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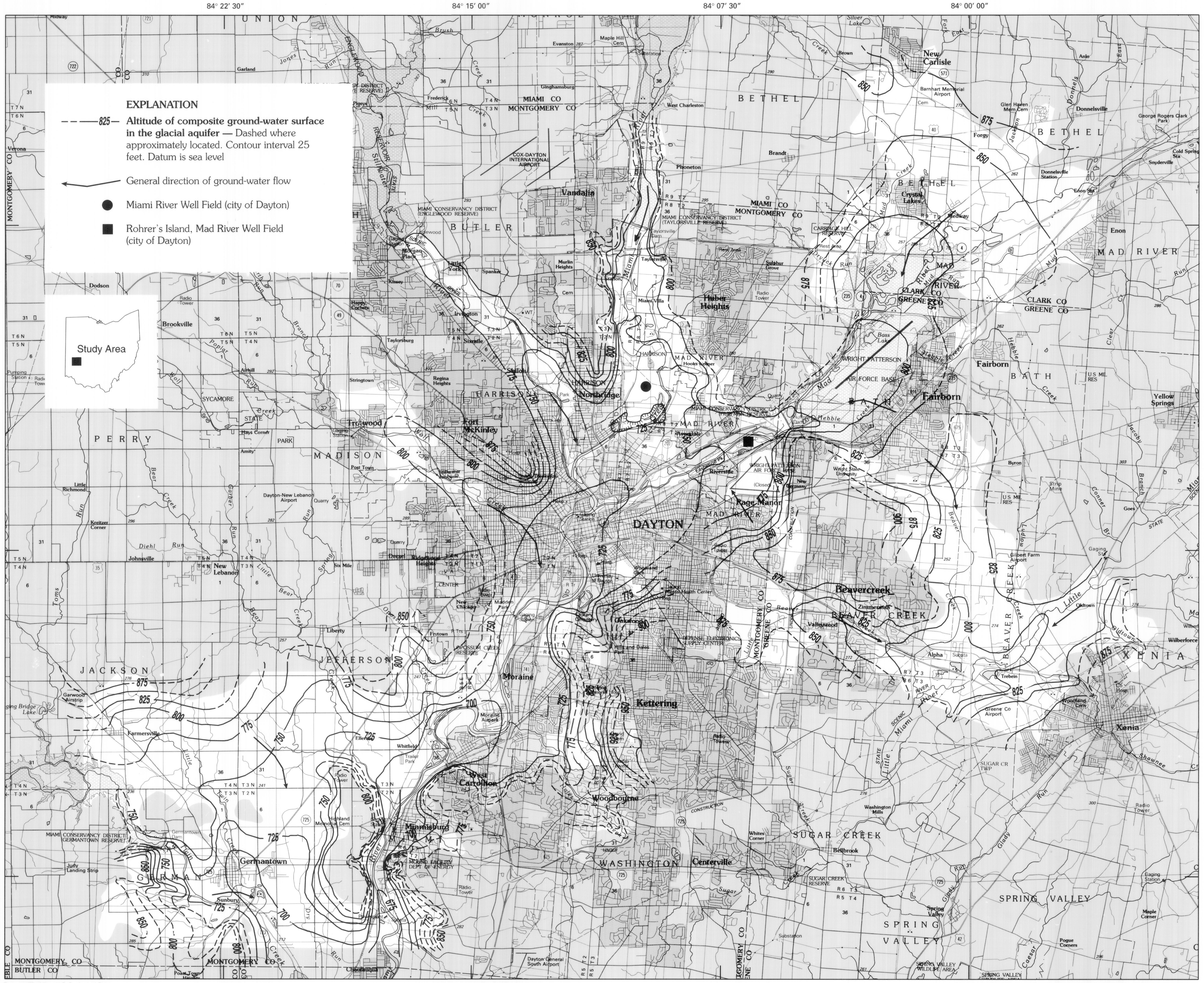

Base modified from U.S. Geological Survey Dayton and Springfield, 1:100,000, 1986

SCALE 1:100,000
1 CENTIMETER ON THE MAP REPRESENTS 1 KILOMETER ON THE GROUND

1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 KILOMETERS
1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 MILES

GROUND-WATER LEVELS AND FLOW DIRECTIONS IN THE BURIED VALLEY AQUIFER AROUND DAYTON, OHIO, SEPTEMBER 1993

by

Denise H. Dumouchelle

USGS
science for a changing world

INTRODUCTION

The glacial aquifer underlying Dayton, Ohio, and surrounding communities consists of highly permeable sands and gravels interspersed with fine-grained tills. The extent of the aquifer is defined by buried bedrock valleys that were incised into Ordovician-age shales. Ground water is the major source of drinking water for the Dayton area; more ground water is withdrawn in Montgomery County than in any other county in Ohio (R.J. Veley, U.S. Geological Survey, written commun., 1996). In 1988, the buried valley aquifer was designated a sole-source aquifer by the U.S. Environmental Protection Agency (USEPA) (1993). The U.S. Geological Survey (USGS), in cooperation with the USEPA, prepared this map of water levels in the regional glacial aquifer as part of a study of ground-water conditions in the aquifer.

