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A PRELIMINARY REPORT ON NITRATE CONTAMINATION OF SHALLOW GROUND WATERS IN DELAWARE

BY

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INTRODUCTION

Inspection of water analyses on file at the Delaware Geological Survey revealed that 25 percent of the shallow wells yield water with nitrate concentrations approaching or in excess of the Delaware State Board of Health and U. S. Public Health Service limit of 45 parts per million (ppm).

Nitrate concentrations greater than 45 ppm seem to be detrimental to the health of infants during their first few months of life; adults drinking the same water are not affected but breast-fed infants of mothers drinking such water may become ill. The illness ("blue baby sickness" or methemoglobinemia) results from the conversion of nitrate to nitrite by nitrite-forming bacteria in the upper part of the digestive tract of some infants and the further conversion of hemoglobin to methemoglobin which is incapable of transporting oxygen; the result is oxygen starvation. Little is known about the low level effect of undetected methemoglobinemia on infants.

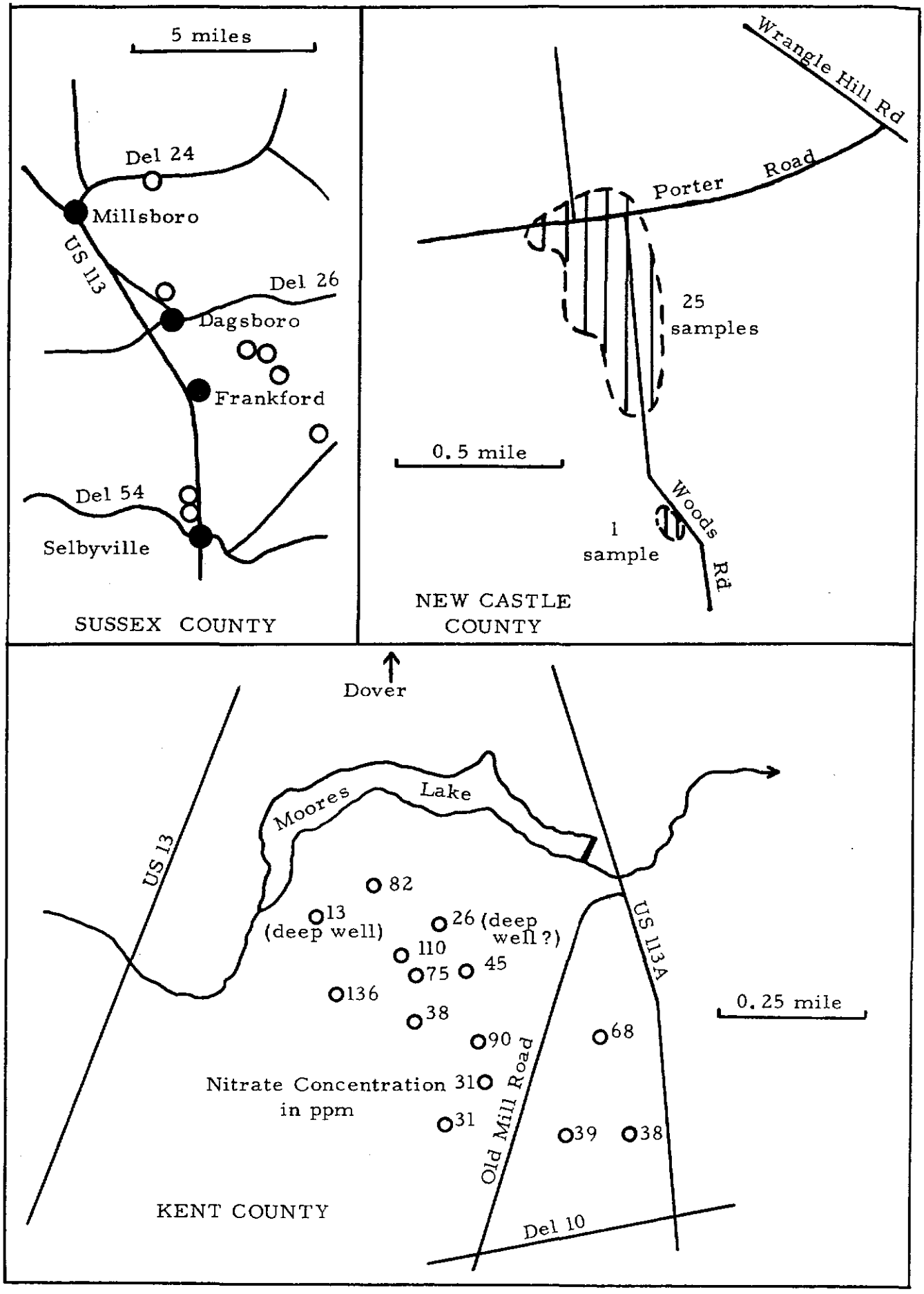
Although there have been no confirmed reports of methemoglobinemia in Delaware, it is prudent to evaluate certain areas of the State that are more likely to have higher concentrations of nitrate in the ground water due to hydrogeologic conditions in combination with Man's activities, especially as the presence of excessive amounts of nitrate may be

