

# Water Chemistry

For Dummies &  
Knucklehead Brewers

# Things You CAN Learn Here

- Water constitutes 85% of every batch of beer you make
- How to get your water analyzed
- How to adjust your water to.....
  - Make yeast happier
  - Manage pH to ensure optimal mashes
  - Protect against tannin extraction
  - Tailor your water to fit desired styles

# Where to go for more

- <http://www.HowToBrew.com/>  
–Chapter 15
- <http://www.Wikipedia.org/>

# Ignoring The Biggest Factor?

	Pctg by Weight	Cost
Grains	14%	\$25
Hops	0.5%	\$4-\$10
Yeast	0.5%	\$6.25 + DME

# Chlorine / Chloramines

- Most Water Depts now use Chloramines
  - Less volatile
  - More stubborn
- Carbon filter
- Campden tabs



# Micro-minerals

- Manganese
- Iron
- Copper
- Zinc
- Use a yeast nutrient like Wyeast's mix



# Water Testing Lab

- Ward Lab Inc.
  - \$16.50 for Household Water Test (W-6)
  - <http://www.WardLab.com/>



pH	8.9
Total Dissolved Solids (TDS) Est	69
Electrical Conductivity, mmho/cm	0.12
Cations / Anions, me/L	0.9 / 0.9

	<u>ppm</u>
Sodium, Na	4
Potassium, K	2
Calcium, Ca	10
Magnesium, Mg	2
Total Hardness, CaCO <sub>3</sub>	33
Nitrate, NO <sub>3</sub> -N	0.3 (SAFE)
Sulfate, SO <sub>4</sub> -S	3
Chloride, Cl	7
Carbonate, CO <sub>3</sub>	9
Bicarbonate, HCO <sub>3</sub>	12
Total Alkalinity, CaCO <sub>3</sub>	26



# Six Key Minerals

- **Calcium<sup>+2</sup>** – vital to many yeast, enzyme and protein reactions, both in mash and boil; promotes clarity, flavor, stability.
- **Magnesium<sup>+2</sup>** – vital yeast nutrient
- **Bicarbonate<sup>-1</sup>** – alkaline, neutralizes dark malt acidity
- **Chloride<sup>-1</sup>** – accentuates flavor and fullness
- **Sulfate<sup>-2</sup>** – accentuates bitterness, drier/crisper
- **Sodium<sup>+1</sup>** – roundness, sweetness

# NASCAR Beer = Bo Pils?

	<i>Calcium (ppm)</i>	<i>Magnesium (ppm)</i>	<i>Alkalinity as CaCO<sub>3</sub></i>	<i>Sodium (ppm)</i>	<i>Chloride (ppm)</i>	<i>Sulfate (ppm)</i>
<b>CLT</b>	<b>10</b>	<b>2</b>	<b>20</b>	<b>6</b>	<b>11</b>	<b>11</b>
Pfizer, OR	7	2	15	2	5	5

