Calculating water adjustments

- A few cautionary words:
  - Adjusting water chemistry is a somewhat advanced brewing technique that is generally not necessary for making good beer. Stated water profiles from historic brewing cities can be pretty extreme (especially Dublin and Burton-on-Trent). In addition, the water chemistry can vary pretty drastically from one local area to another within even a fairly small region. An excellent discussion of this phenomenon is an article about Burton water by Martin Brungard in a recent Zymurgy. He starts out describing extremely radical water from some parts of the region, but after discussing the variations due to topography and geology of the region, and how Burton brewers probably arrived at the water they actually used, his best guess of the profile they actually used is *much* more moderate. Also, local brewers may treat their water to completely alter the characteristics of local sources. An example is Cologne and Kölsch; Kölsch is known for having a soft character, yet the water in the Cologne area is not especially soft. So the lesson is, be very wary of setting out to duplicate a stated water profile. Instead, strive to understand which minerals are generally beneficial and those that can work against desired mash pH, as well as how the various minerals enhance various flavors and how they can adversely affect flavor if overdone, or if emphasized in a beer style for which they are less appropriate.

Calculating water adjustments

- Brewing software makes it easy
  - Notes for using ProMash to tailor water are included toward the end of this presentation
    - Other brewing software and various spreadsheets are at least as effective
- Terminology
  - “Minerals”, “Salts”, “Mineral salts”
    - Interchangeable – all generally refer to the minerals commonly found in water
  - They cannot be filtered out of water

Important brewing minerals

- **Calcium**
- **Carbonate** (bicarbonate, actually)
  - For our purposes, they're the same
- Sulfate
- Magnesium
- Chloride
- Sodium

pH – acidity vs. alkalinity

- pH is a measure of acidity/alkalinity
  - 7.0 is neutral
    - Lower is acid
    - Higher is alkaline
  - Mash pH measurement is affected by temperature
    - Elevated temperature = greater chemical activity = more hydrogen ions = more acidic = lower numeric reading/indication
    - Difference in reading/indication between mash temps and room temp is ~ 0.3

Mash Acidity

- Mash enzymes work best in acidity
  - 5.1 to 5.6 when measured at mash temperature
  - 5.3 to 5.8 when measured at room temperature
- **Calcium** reacts with phosphates in the grist to acidify the mash
  - Produces hydrogen ions (the basis of acids)
  - Naturally acidifies the mash, usually to the above range
    - Dependent on carbonate and calcium content

What affects mash acidity?

- Calcium
  - Gotta have enough – needed for the natural acidification reaction of the grist
- Alkalinity of the water
  - Carbonate is the main component of alkalinity
    - Acts as a “buffer” –resists acidification (lowering of pH) until it is overwhelmed by acid addition (then the pH drops rapidly)
      - The more there is, the greater the buffering effect
      - With lighter-colored grists, want to keep carbonate reasonably low (<100 ppm)
- Acidity of the grist (types of grains used)
  - Darker = more acidic, so can tolerate more carbonate

Other Considerations

(beyond mash chemistry)

- Calcium - important additional benefits
  - Aids flocculation/clarity
  - Essential for yeast health
- Flavor
  - All minerals affect the flavor (see next slides)

Flavor Considerations

- Sulfate
  - Accentuates bitterness and dryness
- Magnesium
  - Accentuates bitterness and dryness
    - ***Can be sour or harsh ("minerally") if overdone***
- Chloride
  - Accentuates fullness and sweetness
    - Can give too much sweetness if overdone

Flavor Considerations (cont)

- Sodium
  - Accentuates fullness and sweetness
    - With high levels of sulfate, tends to harshness
- Carbonate
  - Accentuates malt flavor/sweetness
    - Can lend a chalky aspect in high amounts

How Much?

- Calcium: 50 – 150 ppm
- Carbonate: 0 – 50 ppm (optimal range)
  - 100 and up can be problematic for non-dark beers
    - Mash pH too high
  - Very dark grists are more acidic, can deal with more carbonate (125 – 200 ppm)
- Sulfate: 100 – 150 ppm
  - Less for light or malty beers
  - To 300 ppm in English Bitters (or more, but beware!)

How Much (continued)?

