New Jersey's Ambient Ground Water Quality Monitoring Network: Status of shallow ground-water

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Water quality data from the 150 well, New Jersey, Ambient Ground-Water Quality Monitoring Network (AGWQMN) yields information about the quality of shallow ground water in agricultural, urban and undeveloped land use areas. The major goals of this NJDEP/USGS cooperative network are to evaluate the status and trer of shallow ground-water quality as a function of land use related non-point source pollution. Network wells are screened just below the water table and are sampled 30 per year on a 5-year cycle. The first cycle was completed and the second started in 2004. The New Jersey Geological Survey (NJGS) manages the network design, well installation, well maintenance and data interpretation and reporting. The NJDEP Bureau of Fresh Water and Biological Monitoring and the USGS collect the well-water samples, and the USGS laboratory in Denver, Colorado analyzes them. Chemical and physical parameters analyzed at each well include: field parameters such as pH, SC, DO, T and alkalinity; major ions, trace elements, gross-alpha particle activity, volatile organic compounds, and pesticides. Total dissolved solids concentrations, as well as the concentration, frequency, and variety of trace elements, nutrients, volatile organic hydrocarbons (VOC) and pesticides are found at significantly higher levels in wells located in agricultural and urban areas than from wells in undeveloped areas. Shallow ground water in agricultural land use areas have the highest frequency of pesticide detection's, highest median nitrate concentrations (maximum up to 56 mg/L in this network) and gross alpha pa activity. These concentrations are likely related to the application of agricultural chemicals. In Urban areas, there are generally lower dissolved oxygen and higher total dissolved solids, dissolved iron, chloride, and VOC (such as MTBE) concentrations found in the ground water.

Acknowledgments

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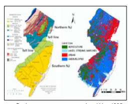
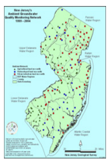
Background

New Jersey is the fifth smallest state in the nation yet is one of the most hydrogeologically diverse. Approximately 8 million people live within New Jersey's 7,836 square miles making it the most densely populated state in the nation. Highly concentrated urban and industrial centers, shrinking agricultur and undeveloped areas, expanding suburban areas and protected and unprotected undeveloped areas generally characterize the State's land use. Because of the high population and variable land uses, the State's streams, lakes, ponds, bays, ocean and ground water are impacted to varying degrees by point and non-point sources of pollution. To understand and properly manage the quality of water in the state it is necessary to establish effective monitoring programs. One such program is New Jersey's Ambient Ground Water Quality Network (AGWQN)



Geology Land Use 1995

The quality of shallow ground water is important because it is this water that recharges deeper aquifers used for potable water supplies and provides mu baseflow to local streams and wetlands. Information in this summary report was compiled using analytical data associated with wells in the AGWQMN. This 150 well network is an NJDEP and USGS cooperative project that provides information about land use related non-point source pollution impa to shallow ground-water quality in the state of New Jersey (Serfes, 1998). Wells are sampled, 30 per year, on a 5-year cycle. The first cycle is now complete and the second started in 2004. The water-quality data summary presented here is from the first complete sampling cycle of the 150 wells.



The water table is the first and most significantly impacted part of the ground-water system. Network wells are screened or open just below the water table and the sample water is therefore generally expected to be relatively young ground water. Goals of the AGWQMN are: (1) To assess the water-quality status, (2) To assess water-quality trends, (3) To evaluate contaminant transfer relations (sources), and (4) To identify emerging water-quality issues. Wells sites were located using a stratified-random site selection process as outlined by Scott (1990). The final distribution of wells as a function of land use is 60 in agricultural areas, 60 in urban/suburban areas, and 30 in undeveloped land use areas. Land use designations were determined using 1986 and 1995 land use coverage's, 1995 aerial photographs, site visits and estimations of ground-water flow directions based on the local geologic framework and site specific topographic relationships. The 1986 and updated 1995 digital land use data categories were interpreted from 1986 and 1995 color infrared aerial photography (NJDEP, 2000).

Water-quality constituents and parameters

The water-quality parameters such as temperature, dissolved oxygen, pH and total dissolved solid (TDS) concentration values yield information about the general character of shallow ground water as a function of geology and land use. Comparison of undeveloped land use areas with agricultural and urban areas yields clues to a natural versus anthropogenic source. Lower pH and TDS values in the south reflect the difference in geologic makeup. Also, it is generally cooler in northern New Jersey, which is reflected in the cooler shallow ground-water temperatures relative to the south. The lower dissolved oxygen concentration in urban areas in both the north and south, may result from the large percentage of heat adsorbing impervious surface area and resulting poorer exchange with atmospheric oxygen, and the higher temperature surface effects on the density of air. Increased total dissolved solids concentrations in agricultural and urban areas are due to the road salt and agrochemical applications

Northern NJ - General ground-water quality parameters in the 3 land use areas in bedrock, glacial and regolith.

	Agriculture			Urban			Undeveloped		
	Min.	Med.	Max.	Min.	Med.	Max.	Min.	Med.	Max.
T (Celsius)	10.3	13.3	23	6.8	12.8	18.3	10	12	14
DO (mg/L)	<0.2	4.3	11	<0.2	2.9	6.9	<0.2	4.2	6.7
pH	6.5	7.4	8.1	5.2	6.9	8.4	5.8	7	8.1
TDS (mg/L)	167	269	938	208	550	2200	22	119	387

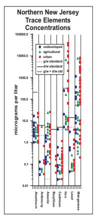
Key : T, temperature; DO, dissolved oxygen; TDS, total dissolved solids; Min., minimum; Med., median; Max., maximum

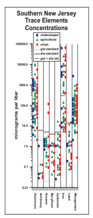
Southern NJ - General ground-water quality parameters in the 3 land use areas in sands, silts and clays of the NJ Coastal Plain.

