PREPARED IN COOPERATION WITH
TOOELE COUNTY;
UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY,
DIVISION OF WATER QUALITY; AND
UTAH DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF WATER RIGHTS AND UTAH GEOLOGICAL SURVEY

Water levels on the potentiometric-surface map of the east Erda area (fig. 5) were measured in 24 wells during March 14 to 22, 1995, and altitudes of the wells were surveyed. The direction of ground-water flow is perpendicular to the potentiometric-surface contours. In the east Erda area, the ground water generally flows toward the north-northwest, and the hydraulic gradient is about 5 ft/mi.

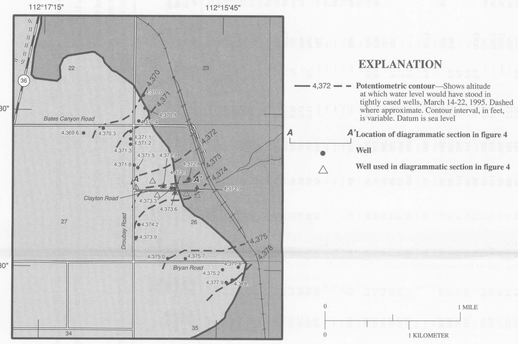

Figure 5. Potentiometric surface of the east Erda area, Utah. (Area of inset shown in fig. 3.)

RECHARGE AREAS

Recharge areas in the unconsolidated basin-fill deposits (figs. 3 and 6) were delineated according to criteria and methods outlined by Anderson and others (1994). This method generally relies on well drillers' lithologic logs for interpretation of confining layers and aquifers. Layers of clay, silt, sandy clay, or silt and clay, as described by the driller, are interpreted as confining layers that impede the downward movement of surface water into the ground-water system.

Primary recharge areas in the unconsolidated basin-fill deposits are delineated where deposits between the land surface and water table consist of sediments that contain no confining layers thicker than 20 ft. Few drillers' logs were available for the areas northwest of Tooele (Township 3 South and Range 4 West) and south of Grantsville. The Stansbury shoreline of Lake Bonneville as mapped by Solomon (1993) was used to delineate the primary recharge areas in these parts of the valley. West of Grantsville and around the Warm Springs area, topography of the pre-Lake Bonneville-age alluvial fans was used to delineate recharge areas. In the western and northwestern areas of the valley, the Gilbert shoreline was used to delineate primary recharge areas. In addition, all the consolidated rock surrounding the valley has been delineated as primary recharge area.

In some areas designated as primary recharge areas, local conditions may impede the flow of water from surface sources into the ground-water system. For example, the alluvium southeast of Tooele City is poorly sorted and contains fine-grained material and could limit recharge from surface sources in this area.

The secondary recharge area, where present, is the area between the primary recharge area and the discharge area. Infiltration of water from surface sources to the deeper parts of the ground-water system in this area may be impeded by confining layer(s) at least 20 ft thick. However, a unconfined aquifer above the confining layer could be present and would be susceptible to contamination from surface sources. The secondary recharge area includes places where an upward gradient from the deeper to shallower parts of the confined aquifer exists and could contain flowing wells. However, the area lacks natural pathways of ground-water discharge such as springs, discharge to streams, and evapotranspiration by phreatophytes.

DISCHARGE AREAS

Discharge areas are designated where ground water discharges to the surface through natural means, mainly springs, seeps, or mud flats, or where phreatophyte growth is well established. Discharge areas were determined from interpretation of aerial photos and topographic maps, ground reconnaissance, and previous phreatophyte mapping by Razem and Steiger (1981, fig. 6).

CHEMICAL QUALITY

Ground-water quality in Tooele Valley is reported as the results of chemical analyses obtained from the files of the U.S. Geological Survey, Utah Department of Environmental Quality, Tooele County Health Department, and various consultants. The results of 400 chemical analyses of samples from 206 wells or springs, with 61 of the sites having more than one analysis, are shown in tables 2 and 3. The samples were collected as early as May 1964 and as recently as October 1995, with 109 of the samples collected during 1994-95. Some of the results of the chemical analyses by the U.S. Geological Survey were originally published by Razem and Steiger (1981) and Stolp (1994). They are being reprinted in this report to illustrate any temporal changes and compile water-quality data into one document. The most recent dissolved-solids and nitrate plus nitrite concentrations measured from 1978 to 1995 are shown next to the well location on figures 3 and 6. Dissolved-solids values on the figures were determined from either sum of total constituents or by residue on evaporation at 180°C. If a value is missing, there are no data for that parameter.