indicative of contamination of ground waters by sewage containing other undesirable elements such as bacteria and detergents. This report presents the results of preliminary samplings of ground water from shallow wells in the three counties of Delaware and makes recommendations based on a knowledge of the hydrogeology of the areas sampled.

RESULTS

At the start of the project the most likely sources of nitrate contamination of ground water in Delaware were considered to be the following: 1) leaching of residual nitrate from croplands where artificial and natural fertilizers were applied; 2) percolation from feedlots, poultry farms, and manure piles, and 3) seepage from septic tanks and tile fields.

Sussex County. With the above mentioned possible sources in mind, sampling was started in October, 1970 in the Millsboro-Dagsboro-Frankford-Selbyville area from shallow wells near feed companies, small farms, and rural homes (see map). Analyses during this period were done by the Technical Services Section of the Delaware Department of Natural Resources and Environmental Control. The nitrate content of 8 samples ranged from less than 0.5 to 13 ppm. Although these values are well below the health limit of 45 ppm, previous analyses on file at the Delaware Geological Survey (23 and 36 ppm) and at the Delaware State Board of Health (163 ppm near Millsboro) indicate that further sampling must be undertaken.


5 miles
Del 24
Millsboro
US 113
Del 26
Dagsboro
Frankford
Del 54
Selbyville
SUSSEX COUNTY
Wrangle Hill Rd
Porter Road
25 samples
0.5 mile
1 sample
Woods Rd
NEW CASTLE COUNTY
Dover
Moores Lake
US 13
US 113A
82
13 (deep well)
26 (deep well ?)
110
75
45
136
38
90
68
Nitrate Concentration in ppm
31
39
38
Old Mill Road
0.25 mile
KENT COUNTY
Del 10

New Castle County. Sampling of ground water from shallow (13-35 feet deep) dug and drive-point wells in the area of Porter Road and Woods Road, two miles southeast of Glasgow, Delaware, was started in late August of 1971 (see map). The samples were taken from kitchen faucets and outside spigots. The area was selected because of high water tables, periodically water-logged and poorly drained soils, and reports of overflowing septic tanks and odors during the rainy months.

Soils in the area are of the Elkton, Fallsington, Keysport, and Woodstown types: generally of low to moderate permeability with seasonally high water tables and poor drainage (Matthews and Lavoie, 1970). The water table in the study area rises to within 1-4 feet of land surface during the spring rains (Adams and Boggess, 1963).

Analyses of the ground waters were conducted within 24 hours of sampling at the Delaware Geological Survey laboratory using an Orion specific ion electrode calibrated by known nitrate standards (the method is accurate to within 1-4 ppm of the standard brucine method according to Langmuir and Jacobson, 1970). Samples from 26 wells ranged from 2.0 to 51 ppm nitrate, with an average of 16 ppm. Only three waters had a nitrate content (27, 44, and 51 ppm) approaching or exceeding the drinking water limit of 45 ppm. Recommendation was made to the owners of these three wells that they contact the New Castle County Health Unit for a bacteriological analysis of their well water, and the State Board of Health was informed of the nitrate levels.