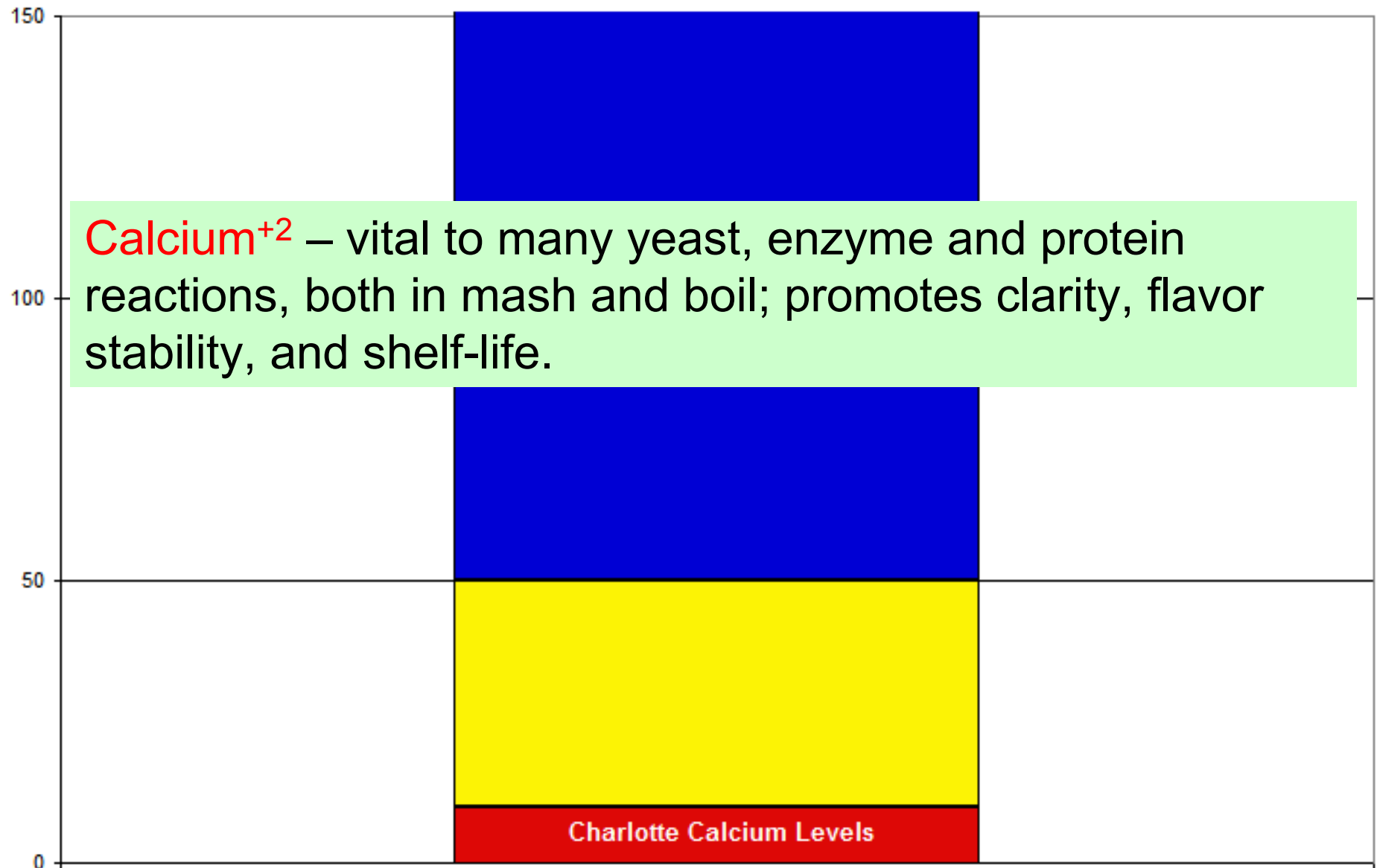
# CLT Mineral Shortage

<u>Adjusted Mash</u>	<i>Calcium</i> (ppm)	<i>Magnesium</i> (ppm)	<i>Alkalinity</i> as <i>CaCO<sub>3</sub></i>	<i>Sodium</i> (ppm)	<i>Chloride</i> (ppm)	<i>Sulfate</i> (ppm)
<u>Ranges</u>	50-150	10-30	20-200	50-100	50-150	50-250
(ppm)	10	2	20	6	11	11
<b>CLT</b>	<b>10</b>	<b>2</b>	<b>20</b>	<b>6</b>	<b>11</b>	<b>11</b>
Minimums	50	10	20	50	50	50
Our Deficit	<b>40</b>	<b>8</b>	-	<b>44</b>	<b>39</b>	<b>39</b>

