COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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Denver Water Quality

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Since the article on water quality appeared in CFGA Bulletin 222, increasing attention has been given to modifying fertilizer recommendations in accordance with what is in the water supply. For many years it has been known that increasing salts, either in the soil or in the water supply, will reduce carnation yield (CFGA Bulletins 95, 229). Aside from those water analyses published in Bull. 222, over 90 water samples have

Table 1. Denver water analyses for various water sources. Figures in parentheses show extremes.

Type	Shallow wells	Deep wells	Surface waters	Domestic
No. of samples	36	8	3	7
pH	7.6	8.4	7.7	7.6
	(6.6-9.2)	(7.5-8.6)	(7.5-8.0)	(6.6-9.1)
Soluble salts	1169	542	1770	289
(umhos/cm)	(422-2687)	(243-1020)	(943-2603)	(67-391)
Salts (meq/l)				
Ca	4.1	1.0	6.2	1.5
	(0.0-10.1)	(0.0-5.9)	(0.6-11.0)	(0.7-2.6)
Mg	4.6	0.7	7.7	1.2
	(0.5-13.7)	(0.0-1.6)	(3.1-14.2)	(0.4-3.2)
Na	4.7	5.3	8.8	1.3
	(0.5-15.4)	(1.8-12.0)	(5.0-12.1)	(0.2-2.9)
K	0.1	0.1	0.2	0.1
	(--- -0.4)	(0.0-0.2)	(0.1-0.3)	(0.0-0.5)
CO3	---1	0.3	0.1	---1
	(0.0-0.9)	(0.0-0.9)	(0.0-0.3)	(0.0-0.5)
HCO3	5.0	5.3	3.4	2.0
	(2.0-9.2)	(2.1-11.5)	(2.8-3.8)	(0.3-4.1)
Cl	1.1	0.6	1.4	0.7
	(0.2-7.3)	(0.1-1.3)	(0.9-2.0)	(0.3-1.8)
SO4	6.3	1.0	17.6	1.0
	(0.8-22.9)	(0.1-4.4)	(3.8-33.8)	(0.2-2.9)
NO3	0.7	---1	0.3	---1
	(--- -5.7)	0.0-0.3)	(0.0-0.6)	(--------)

---1 Indicates concentrations less than 0.1 meq/l.

been analyzed at CSU since 1969. About a third of these have been either repetitious, the source could not be determined, or the sample was taken after fertilizer injection. The remaining samples were analyzed on the basis of source, location, and frequency of concentrations of various constituents found in the water.

The general results are summarized in Table 1. Variability is considerable, however:

1. pH ranges for each source do not vary markedly.
2. Domestic supplies will usually have the lowest salt concentration and are the easiest to modify for fertilization. Yields will be highest using these sources, with fewer soil structure and precipitation problems.
3. Surface supplies may have the highest salt concentrations, particularly if taken in areas receiving run-off from fertilized fields.
4. Deep wells will usually have lower concentrations of calcium, magnesium, and sulfate, but they may have higher sodium levels, causing greater difficulty in maintaining soil structure.
5. Bicarbonate concentrations in both shallow and deep wells will be relatively high, with generally higher levels in deep wells.
6. Chlorine levels are usually less than 1.0 meq/L. While some chlorine may be desirable for growth, addition of potash (KCl) to the water supply will increase total salt concentration, without any nutritive benefit from the chlorine.
7. Some traces of potassium will be found in all water sources. Nitrates may be expected in shallow wells and surface supplies.
8. Repetitive samples of the same water supply do not show any consistent or significant changes. However, the number of samples in this category was insufficient.

From the shallow well analyses, there were sufficient samples to determine average concentrations for five locations in the Denver area. These are indicated in Fig. 1 and the results given in Table 2. Of particular interest is the gradual increase in total salts from west to east (locations A, B, C, and D, Fig. 1). In terms of distance from the mountains and local topographic conditions, however, location "E" might be considered similar to "D". It appears that shallow wells located in watersheds more than a few miles distant from the mountain range will invariably contain total salts exceeding 1000 μmhos/cm. Concentrations of individual ions, however, may vary considerably.