- Magnesium: 10 – 40 ppm
  - 30 is usually the upper end
    - Can be very harsh/minerally/sour
- Chloride: 10 – 100 ppm
  - Low side when calcium is high, to avoid harshness
  - High side can be overly sweet in some styles
- Sodium: 10 – 50 ppm

Our Base Water

- Is somewhat low in calcium
  - 25 to 35 ppm is typical for the area
- Is somewhat high in carbonate
  - Knox Chapman and Crossville are good (20 - 40 ppm)
  - Most others are moderate (65 - 75 - 115 ppm)
  - Hallsdale-Powell & Love Creek are high (190 ppm or more)
- Fairly low in Mg, sulfate, sodium & Cl
- All in all, we're blessed with adaptable, very usable brewing water
  - Compared to many locations, we are extremely fortunate

So What Should We Do?

- Add calcium
  - Calcium good!
- Can afford to add sulfate and chloride
  - Sulfate for bitter styles (gypsum is calcium sulfate)
  - Chloride for malty styles (calcium chloride)
    - beware over-doing (sweetness)
- Sodium? Don’t push it.
  - Baking soda (sodium carbonate) adds carbonate, which we usually don’t want
  - Salt – sodium chloride – can add salty flavor

What adds What?

- Calcium chloride
  - Would you believe ***calcium*** and chloride?
- Gypsum (CaSo4)
  - ***Calcium*** and sulfate
- Epsom salts
  - Magnesium and sulfate
- Salt (Kosher/non-iodized)
  - Sodium and chloride

What adds What (cont)?

- Baking soda
  - Sodium and carbonate (bicarbonate)
- Chalk ($CaCO_3$)
  - Calcium and carbonate
  - Chemists want us to call it calcium carbonate, not chalk, but chalk is the common name
    - Call it what you want; you will see it referred to as any of the above

You Cain't Always Get What You WAAaaANT

- Water treatments are a compromise
  - You can almost never "duplicate" a given water profile
  - Starting with distilled or RO-DI water gives you more control
  - Diluting your water with distilled or RO-DI water often gives you enough control

For Light or Delicate Beers

- Light malts are low in acidity, so
  - Reduce carbonate
    - Can dilute with distilled water - recommended
      - Reduces all minerals by the dilution ratio
    - Can add acid
      - Trying to reduce the pH is very tricky
        - the carbonate (“buffer”) will resist pH change
        - At a certain point when the buffering capacity is overcome, the pH will plummet
        - Unless you have software to assist you, and you understand the safety concerns with acids, dilution is the way to go

For Dark Beers

- Dark malts are higher in acidity, so
  - Can stand higher carbonate
  - Add calcium
    - Chalk adds calcium and carbonate, so if you want to add alkalinity for a darker beer, you can add chalk
  - Add chloride and/or sodium
    - Baking soda can work well in dark beers (adds sodium and carbonate)

Teaspoon/Gram Equivalents

- Gypsum:¼ tsp = 1g
- Calcium Carbonate :¼ tsp = 1.1g
- Epsom Salts :¼ tsp = 1.2 g
- Chalk :¼ tsp =0.6 g
- Baking soda :¼ tsp = 1.6g
- Salt (Kosher) :¼ tsp = 1.5g

Let's Make Water!

- "Typical" water for "typical" beers:
  - Carbonate: dilute to 75 – 90 ppm
  - Calcium: 50 – 100 ppm
  - Sulfate: 50 – 100 ppm
  - Chloride: 50 – 75 ppm
  - Sodium, magnesium: let it ride
- Don't try to dissolve the salts in the water
  - Gypsum is difficult to dissolve, chalk is very difficult
    - Add mash salts to the grist or mash
    - Add boil kettle salts to the wort in the kettle
      - Both the mash and the wort are lower in pH, which helps salts to dissolve

