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ABSTRACT

A proposed landfill site near Wheeler, Washington Co., Arkansas, was investigated for its hydrogeologic suitability. The site is located on the highly fractured, cavernous, and cherty Boone Ls. The site is a small upland valley 4500 ft. north of Clear Creek. The valley containing the proposed site is a karst dry valley in which precipitation rapidly infiltrates, recharging the water table and local springs.

The water table around the site was mapped to determine the hydraulic gradient and direction of ground-water movement. The water table slopes in a SE direction from the landfill towards Clear Creek with a steep hydraulic gradient of an average 200 ft/mile. Water levels in wells near the site are 17-80 ft. below the surface of the valley. Specific capacity values of 0.54 and 0.94 gpm/ft. and transmissibility values of 257 and 301 gpd/ft were determined from two pumping tests in the unconfined and semi-confined Boone-St. Joe aquifer. These values indicate a relatively high permeability of the aquifer. The cherty soil to be used as a liner is inadequate due to its highly variable permeability. Therefore, the site as designed, is judged unsuitable. One large spring and five wells in the area were monitored for Cl^-, NO_3^{-1}, and SO_4^{-2} and found uncontaminated according to health standards. Since the Arkansas DPCE has granted permission for the landfill, these same sites will be monitored through time to detect any leachate contamination.

INTRODUCTION

A new landfill site for the Fayetteville area was chosen near the community of Wheeler, Arkansas, as the old landfill at Johnson filled. Controversy over the proposed new site began. The landfill at Johnson is on similar soils and rock types as the proposed new site, and leaks leachate to the ground water. Therefore, concerned residents in the area requested that a hydrogeologic investigation be performed around the proposed site to test its suitability for waste disposal. The area was investigated by the authors, and a report was presented at a hearing of the Arkansas Department of Pollution Control and Ecology in January 1978. This paper presents the data and conclusions of this investigation.

LOCATION, GEOLOGY, AND SOILS

The Wheeler sanitary landfill site is located in the northwest part of section 23, T17N, R31W (Figure 1) Washington Co., Arkansas. Topographically, the area consists of a gently undulating uplands surface that is dissected by ephemeral tributaries that lead to the floodplain valleys of Clear and Little Wildcat Creeks. The landfill site is at the head of one of these tributaries.

The geology of the landfill is relatively simple. It is underlain by highly fractured, cherty, and cavernous Boone Limestone of Missippian age (Figure 2). The Boone is over 250 feet thick at the site, as indicated by nearby water wells. Structurally, the site is along the axial trace of the "Wheeler Anticline" (Evans, 1952). Subsequent field examination has not demonstrated the existence of this structure (Konig, pers. comm.). The rocks have a regional dip of less than one degree to the southeast. Solution enlarged joints are common in bedrock exposures in the area.

The residual soils covering the Boone Limestone are characteristically red and are silty-clay and clay in texture, with a high content of chert fragments. The site is primarily on the Baxter and Clarksville cherty silt loam of 12-60% slope (Harper et al., 1969). Borings made by McClelland Eng. Inc., (1977) at the landfill site were made up to a depth of 31 feet. The McClelland's (1977) report states the following about the soils at the site:

> "Due to the nature of the weathering and the presence of broken and fractured chert seams and layers, mass vertical and horizontal permeabilities of the strata are highly variable".

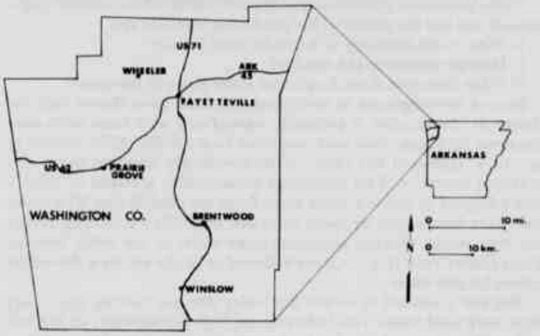

Figure 1. Location of the study area.

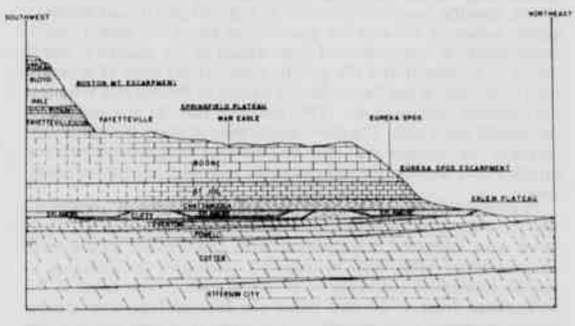

Figure 2. Cross section showing the generalized stratigraphy of the study area.

This report further says that:

> "due to the inherent variability of the residual deposits of the Boone Formation, it is not possible to pinpoint exact areas with high or low potential for leachate seepage . . ."

The U.S. Soil Conservation Service at Fayetteville, Arkansas, drilled several test holes at the site in April 1976. These borings showed soils of moderate to high permeability and high percentages of chert (Gaston, 1978). This report states:

> "The alluvial layer of gravelly silt loam in the bottom of the narrow drains, transmits water too rapidly for good pollution control".

A study by Ransom et al., (1975) which characterized the Clarksville soils as to their suitability for septic tanks, found that the Clarksville Soil Series has a moderate to rapid rate of dye percolation from septic tanks.

