Summary and Conclusions

The goal of this project was to summarize and evaluate groundwater quality from Basin Management Unit 3 using results of analyses that were stored in the Kentucky Groundwater Data Repository. The results are important to resource planners, environmental quality regulators, researchers, and private citizens.

This report summarizes thousands of analytical results from thousands of wells and springs in BMU 3 (watersheds of the Upper and Lower Cumberland and Tennessee Rivers, and the Mississippi and Ohio Rivers in the Jackson Purchase) for important groundwater-quality parameters. Twenty-eight analytes, selected by the Kentucky Division of Water, are considered: basic groundwater parameters and major ions (conductance, hardness, total dissolved solids, total suspended solids, pH, chloride, sulfate, iron, and manganese); inorganic solutes that can affect human health (fluoride, arsenic, barium, and mercury); nutrients (ammonia, nitrate, nitrite, orthophosphate, and total phosphorus); pesticides (alachlor, atrazine, cyanazine, metolachlor, and simazine); and volatile organic compounds (benzene, ethylbenzene, toluene, xylenes, and MTBE). The number of measurements; number of sites; maximum, third quartile, median, first quartile, and minimum values; and number of sites at which maximum contaminant levels or other significant values are exceeded were tabulated for each analyte. Probability plots and box-and-whisker diagrams illustrate the data population, and the data are mapped to show sample site distribution.

Overall quality of Kentucky groundwater in BMU 3 is good. There are many wells and springs where groundwater exceeds recommended levels for water properties, inorganic anions, metals, nutrients, pesticides, and volatile organic chemicals, however. In some cases, the sources appear to be entirely natural; in other cases, there is clear evidence of contamination by nonpoint-source chemicals. Table 34 summarizes the findings.

General water properties (pH, total dissolved solids, total suspended solids, electrical conductance, and hardness) and inorganic ions and metals (chloride, sulfate, fluoride, arsenic, barium, mercury, iron, and manganese) are largely controlled by bedrock lithology. Some exceptionally high values of conductance, hardness, chloride, and sulfate may be the effects of deep brines associated with coal fields or oil and gas production, and some exceptionally low pH values may show the input of mine drainage.

Nutrient concentrations, particularly nitrate-nitrogen, show a strong contribution from agricultural practices. Springs and shallow wells generally have higher nutrient concentrations than wells that produce water from intermediate or deep strata.

Pesticides are synthetic organic chemicals that do not occur naturally. The presence of any detectable pesticide in groundwater indicates a nonpoint-source contribution from agricultural or suburban applications. The relative scarcity of detectable pesticide concentrations found in this study may be misleading, for two reasons. First, shallow wells in rural areas, those most susceptible to pesticide contamination, were not specific targets for sampling in the ambient groundwater-quality investigations that provide much of the data for this summary. Second, pesticide levels in groundwater are known to be highest following applications and after rainfalls. Sampling one time or on a quarterly schedule may miss the presence of pesticides if the sampling does not closely follow field and lawn applications or significant rainfalls. High pesticide concentrations in water from a well or spring are a health hazard when the water is used regularly for domestic purposes, even though the available analyses did not show high pesticide concentrations at the time of sample collection. For these reasons, pesticides are likely more common in wells and springs, and potentially a greater health threat than these data sets suggest.

Like pesticides, refined volatile organic chemicals generally do not occur naturally in groundwater and can have significant chronic health effects at very low concentrations. The occurrence of volatile organic chemicals in groundwater is not natural and can only be the result of human activities. This project was designed to exclude analyses of groundwater from wells or springs that were known to be affected by leaking underground storage tanks and other sources of volatile organic chemicals. Detection of volatile organic chemicals in wells and springs that were previously thought to be free of such compounds suggests that volatile organic chemicals are a greater threat to groundwater than was previously thought.

Throughout the project area, springs and shallow wells are more likely to have potentially harmful levels of metals, nutrients, pesticides, and volatile organic chemicals than intermediate or deep wells. The potential contamination of the shallow groundwater system (springs and shallow wells) is cause for concern, as is the need to protect the intermediate and deeper groundwater system.

Table 34. Summary of nonpoint-source effects on groundwater quality in Basin Management Unit 3.

	Parameter	No Significant Impact on Groundwater Quality	Possible Impact on Groundwater Quality	Definite Impact on Groundwater Quality
Water Properties	Conductance		X	
	Hardness		X	
	pH		X	
	Total dissolved solids	X		
	Total suspended solids	X		
Inorganic Ions	Chloride		X	
	Sulfate		X	
	Fluoride	X		
Metals	Arsenic	X		
	Barium	X		
	Iron	X		
	Manganese	X		
	Mercury	X		
Nutrients	Ammonia-nitrogen		X	
	Nitrate-nitrogen			X
	Nitrite-nitrogen	X		
	Orthophosphate-phosphorus		X	
	Total phosphorus		X	
Water Properties	2,4-D			X
	Alachlor			X
	Atrazine			X
	Cyanazine			X
	Metolachlor			X
	Simazine			X
Volatile Organic Compounds	Benzene			X
	Ethylbenzene			X
	Toluene			X
	Xylenes			X
	MTBE			X

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