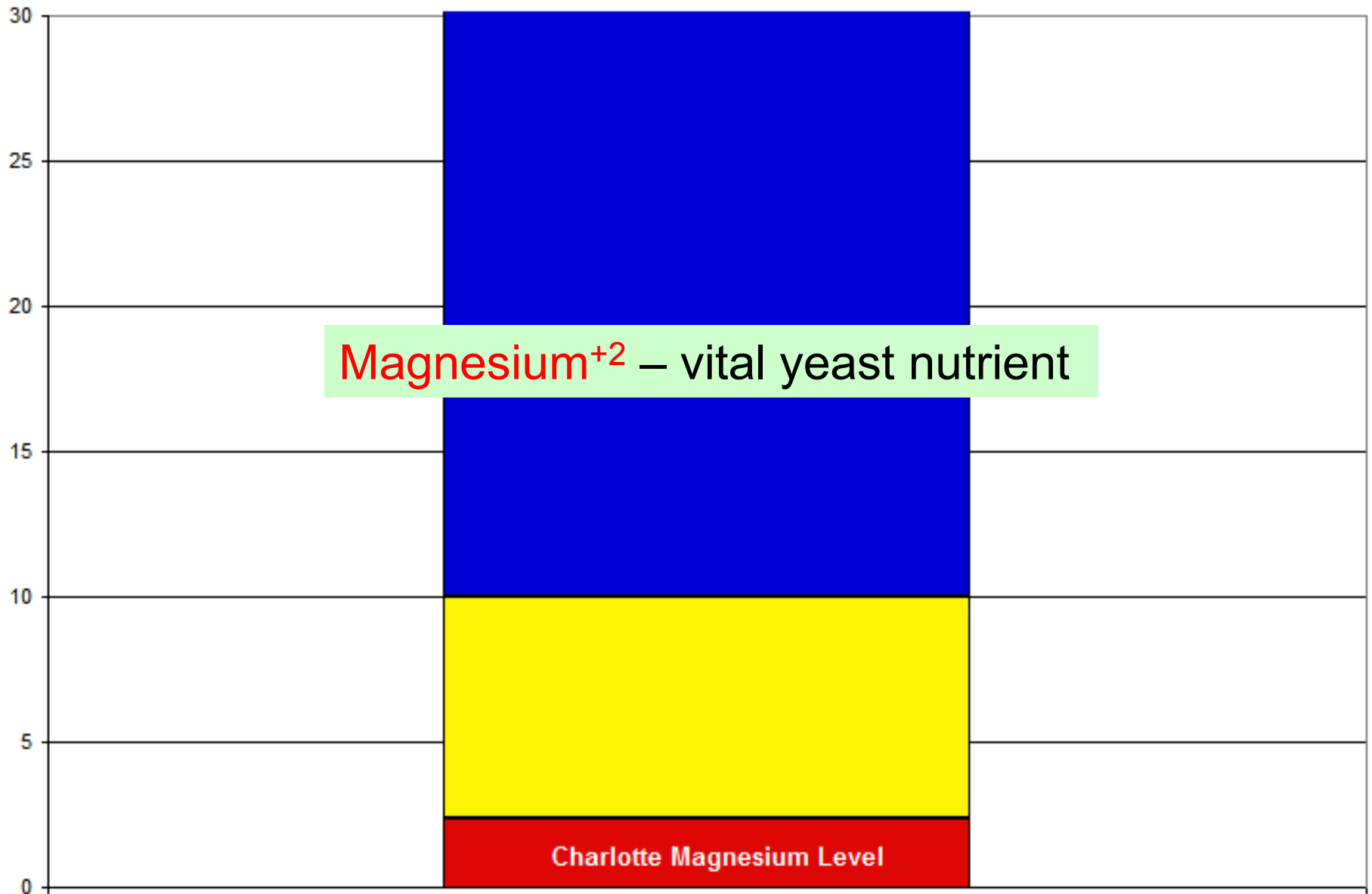
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# Calcium

