1996

# Rural Domestic Well-water Quality -- Hat Creek-White River Drainage Basin

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# Rural Domestic Well-water Quality in the *Hat Creek-White River Drainage Basin*

Groundwater Region 13 from *Domestic Water-well Quality in Rural Nebraska*
(A data-analysis report for the Nebraska Department of Health compiled by D. C. Gosselin and others, 1996)

## Geology and Hydrogeology

Groundwater Region 13 is located in the northern part of Nebraska's Panhandle (Figure 1). The area is characterized by a lack of any substantial groundwater resource. The Pierre shale crops out at the surface or is present at shallow depth in much of the northern part of this area. It is a black marine shale of Cretaceous age and ranges in thickness from 0 to about 5,000 feet or more. This impermeable shale does not yield sufficient quantities of water for domestic or livestock use. Groundwater developed in the northern part of this region is limited to a few isolated low-yield wells drilled into river-deposited sediments along the major drainages. In the areas underlain by the Pierre shale, water is piped many miles for domestic or livestock use (Table 1).

The Tertiary White River Group underlies the southern part of region 13 and has been locally developed as a source of groundwater. This group consists of the Chadron and the Brule formations. The Chadron Formation consists of a basal sand unit that ranges in thickness from 0 to 350 feet. It is overlain by as much as 150 feet of bentonitic mudstones. The Brule Formation (130 feet to 530 feet thick) consists of interbedded siltstone and mudstones with isolated channels of arkosic sands. The Brule Formation yields groundwater from channel sands. The sands near the bottom of the Chadron Formation yield sodium-sulphate water with high total dissolved solids. Near uranium deposits in the Crawford area, groundwater from the Chadron Formation is not suitable for domestic or livestock purposes because of high radium concentrations.

## Results* and Discussion

### Well Characteristics

Characteristics of the wells sampled in 1994-1995 are summarized in Table GW13.1. Where information was available, the average year of installation was 1956. The oldest well was installed in 1900. All of the wells are cased; about 63 percent have steel casing and the remainder are cased with PVC. All wells had sanitary seals except one. Excluding the deepest well (245 feet), the average depth of the wells was 66 feet and the average depth to water was 37 feet. The average well diameter is 6 inches, the minimum being 4 inches and the maximum being 8 inches. Each well is used by an average of 3.3 individuals. Nitrate was used at only one location. Pesticides were used at half the locations.

### Nitrates

Nitrate data for wells sampled during the 1994-1995 study are summarized in Table GW13.1. The locations of the eight wells sampled are shown in Figure. GW13.1 The nitrate-nitrogen concentrations ranged from 0.2 parts per million (ppm) to a maximum of 16.5 ppm. Only two wells had concentrations greater than 1.7 ppm, one of which exceeded the 10 ppm maximum contaminant level (mcl) for nitrate. The average value for all samples was 3.8 ppm, and the median value was 1.1 ppm.

Comparing the nitrate-nitrogen concentration from the 1985-1989 sampling period to those in the 1994-1995 period indicated seven of the eight samples had an increase in the amount of nitrate present (Figure GW13.2). The Wilcoxon Signed Rank Test demonstrated that this shift to higher concentrations is statistically significant.

The factors that may influence the nitrate-nitrogen concentrations in rural domestic wells are divided into three groups: 1) well-construction factors: casing type, age, diameter, well completion in or out of a pit, sanitary seal, and well type; 2) distance factors: distance to cesspools, septic systems, waste lagoons, barnyards, pasture, and cropland; and 3) hydrogeologic and site factors: well depth, depth to water, landscape and soil characteristics (Figure GW13.1), and agricultural chemical use.

***Where associations, relationships, increases or decreases are discussed, our analyses have determined they are statistically significant. If the relationship between contaminant concentrations and various factors are not discussed, they have not been demonstrated to be statistically significant.***