Most of the study area is in Montgomery County, in southwestern Ohio. Also within the study area are southwestern Clark County and the northwestern part of Greene County, from Wright-Patterson Air Force Base (WPAFB) south-east to Xenia. The extent of the buried valley aquifer was determined from bedrock topography based on Ohio Department of Natural Resources manuscript maps for Greene County (no date) and Montgomery County (1986) and a map by Dumouchelle (1992). The study-area boundary was defined by the 800-foot bedrock-altitude contour. The 800foot contour was selected because in most of the area this contour roughly corresponds to one or more of the following conditions: (1) the knickpoint between the land surface of the river valleys and the uplands, (2) a knickpoint in the bedrock topography, or (3) a location about two-thirds the distance up the bedrock-valley wall in areas where the bedrock slope is reasonably constant. The boundary was then modified to account for significant sand and gravel deposits above the 800-foot bedrock-altitude contour. Well logs and maps (Schmidt, 1982, 1984, 1986, 1991; Struble, 1987) were examined, and areas adjacent to the bedrock valleys were included if sand and gravel deposits in these areas were roughly 50 feet thick or more.

METHODS OF INVESTIGATION

Water-level data from 678 wells screened at various depths in the glacial deposits were used to assess ground-water levels and flow directions. The USGS, the Miami Conservancy District (MCD), city of Dayton, and private individuals measured water levels in domestic water wells and municipal and industrial observation wells during the period September 1–24, 1993. Water levels were measured by several methods: steel tape, electric tape, digital recorder (pressure transducer), and Stevens-type recorder. Personnel from the USGS measured water levels in 238 wells, MCD personnel measured 301 wells, and other organizations and individuals supplied water-level data for the remaining 139 wells. The data and detailed descriptions of the collection methods are presented in Yost (1995).

The altitude of the ground-water surface was determined by subtracting the measured water level (in feet below land surface; to convert to meters, multiply feet by 0.3084) from the land-surface altitude (in feet above sea level) at the well site. Many land-surface altitudes were estimated from topographic maps with 10-foot contour intervals; the land-surface altitude at some wells had been surveyed. In areas of steep topography, a slight mislocation of the well could result in substantial errors (greater than 10 feet) in the estimated land-surface altitude. As a result, the accuracy of the ground-water-level data ranges from ± 5 feet in the flattest parts of the study area to ± 15 feet along the valley walls. For wells where the land-surface altitude was surveyed, the accuracy of the ground-water-level data is ± 1 foot or better.

An effort was made to measure only static (non-pumping) water levels; however, some water levels were measured in observation wells that could have been affected by drawdown from nearby water-supply wells. The water-level data were hand-contoured at a scale of 1:24,000 and then digitized for use in a ground-water-flow model. The ground-water-level contour interval is 25 feet.

In areas where few wells were measured, static water-level data reported on drillers' well logs and the land-surface altitudes determined for the well sites were used to constrain the water-level contours. Land-surface altitudes were used to indicate the maximum possible water-level altitude. Consideration of the land-surface altitude was particularly important in areas of steep topography to prevent incorrect placement of the ground-water-level contour above the land surface.

Ground-Water Levels and Directions of Flow

Ground water flows in the direction of decreasing hydraulic head; contours on a ground-water-level map represent lines of equal hydraulic head. The water-level data were from wells that were screened at many depths, and thus the ground-water-level surface shown represents a composite rather than a confined or a water-table surface. Water-level contours are shown only for areas corresponding to the study area—the unconsolidated deposits in and adjacent to the buried valley aquifer. Water levels in the upland areas were not measured: as a result, no contours are shown for several bedrock highs or "islands".

In the absence of confined conditions or human-induced changes (such as pumping), ground-water-level contours generally will mimic the land-surface topography. The spacing of water-level contours reflects some combination of the steepness of the topography and the permeability of the deposits. Closely spaced contours indicate steep topography and (or) poorly permeable deposits; widely spaced contours indicate the opposite. For example, the wide spacing of contours in the center of the valleys is to be expected in these areas of flat topography and highly permeable deposits.

