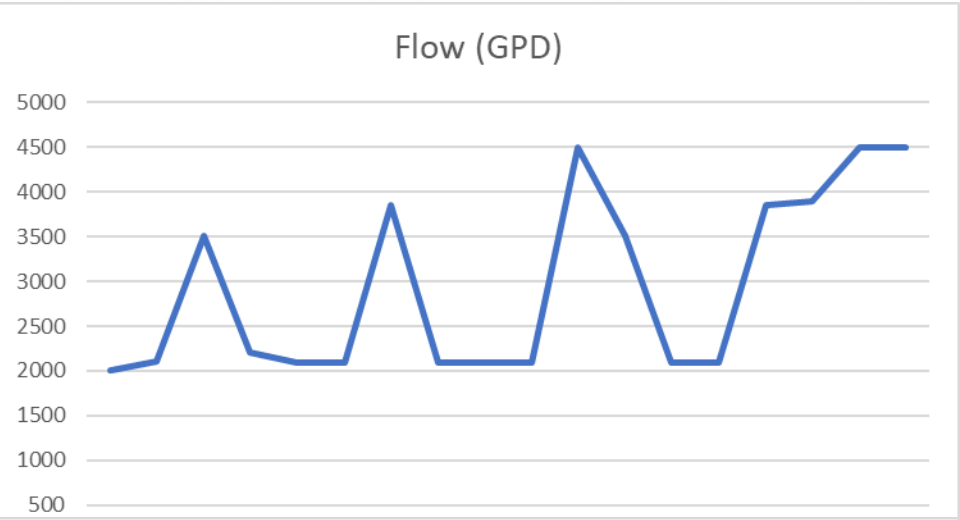
4. The oil-grease interceptor shall be cleaned out at least every ninety (90) days. Clean out records shall be submitted quarterly with Permit required Periodic Compliance Reports.

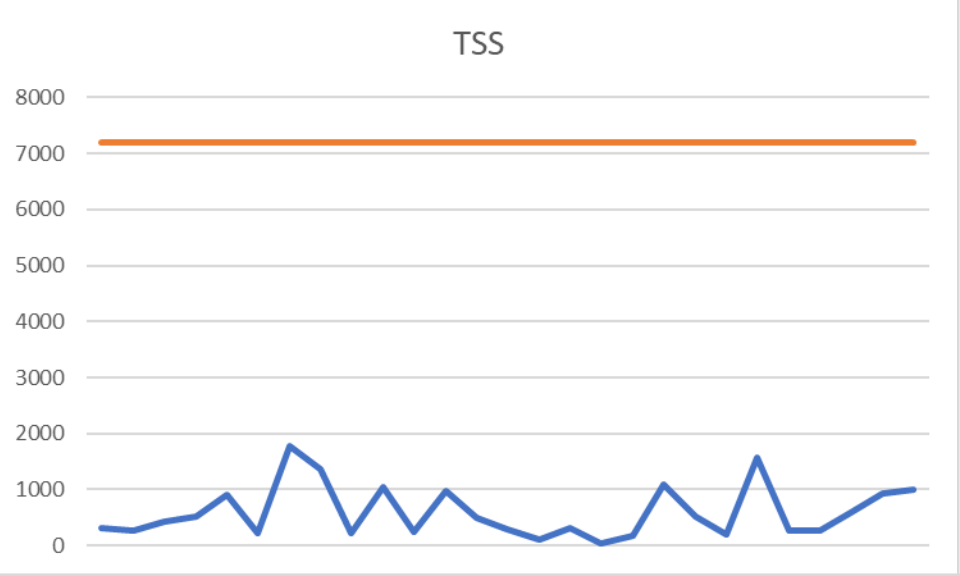
5. The Permittee shall pay an administrative fine of $3,000.00 for the improper disposal of substances into facility floor drains and violation of BOD and COD Permit limits. Payment of this administrative fine is due thirty (30) days from the date of this Order. Payment can be made to the address provided below.

