

SALT IN WELL WATER, Is a Softener in the Background?

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Contamination of well water by salt has long been associated in the northeast United States with the use of salt to de-ice roads in the winter, but it may not be the main contributor. A statistical treatment of well water analysis done in the Stamford area shows a significant difference in total chloride concentrations in wells not treated with a water softener and wells with a softener. Most softeners (greater than 85% in the homes surveyed) use an on-site regeneration system, requiring the discharging of the salt solution into either a septic system or a dry well. Of the 1,424 samples assayed for chlorides, 308 had softeners on the supply and 1,116 were not softened. Of the softened samples, 123 had levels of chloride greater than 150 mg/l compared with 262 of the non-softened samples having similar chloride levels(chi-square $p < 0.0001$.) The total samples are sorted to include only unique supplies and the p values of this group agree with the softener to non-softener comparison. Comparisons of chlorides in homes near softened supplies also showed significance. Chloride analysis of wells before the installation of a softener and after support this contention. Total chlorides represent a contamination of a non-toxic nature, but are a cumulative contaminant of the aquifer and can result in levels of an unpalatable nature.

The area studied is the northern portion of Stamford, Connecticut, a populated hilly area mostly served by wells and septic systems. Land elevations in the area in which the wells are located range from 100 to 500 feet, and the area is 3 miles from Long Island Sound. There are some 5,230 wells¹ in this area and their depth's range from 50 to 1,200 feet. The aquifers these wells draw from generally flow from north to south. Zoning is strictly residential with one acre lots being the norm. North of Stamford, development continues to be strictly residential. Geologically, the area can be described as primarily glacial till with exposed ledge.

There may be many sources of chloride contamination, intrusion from Long Island Sound, road salting and water treatment devices. This study chooses to look primarily at the discharge from water softeners to see if any correlation can be made. The most widely used form of water treatment is softening, in which an ion exchange resin exchanges the calcium and magnesium in the water with sodium ions in the resin. Nearly 15% of the wells in this area are treated in this manner. In a softener, the ion exchange bed is regenerated periodically by passing a brine solution through the resin to reactivate the exchange sites. There are two types of salt that can be used, sodium or potassium chloride. It is assumed that sodium chloride is the primary form used in this area since no samples have been received that use potassium chloride as the regeneration salt. The regeneration process can be performed at the same location where the softener unit is used, or the resin tank can be removed for regeneration at a different location. Greater than 95% of the samples reported in this survey regenerate the softener on-site, with the salt backwash going to the septic system, a dry well or discharged on the surface of the ground. Discharge into the septic

¹U.S. Census Bureau, 1980.

system is the most prevalent. The amount of salt used for this regeneration can range from as little as 200 pounds per year to over 4,000 pounds per year depending on the level of hardness and the type of softener.

High salt levels are a significant concern in the Stamford area with more than 26% of the wells analyzed having total chlorides greater than 150 mg/l. The normal range of total chlorides in the wells in Stamford is less than 75.0 mg/l. The differential of 150 mg/l was chosen, after evaluating 50.0 mg/l, 100 mg/l, 125 mg/l, 150 mg/l and 200 mg/l as partitions, as the best level to include most salt contamination of wells without including any natural variations. A comparison of differences between these chloride levels are shown in figure #1.

Our purpose in this study was to see if a link could be formed between the levels of chlorides in a well's water and the well's proximity to a softened supply. Aspects that can alter these effects are the distance and direction the well is from the discharge point, the amount of salt used in the backwashing process, the direction of flow of ground and surface water and the direction of flow of the aquifer.

The data for the analysis of wells has been accumulated over the course of five years and includes just over 14% of the total number of wells in the Stamford area. With this percentage recorded, not every supply with a softener has been documented and not all wells adjacent to water supplies with a softener have been analyzed. Two wells whose chloride content are linked to road salting were discarded. These discarded wells were shallow, less than 80 feet from a road with no curbing, and with drainage leading to the well area.

In addition to the general summary, a specific look at an area where high salt levels were discovered in several wells is included. A series of chloride tests performed on two wells in other areas is included as a contrast of the accumulation chlorides from the softener backwash and the clearing of chlorides after contamination by softener backwash.