Although ground-water-level contours for the upland areas are not shown on the accompanying map, ground-water divides are expected to be generally in the same areas as surface-water divides. Thus, ground-water divides are expected between the Mad and Great Miami Rivers, between the Great Miami and Stillwater Rivers, between the Stillwater River and Wolf Creek, and between Wolf Creek and Bear and Opossum Creeks. Some ground-water divides can be determined from the contours. For example, a ground-water divide is present south of New Carlisle, between the Mad River and Honey Creek, as evidenced by two 850-foot contours showing a decrease in ground-water altitudes to the north and south. A similar ground-water divide can be delineated between Hebble and Beaver Creeks near WPAFB. The ground-water divides between the Mad River and Little Beaver Creek and between Bear and Little Twin Creeks are less distinct.

Ground water probably flows roughly radially off the bedrock-high "islands". The contours show ground-water flow from the edges of the "islands" and other upland areas toward the center of the river valleys. In the center of the valleys, ground-water flow is generally to the south-southwest. General flow directions are indicated on the map with arrows.

The effects of water-supply wells on ground-water levels are not readily apparent because the large contour interval does not reveal perturbations in ground-water levels that are less than 25 feet. The effects of water-supply wells also are indeterminate because water levels in highly transmissive sands and gravels are not significantly affected by large withdrawals. Some effect of the Miami River Well Field can be seen in the 725-foot contour to the south and in 750-foot contour to the north. Near the Mad River Well Field, the 750-foot and 775-foot contours are affected by pumping. Although pumping at the Dayton well fields does not seem to have a widespread effect on ground-water levels, the combined effect of other large-volume ground-water withdrawals and the public-supply fields could change in the future.

A comparison of the ground-water-level contours for 1993 with previous potentiometric maps in the study area provides some indication of ground-water trends. Ground-water contour maps covering parts of the study area were prepared in 1955, 1959, and 1960 (Walton and Scudder, 1960; Norris and Spieker, 1966). More recent contour maps have been prepared for the city of Dayton well fields, WPAFB, and other sites in the area (Geraghty & Miller, 1987, 1990; CH2M Hill, 1989; Schalk, 1992; Schalk and others, 1996; Smindak, 1992; U.S. Department of Energy, 1995; Weston, 1990). Comparisons with water levels on these maps do not reveal any significant changes in either water-level altitudes or ground-water-flow directions. The water-level contours or data from previous reports for areas near Miamisburg, Medway, and WPAFB and north of Dayton are comparable with the 1993 contours and are within seasonal fluctuations of 4 to 6 feet (J. Heig, Miami Conservancy District, oral commun., 1997). Locations where differences greater than seasonal fluctuations were noted are south of Fairborn, near Rohrer's Island, and near West Carrollton.

South of Fairborn, between WPAFB and Beaver Creek, two previous maps (Walton and Scudder, 1960; Schalk, 1992) show an area of ground-water levels greater than 850 feet; the area would be between the two 825-foot contours of this map. The ground-water high on the previous maps was based on three measurements in 1960 (871, 866, and 850 feet) and one measurement in 1987 (865 feet); both of these previous maps also show other wells nearby where measured water levels were more than 20 feet lower (815 to 840 feet). The wells measured in these previous studies were not remeasured; only one well was measured is this area in 1993, and that well is comparable in location and water level to the lower values shown on the previous maps. The ground-water high area shown on the previous maps could be the reflection of a perched water level and may thus be of limited areal extent. According to the previous maps, the depth to water in the high area was less than 50 feet, whereas in adjacent areas with the about the same land-surface altitude, the depth to water was greater than 75 feet. This map does not show the ground-water high because no data were collected in 1993 that indicated the higher ground-water levels.

Water-level contours in the area around Rohrer's Island, which is part of the Mad River Well Field, differ the most from contours on previous maps (Norris and Speiker, 1966; Geraghty & Miller, 1987; Schalk, 1992; Schalk and others, 1996). In most cases, previous ground-water levels at Rohrer's Island were about 15 to 20 feet lower than in 1993. Changes in water levels at and adjacent to major well fields are to be expected because pumping rates and ground-water levels vary seasonally and annually.

Differences were also noted between the 1993 ground-water level map and the maps by Norris and Spieker (1966) for the area near West Carrollton. The older maps show water levels that are about 10 feet higher in April 1959 than in September 1993, but 10 to 15 feet lower in October 1960 than in September 1993. A number of industries and the city of West Carrollton make significant withdrawals in the area. The 1960 map (Norris and Spieker, 1966) was for the "lower" aquifer only, whereas the 1993 contours are based on water levels in wells completed at various depths in the glacial deposits. Considering the effects of variations in pumping and the differences in depths of the wells in which the water levels were measured, the similarity, rather than the differences, between the maps indicates of the long-term stability of ground-water levels in the area.

On the basis of comparisons between this report and previous reports, no trends in ground-water levels in the study area are apparent. However, the 25-foot contour interval and the accuracy of the land-surface-altitude estimations may combine to obscure temporal changes in ground-water levels in the study area.

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