Using ProMash to Calculate Mineral Salt Additions

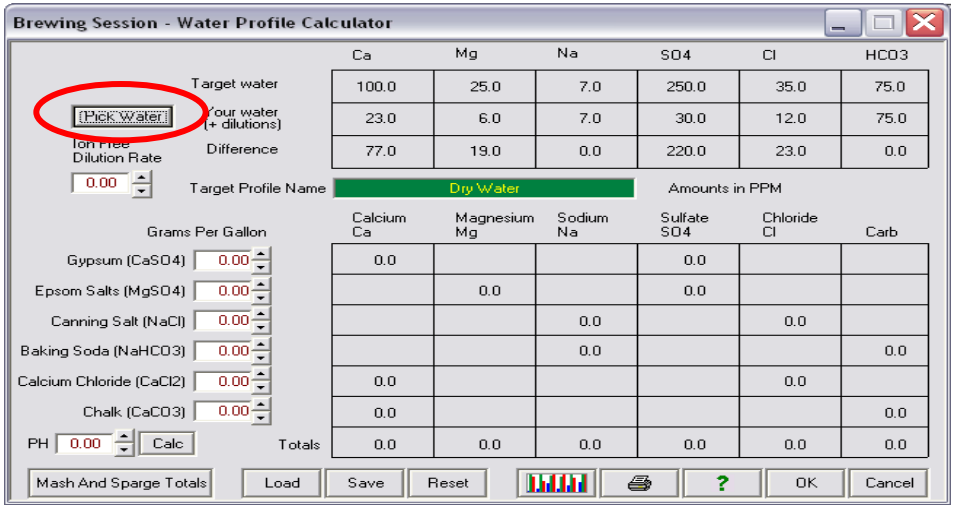
- Add a water profile for your base water
  - You can either create a new profile or clone an existing water profile, then edit to rename it and edit the mineral amounts to match your local water source
- Add a water profile for your target water
  - Use the same procedure to create a profile for the water you want to end up with

Using ProMash to Calculate (continued)

- Formulate a recipe for the beer you want to make, and save it
  - Including picking the target water profile as part of the recipe (“Pick yeast and water”)
- Open a new brew session
  - Pick the recipe
  - Set the Mash Schedule variables
  - Set the Water Needed (amounts) variables