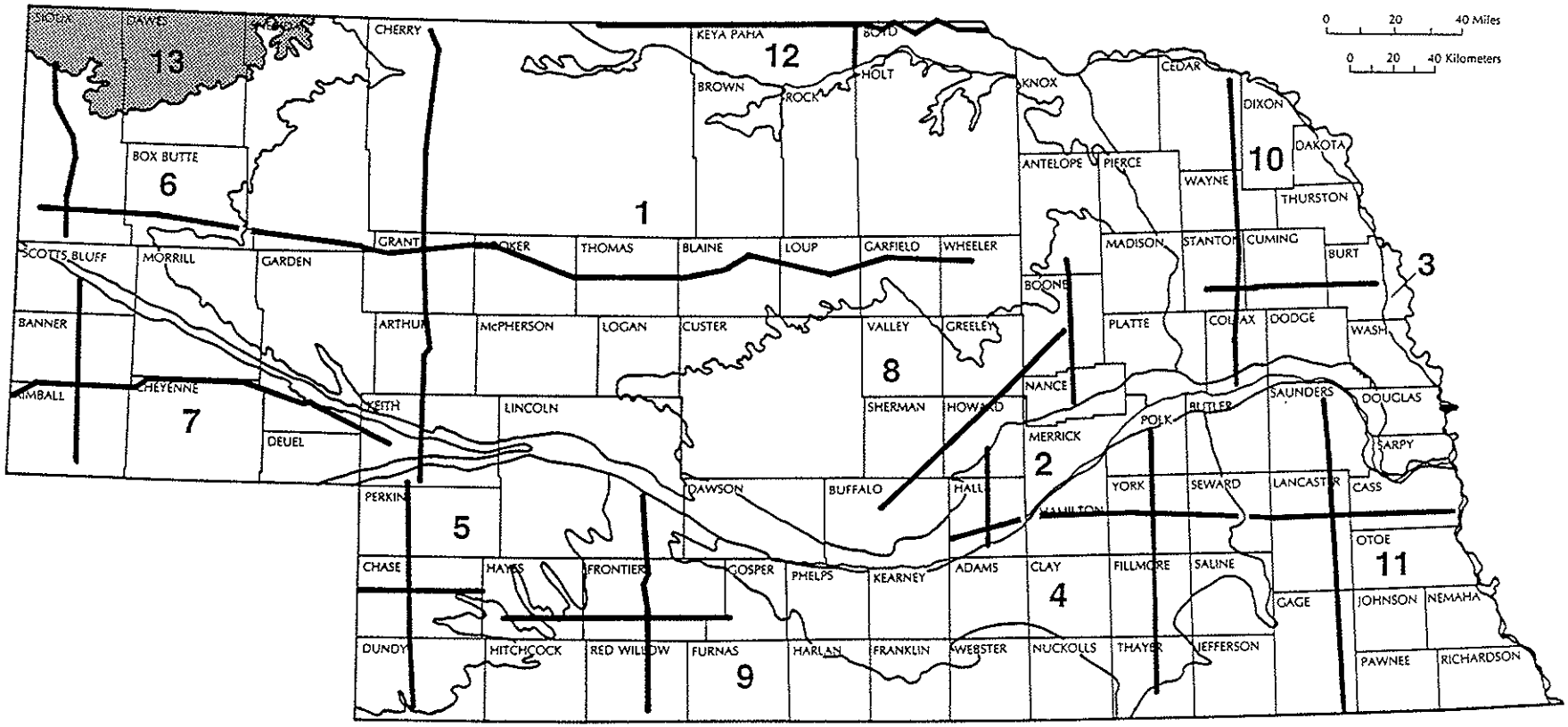



**Fig. 1—*Locations of geologic cross sections*** **(Region 13 in gray)**

## Water-bearing Properties of Major Rock Units in Nebraska

From *The Groundwater Atlas of Nebraska* — Conservation and Survey Division, University of Nebraska-Lincoln