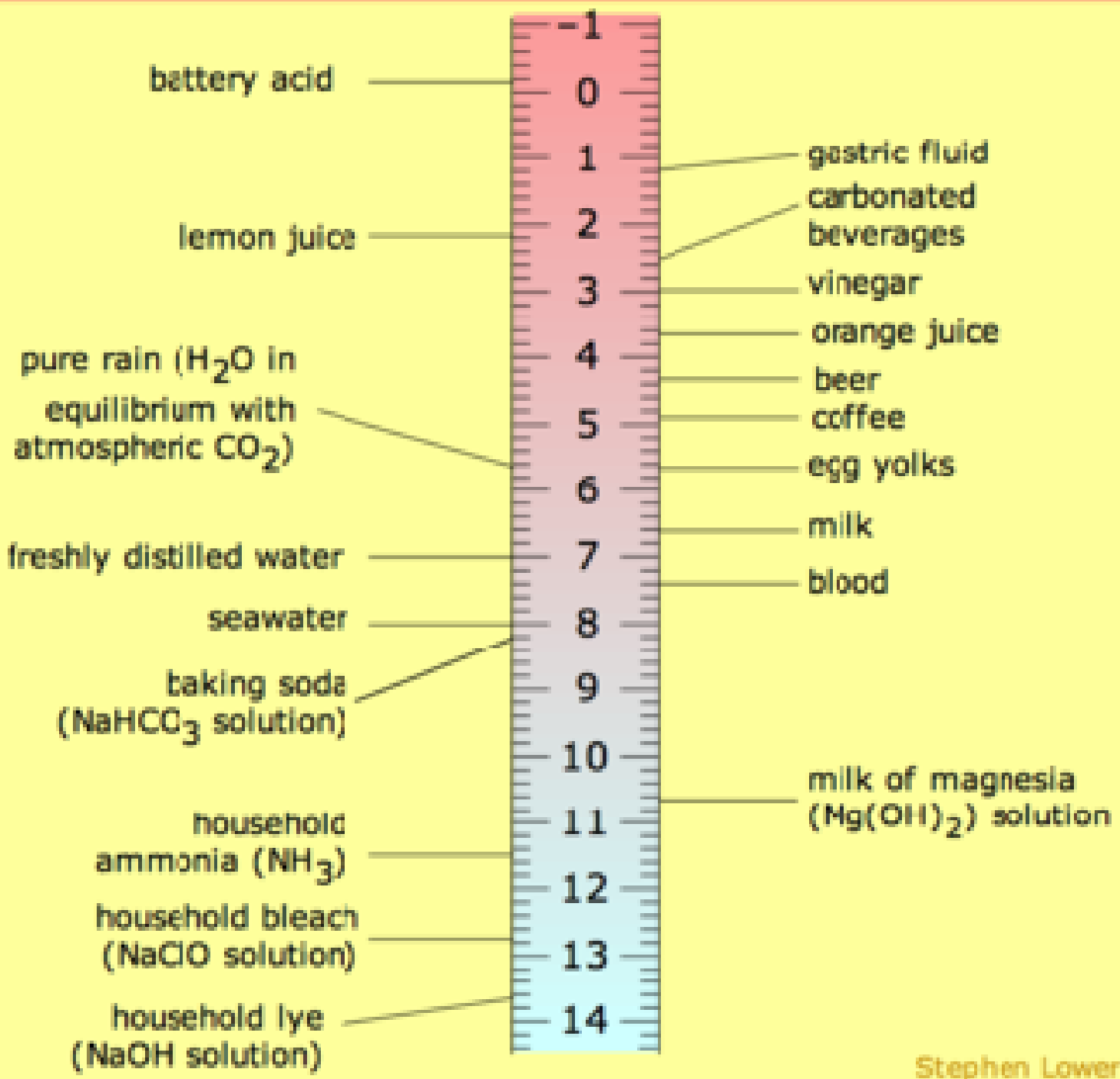


# Magnesium



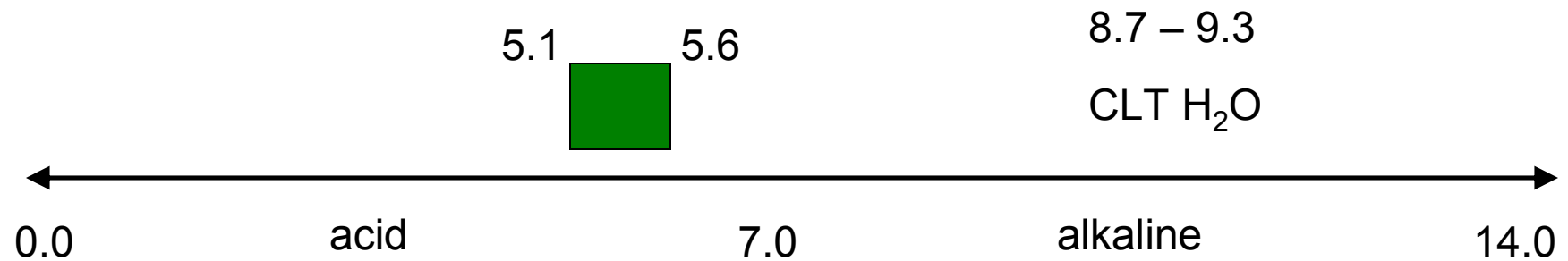
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# pH – Power of Hydrogen