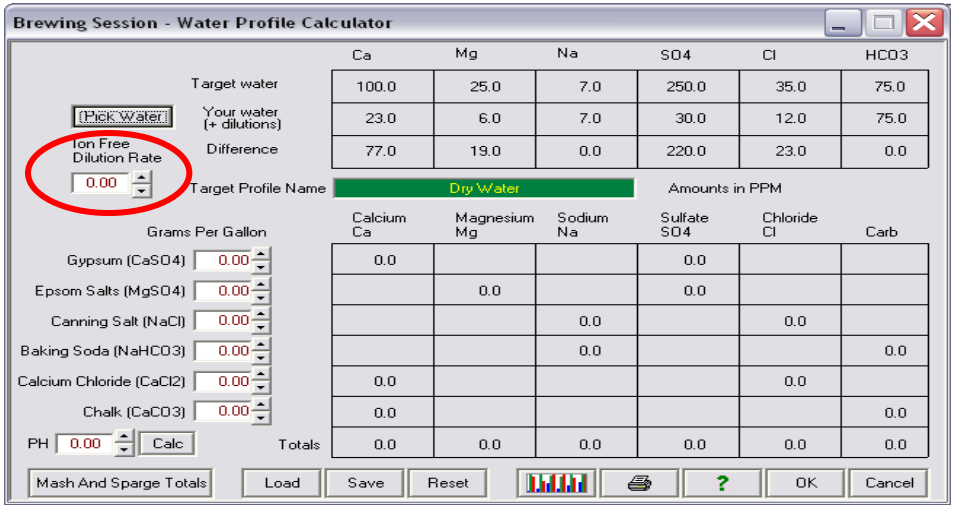
ProMash Water Setup Steps

- Click Water Profile



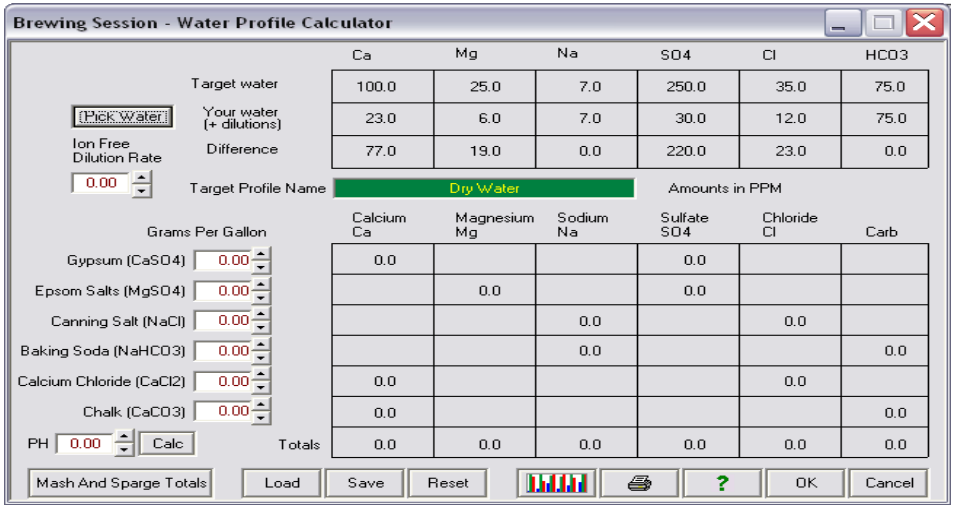
  - Click the Pick Water button
    - Pick your ***base*** water (your local water source)
    - This is the water you will modify to end up with the water you want for the beer

ProMash Water Setup Steps



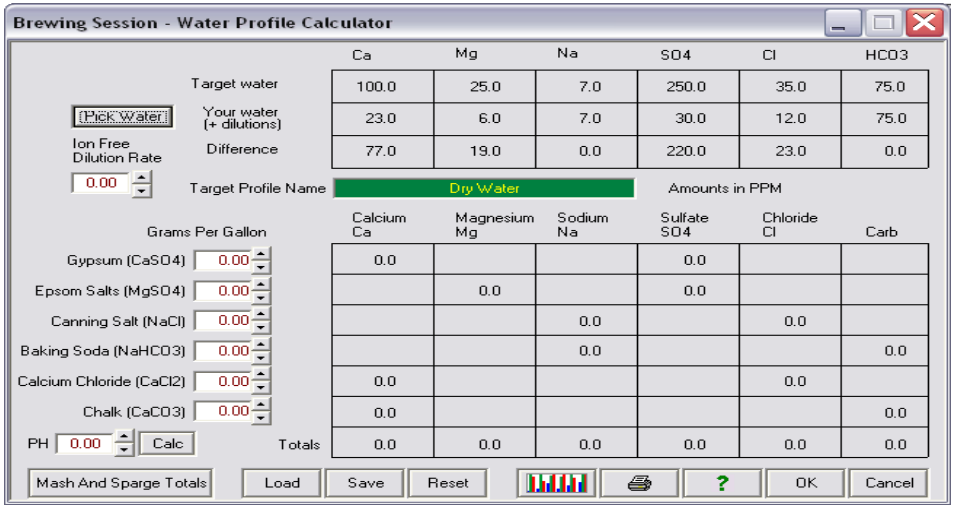
- If the carbonate (HCO3) is too high
  - Increase the Ion Free Dilution Rate percentage until the carbonate is low enough
    - You will need to dilute your source water by this percentage with distilled or RO-DI water