| Era | Period | Epoch | Millions of years | Group or Formation | Lithology | Water-bearing Properties |
|---|---|---|---|---|---|---|
| Cenozoic | Quaternary | Holocene | 0.01 | | Sand, silt, gravel and clay | Principal groundwater reservoir; Ogallala is absent in east and northwest. Arikaree is present primarily in west. |
| | | Pleistocene | ~2.0 | | | |
| | | Pliocene | 5 | | Sand, gravel and silt | |
| | | Miocene | 24 | Ogallala | Sand, sandstone, siltstone and some gravel | |
| | | Oligocene | | Arikaree | Sandstone and siltstone | |
| | | | 37 | White River | Siltstone, sandstone and clay in lower part | Secondary aquifer in west; water may be highly mineralized. |
| | | Eocene | 58 | Rocks of this age are not identified in Nebraska. | | |
| | | Paleocene | 67 | | | |
| Mesozoic | Cretaceous | Late Cretaceous | | Lance | Sandstone and siltstone | Generally not an aquifer; yields water to few wells in west. |
| | | | | Fox Hills | | |
| | | | | Pierre | Shale and some sandstone in west | Generally not an aquifer; sandstones in west yield highly mineralized water to few industrial wells. |
| | | | | Niobrara | Shaly chalk and limestone | Secondary aquifer where fractured and at shallow depths, primarily in east. |
| | | | | Carlile | Shale; in some areas contains sandstones in upper part | Generally not an aquifer; sandstones yield water to few wells in northeast. |
| | | | | Greenhorn-Graneros | Limestone and shale | Generally not an aquifer, yields water to few wells in east. |
| | | Early Cretaceous | 98 | Dakota | Sandstone and shale | Secondary aquifer, primarily in east; water may be highly mineralized. |
| | Jurassic | | 144 | | Siltstone and some sandstone | Not an aquifer |
| | Triassic | | 208 | | Siltstone | Not an aquifer |
| Paleozoic | Permian | | 245 | | Limestone, dolomites, shales and sandstone. | Some sandstone, limestone and dolomites are secondary aquifers in east. Water may be highly mineralized. |
| | Pennsylvanian | | 286 | | | |
| | Mississippian | | 320 | | | |
| | Devonian | | 360 | | | |
| | Silurian | | 408 | | | |
| | Ordovician | | 438 | | | |
| | Cambrian | | 505 | | | |
| Precambrian | | | 570 | | | |

***Table 1—Hydrostratigraphic chart (showing water-bearing rock units) of Nebraska***
***Time divisions are not to scale.***