In the general survey we observe only the chloride levels in well water and a distinction is made between the different samples in the following manner. Wells whose supply is treated with a softener with the brine solution used for regeneration being disposed of on-site are in one group. Wells which do not have a softener on the supply, but are near a supply that is treated with a softener with on-site regeneration are in another. Wells which do not have a softener or have a softener with offsite regeneration and are not documented to be near a softener are in a final group. It is the number of wells for each group, distinguished between wells with chloride levels above 150 mg/l and those below, that the conclusion on the effect of water softener discharge is drawn.

All chloride analysis was performed using the mercuric nitrate titration method.²

The number of samples documented in this survey is 1,740 samples. Total chlorides have been analyzed in 1,424 samples. Of that number 1,116 were not softened, 308 were

²Standard Methods of Analysis for Water and Wastewater, 17th edition, 1989.

softened and 385 had a chloride content of greater than 150 mg/l. Of the 385, 123 had a softener with on-site regeneration and 262 did not.

The total number of samples received by the lab did not provide a clear picture of how the chloride contamination is distributed. Many of the wells, particularly those with high chloride values, have had more than one test performed over time. The total samples were sorted so that only one sample from each address was included with the duplicates, containing the lowest chloride values, discarded. This showed that 821 total supplies were analyzed for total chlorides with 237 having levels greater than 150 mg/l. Two of these samples were known to be contaminated by road salt and were discarded. There are 162 softened samples that use on-site disposal of the salt backwash and 61 of these have chloride levels greater than 150 mg/l.

To observe how softeners with on-site regeneration might affect nearby wells without softeners, wells that were three houses to either side of a softened supply, directly across the street, and to either side of the house across the street were separated from those wells without softener treatment. Wells on streets behind or intersecting the street where a softened supply was located were not included due to programming difficulties. In this way, 85 non-softened supplies were identified to be near a softener with 32 having high chloride levels. All groups are compared visually in figure #2.

The ratios of high to low chlorides for each group is 40.2:100 for all wells, 23.3:100 for wells not softened and not near a softener, 60.4:100 for wells with softeners and 60.4:100 for wells near a home that uses a softener. This ratio is shown in figure #3.

The supplies not softened and not identified to be near a softener were considered to be the control wells. These are compared with each of the other two groups. Both chi-square evaluations gave p values less than 0.0001 and the differences were considered very significant. When the softened supplies' chloride values were compared to those of the supplies not softened near a softener, no significance was noted. This would indicate that the risk of chloride contamination for wells with softeners on the supply and those wells near the softeners is virtually identical. When the number of softened supplies and the supplies near the softened supplies were combined and the number with high chloride levels were compared with those levels of the supplies not softened and not near a softener, the Chi-square's p value is less than 0.0001.

The graphical comparison of the control supplies with both the softened supplies and supplies near the softened supplies is shown in figure #4.

Two different scales are used so that the ratios between these groups can be seen. One uses the total number of wells without a softener as the maximum. The other scale uses the total number of wells with a softener or near a softener as the maximum.

With the influence of softener discharge on well water presented as an overview, a specific area where this effect is documented is viewed. Water from the majority of the homes in this location were analyzed for chlorides over a short period of time. There were four softeners with on-site regeneration in this area. All the homes with softeners had chloride levels greater than 150 mg/l and two homes directly next door to the softened supplies had similar high chloride levels. Five other homes, three not near the softened supplies, had low chloride levels. With this particular example, a few more facts should be presented. Road salting practice in Stamford uses 100% sodium chloride. The level of chloride varied in two of the wells over time, as did the total and calcium hardness.

Figure #5 gives a graphical representation of the area and the chloride levels found in the wells. Figure #6 shows the change in chlorides, total hardness, and calcium hardness over time. Softener discharge contains both total chlorides and hardness.

In the final example, two wells are observed, one was softened for a number of years with the regeneration brine discharged into the septic system when the first test was performed and the other had no treatment when first tested. Although, the level of chloride never exceeded 150 mg/l in the well, this well is significant in how the chloride level dramatically decreased after discontinuing the softener. The water shows a decrease in the chloride level of 90% over the course of testing after the softener was disconnected. The contrast to this is a well that initially had low levels of chlorides before a softening system was installed. Four years later tests showed the chloride levels had increased ten fold. For this house the septic fields are located on the opposite side of the house than that of the well and the land slopes toward the road which is south of the well. The well is 75 feet south of the septic system. Figure #7 illustrates this comparison.