ProMash Water Setup Steps



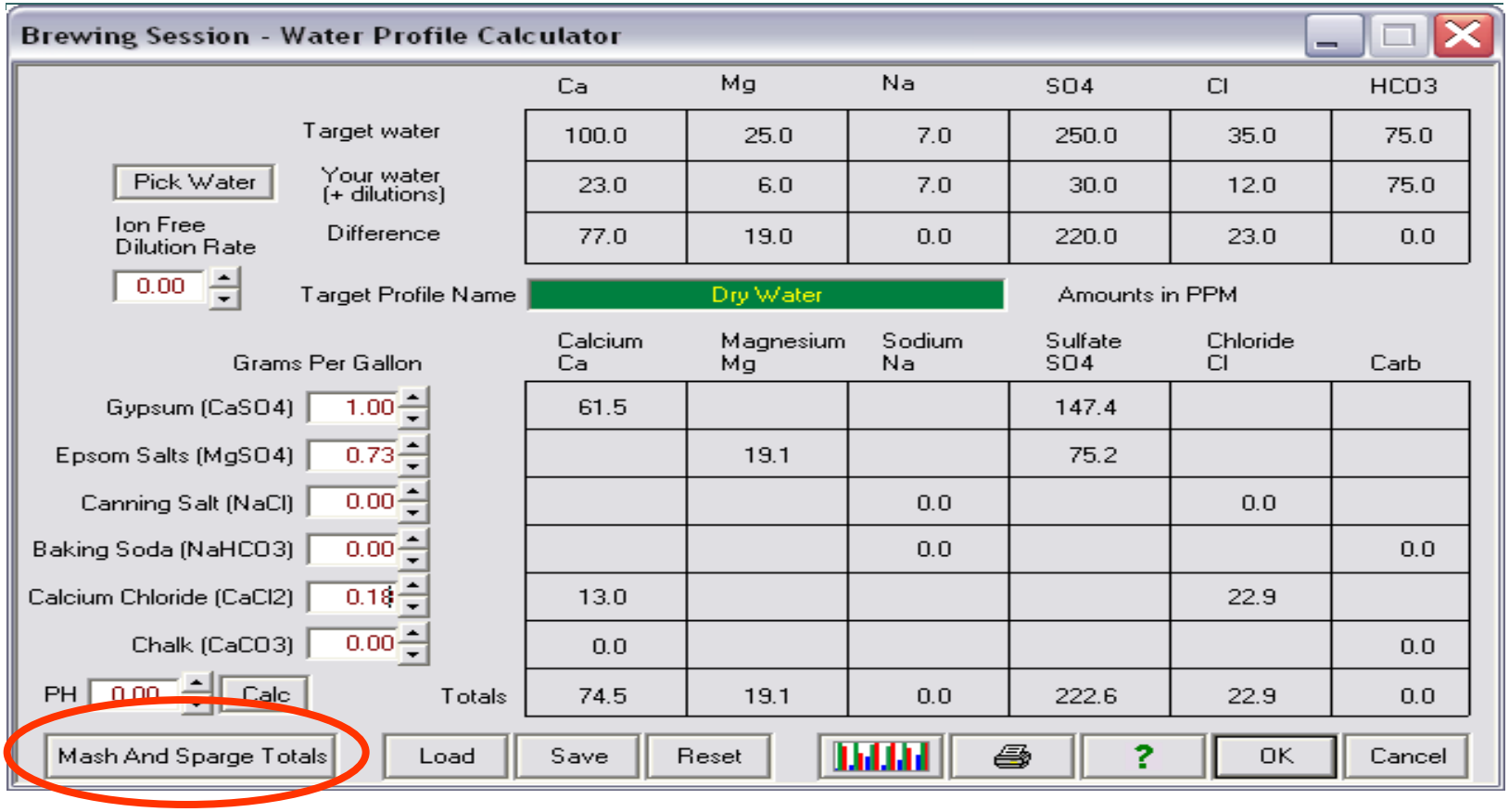
- Increase the minerals
  - Start with Epsom salts to get the Mg (if required)
  - Add canning salt to get the required sodium (Na)
  - Add calcium chloride if more Cl is needed
  - Add gypsum to get the desired sulfate (SO4)

ProMash Water Setup Steps



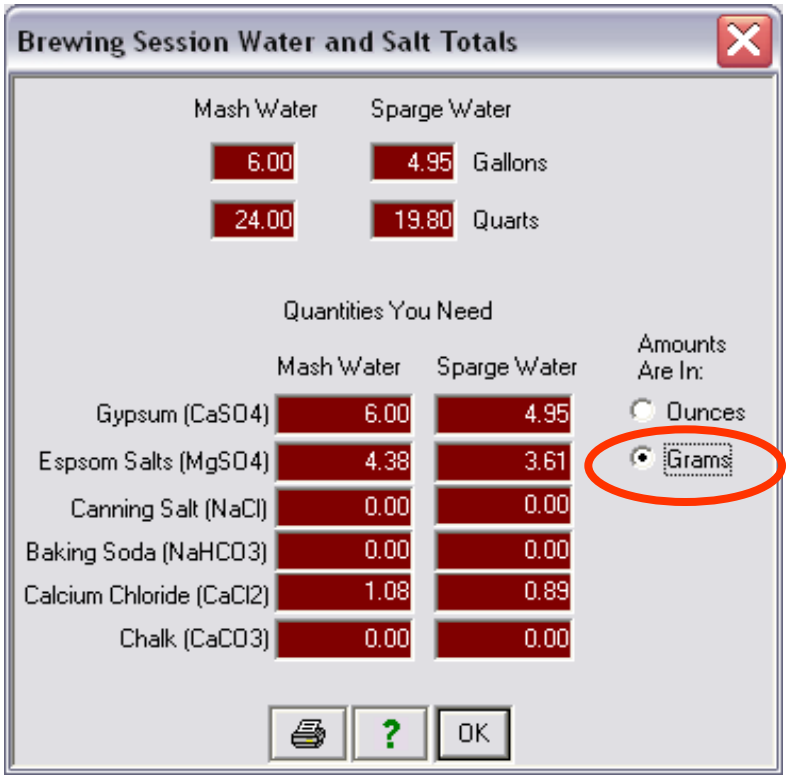
- Tweak the additions
  - Remember that water adjustment is a compromise – each compound is a combination of two of the salts
    - The more you dilute with zero-salt water (distilled/RO-DI), the more flexibility you will have.