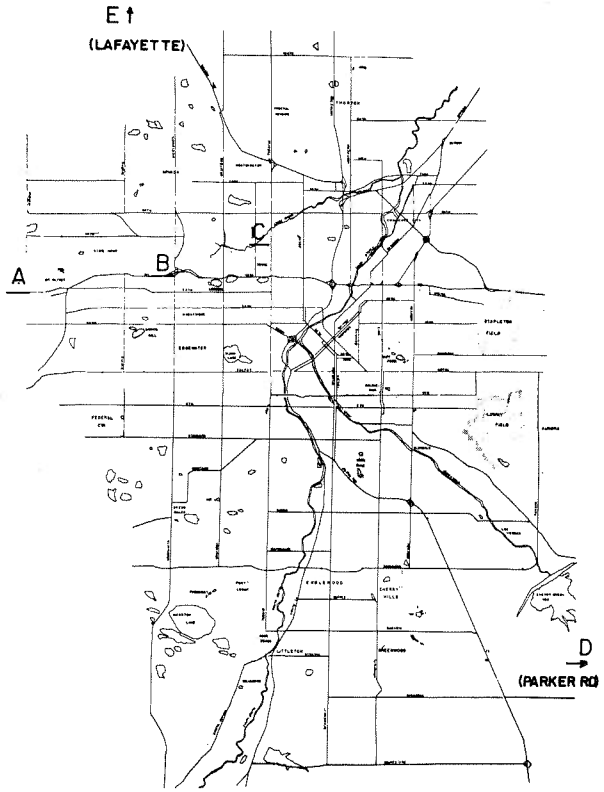

Figure 1. Locations for shallow well analyses given in Table 2. Area "D" in the region near Parker Road and Arapahoe intersections; area "E" north of Lafayette and west of U.S. 85.

There were sufficient shallow well samples to provide a detailed analysis for individual ions, shown in Figures 2, 3, and 4. It may be noted that averages have little meaning in terms of concentrations that may be expected from shallow wells. Thus, nearly half of all shallow wells may be expected to have concentrations

Table 2. Average shallow well water analyses for five Denver area location. See Figure 1 for location.

Area	Soluble salts (micromhos/cm)	Milliequivalents/liter						pH
		Ca	Mg	Na	HCO3	Cl	SO4	
A	628	0.3	5.5	1.7	4.9	0.5	1.7	7.8
B	1019	5.2	2.5	2.9	4.0	0.9	3.8	7.2
C	1292	4.9	5.2	5.6	4.1	1.7	9.7	7.3
D	1384	7.4	5.5	5.3	4.7	1.9	8.7	7.7
E	1462	1.0	10.3	5.9	5.9	0.3	10.1	7.8
	**	**	N.S.	N.S.	N.S.	**	N.S.	N.S.
HSD	786	5.4				1.4		

***Indicates that values above are significantly different. the value required for significance shown directly below.*

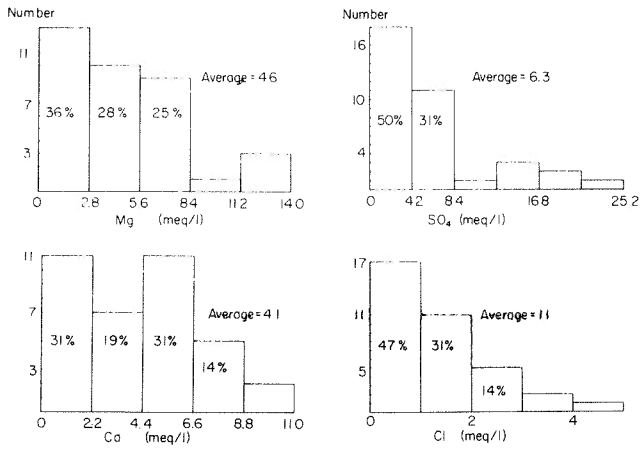

Figure 2. Concentrations of magnesium (Mg), calcium (Ca), sulfate (SO4), and chlorine (Cl) found in 36 shallow wells in the Denver urban area. The vertical axis shows the number of samples, with concentrations on the horizontal axis as milliequivalents per liter (meq/l). Values in each bar give the percentages found in each range.