For this study, water from 50 wells was sampled during November-December 1994. Specific conductance, water temperature, and pH were measured in the field. Laboratory analyses for common ions, nutrients, and metals were done by the Utah Department of Health Laboratory. Ten of the 50 samples also were analyzed for several organic chemicals. Duplicate quality-assurance samples from five wells were analyzed by the U.S. Geological Survey National Water Quality Laboratory for common ions and nutrients. Duplicate-sample analyses for selected constituents are shown in figure 7. If the concentrations from the analyses from each laboratory are equal, the data plot on the line of equal concentration. The values in figure 7 are all near the line, with the exception of one chloride value, and indicate that the duplicate samples analyzed by the two laboratories yielded similar results. Duplicate samples on all 50 sites also were analyzed for nitrate plus nitrite concentration. A paired t-test was used to analyze any differences between the two laboratories. There was no significant difference between the results of the two laboratories at the 95-percent confidence level.

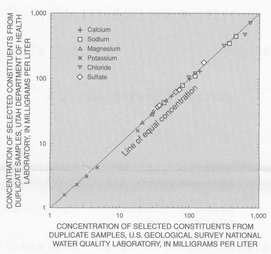

Figure 7. Relation between duplicate water samples from Tooele Valley, Utah, analyzed by the Utah Department of Health Laboratory and the U.S. Geological Survey National Water Quality Laboratory.

The water-quality data for each site were divided into two categories on the basis of the saturated thickness of the basin-fill deposits penetrated by each well. Saturated thickness of deposits is used instead of well depth because of the differences in thickness of the unsaturated basin-fill deposits. The unsaturated deposits are as much as 600 ft thick in some of the wells in the southeastern part of the valley. The division of wells penetrating deposits of saturated thickness of less than or equal to 150 ft, and wells penetrating deposits of saturated thickness of greater than 150 ft, is arbitrary. It is not meant as a dividing line between two separate systems but is a means of organizing the large quantity of water-quality data between shallow and deeper zones of the aquifer.

The State of Utah has established water-quality standards for ground water (Utah Department of Environmental Quality, Division of Water Quality, 1995). Constituents with established standards are listed in table 1, part B. Concentrations of inorganic constituents and metals in the study area generally were less than the Utah ground-water quality standards. Utah ground-water quality standards for cadmium were equaled or exceeded in water from three wells and one spring. Concentrations in water from two of those wells equaled or exceeded the Utah ground-water quality standard in the 1970s but were lower than the standard in 1985. Water from six wells equaled or exceeded the standards for lead. Water from four of the wells did not exceed the standard in later sampling. Water from seven wells exceeded the standard for nitrate plus nitrite. One well was deepened, and nitrate plus nitrite concentration declined below the water-quality standard. Concentrations of the volatile organic chemicals, trichloroethylene and carbon tetrachloride, exceeded Utah ground-water quality standards in the ground water in the eastern part of Tooele Army Depot. The extent of the trichloroethylene plume, modified from James M. Montgomery, Consulting Engineers Inc. (1989), and Metcalf and Eddy (1995), that was at or exceeded the Utah ground-water quality standard on the basis of the sampling of the wells penetrating deposits of saturated thickness of less than or equal to 150 ft is shown in figures 3 and 6. Hydrologic and water-quality data defining the extent and movement of other contaminant plumes are well documented in other reports (James M. Montgomery, Consulting Engineers Inc., 1986, 1988, 1989; Metcalf and Eddy, 1995). Monitoring and remediation of these contaminant plumes by the U.S. Army is ongoing.

Wells Penetrating Deposits of Saturated Thickness Less Than or Equal to 150 Feet

Dissolved-solids concentrations in water from wells penetrating deposits of saturated thickness less than or equal to 150 ft range from 302 mg/L to more than 37,000 mg/L (fig. 3 and inset 1). Concentrations were at or less than 500 mg/L in water from 35 of the wells and springs analyzed, between 500 mg/L and 3,000 mg/L in 59 wells and springs, and exceeded 3,000 mg/L in four wells and one spring. Concentrations are less than 500 mg/L in the primary recharge area southeast of Tooele and in parts of Erda and Grantsville. The contour for dissolved-solids concentration of 10,000 mg/L was modified from Razem and Steiger (1981, fig. 6).