ProMash – Adjusted Water



Click the Mash & Sparge Totals button to see the amounts to add

Mash & Sparge Mineral Amounts



*Be sure to select **grams** (the amounts are* based on your Water Needed settings)

ProMash Water – Additional Notes

- If you modify and save your target water, you have to Pick that water again (in the Edit Recipe section) to show the latest values in the water profile screens
- You don’t have to pick a water profile in your recipe
  - You can formulate the water in the Profile screen, then Save it directly from that screen
  - Saves in WaterProfiles subfolder
- I do not know where water profiles that are created from the ProMash Water button are stored, but they’re always accessible via the Water button

Pale Ale Water

- Typical hoppy/bitter beer water
  - Carbonate: dilute to 50 – 90 ppm
  - Calcium: 75 – 125 ppm
  - **Sulfate: 125 – 175 ppm** (emphasize bitterness)
  - Chloride: 25 – 75 ppm
  - Magnesium: 10 – 15 ppm
  - Sodium: let it ride

Amber Beer (O'fest) Water

- Typical Amber/Fest beer water
  - Carbonate: 75 – 150 ppm (can tolerate some carbonate)
  - Calcium: 75 – 100 ppm
  - Sulfate: 20 – 50 ppm (low, to de-emphasize bitterness)
  - **Chloride: 50 – 75 ppm**
  - Magnesium: 5 – 10 ppm (de-emphasize bitterness)
  - Sodium: ??? I usually don't exceed 20 or 25 ppm

English Bitters Water

- Typical “Burton”water
  - Carbonate: dilute to < 125 ppm
  - Calcium: 100 – 200 ppm
  - **Sulfate: 175 – 300 ppm (emphasize bitterness)**
  - Chloride: 20 - 50 ppm
  - **Magnesium: 15 – 25 ppm (emphasize dryness)**
  - Sodium: let it ride, or 10 to 20 ppm

Porter/Stout Water

- Typical dark beer water
  - **Carbonate: 125 – 175 ppm or more (per color)**
  - Calcium: 100 – 200 ppm (counteract carbonate)
  - Sulfate: 50 - 150 ppm
  - **Chloride: 50 - 100 ppm**
  - Magnesium: 5 – 10 ppm
  - **Sodium: 50 – 100 ppm (can tolerate baking soda)**
    - I've never used this much sodium, so don't know what happens

Pilsner Water

- Pilsner water is a very special case
  - Very lightly kilned malts are low in acidity, cannot neutralize a lot of carbonate
  - The style calls for a very soft water profile
    - All minerals should be low, especially sulfate, magnesium and carbonate (preferably, less than 10 ppm)
      - Low carbonate and magnesium means low alkalinity, so little calcium is required in the mash

In Closing

- Go easy
  - Beware stated “classic” water profiles.
    - The classic Burton bitters water profile has mineral levels that can easily ruin a beer – few people, if any, go to these extremes
  - Even more mainstream (no pun intended) classic regional water may be too aggressive if you strive to duplicate it. If duplicating a stated regional water profile produces annoying results, back way off and approach it gradually over several brewing sessions
    - Better yet, start at a third or half and gradually work up