Nearly 40% of the wells in the Stamford area with a high total chloride level seem to be traceable to the discharge of the brine solution used to regenerate a softener's resin. Since not all the supplies with softeners have been located the actual effect should only increase as these are included. The specific examples used are repeated many times in the data, but these provided a better illustration of the correlation between softener discharge and chloride levels in well water.

Software acknowledgments: Database collection and analysis uses DataEase, version 4.2; statistical analysis is performed using Microstat, version 4.1; graphics are produced using Harvard Graphics, version 2.3 and WordPerfect 5.1 is used for the word processing.

Comparison of various levels of chlorides in well water

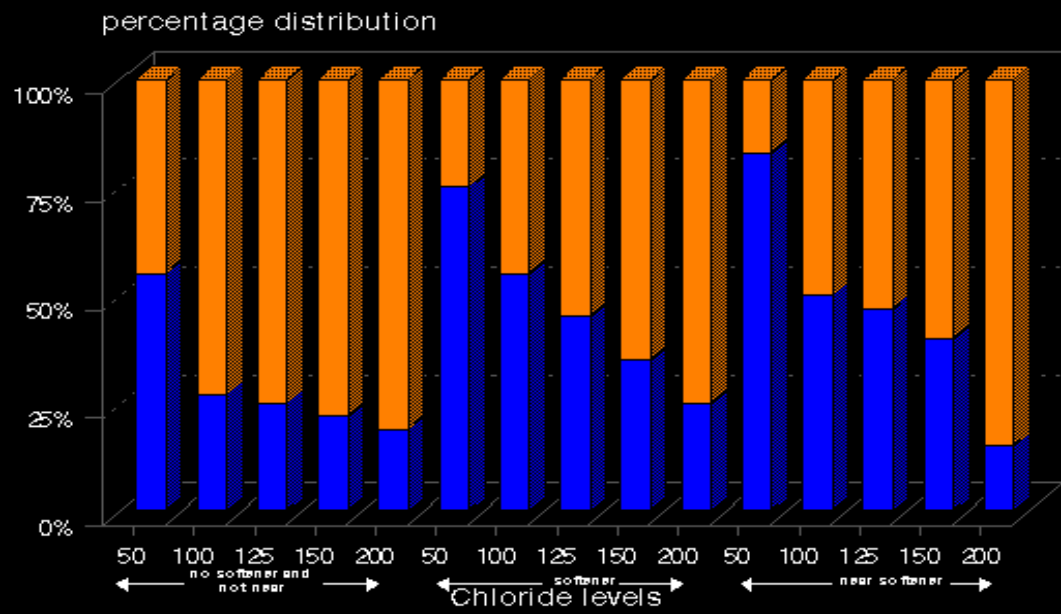


Figure #1

■ Cl- levels above ■ Cl- levels below

Chloride differences softened, not softened and supplies near softeners

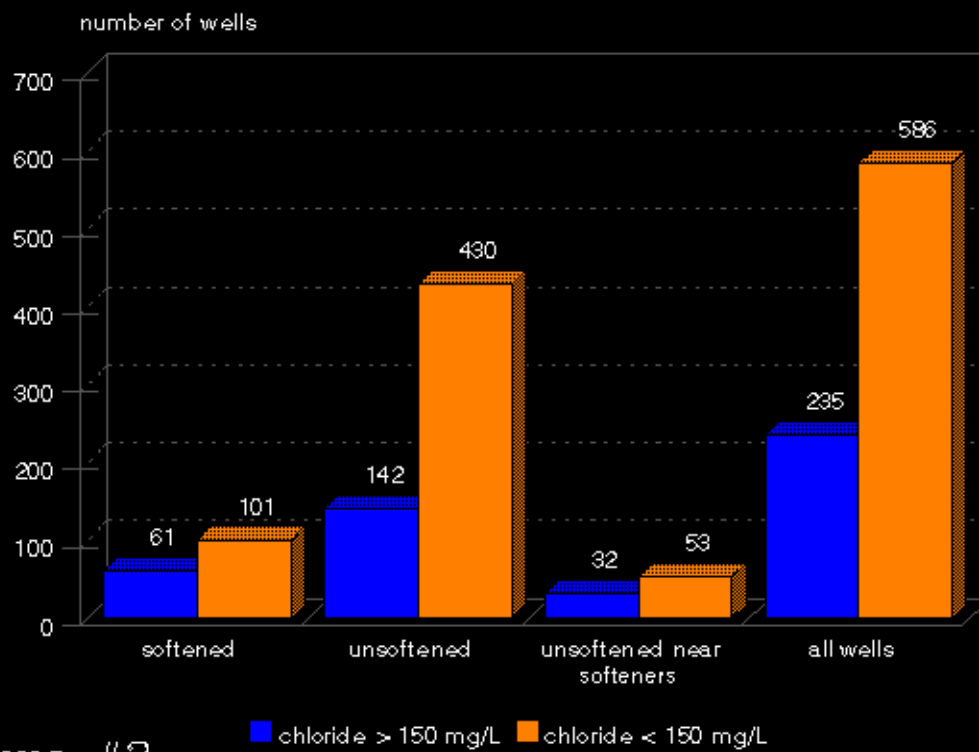


Figure #2

Ratio comparison

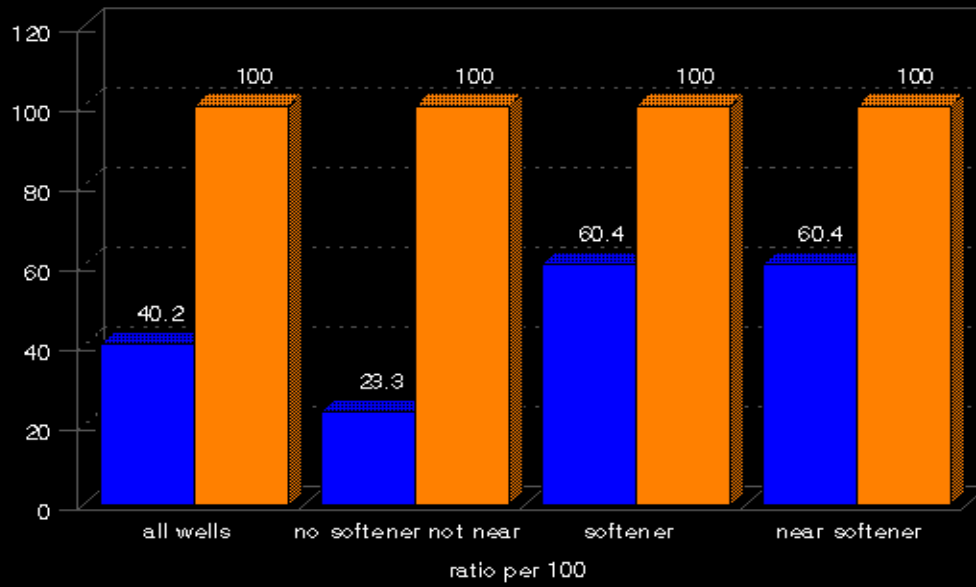


Figure #3

■ chlorides > 150 mg/L ■ chlorides < 150 mg/L

Chloride differences of softened supplies and those near softeners vs nonsoftened supplies not near softeners