HYDROGEOLOGY: DIRECTION AND RATE OF OF WATER MOVEMENT

Carbonate rocks are known by geologists to have zones of extremely high permeability due to solution in favorable lithologies, jointed and faulted regions, and along bedding planes. Such factors have caused a variety of researchers to recommend that carbonate rock areas not be used as landfill sites (Lessing et al., 1971; Parizek et al., 1971).

Three important questions that must be asked when constructing a landfill that has the potential for producing leachate are:

1) What is the lithology of the underlying aquifer?
2) How permeable is the aquifer?
3) What direction does the ground water move in the area?

Recent investigations in northwest Arkansas have shown that the Boone-St. Joe aquifer is primarily unconfined with local semi-confinement by dense chert and limestone beds (Willis, 1978; Rezaie et al., 1979; Ogden et al., 1979). Wells commonly intersect caves and enlarged fractures. This secondary permeability is found in wells 1 and 2 (Figure 3) located down slope from the landfill site. The caves that were intersected by these wells are waterfilled primarily during the wet season, thereby supplying some water to the wells. Springs along Clear Creek (Figure 3) are believed to be the ultimate discharge points for this water.

The site is located in a karst dry valley that has flowing water only after very hard rains. This indicates the high permeability of the soil and rocks in the area. To further investigate the permeability, pumping tests were performed on two wells downslope from the site (Figure 3, wells 1 and 3). The wells were pumped for 30 min. and allowed to recover for 1 hr. The coefficient of transmissibility (T) and specific capacity (C) were then calculated using the methods of Jacob (1963). Specific capacity values of 0.54 and 0.94 gpm/ft and transmissibility values of 257 and 301 gpd/ft were found for wells 1 and 3, respectively. A comparison of these values to the median C and T values (0.29 gpm/ft and 176 gpd/ft, respectively) from 32 pumping tests performed in the Boone-St. Joe aquifer of Benton and Washington Counties (Rezaie et al., 1979), indicates that the permeability at the landfill site is high. The direct implication of this is that the water, and thus the leachate that may be produced from the landfill, will rapidly move through the soil and rocks with little chance for purification.

In an unconfined aquifer such as the Boone-St. Joe, it is expected that the water table will conform somewhat to the topography. Water levels were measured in wells in the area and the data used to construct a water table map in order to determine the direction of ground-water flow and slope of the water table. Water levels in the wells range from 17-80 feet below the land surface with greater depths occurring in upland wells. The water level data indicate that the water table slopes in a southeast direction from the landfill towards Clear Creek with a steep hydraulic gradient of up to 200 ft/mile.

GROUND-WATER CHEMISTRY

Five wells and one spring were monitored to determine the degree of contamination that existed in the ground water prior to the emplacement of the landfill (Figure 3). Figure 4 shows the concentrations of chloride, nitrate, and sulfate that existed in the sampling sites during several sampling periods. All concentrations were found to fall within limits set by the U.S.E.P.A. (1976). This data will prove useful for later comparisons of water quality, now that the landfill is in operation.

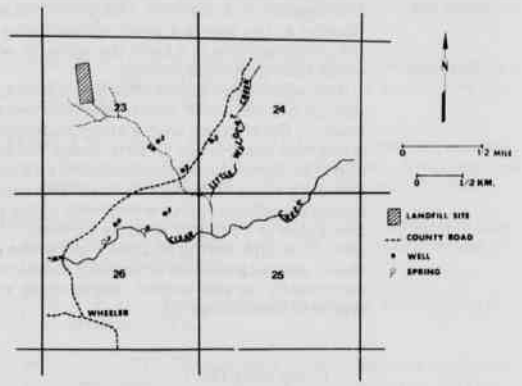

Figure 3. Location of the pumping tests and sampling sites in T17N, R31W and their proximity to the Wheeler Landfill.

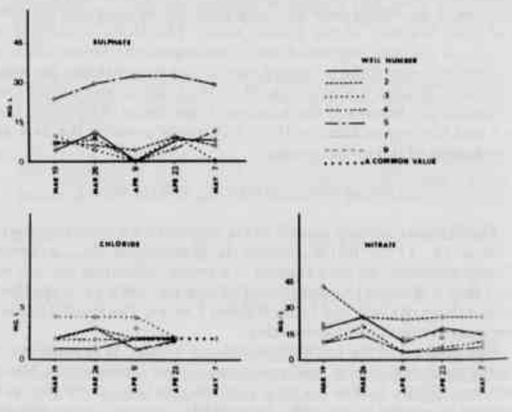

Figure 4. Concentrations of sulfate, chloride, and nitrate at the sampling sites.

SUMMARY AND CONCLUSIONS

This investigation was performed prior to construction of the Wheeler landfill at the request of concerned local residents. Soils are highly variable in permeability and depth. The high chert content in the soil and soil liner, along with the moderate to high permeability, suggests that any leachate produced will infiltrate to the water table. Surface karst features and pumping tests, further substantiate the relatively high permeability of the soil and cherty limestone beneath. A relatively shallow depth to water exists, and the local water table map produced from collected data shows a southeast direction of movement, and discharge probably via springs along Clear Creek. The high transmissibility and specific capacity values and the steep hydraulic gradient of the water table indicate a rapid flow rate of the ground water. Therefore, the site, as designed, is judged by the authors to be unsuitable and likely to contaminate local wells, springs, and ultimately, Clear Creek.

Monitoring of several wells and springs for water quality indicates that the ground water presently is not contaminated and falls within limits set by U.S. E.P.A. (1976) with respect to chloride, sulfate, and nitrate. Future monitoring of these samples sites will show if and when the leachate enters and moves into the ground water system.

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