5.1 5.6

8.7 – 9.3

CLT H<sub>2</sub>O

0.0

acid

7.0

alkaline

14.0

Beer  
4.5

Coke    Vinegar  
2.5    3.0

# pH – Power of Hydrogen



+add grains

+Calcium & magnesium

+Bicarbonate



**5.1**

**Low End**

**pH**

**Residual Alkalinity**

**5.6**

**High End**

Alpha amylase

**Enzymes**

Beta amylase

More acidic

**Beer pH**

Less acidic

Sharper, brighter

**Beer flavors**

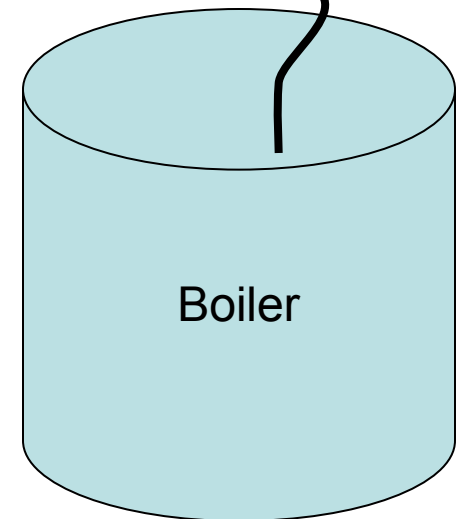
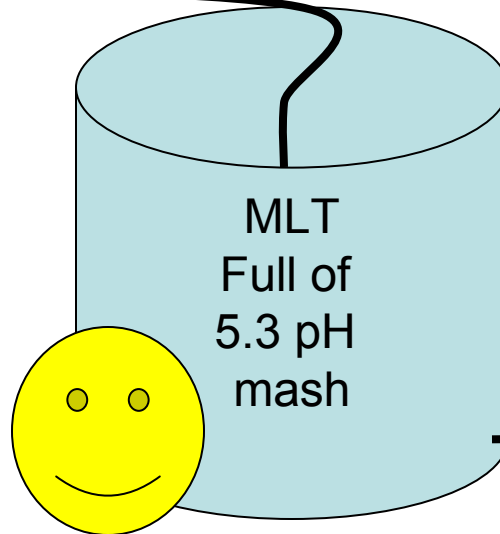
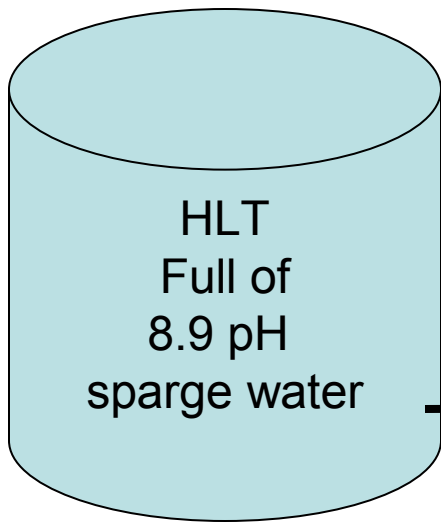
Softer, mellow

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## Sparging Guidelines

- Don't sparge above pH 6.0
- Don't sparge below 1.010 runnings
- Sparge slowly



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# Malty Vs. Bitter Balance

## Chloride : Sulfate Ratio

- Chloride<sup>-1</sup> – accentuates flavor and fullness
- Sulfate<sup>-2</sup> – accentuates bitterness, drier/crisper