Nitrate plus nitrite concentrations range from <0.02 to 30.3 mg/L. East Erda was the only area in the valley where concentrations exceeded 5.0 mg/L. Of the 31 wells sampled in the east Erda area for nitrate plus nitrite, water from 7 wells exceeded the ground-water quality standard of 10 mg/L. The source of nitrate in the shallow wells could be domestic sources, mining, or other upgradient activities. Two nitrogen-isotope ($\delta^{15}N$) samples were collected from wells in the area in April 1995 to try to determine the source of the nitrate, but results were inconclusive. One sample was collected from a well, (C-2-4)26cca-1, with a nitrate plus nitrite concentration of 30.3 mg/L; the other was from a well, (C-2-4)26bcd-1, with a nitrate plus nitrite concentration of 1.87 mg/L. Water from the two wells had values of 7.3 permil and 8.1 permil, respectively. In a report by Komor and Anderson (1993), nitrogen-isotope values were compared with land use to investigate nitrate sources in aquifers. The isotope values in east Erda indicate that the source of nitrate is consistent with residential areas that have septic systems or with cultivated, irrigated fields that have natural organic material in the soil. The Komor and Anderson (1993) report did not include any areas where mining activities were a land-use category. Helen Sadik-MacDonald (Utah Department of Environmental Quality, Division of Environmental Response and Remediation, written commun., 1996) reported that water collected from the unsaturated zone at the old smelter site in Pine Canyon had a nitrate plus nitrite concentration of 50 mg/L.

Dissolved-solids concentrations in samples from 14 wells in the east Erda area were greater than 1,000 mg/L. Concentrations of dissolved solids decreased in water from two of the wells after the wells were deepened. Well (C-2-4)26bdd-2 was first drilled to 160 ft and had water with a dissolved-solids concentration of 2,720 mg/L and a nitrate plus nitrite concentration of 18.1 mg/L. The well was deepened to 224 ft and completed below a 29-ft layer of clay with gravel and an 8-ft layer of clay before penetrating another gravel layer; saturated thickness was still less than 150 ft. The dissolved-solids concentration in water from the deepened well was 428 mg/L, and the nitrate plus nitrite concentration declined to 0.080 mg/L. Another well, (C-2-4)35dcb-1, also was deepened from 260 ft to 340 ft, which increased the saturated thickness to greater than 150 ft. The dissolved-solids concentration in water from the well decreased from 2,850 mg/L to 610 mg/L; nitrate plus nitrite concentration decreased from 30.2 mg/L to 1.82 mg/L.

Wells Penetrating Deposits of Saturated Thickness Greater Than 150 Feet

Dissolved-solids concentrations in water from wells penetrating deposits of saturated thickness greater than 150 ft range from 245 mg/L to 17,000 mg/L (fig. 6). Concentrations were at or less than 500 mg/L in water from 37 wells, between 501 mg/L and 3,000 mg/L in 60 wells, between 3,001 mg/L and 10,000 mg/L in 4 wells, and exceeded 10,000 mg/L in one well. Dissolved-solids concentrations were less than 500 mg/L in southwestern and southeastern Tooele Valley, most of Grantsville, north of Grantsville along Burmester Road, and in Erda. Concentrations exceeded 3,000 mg/L in a small area near the northern boundary of the Tooele Army Depot. The area was identified as having some geothermal influences. The ground water likely circulates at depth, where it is heated and the dissolved-solids concentration increases (James M. Montgomery, Consulting Engineers Inc., 1988). Concentration was measured at 17,000 mg/L in one well in the northwest section of the study area. Data were too sparse to contour concentrations from 3,000 mg/L to 10,000 mg/L. Nitrate plus nitrite concentration ranged from 0.06 to 4.81 mg/L. One well had a nitrate plus nitrite concentration of 19.8 mg/L when sampled in May 1985, but of 3.50 mg/L when sampled in August 1988.

SUMMARY

Ground water is the sole source of drinking water in much of rural Tooele Valley. Rapid growth in the rural areas of this valley, along with the associated use of septic tanks, is a potential cause of increased nitrate concentrations in the ground water. Several new domestic wells in the east Erda area contained water that exceeded the Utah water-quality standard for nitrate plus nitrite concentration. Tooele County Commissioners would like to classify and protect the ground-water resources of the county.

Primary recharge areas were delineated where there are no confining layers of silt, clay, sandy clay, or silt and clay thicker than 20 ft. In secondary recharge areas, where delineated, the flow path of water from surface sources would be impeded by confining layer(s) with a thickness of at least 20 ft. Discharge areas were designated as the areas where ground water discharges from springs, seeps, mud flats, and phreatophyte growth.

The quality of water in Tooele Valley was determined from the results of chemical analyses obtained from the files of the U.S. Geological Survey, Utah Department of Environmental Quality, Tooele County Health Department, and various consultants. Water from 50 wells was sampled for common ions, metals, and nutrients, during November and December 1994. Utah ground-water quality standards for cadmium were equaled or exceeded in water from three wells and one spring in at least one sampling. Water from six wells equaled or exceeded the standard for lead in at least one sampling. A plume of trichloroethylene at Tooele Army Depot where water from wells was in excess of the Utah ground-water quality standard is being monitored and remediated by the U.S. Army.

