Managing Water Chemistry
in the
Beaver Lake Water District

Salt, Pepper & Lemon

Agenda

- Beaver Water District water
- Water report
- What is pH and why does it matter
- Residual Alkalinity – WTF?
- What Beer Styles does our water favor?
- Water adjustment ideas
- Questions and ~~Answers~~ Bullshit

Beaver Water District

The 2nd Best Water in the World for Home Brewing?

Location	Calcium	Magnesium	Sodium	Sulfate	Chloride	Alkalinity
Burton	275	40	25	610	35	270
Dortmund	230	15	40	330	130	20
Dublin	120	4	12	55	19	170
Edinburgh	100	20	55	140	50	285
London	70	6	15	40	38	166
Munich	77	17	4	18	8	295
Pilsen	7	2	2	8	6	16
Vienna	75	15	10	60	15	225
BWD	26	2	7	24	6	53
General Recommendations	50 - 150	10 - 30	0 - 150	50 - 350	0 -250	Lower is Better

What is What in a Water Report?

https://www.bwdh2o.org/regulatory-compliance/

Finished Water Quality Results

January 11, 2022

Alkalinity, Bicarbonate (as CaCO3)	44 mg/L
Alkalinity, Carbonate (as CaCO3)	0 mg/L
Alkalinity, Total (as CaCO3)	44 mg/L
Calcium (as CaCO3)	58 mg/L
Calcium (as Ca)	23.2 mg/L
Chloride	7.0 mg/L
Chlorine, Total	1.47 mg/L
Conductivity	178 µS/cm
Hardness (as CaCO3)	66 mg/L
Iron	<0.01 mg/L
Magnesium (Mg)	1.9 mg/L
pH	8.59
Sulfate	26.0 mg/L
Total Dissolved Solids (TDS)	111 mg/L
Total Organic Carbon (TOC)	1.92 mg/L
Turbidity	0.06 NTU

Assuming water is clean, really just five things matter:

- Hardness (Calcium + Magnesium)
- Alkalinity (mostly Bicarbonate)

} pH and Flavor

- Chloride
- Sulfate
- Sodium

} Flavor

Common approach to managing water:

1. Get the pH of the mash into optimum range
2. Add other minerals as necessary to adjust flavor

Water, pH, and Alkalinity

- Water naturally disassociates:

$$H_2O \leftrightarrow H^+ + OH^-$$

- Carbon dioxide from atmosphere dissolves in water, creating acidity:

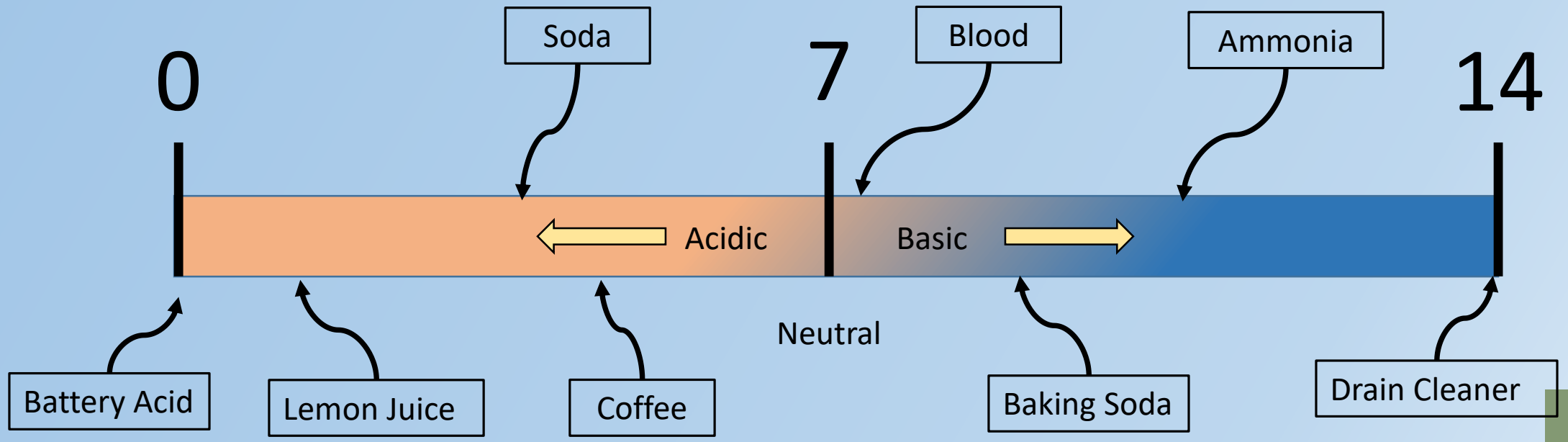
$$H_2O + CO_2 \rightarrow H^+ + HCO_3^-$$

- Water flows over limestone, creating alkalinity:

$$CaCO_3 + H^+ \rightarrow Ca^{++} + HCO_3^-$$

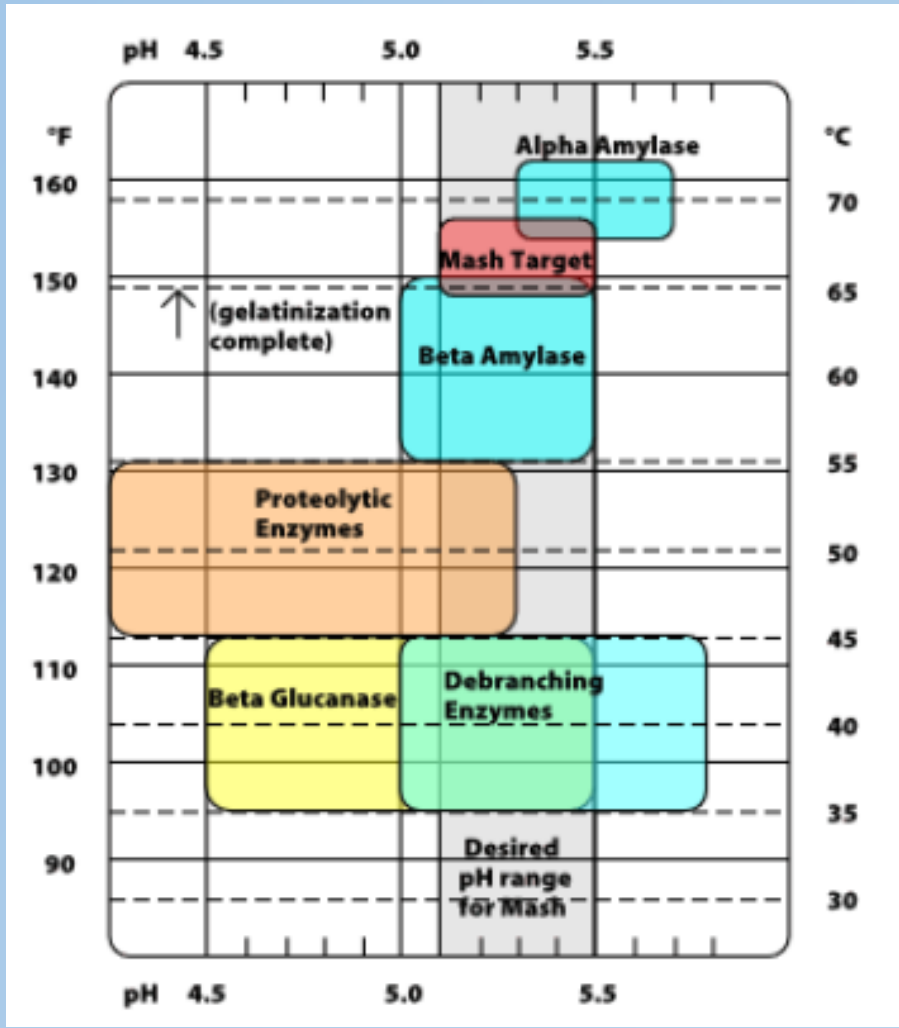
The pH Scale

- It is measurement of the acidity (how many H^+ are in solution)



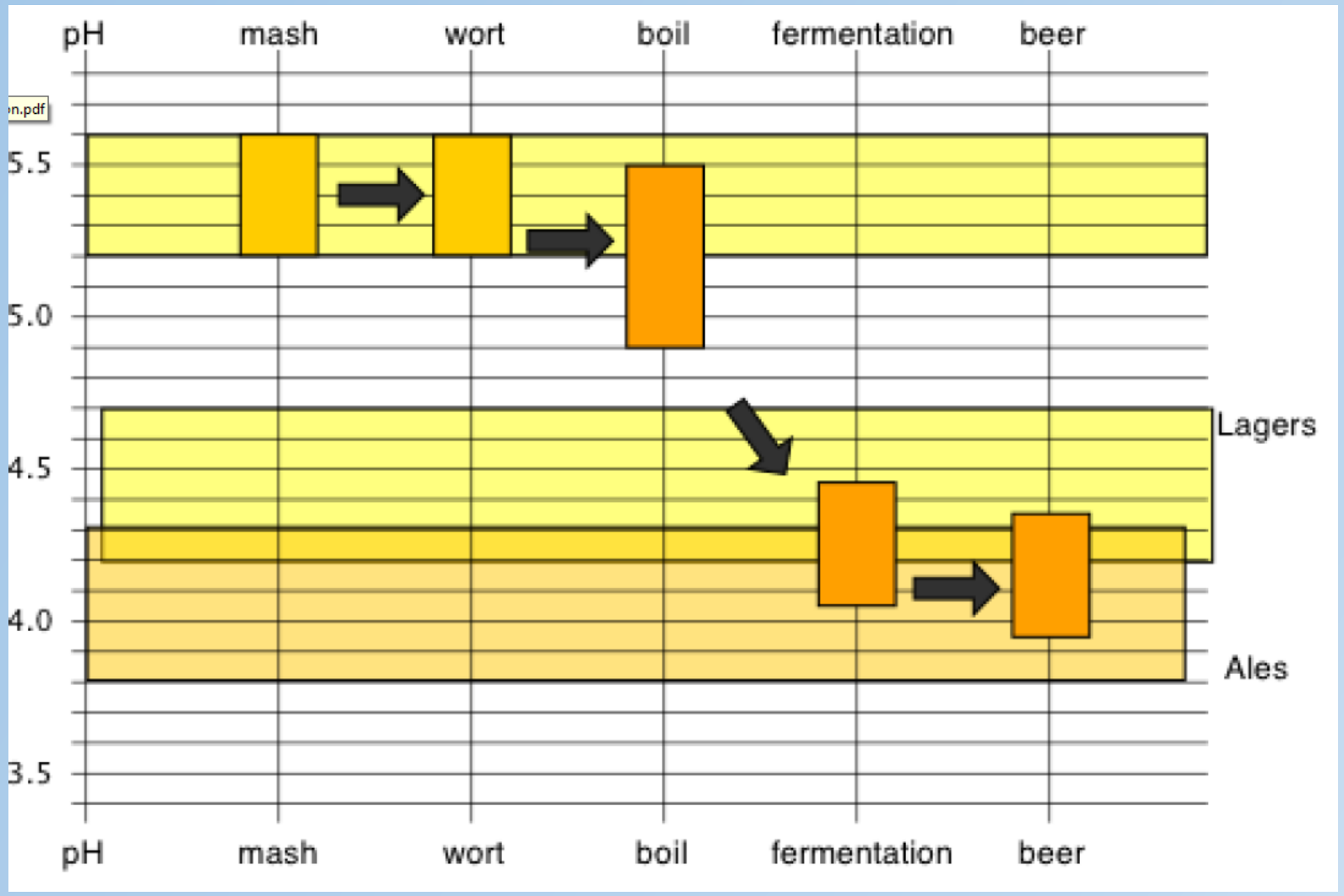
Note: Alkalinity is a measure of how strongly water resists acidification

Why Care About pH?