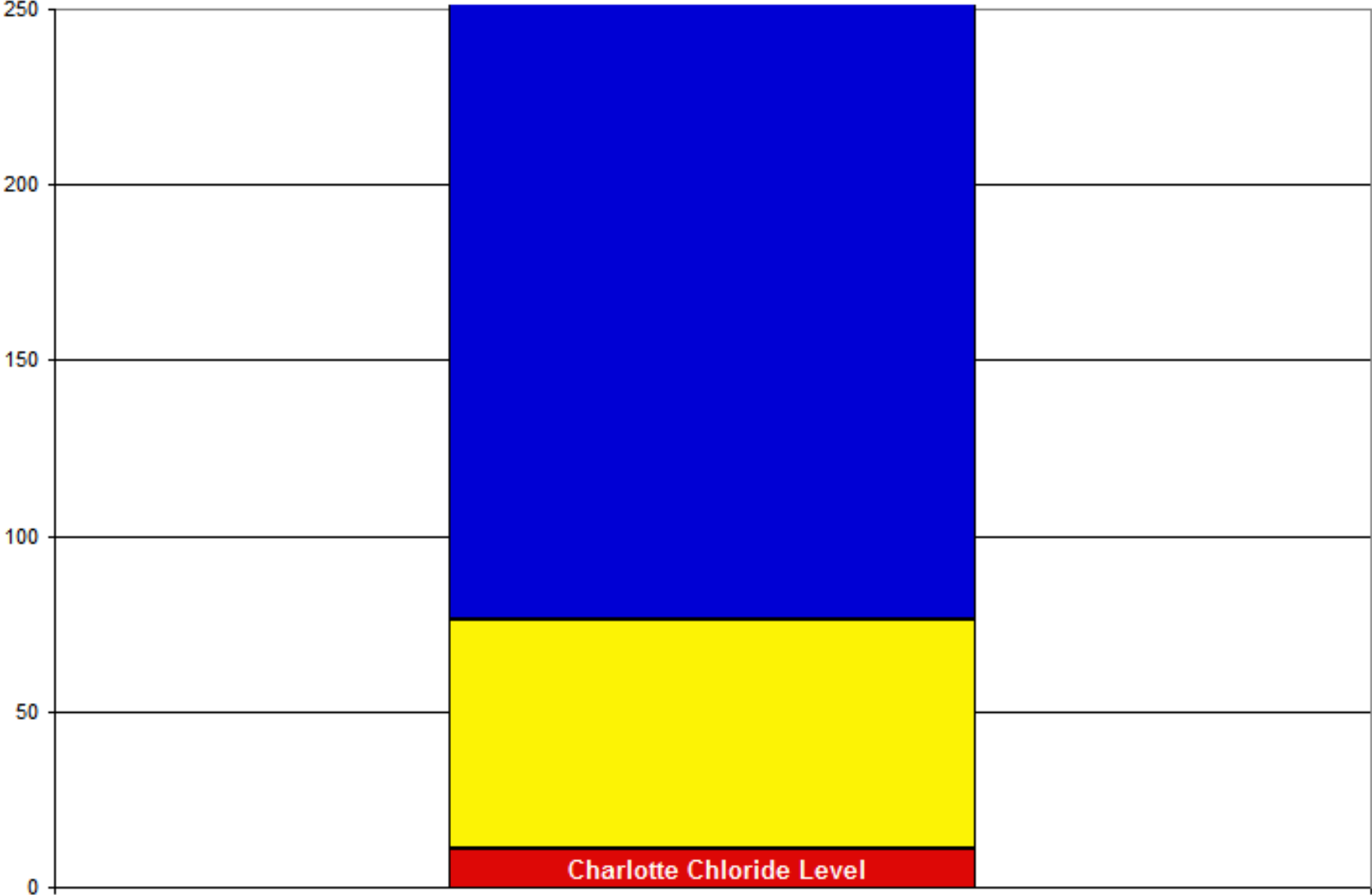
Ratio	Balance
--	Very Bitter
0.501	Bitter
0.768	Balanced
1.300	Malty
2.010	Very Malty