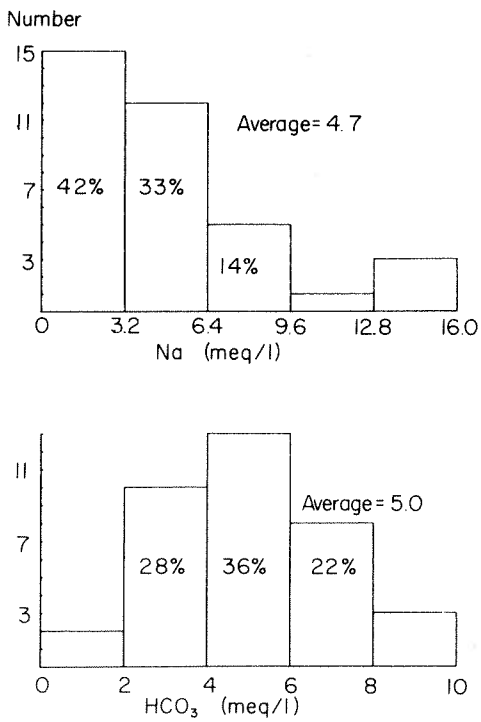

Figure 3. Concentrations of sodium (Na) and bicarbonate (HCO3) found in 36 shallow wells in the Denver urban area. Values in each bar show the percentage of samples found in each range. Vertical axes give the number of samples and the horizontal axis the concentration in milliquivalents per liter (meq/l).

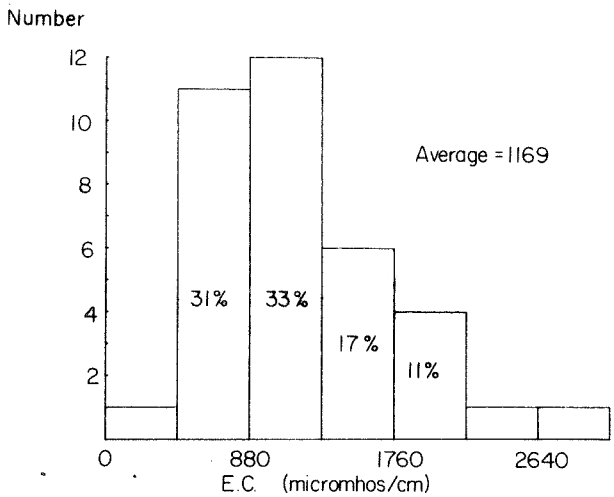

Figure 4. Total soluble salts (E.C.) found in 36 shallow wells in the Denver urban region. Values in each bar are the percentage of samples found in each range.

of sodium less than 3.5 meq/l or chlorine less than 1.1 meq/l. However, calcium and magnesium will usually be high enough to cause problems in precipitation, although these elements will not have to be added to the water supply for carnations. The high levels of bicarbonate will cause problems in calcium availability unless attention is given to ammonium supply. It will be noted that water from shallow wells will usually have total salt levels ranging from 440 to 1320 μmhos/cm, with over a fourth in excess of 1320 μmhos/cm. Thus, all shallow well water supplies will require some modification for fertilizer injection, and we would not recommend many of them as suitable for greenhouse crop production.

The results emphasize the importance of water analyses **before** locating a new range. Secondly, drilling deep or shallow wells is a chancy business, the cost of which should be balanced against the cost of tapping a suitable domestic supply.

Conversion of Milliequivalents Per Liter to Parts Per Million.

MULTIPLY MEQ/L	
Cl X 35.5	(Chlorine)
Mg X 24.3	(Magnesium)
Na X 23.0	(Sodium)
K X 39.1	(Potassium)
NO_3 X 62.0	(Nitrate)
SO_4 X 96.1	(Sulfate)
HCO3 X 61.0	(Bicarbonate)