# Table GW13.1. Summary of Domestic Well Characteristics and Water Quality Data (1994-95)

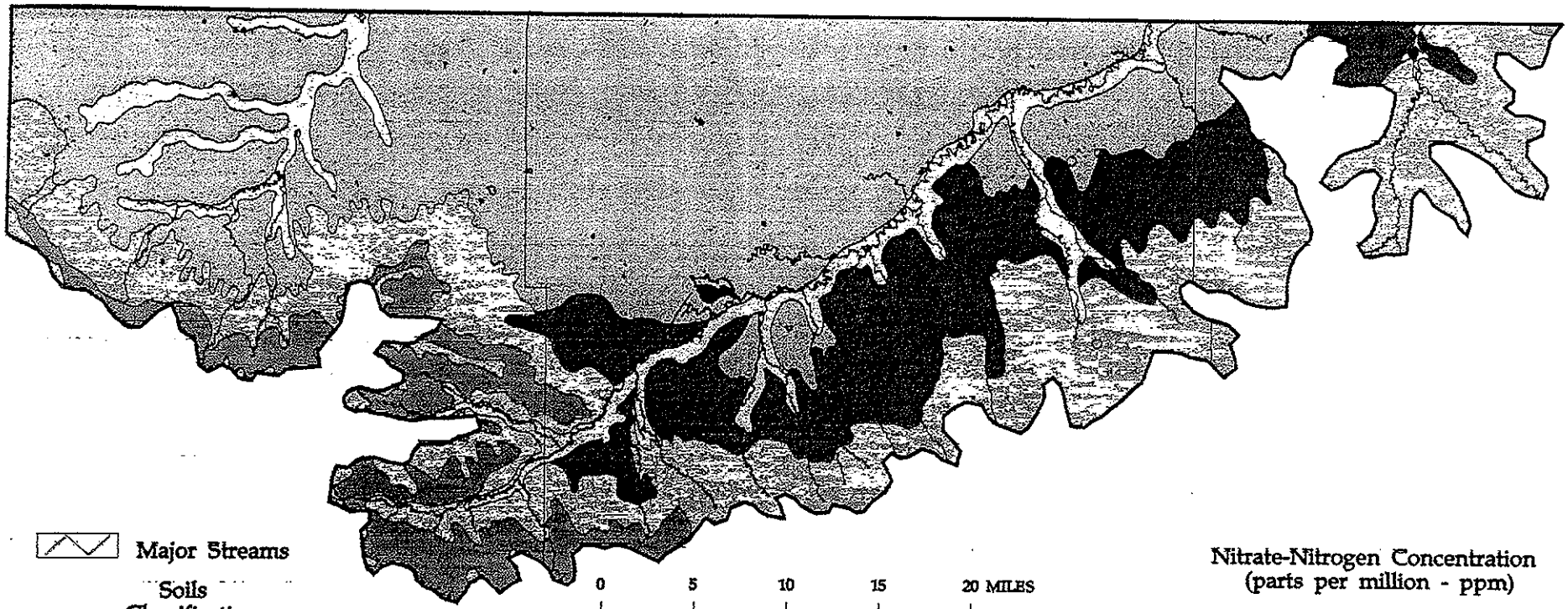
## Well characteristics

| | Number of wells | Mean | Minimum | Maximum | Standard deviation |
|---|---|---|---|---|---|
| **Well Installation Date** | | | | | |
| All | 5 | 1953 | 1900 | 1983 | 32 |
| <1940 | 1 | | | | |
| 1940-1969 | 2 | | | | |
| 1960-1979 | 1 | | | | |
| 1980-present | 1 | | | | |
| **Well Depth (feet)** | | | | | |
| All | 8 | 89 | 45 | 245 | 65 |
| <50 | 2 | | | | |
| 50-99 | 5 | | | | |
| 100-199 | 0 | | | | |
| >200 | 1 | | | | |
| **Well Diameter (inches)** | | | | | |
| All | 8 | 6.0 | 4 | 8 | 1.1 |
| <2 | 0 | | | | |
| 2-3 | 0 | | | | |
| 4-5 | 1 | | | | |
| 6-7 | 6 | | | | |
| >8 | 1 | | | | |
| **Number of Well Users** | 8 | 2.4 | 1 | 5 | 1.3 |
| **Distance to Contaminant Source (feet):** | | | | | |
| cesspool | 0 | - | - | - | - |
| septic | 7 | 233 | 50 | 1100 | 384 |
| waste lagoon | 0 | - | - | - | - |
| barnyard | 6 | 132 | 40 | 250 | 91 |
| pasture land | 8 | 153 | 5 | 650 | 208 |
| cropland | 8 | 1042 | 60 | 2600 | 1032 |
| **Well Type:** | | | | | |
| drilled | 8 | | | | |
| driven | 0 | | | | |
| dug | 0 | | | | |
| other | 0 | | | | |
| **Casing Material:** | | | | | |
| steel | 5 | | | | |
| plastic | 3 | | | | |
| concrete | 0 | | | | |
| brick | 0 | | | | |
| tile | 0 | | | | |
| other | 0 | | | | |
| **Sanitary Seal:** | | | | | |
| yes | 7 | | | | |
| no | 1 | | | | |
| **Casing in Pit:** | | | | | |
| yes | 6 | | | | |
| no | 2 | | | | |
| **Nitrate Used:** | | | | | |
| yes | 1 | | | | |
| no | 7 | | | | |
| **Pesticide Used:** | | | | | |
| yes | 4 | | | | |
| no | 4 | | | | |

## Water Quality Data

| | Number of wells | Mean | Median | Minimum | Maximum | Standard deviation | Detections |
|---|---|---|---|---|---|---|---|
| **Nitrate as Nitrogen (ppm NO3-N)** | | | | | | | |
| 1994-1995 | 8 | 3.8 | 1.1 | 0.2 | 16.5 | 5.8 | |
| **Bacteria (colonies per 100 ml)** | | | | | | | |
| 1994-1995 | 8 | | | 0 | 6 | | 1 |
| **Pesticides (ppb)** | | | | | | | |
| 1994-1995 | 8 | | | 0 | 0 | | 0 |

# Nebraska Department of Health
# Rural Domestic Well Water Quality Study: 1994-1995
# Nitrate Sampling Locations - Region #13



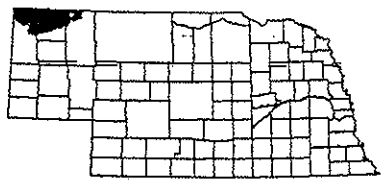
Major Streams

Soils Classification

- Sandy - Level
- Sandy - Sloping
- Silty - Level
- Silty - Sloping
- Loamy - Level
- Loamy - Sloping
- Clayey - Level
- Clayey - Sloping