# C:S Ratio is Balanced

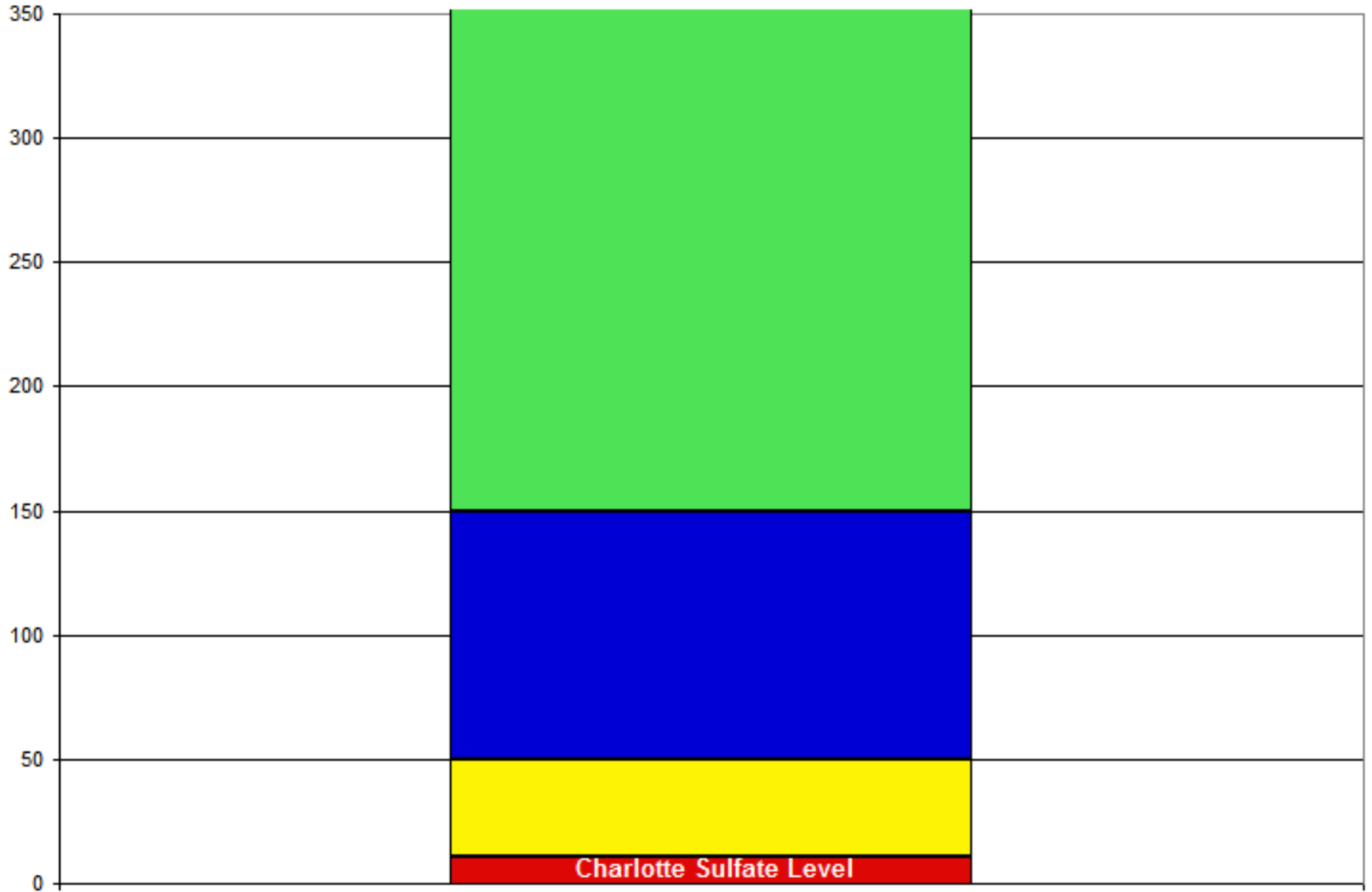
	<i>Calcium (ppm)</i>	<i>Magnesium (ppm)</i>	<i>Alkalinity as CaCO<sub>3</sub></i>	<i>Sodium (ppm)</i>	<i>Chloride (ppm)</i>	<i>Sulfate (ppm)</i>
<b>CLT</b>	<b>10</b>	<b>2</b>	<b>20</b>	<b>6</b>	<b>11</b>	<b>11</b>
<b>Plzen, OR</b>	<b>7</b>	<b>2</b>	<b>15</b>	<b>2</b>	<b>5</b>	<b>5</b>