The most recent water-quality data for the sites were divided into two categories on the basis of saturated thickness of the basin-fill deposits penetrated by the wells: (1) wells penetrating deposits of less than or equal to 150 ft of saturated thickness, and (2) wells penetrating deposits of greater than 150 ft of saturated thickness. Dissolved-solids concentration ranged from 302 mg/L to more than 37,000 mg/L, and nitrate plus nitrite concentrations ranged from <0.02 mg/L to 30.3 mg/L in water from wells with less than or equal to 150 ft of saturated thickness. Dissolved-solids concentrations ranged from 245 mg/L to 17,000 mg/L, and nitrate plus nitrite concentrations ranged from 0.06 mg/L to 4.81 mg/L in water from wells with greater than 150 ft of saturated thickness.

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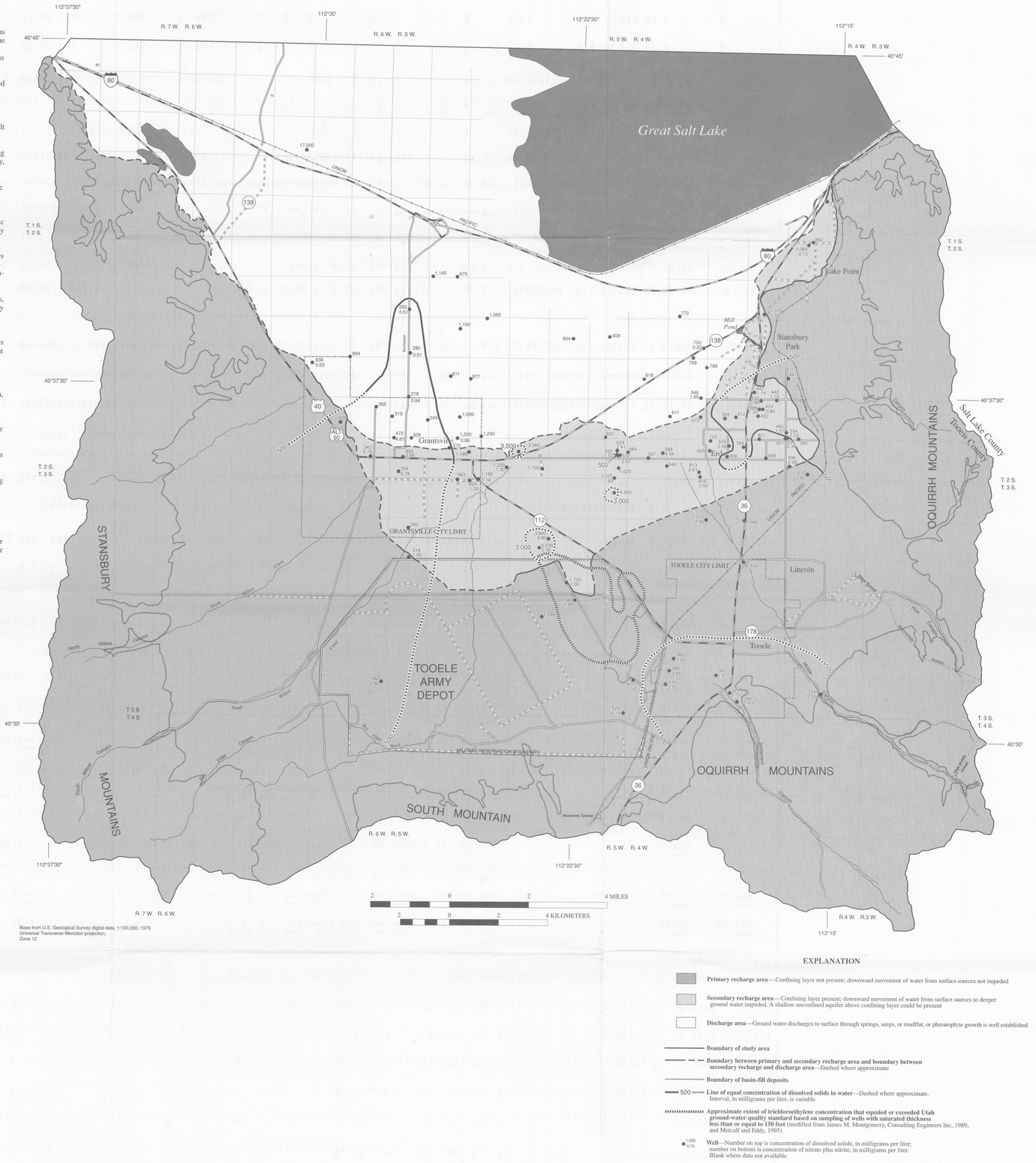

Figure 6. Recharge and discharge areas, well locations, and dissolved-solids and nitrate plus nitrite concentrations in selected wells penetrating deposits of saturated thickness greater than 150 feet, Tooele Valley, Utah.

Recharge and discharge areas and quality of ground water in Tooele Valley, Tooele County, Utah

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