- Like temperature, pH affects mash enzyme performance
- Practically no impact at the homebrewing level
- Let InBev worry…

Mash pH Sets Up Beer pH



And Beer pH Influences Flavor Perceptions…

- “Every beer recipe has an ideal pH, where its flavors are best expressed” - John Palmer, 2014 NHC

- Think about adding a squeeze of lemon or a pinch of salt or some freshly ground black pepper to your food

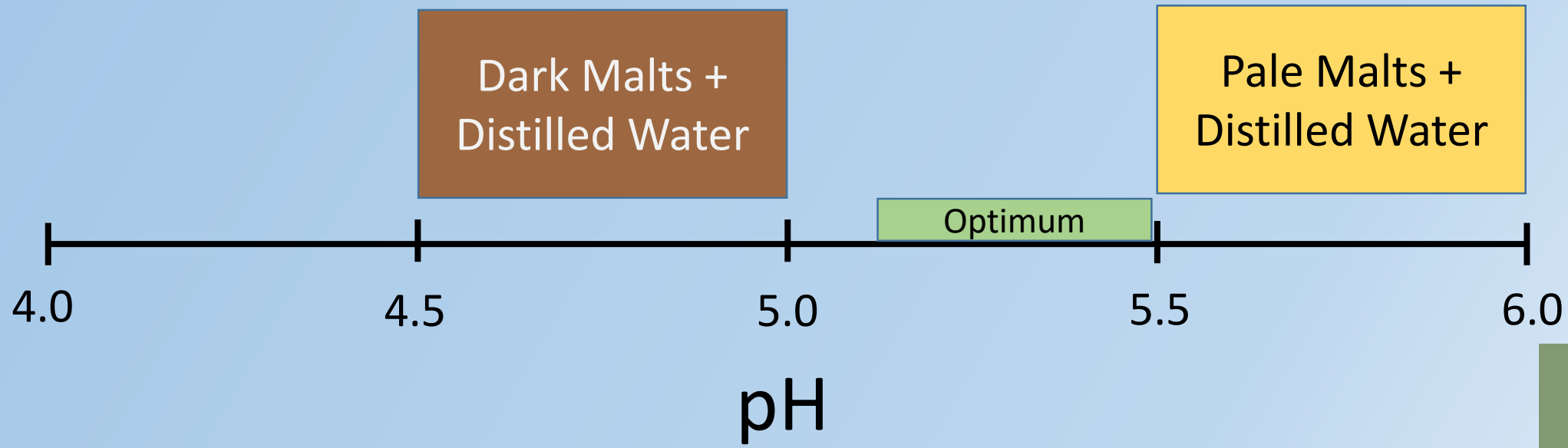
- General guidelines:

  - Lower pH creates perception of crispness (lagers, light colored beer)
  - Higher pH creates perception of fullness (stouts, porters, darker beers)