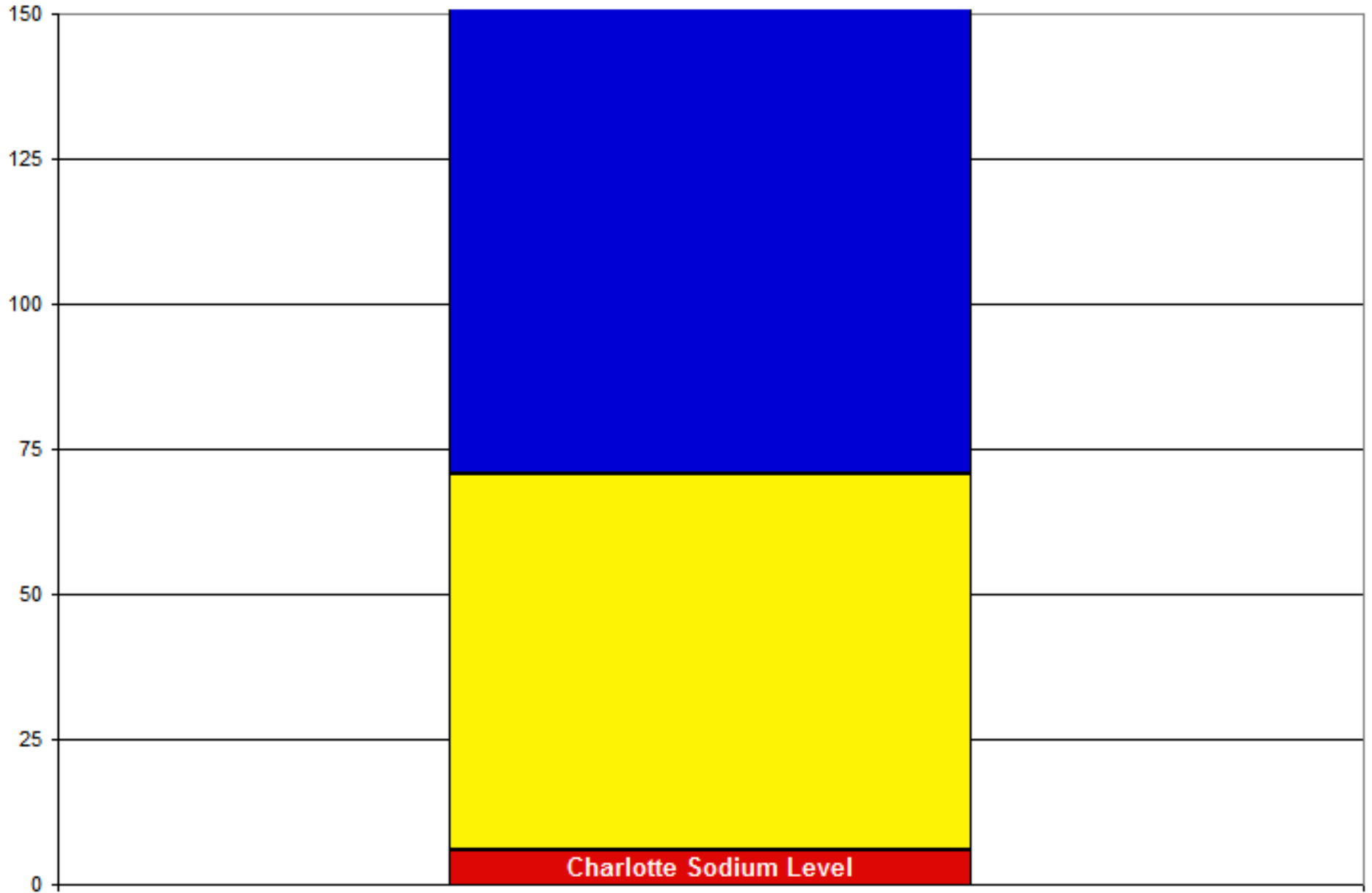
# Chloride



# Sulfate



# Sodium



**Table 15 - Water Profiles From Notable Brewing Cities**

City	Calcium (Ca <sup>+2</sup> )	Magnesium (Mg <sup>+2</sup> )	Bicarbonate (HCO <sub>3</sub> <sup>-1</sup> )	SO <sub>4</sub> <sup>-</sup> 2	Na <sup>+1</sup>	Cl <sup>-</sup> 1	Beer Style
Pilsen	10	3	3	4	3	4	Pilsener
Dortmund	225	40	220	120	60	60	Export Lager
Vienna	163	68	243	216	8	39	Vienna Lager
Munich	109	21	171	79	2	36	Oktoberfest
London	52	32	104	32	86	34	British Bitter
Edinburgh	100	18	160	105	20	45	Scottish Ale
Burton	352	24	320	820	44	16	India Pale Ale
Dublin	118	4	319	54	12	19	Dry Stout

	<i>Calcium (ppm)</i>	<i>Magnesium (ppm)</i>	<i>Alkalinity as CaCO<sub>3</sub></i>	<i>Sodium (ppm)</i>	<i>Chloride (ppm)</i>	<i>Sulfate (ppm)</i>
<b>CLT</b>	<b>10</b>	<b>2</b>	<b>20</b>	<b>6</b>	<b>11</b>	<b>11</b>
Plzen, CR	7	2	15	2	5	5
Concord 2006	13	5	43	25	26	15
Raleigh Well	28	3	83	20	6	3
Raleigh Tap			30		12	
Greenville NC	18	11	20	23	19	16
Eastern Pines	43	10	20	110	5	7
Sylva	4	<1	12	8	2	4
Bristol TN	28	7	99	8	13	4

# Recommendations

- Chlorine and nutrients
- 5.2 pH buffer
- Ca and Mg additions
  - 2.0 grams CaCl
  - 2.5 grams Epsom Salt