0 5 10 15 20 MILES

0 5 10 15 20 KILOMETERS

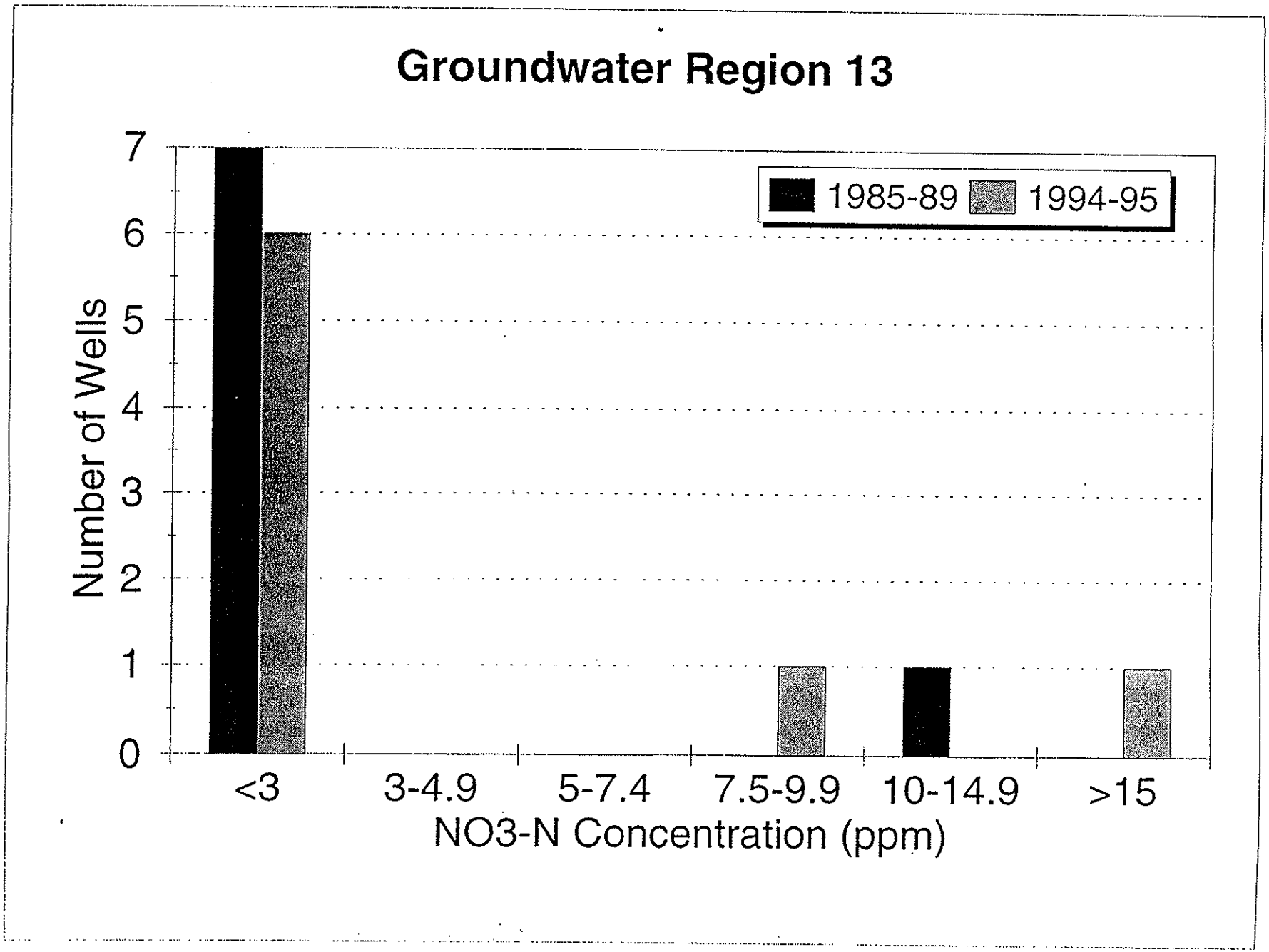


Groundwater Region #13

Nitrate-Nitrogen Concentration (parts per million - ppm)

- ○ Less than 3.0
- △ 3.0 to 5.0
- ▽ 5.0 to 7.5
- ● 7.5 to 10.0
- ▲ 10.0 to 15.0
- ▼ Greater than 15.0

Figure GW13.1


Groundwater Region 13
1985-89
1994-95
Number of Wells
0
1
2
3
4
5
6
7
<3
3-4.9
5-7.4
7.5-9.9
10-14.9
>15
NO3-N Concentration (ppm)

*Well-construction factors*

There were only a sufficient number of samples to evaluate the completion in or out of a pit and the casing type with the Mann-Whitney Rank Sum Test. There were no statistically significant differences between groups. As might be expected, the oldest well was the only one to exceed the 10 ppm mcl for nitrate.