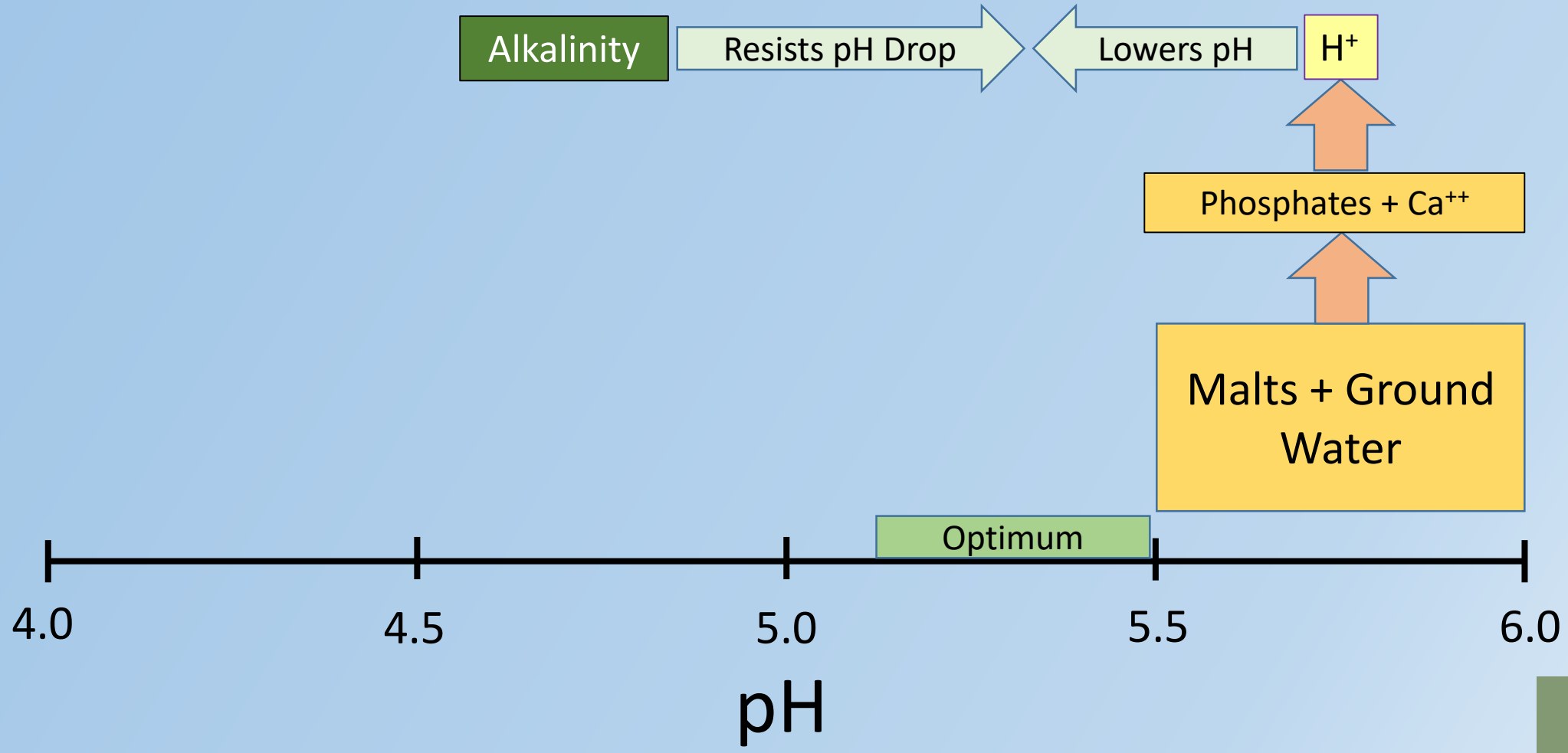
Residual Alkalinity

Or How I Learned to Stop Worrying (about pH) and Love the Beer

What Happens in a Mash with Distilled Water



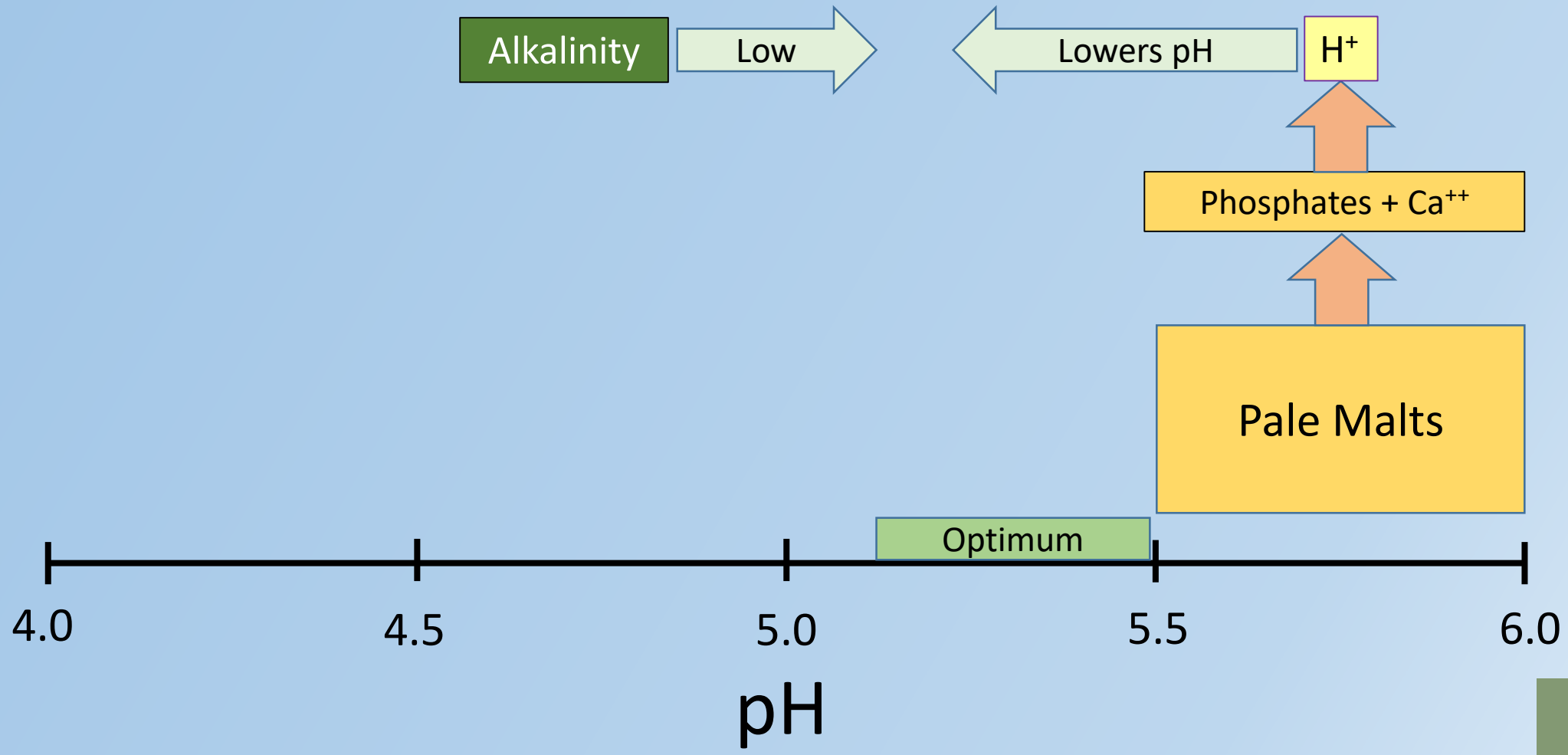
What Happens in a Mash with Ground Water