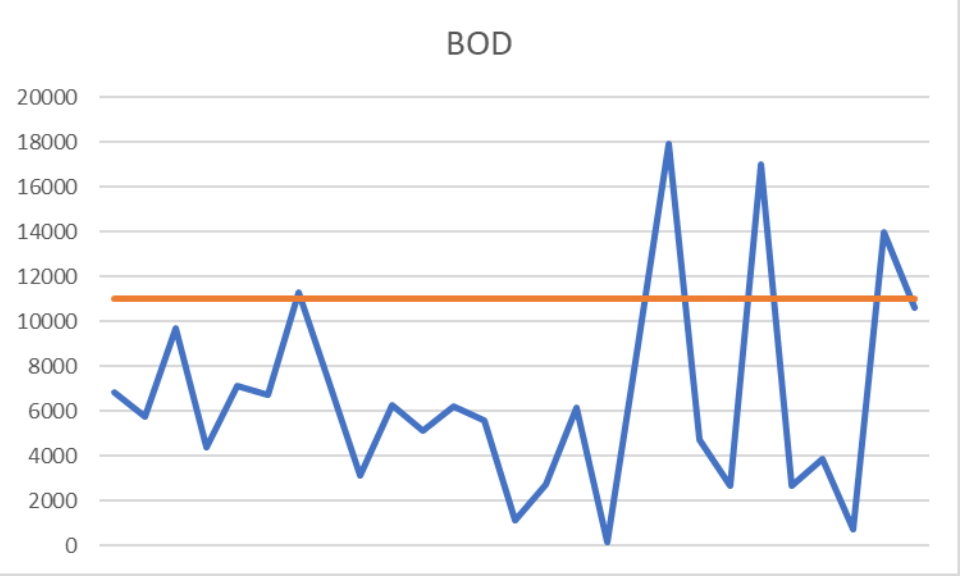
6. In accordance with Section 17.68.060.E., of the Ordinance, the Permittee has the right to dispute any fine or assessment provided herein. In order to dispute such fines or assessments, the Permittee shall submit a written request for reconsideration to the Director of the Salt Lake City Department of Public Utilities or the designated representative (Director) along with full payment of the administrative fine within 30 days of receipt of this Order. The Director may convene a hearing on the matter within 14-days of receiving said request from the Permittee.

Brewery B - Overview









Brewery B - Compliance

Date	Violation	Enforcement
6/12/19	pH	Verbal Warning
7/1/19	BOD	Warning Letter
8/5/19	pH	Warning Letter
8/16/19	pH	Warning Letter
7/14/20	BOD, pH	Warning Letter
8/18/21	pH	NOV, Departmental Meeting

A pattern emerges…

Brewery B – Compliance

Manual Composite Sampling & pH Field Sheet

Monitoring Point #: 001

Collection Date: June 30 2022

Manual Composite Sampling

Sample Number	Sample Time	Sample Volume	pH[1]	Sampler's Initials
1	7:45	80 ml	5.03	a
2	8:00	80 ml	5.03	a
3	8:15	80 ml	4.99	a
4	8:30	80 ml	4.96	a
5	8:45	80 ml	4.96	a
6	9:00	80 ml	4.95	a
7	9:15	80 ml	4.96	e
8	9:30	80 ml	4.93	e
9	9:45	80 ml	4.93	e
10	10:00	80 ml	4.94	e
11	10:15	80 ml	4.93	e
12	10:30	80 ml	4.93	e
TOTAL[2]			N/A	N/A
Grab				

NOTES:

(1) Field pH shall be measured at each sampling event using a calibrated pH meter. Report the INITIAL pH reading along with the sampler's initials. If a violation occurs, correct wastewater pH and report both initial and final pH values on the Field Sheet and COC.

(2) Totals are for pretreatment program internal analysis and do not need to be reported on the PCR cover sheet.

Date	Violation	Enforcement
1/31/22	pH	NOV, Fine
7/5/22	BOD, pH	Compliance Order

Brewery B – Compliance

TABLE 1

Item #	Compliance Order Item Description	Item Due Date
1	The Permittee shall utilize a third-party licensed engineer who specializes in wastewater treatment to develop a facility-specific wastewater treatment plan (Plan) that will ensure compliance with all wastewater discharge Permit limits. The Plan shall be submitted to the SLCWRF and the City's Development Review office (https://www.slc.gov/utilities/contracts-and-construction/) within 90 days of receipt of CO 2022035. The Plan shall include details of new or upgraded wastewater pretreatment systems (e.g., automatic pH adjustment system) as well as the equipment's operation and maintenance practices and procedures that will ensure compliance with the wastewater discharge limits stipulated in the Permit and Ordinance. The Plan shall be stamped by the third-party licensed engineer.	Within 90 days of receipt of CO 2022035
2	The Permittee shall install and maintain any and all pretreatment equipment and operating procedures identified in the Plan. Equipment and processes shall be installed and operational within 30 days of the Plan approval by the City. The Permittee shall notify the SLCWRF once required equipment is installed to allow for inspection.	Within 30 days of the Plan approval.
3	The Permittee shall collect daily wastewater pH discharge compliance samples from MP001 and submit the results on the attached Monthly PCR form (see **Attachment A**) until cessation of CO 2022035. The respective Monthly PCR shall be due no later than the 28th day of the month following the month of sample collection (e.g., the Monthly PCR submission for wastewater pH samples collected during the month of July shall be due between August 1st and 28th). The collection and submittal of the wastewater discharge compliance results for pH shall adhere to the requirements provided in the Permit.	Immediately upon receipt of this Order

Brewery B – Compliance

Brewery B - Compliance

Date	Violation	Enforcement
10/21/22	BOD, pH	NOV
1/26/23	Late Report, pH	NOV
3/17/23	Late Report, Resample	NOV, Fine

Noncompliance problems fixed?!

Brewery B - Compliance

- Next steps:
  - Continued patter of noncompliance
  - New management less responsive
  - Likely NOV and Order to Show Cause
  - Issuance of Significant Noncompliance (SNC)
  - Escalated fines
  - Potential for Permit suspension/termination

Questions?

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