*Distance factors*

The Spearman Rank Order Correlation Test did not indicate any statistically reasonable associations.

*Hydrogeologic and site factors*

Nitrogen was used on the premises at one location. This well had the lowest concentration of the eight samples. The Spearman Test did not indicate any statistical association between well depth or depth to the water table and nitrate-nitrogen concentrations.

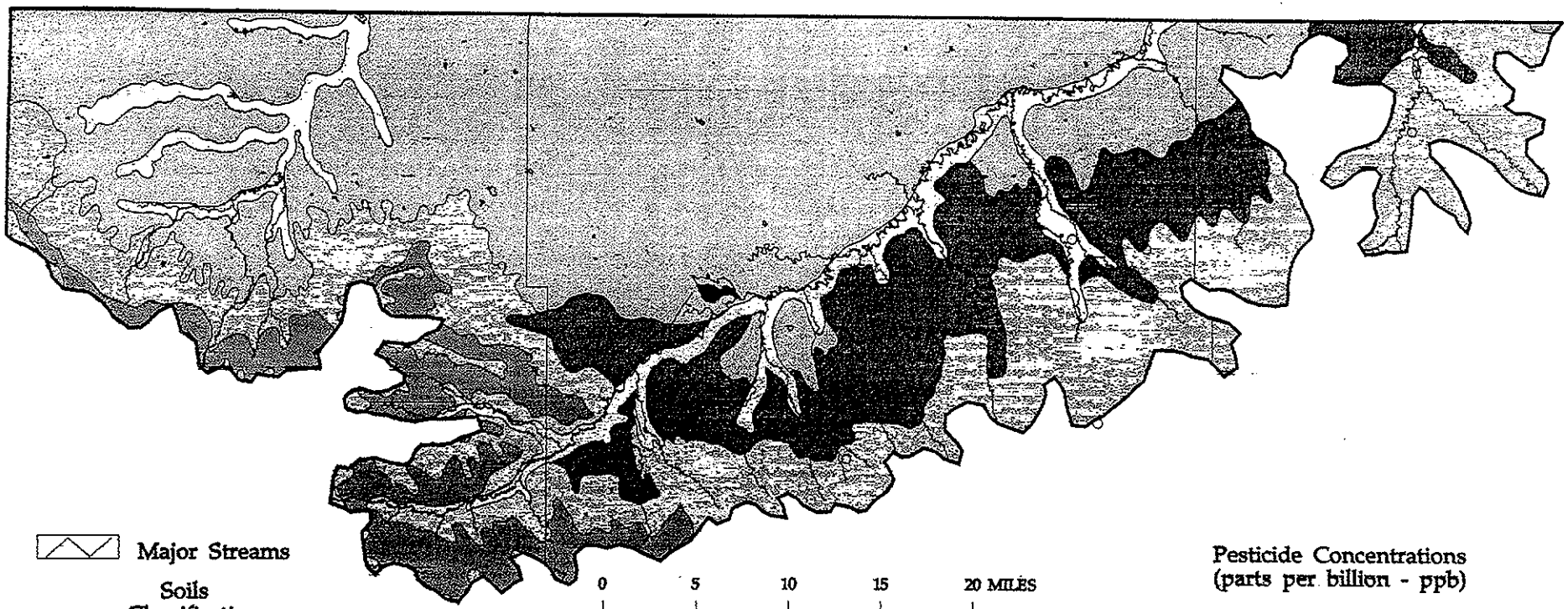
**Pesticides**

Pesticides were not detected in any of the wells (Figure GW13.3).

**Bacteria**

Coliform bacteria was identified in only one of eight wells (Figure GW13.4). This well was the only well without a sanitary seal. There was an insufficient number of wells with bacteria present to conduct any type of statistical analysis.

