Gross alpha (α) radiation consists of the emissions of positively charged helium nuclei having high atomic weight. This radioactive decay is measured as gross α in units of picocuries per liter (pCi/l). Alpha-emitting isotopes in natural waters are primarily isotopes of Ra_{226} and Ra_{228}, Ra_{226} being the disintegration product of uranium (U_{238}), and Ra_{228} the disintegration product of thorium (Th_{232}). Ra_{226} decays to radon gas (Rn_{226}), which is also an α-emitter. Gross beta (ß) radiation consists of the emission of high energy electrons and positrons from the nucleus of atoms having high atomic weight. Natural ß-emitting isotopes occur in the uranium and thorium disintegration series, among other natural sources. In these analyses, gross alpha and gross beta ranged from 2 - 12 and 4 - 14 pCi/l, with an average of 3.4 and 5.1 pCi/l, respectively; none were in excess of the MCL.

COMPARISON TO PREVIOUS WORK

In a simple map accompanying one of the earliest descriptions of Woodbine water quality (Plummer, 1931), the contour delineating the limit of "fresh" water is essentially the same line marking the present-day downdip or easternmost limit of usable quality water. Although this report was written mainly for the purposes of determining changes in water composition in relation to oil accumulations in the East Texas field, the few analyses of samples in the western part of the study area indicate that concentrations of dissolved solids and chlorides gradually increase to the southeast, that bicarbonates correspondingly decrease to the southeast, and that sulfates, generally high in the freshwater area, decrease in the vicinity of the oil fields. In Nordstrom's comprehensive study of Cretaceous aquifers (1982), 40 percent of the 800 samples contained dissolved solids in excess of 1,000 mg/l; 10 percent contained chloride in excess of 300 mg/l; 32 percent contained sulphate in excess of 300 mg/l; high nitrates were not found; and 80 percent of the water was classified as soft. Baker and others (1990) note that sulfates are high in the southern outcrop area of Tarrant and Johnson counties as well as the artesian portion of the aquifer, and that boron is high throughout the area. Outcrop descriptions (Plummer and Sargent, 1931; Stephenson, 1952; and Cotera, 1956) mention the presence of ferruginous sandstones, and Nordstrom (1982) discusses higher iron content, commonly in excess of 300 µg/l, in the uppermost Woodbine zone.

Historical data taken from balanced analyses in the TWDB ground-water database were examined to assess water-quality deterioration over time. Query language calculated averages of dissolved solids, chloride, sulfate, fluoride, and hardness during the last four decades and the present partial decade (Table 6). Averages do not reflect the same sample population for each time period, as although frequently the same wells were sampled during more than one decade, none were sampled repeatedly in each of the five time periods. Furthermore, the choice of decades as the time period most appropriate for the calculation of averages is arbitrary, as sampling events were not timed to correspond with any certain time period. Averages of dissolved solids and chloride are highest in the samples collected in the 50s and 60s; averages for dissolved solids, chloride, and sulfate are all lowest during the 70s; these three constituents increase, for the most part, through the most recent sampling event.

Time Period (# of analyses)	Dissolved Solids	Chloride	Sulfate	Fluoride	Hardness
> 1990 (61)	1,071	112	319	1.1	171
'80 - '89 (226)	979	124	221	2.3	43
'70 - '79 (577)	882	86	218	1.7	74
'60 - '69 (251)	1,225	177	282	1.7	34
'50 - '59 (133)	1,275	240	249	1.9	63

Table 6. Comparison of averages of dissolved constituents, in milligrams/liter, in Woodbine aquifer water over time.

A qualitative comparison of change in water quality in individual wells with multiple sampling events (analyses from at least two decades) similarly does not reveal any simple trends. When considering the overall change in dissolved solids in Ellis County from 34 wells with multiple analyses, for example, essentially no change occurred in three wells, increases on the average of 44 mg/l occurred in 16 wells (with average total well depth of 981 feet), and decreases on the average of 64 mg/l occurred in 15 different wells (with average total depth of 1280 feet). A few wells exhibited an increase from one decade to the next followed by a decrease, and vice-versa. Changes in the majority of the wells showing improvement (decreased dissolved solids) occurred before the end of the 80s, whereas changes in the majority of those wells showing a slight deterioration in water quality (increased dissolved solids) occurred since the 70s. With the exception of fluoride and chloride, averages in Table 6 also appear to suggest that a slight deterioration in ground-water quality has happened recently, with shallower wells, as expected, somewhat more susceptible.

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