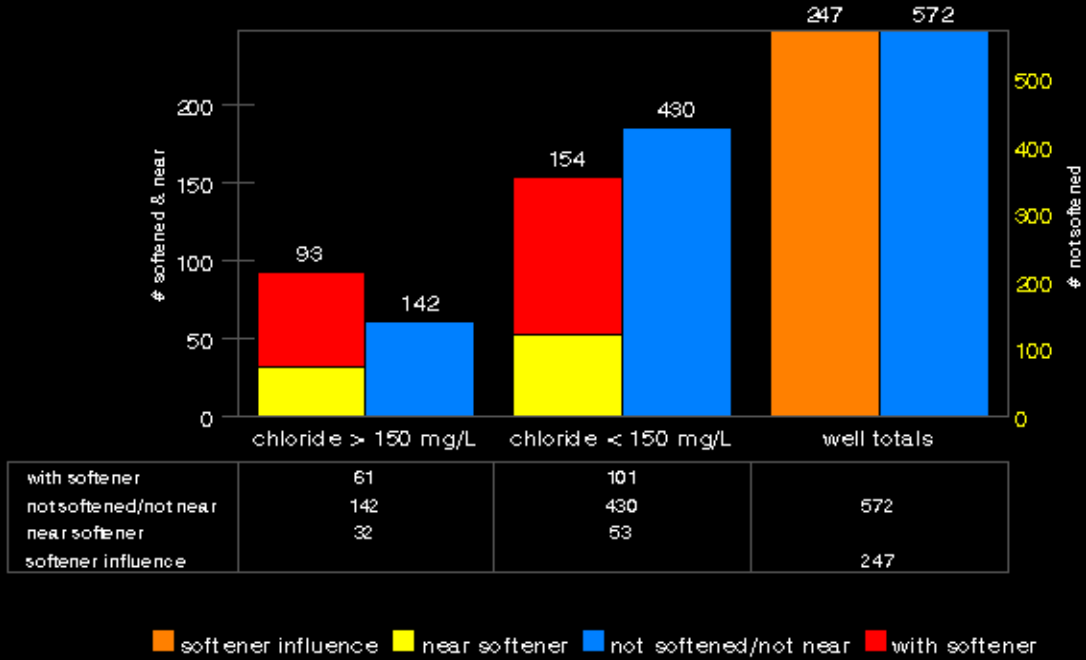


Figure #4

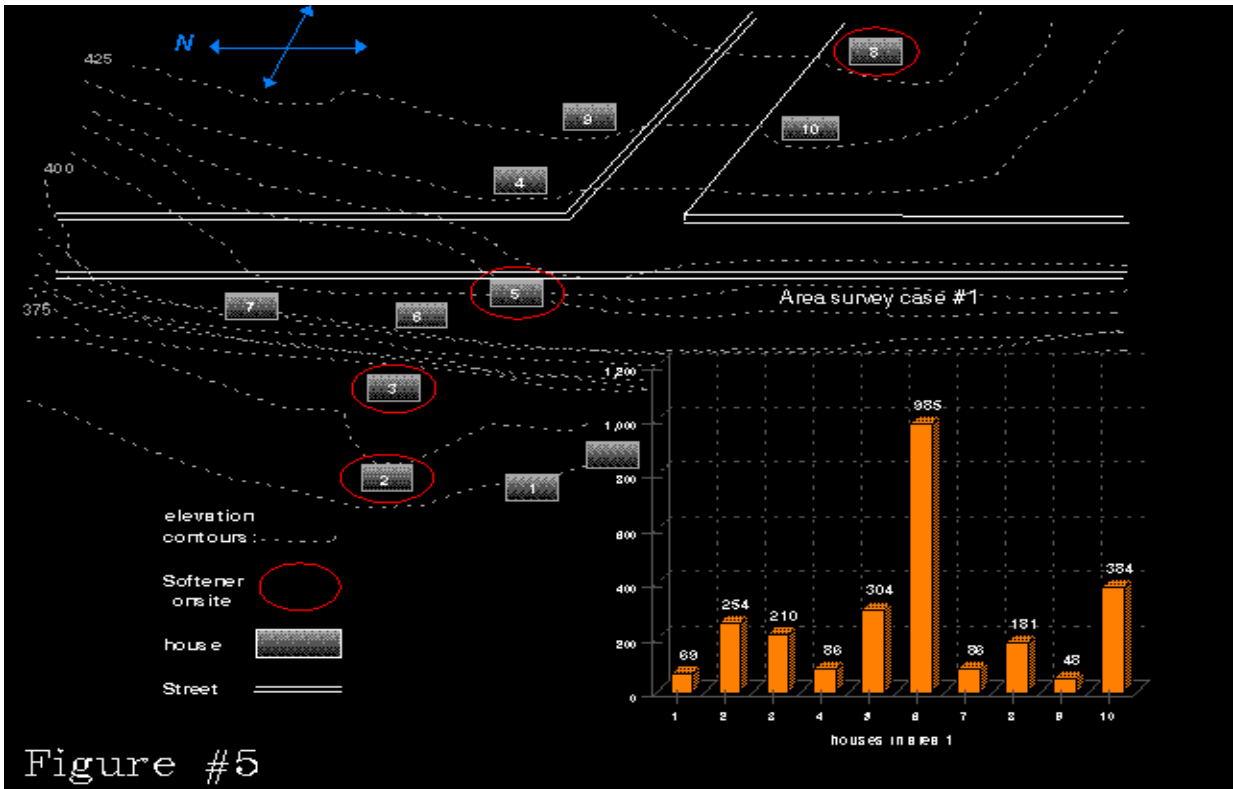


Figure #5