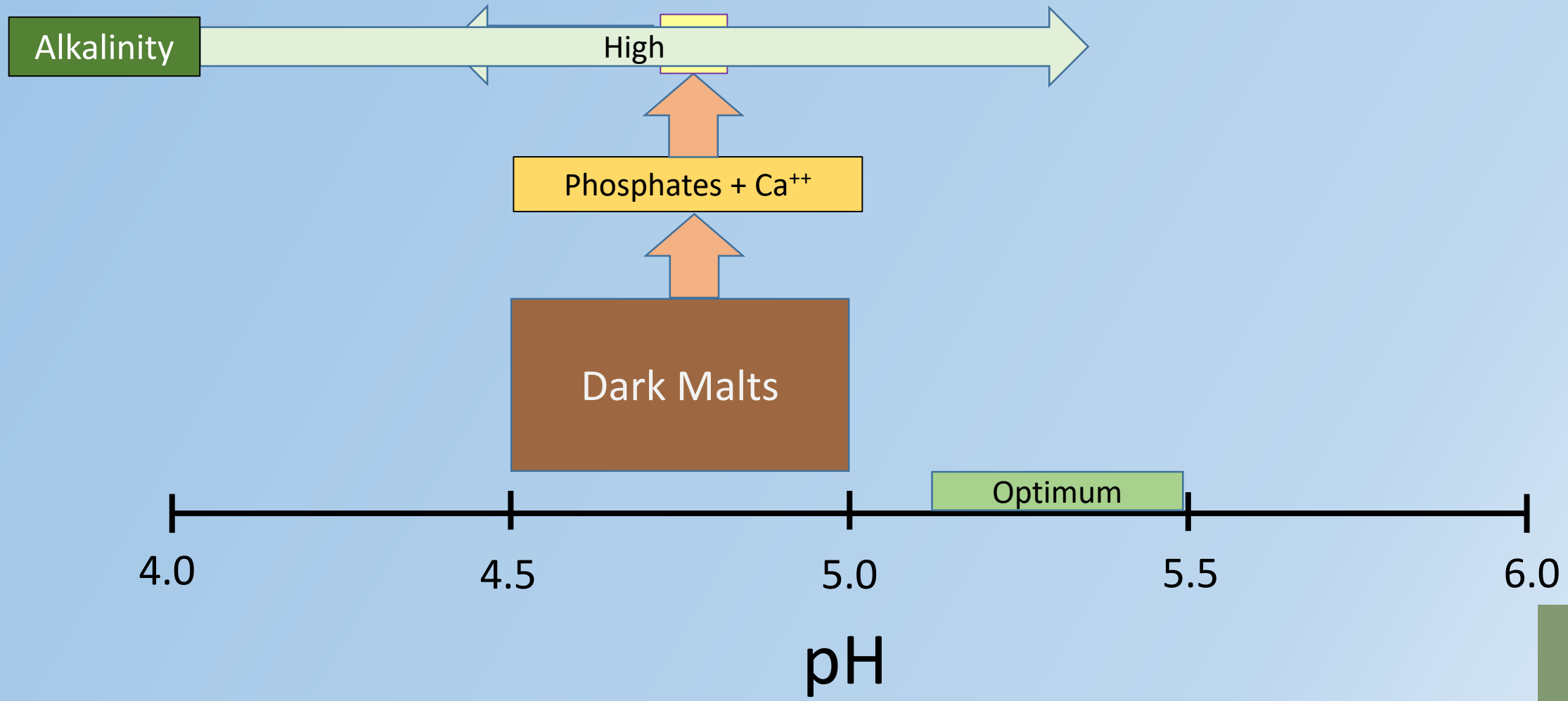
Residual Alkalinity

- Amount of alkalinity that remains in the water after the reaction with H^+ generated from the mash
- Residual alkalinity can be negative (excess H^+)

When do We want Low RA?



When do We want High RA?



Still there?

What Kinds of Beers are Suited to the BWD?

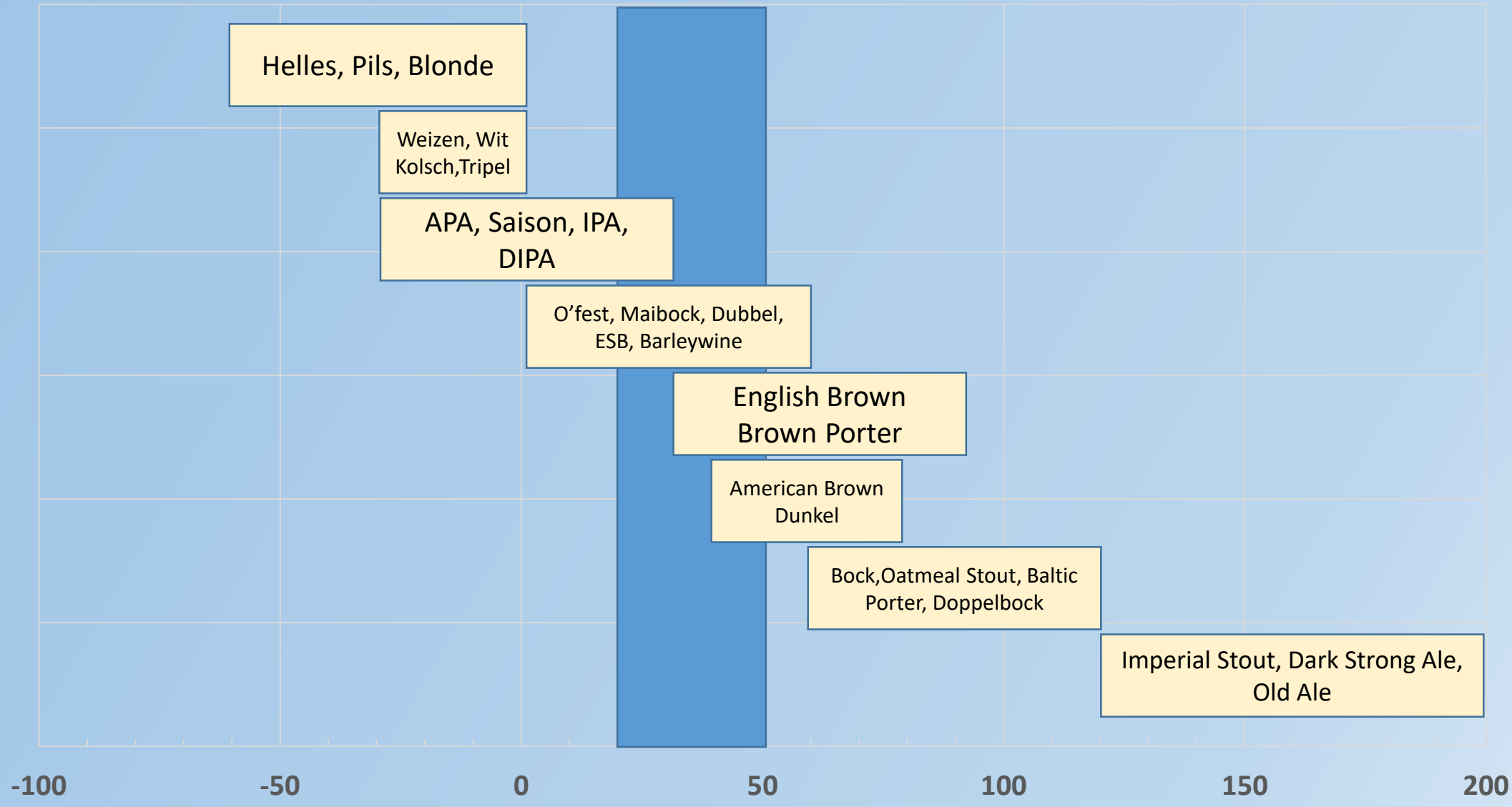
Calculating Residual Alkalinity for the BWD

$$RA = \text{Total Alkalinity} - \left[\frac{\text{Ca (ppm)}}{1.4} + \frac{\text{Mg (ppm)}}{1.7} \right]$$