# Nebraska Department of Health
# Rural Domestic Well Water Quality Study: 1994-1995
# Pesticide Sampling Locations - Region #13



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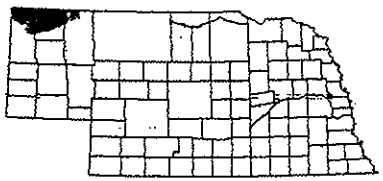
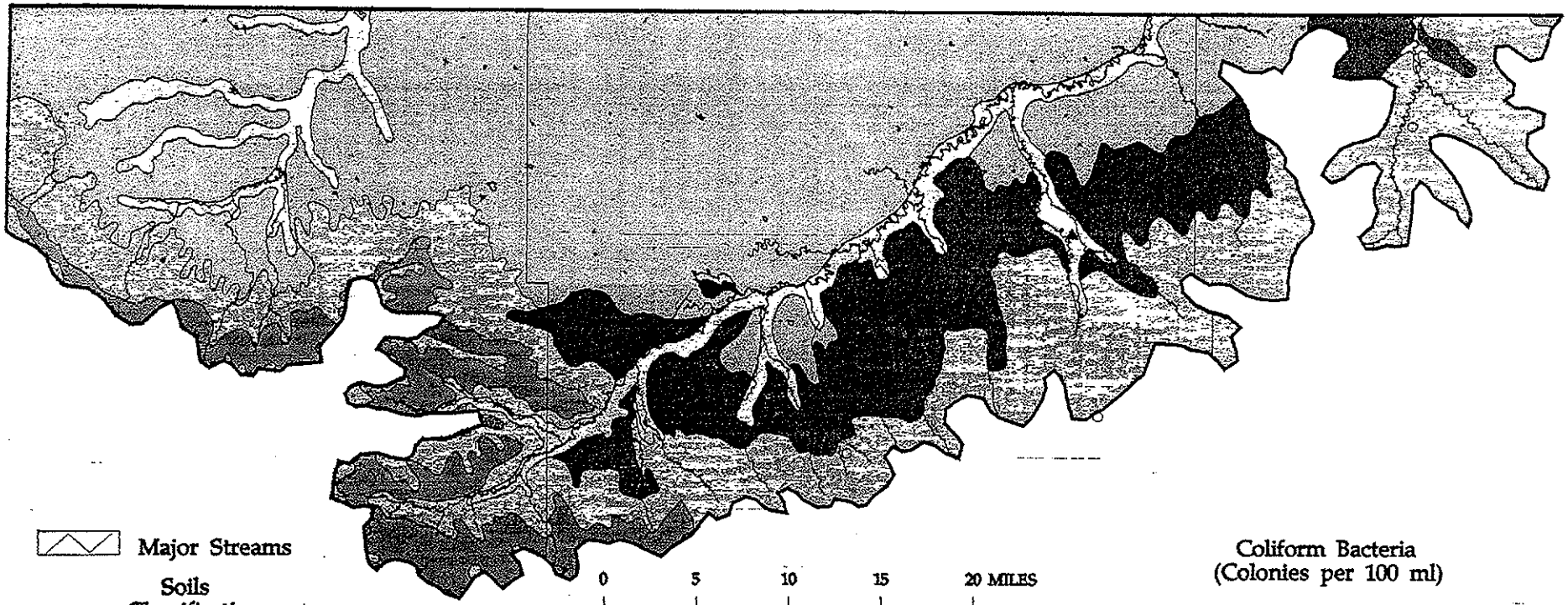


Groundwater Region #13

Pesticide Concentrations (parts per billion - ppb)

- ○ None Detected
- ▲ 0.10 - 2.99
- ● 3.00 or More

# Nebraska Department of Health
# Rural Domestic Well Water Quality Study: 1994-1995
# Bacteria Sampling Locations - Region #13



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- Sandy - Sloping
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- Silty - Sloping
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- Loamy - Sloping
- Clayey - Level
- Clayey - Sloping

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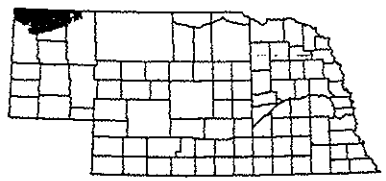
0 5 10 15 20 KILOMETERS



Groundwater Region #13

Coliform Bacteria
(Colonies per 100 ml)

- ○ None Detected
- ▲ 1 - 9 Counted
- ● 10 or more Counted