	Agriculture			Urban			Undeveloped		
	Min.	Med.	Max.	Min.	Med.	Max.	Min.	Med.	Max.
T (Celsius)	12	16	22.5	15	18.2	29	12	14.5	18
DO (mg/L)	<0.2	6.4	10.5	<0.2	2.1	10	<0.2	4.6	9.3
pH	4	5.1	7.9	3.8	4.9	7.8	3.7	4.7	6
TDS (mg/L)	35	194	690	57	161	816	15	27	152

Trace Elements

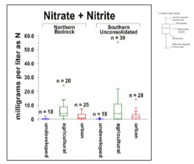
Trace elements shown are those that have at least one concentration that exceeded the New Jersey Ground and/or Drinking Water Quality Standards. In northern New Jersey, antimony, arsenic, cadmium, lead and manganese appear to be mostly natural in origin., Fe and Be have an urban association. Beryllium emissions from the burning of coal, fuel oil and municipal waste can increase the Be concentration in soil, water and air (ATSDR, 2002). In the Southern Coastal Plain, aluminum, antimony, and iron appear to by mostly natural in origin. Two urban wells sampled during the year 2000 contained 1 ug/L and 42 ug/L arsenic. The elevated arsenic concentrations are likely related to the unusually high degree of iron-oxide dissolution although the ultimate source of the As is unknown. Be, Cd and Pb have higher occurrence and concentrations in the agricultural and urban areas. This may be due to the application of fertilizers and other agricultural and lawn care products either as sources or mobilizing agents





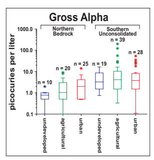
Nutrients

Nutrient concentrations are dominated by nitrate and the frequency and concentration by land use in both Northern and Southern New Jersey are: agricultural > urban > undeveloped. The use of nitrogen-based fertilizers in agricultural and urban areas and possibly septic system and sewer system leakage in urban areas are considered the major sources. No sample had an ortho-phosphorous concentration greater than 0.2 mg/L.



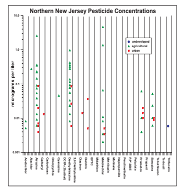
Radionuclides

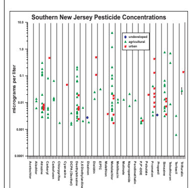
Gross alpha particle activity was analyzed within 48 hours after sample collection. This ensures that the radioactive decay of short-lived radium-224 (half-life of 3.64 days) is measured along with the other alpha emitters. The Federal and New Jersey drinking water standard of 15 pCi/L gross alpha particle activity still applies even though the shorter holding time results in increased activity if significant radium-224 is present. The distribution of gros alpha particle activity as a function of land use is shown in figure 8. Generally higher activity are found in southern versus northern New Jersey in all land use settings. This is most likely due to the greater abundance of radium-224 southern New Jersey and the low pH of the ground water which would increase its mobility. In both the north and the south, the highest activity is associated with agricultural and urban land use areas. The application of agricultural and lawn chemical products can compete with naturally occurring radium for adsorption sites thereby mobilizing more of it than normal into the ground-water system.



Pesticides

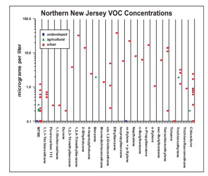
The total number of detections of one or more pesticides from individual well water samples from the entire network as a function of land use are: agricultural (146) > urban (57) > undeveloped (3, or 6 when normalized to 6 wells). However, the concentration of pesticides is very low in all land use categories. Atrazine, Deethylatrazine, Metolachlor, Prometon and Simazine were the most frequently detected compounds . They are all herbicides used to control grasses and broadleaf plants, except for Deethylatrazine which is the major metabolite of Atrazine. It must be noted the degradation by-products of these pesticides, except for Deethylatrazine, are not measured and may be at much higher concentrations than the parent compounds (personal communication; Roy Meyer, NJDEP/Pesticide Control Program).

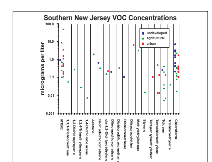




VOCs

The total number of detections of one or more VOC's from individual well water samples from the entire network as a function of land use are: urban (87) > agricultural (34) > undeveloped (17, or 34 when normalized to 60 wells). Most of the VOCs detected are at very low concentrations. Thirty-eight out of 148 network wells sampled for VOCs had detectable levels of methyl tertiary-butyl ether (MTBE), wit maximum value of 47 ug/L. It must be noted that the well with 47 ug/L was within 1000 feet of a Bureau of Underground Storage Tank (BUST) case site pollution case. The percentages of detectable levels of MTBE as a function of land use are: 47 percent of urban, 13 percent of agricultural and 6 percent of undeveloped wells. This distribution is not surprising since gasoline, in which MTBE is an additive, is used most in urban areas. Low concentrations of chloroform and MTBE have been measured in the atmosphere and related to concentrations in shallow ground water by Baehr and others, 1999. Trichloromethane or chloroform was also frequently detected in 34 percent of undeveloped, 32 percent of urban and 12 percent of agricultural network wells. Non-point sources of chloroform include housing developments using individual septic systems, leaking sewers in urban areas, and the use of chlorinated drinking water for watering lawns and gardens and filling swimming pools. Southern New Jersey has a greater percent of VOC detects than northern New Jersey and a higher percentage of agricultural and undeveloped area wells with detects, however, the variety of compounds detected was greater in the





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