$$RA = 53 - \left[\frac{26}{1.4} + \frac{2}{1.7} \right] = 33^{*}$$

*Seasonally, 20 to 50

Residual Alkalinity Recommendations

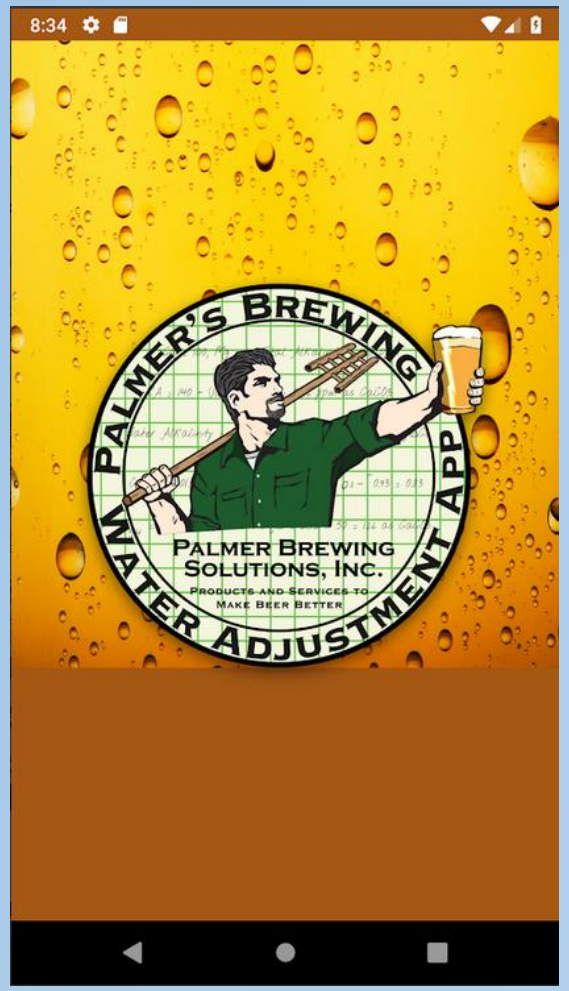


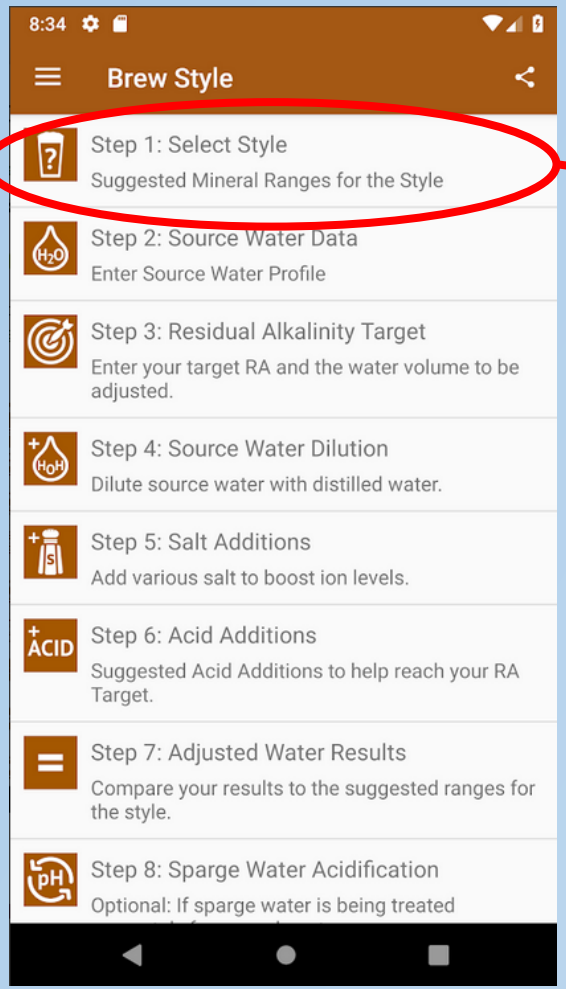
So Now What?

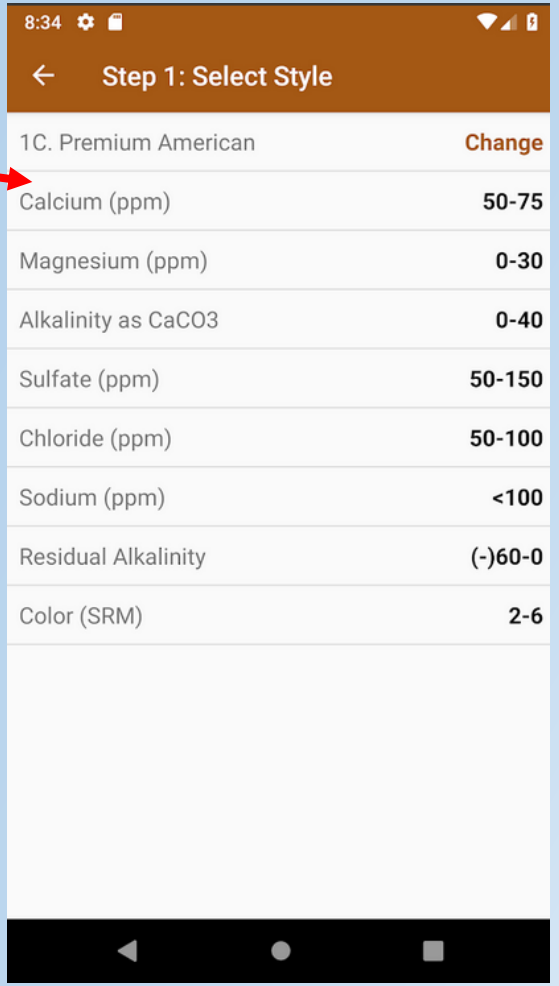
I just wanna brew some beer…

Water Guidelines by Style

"If you don't know where you are going, you'll end up someplace else."
— Yogi Berra







You can’t always add what you want…

	ppm added per gram per gallon				
	Calcium	Chloride	Sodium	Sulfate	Magnesium
Calcium Chloride	72	127			
Gypsum	61			147	
Epsom Salt				103	26
Table Salt		160	104		
Baking Soda			72		
Pickling Lime	143				
Chalk (Calcium Carbonate)	Not recommended				
Lactic Acid (88%)	Reduces RA by about 95				
Phosphoric Acid (10%)	Reduces RA by about 13				
Acid Malt	1% in grain bill reduces RA by about 20				

Water Adjustment Ideas - IPA

	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	26	2	7	6	26	53	33
Target	50-150	0-30	< 100	< 100	100 - 400	40 - 120	(-30) – 30
Calcium Sulfate (Gypsum)			10 grams, to boil kettle				
Magnesium Sulfate (Epsom Salts)			5 grams, to boil Kettle				
Finish	126	~~2~~ 23	6	7	~~26~~ 350	53	33

