CONCEPTS FOR STUDY OF THE CONTAMINATION POTENTIAL OF BEDROCK AQUIFERS IN THE BLACK HILLS AREA, WESTERN SOUTH DAKOTA

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EXECUTIVE SUMMARY

Bedrock aquifers are the primary source of drinking water in the Black Hills area of western South Dakota. Large secondary porosity and permeability from fracturing or solution enhancement can allow extremely rapid infiltration of recharge with very little filtering of potential contaminants. Extensive development that is occurring in recharge areas has potential for introduction of contaminants. Contamination of bedrock aquifers could impair the quality of water supplies for a large part of the population in the Black Hills or require investment in expensive water treatment facilities. Conversely, limiting growth and development in recharge areas also has substantial economic implications. Thus, information regarding the contamination potential of bedrock aquifers in the Black Hills area would be extremely useful for a variety of water-resource managers and land-use planners.

The U.S. Geological Survey has prepared a preliminary concept paper that identifies possible approaches for evaluating the potential for contamination of bedrock aquifers in the Black Hills area. Major highlights of that concept paper are provided in this executive summary.

The study area for the proposed study probably would be similar to that used for the Black Hills Hydrology Study, which includes most of the major population centers in the Black Hills area. The highest priority probably would be placed on the Madison and Minnelusa aquifers, which are extensively utilized for water supplies and have especially large secondary porosity and permeability. Relatively high priorities also could be placed on the Minnekahta aquifer and on localized aquifers in the Precambrian igneous and metamorphic rocks in the central core of the Black Hills area. These aquifers also have relatively large secondary porosity and permeability, are utilized extensively for domestic water supplies in many areas, and have been subject to extensive development during recent years in many outcrop areas. The lowest priority probably would be placed on the Deadwood and Inyan Kara aquifers, which probably have larger capacity for filtering of potential contaminants because secondary porosity and permeability generally are smaller than in the other aquifers.

A study to evaluate the potential for contamination of bedrock aquifers would require sampling numerous locations in various aquifers for a number of constituents indicative of human (anthropogenic) influence. A primary source of anthropogenic influence probably is individual on-site waste-disposal systems (septic systems). Other potential sources of contaminants may include chemicals applied to lawns, automotive byproducts contained in runoff from roads, and catastrophic spills or releases of petroleum products or industrial chemicals.

Extensive knowledge of ground-water flow and mixing conditions in bedrock aquifers also would be necessary because current concentrations of constituents indicative of anthropogenic influence probably are extremely dilute in ground water in most locations. Proportions of recharge influenced by current anthropogenic activities generally are small relative to total recharge. Concentrations of constituents indicative of anthropogenic influence can be further diluted at most potential sampling locations because of relatively large proportions of water recharged prior to anthropogenic influence. Proportions of recharge influenced by anthropogenic activities presumably will increase as population growth continues, which, in combination with ongoing displacement of relative old ground water by younger water, eventually will increase concentrations of constituents indicative of anthropogenic influence in many locations. Thus, detection of extremely dilute concentrations of various constituents in ground water could provide early indications of potential water-quality problems in the future.

Sampling efforts for the proposed study would be divided into two categories, including sampling to obtain knowledge of ground-water flow and mixing conditions, and sampling to provide early indications of anthropogenic influence. An array of environmental tracers would be used in evaluating the potential for contamination of bedrock aquifers in the Black Hills area. Two general categories of environmental tracers that would be considered include "recharge tracers" that would be used in assessing ground-water flow and mixing conditions and "anthropogenic indicators" that would be used as indicators of anthropogenic influence.

Detection of anthropogenic indicators in ground water would require identification of sampling locations where anthropogenic influences in contributing recharge areas are large enough, and recent enough, to result in measurable concentrations. Thus, one purpose of sampling for recharge tracers would be to identify locations with relatively large proportions of recently recharged water, where detection of anthropogenic indicators would be likely (assuming sufficient anthropogenic influence within likely recharge areas). Another important purpose would be to improve capabilities for assessing ground-water flow and mixing conditions, which would require sampling for recharge tracers in numerous locations, regardless of current potential for anthropogenic influence.

Because concentrations of anthropogenic indicators in ground water probably are small in most locations, sampling efforts would first need to be focused in areas with relatively high probabilities of detecting indicators. The highest probabilities generally would exist for sites (wells or springs) with high proportions of recently recharged water that are downgradient from recharge areas where extensive and long-term development has occurred. Samples for anthropogenic indicators also should be collected from small streams in basins with extensive development pressure, which would provide an indication of whether anthropogenic indicators

can be detected in a setting where traveltimes are inconsequential. Such sampling also would provide an indication of concentrations that might be expected in streamflow recharge, which is an important recharge mechanism for the Madison, Minnelusa, and Minnekahta aquifers.

Implementation of a study to evaluate the potential for contamination of bedrock aquifers in the Black Hills area could begin relatively soon. Planning required for initial implementation of preliminary study efforts may be relatively minor; however, preliminary results would need to be considered before some of the future study directions could be determined.