It appears that the concentration of nitrate in ground water from wells in the Porter-Woods Roads area is cyclic and dependent on rainfall, as the highest nitrate levels probably occur during the summer months when less rainfall reaches the water table to dilute the nitrates seeping downward from the septic tanks. The late August and early September rains and the March to May thaw-rain period are times when bacteriological contamination of the well waters might result from overflowing septic tanks. The 26 wells sampled previously will continue to be sampled as the seasons change in order to verify the cyclical nature of the nitrate concentration.

Kent County. Sampling in the area directly south of Moores Lake near Dover (see map) was conducted as a result of reports that nitrate concentrations double and treble the drinking water limits had been recorded by private laboratories. Samples were taken from 14 homes chosen at random and analyzed with the nitrate specific ion electrode. One of the wells is in a deeper aquifer (200+ feet -- probably the Cheswold aquifer) and yields water with only 13 ppm nitrate. The other 13 wells contain the following nitrate concentrations: 26, 31, 31, 38, 38, 39, 45, 68, 75, 90, 110, and 136 ppm. The higher nitrate concentrations of nitrate are found downslope topographically and hydrologically from the lower concentrations.

Soils in the area are of the Sassafras type, a deep, well-drained soil formed on the uplands from sandy sediments with moderate amounts of silt and clay (Matthews and Ireland, 1971). The water table occurs

15-20 feet below land surface and varies 2-4 feet seasonally (Boggess, Davis, and Coskery, 1965). The shallow wells, generally drive-points, obtain their water from highly permeable sands in the Columbia Formation. Septic tanks, installed in the same geologic horizon, appear to be of two types: concrete boxes without tile fields and others with tile fields. Evidence of subsidence of the land surface above the septic tanks is common in the central portion of the area, and cavitation has reached the surface. Rainfall undoubtedly accumulates in these depressions and moves downward.

It is very likely that the concentration of nitrate in ground water from wells constructed in permeable sands overlain by Sassafras and similarly well-drained soils is cyclic and dependent upon an absence of diluting rainfall for the higher concentrations. The highest concentrations would occur during the summer dry period when the downward percolation of rain water is least and the water tables fall (June to August). Any ground water withdrawn by means of wells is simply returned to the water table after use by means of the septic tank system, thus constantly building up the nitrate concentration. It is also likely that the nitrate levels recently recorded in the Moores Lake area are not as high as the nitrate levels that existed in July when the water table reached its lowest point.

An additional observation to be made regarding the contamination of water supplies in areas where the soils and underlying sediments are

very permeable is that pesticides, herbicides, funcicides, and fertilizers applied to lawn and plants, particularly in the vicinity of shallow wells, could pose an even greater health threat than the nitrates

CONCLUSIONS AND RECOMMENDATIONS

1) The practice of constructing wells and septic tanks in the same geologic horizons should be abandoned, particularly in crowded urban and suburban areas.

2) Percolation tests alone seem not to be adequate for evaluating the effectiveness of human waste disposal by means of septic tank systems. Consideration should be given to the hydrologic, geologic, climatologic, and pedologic characteristics of the area.

3) A survey of all communities with septic systems in the same geologic horizon as wells should be undertaken to evaluate the extent of nitrate contaminations of shallow ground water resources.

4) Additional studies should consider the effect of agricultural activities on the quality of ground water in the shallow aquifers.

5) Recommendations should be made for proper siting of landfills. Movement of leacheates from landfills located inpermeable sands could contaminate ground water supplies in shallow aquifers.

6) Residents of affected areas should be guided toward the practice of drilling deeper wells into water-bearing rock units that are safe from downward movement of nitrate. In the Moores Lake area the Cheswold aquifer (200+ feet down) could supply individual or community wells. Sewage treatment systems and/or central water systems would be better alternatives.

References

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