Water Adjustment Ideas – Blond Ale

	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	26	2	7	6	26	53	33
Target	50-100	0-30	< 100	50 - 100	100 - 200	0 - 80	(-60) – 0
Calcium Chloride			4 grams in mash				
Magnesium Sulfate (Epsom salts)			6 grams in mash				
Finish	67	24	7	79	115	44	-50

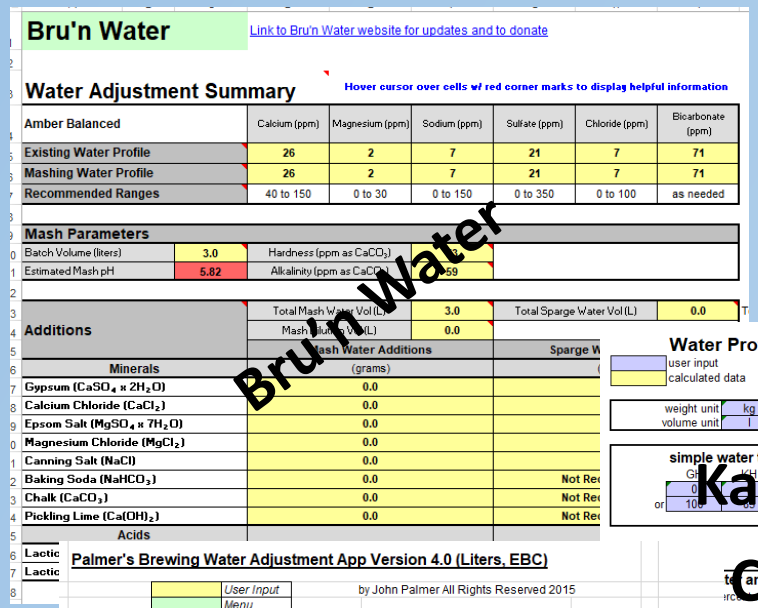
Water Adjustment Ideas – Imperial Stout

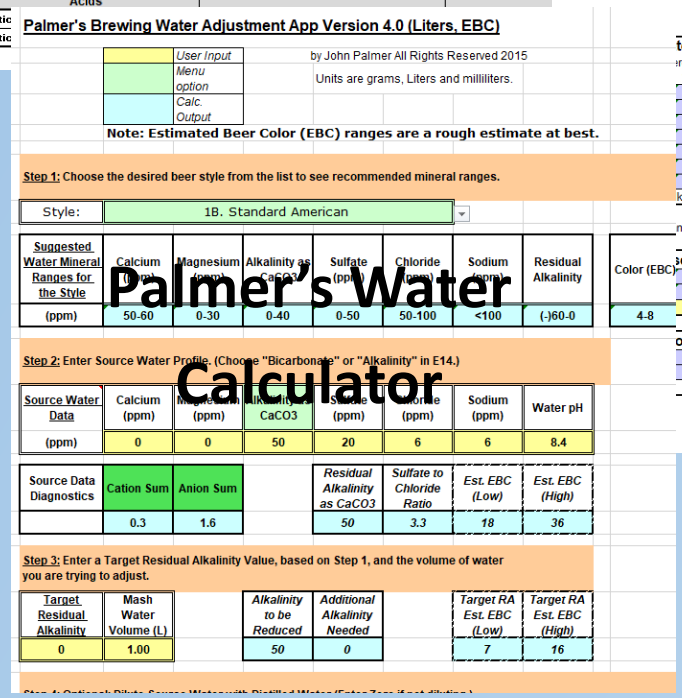
	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	26	2	7	6	26	53	33
Target	50-75	0-30	< 100	50 - 150	50 - 150	120 - 200	120 - 200
Calcium Chloride			3 grams in mash				
Calcium Sulfate (Gypsum)			2 grams in mash				
Baking Soda (Sodium Bicarbonate)			7 grams in mash				
Finish	69	2	72	55	72	254	181

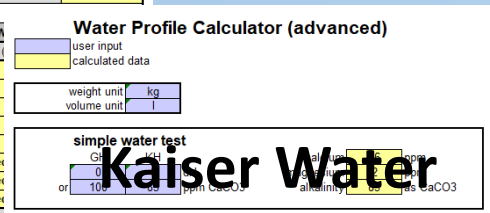
Water Adjustment Ideas – Czech Pils

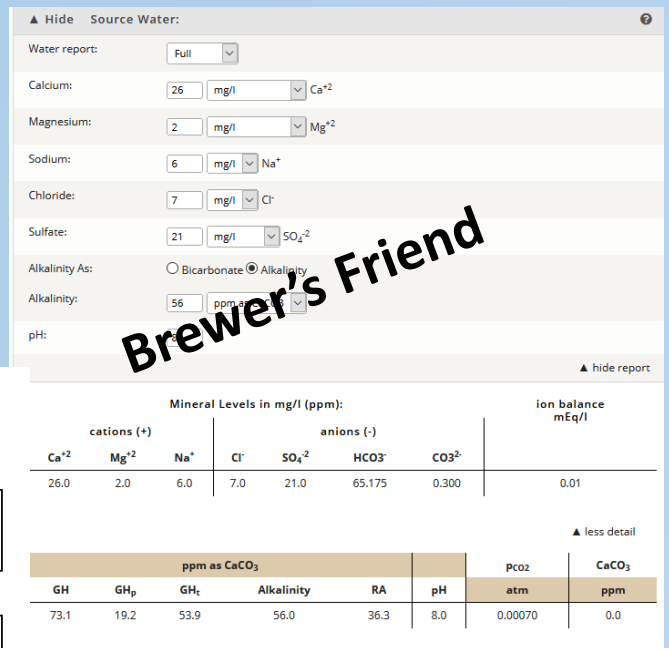
	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	26	2	7	6	26	53	33
Target	7	2	2	6	8	16	-60
Dilute water			67% distilled / 33% BWD				
Lactic Acid			2.5 gram in mash				
Finish	9	1	2	2	9	16	-55

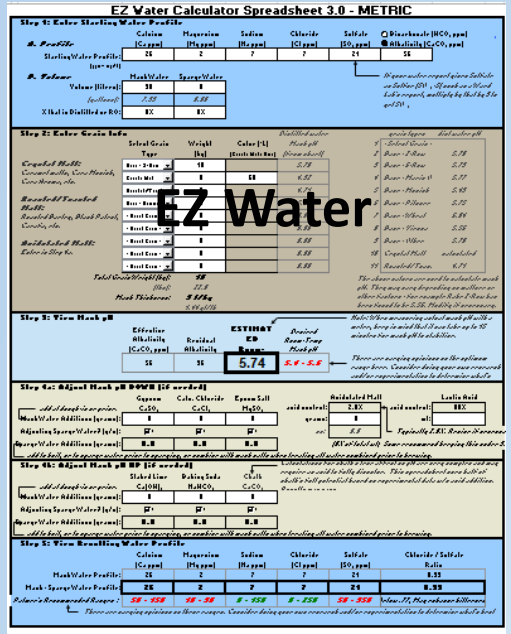
Water Calculators

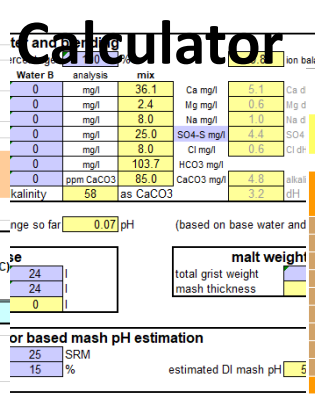


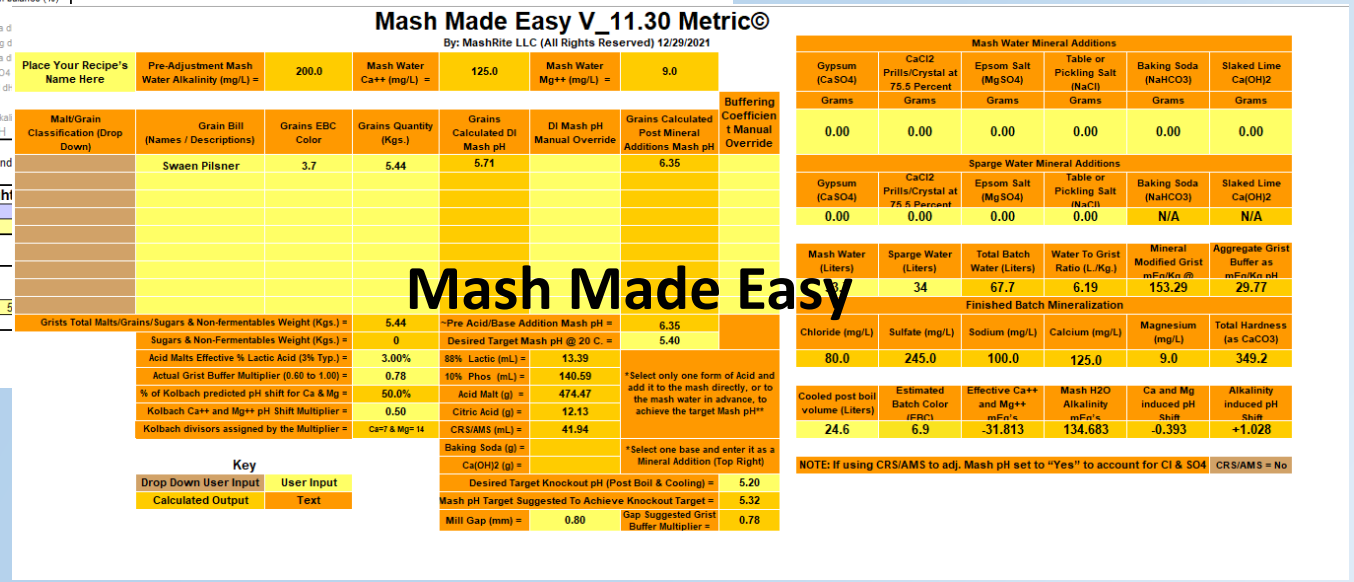






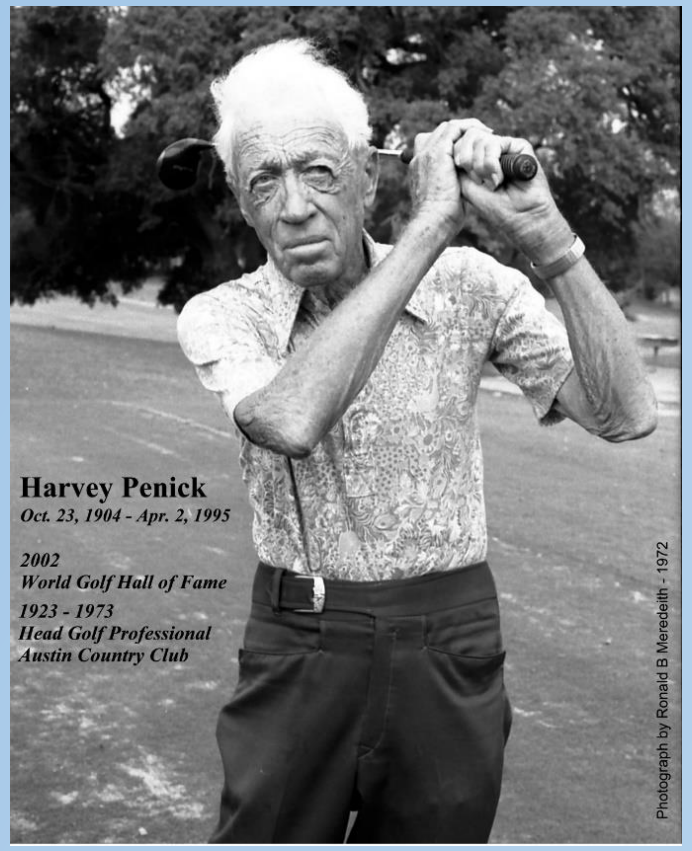






In Closing…

~~Golf~~ *Brewing* tips are like aspirin. One may do you good, but if you swallow the whole bottle you will be lucky to survive.



- Harvey Penick

FLOPSCLUB
EST. 1994

The Beer Tonight

	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	24	2	7	7	25	44	26
Target	50-75	0-30	< 100	50 - 100	50 - 150	80-150	120 - 200
Control	14	2	4	4	15	26	15
Adjusted	67	8	62	80	99	118	66

Cheers !