GROUND-WATER RESOURCES OF LUCAS COUNTY

Introduction

Approximately 50% of the water used in Lucas County comes from ground water sources. It is estimated that the use of ground water in the county currently approaches .33 billion gallons per year. For comparison, this amount would provide each resident with 89 gallons of water a day during the year. These higher per capita figures reflect the larger demands of livestock and commercial uses.

The users of ground water in the county draw their supplies from several different geologic sources. Several factors must be considered in determining the availability of ground water and the adequacy of a supply source.

- distribution - having water where it is needed,
- accessibility - affects the costs for drilling wells and pumping water,
- yield - relates to the magnitude of the supply that can be sustained,
- quality - determines for what purposes the water can be used.

In terms of these factors, there are few locations in Lucas County where the availability of ground water is not limited. The most common limitation is poor water quality, that is, highly mineralized ground water. Secondary limitations are generally related to poor distribution, small yields from some sources, and poor accessibility due to the great depths of adequate sources.

Occurrence of Ground Water in Lucas County

The occurrence of ground water is influenced by geology -- the position and thickness of rock units, their ability to store and transmit water, and their physical and chemical make-up. Geologic units that store and transmit water, and yield appreciable amounts to wells are called aquifers. The best aquifers are usually composed of unconsolidated sand and gravel, porous sandstone, and porous or fractured limestone and dolostone. Other units with materials such as clay and silt, shale, siltstone, and mudstone yield little or no water to wells. These impermeable units are called aquicludes or aquitards and commonly separate one aquifer unit from another.
In Lucas County there are two principal sources from which users obtain water supplies: the loose, unconsolidated materials near the land surface that comprise the surficial aquifer, and a deep rock aquifer. Between the surficial aquifer and the deep Cambro-Ordovician aquifer are two other major water-bearing units, the Mississippian and the Devonian aquifer systems. However, throughout Lucas County the water contained in these aquifers is highly mineralized and of too poor quality for human or livestock use. Figure 1 shows the geologic relations of these beneath the county. Each aquifer has its own set of geologic, hydrologic, and water quality characteristics which determine the amount and potability (suitability for drinking) of water it will yield.

Surficial Aquifers

Unconsolidated deposits at the land surface are comprised of mixtures of clay, silt, sand, gravel, and assorted boulders. The water-yielding potential of these deposits is greater in units composed mostly of sand and/or gravel. Three sub-types of surficial aquifers used in the county are: alluvial aquifers, the drift aquifer, and buried channel aquifers.

Alluvial aquifers consist mainly of sand and gravel transported and deposited by modern streams and make up the floodplains and terraces in major valleys. Alluvial deposits are near surface, generally less than 50-60 feet, and because of their near surface position can be contaminated by percolating surface water.

The drift aquifer is the thick layer of soils materials deposited over the bedrock by glacial ice which invaded the county at least twice in the last two million years. The composition of the glacial drift varies considerably and in many places does not yield much water. There may, however, be lenses or beds of sand and gravel in the drift that are thick and widespread enough to store and furnish dependable water. These may be difficult to locate because of their irregular shape and because they are buried within other drift materials. Usually one or two sand layers can be found in most places that will yield enough water to meet domestic needs.

Buried channels are bedrock stream valleys containing alluvial materials that existed before the glacial period. The valleys were overridden by glaciers and are now buried under the drift and more recent alluvial materials.

The location, yield, and water quality characteristics for the surficial aquifers are summarized in Figures 2 and 9 and Table 3. An indication of general thicknesses can be obtained by comparing the elevations of the land surface and the bottom (the bedrock surface) of the surficial deposits in Figure 4 and 5. The thickness of the glacial drift or the depth of buried channels can be determined by subtracting the elevation of the bedrock surface from the elevation of the land surface.
Figure 1

BLOCK DIAGRAM SHOWING THE GEOLOGY OF LUCAS COUNTY

Key

- Glacial Drift
- Shale
- Limestone
- Sandstone
Rock Aquifers

Below the drift and other surficial materials is a thick sequence of layered rocks formed from deposits of rivers and shallow seas that alternately covered the state during the last 600 million years. The geologic map (Figure 3) shows the geologic units which form the surface of this rock sequence. These rocks are Pennsylvanian in age and are mainly shales. Although the Pennsylvanian rocks usually act as an aquiclude, sandstone layers within the Cherokee Group provide several wells in the eastern and southern half of the county with fair yields (5 to 20 gpm). The thickness of these sandstone units is quite variable and the depth of wells drilled into them vary in depth between 300 and 400 feet. The water drawn from these wells is of uniformly poor quality, with total dissolved solids concentrations ranging from 1500 to over 2500 mg/l and sulfate concentrations that generally exceed 1000 mg/l.

Underlying the Pennsylvanian aquiclude is a sequence of older rocks, portions of which form the major rock aquifers beneath Lucas County. This sequence and its water-bearing characteristics are shown in Table 1.

Examples of the rock units encountered in several wells at various locations in Lucas County are indexed and illustrated in Figures 7 and 8. The geologic unit that supplies ground water and the rate of yield are shown for each well.

The accessibility of ground water in rock aquifers depends on the depth to the aquifer. The deeper a well must be, the greater the cost for well construction and pumping. The depths to and thicknesses of units at specific sites will vary somewhat because of irregularities in the elevation of the land surface and in the elevation of the tops of the underlying rock units. Estimates of depths and thicknesses can be made by comparing Figure 4 with the maps of aquifer elevations in Figures 11, 12, and 13. The range in depth below land surface to the top of the county's principal bedrock aquifers is given for each township in Figure 6.

A second factor which affects ground water accessibility is the level to which the water will rise in a well (the static water level). Throughout the county water in the rock aquifers is under artesian pressure and rises in wells once the aquifer is penetrated. This can reduce the cost of pumping. Average static water levels for Lucas County wells are shown in Figures 11, 12, and 13.

Average rates of yield and water quality characteristics for each of the aquifers are summarized in the maps in Figures 11, 12, 13 and Table 4.
<table>
<thead>
<tr>
<th>Age</th>
<th>Rock Unit</th>
<th>Description</th>
<th>Thickness Range</th>
<th>Hydrogeologic Unit</th>
<th>Water-Bearing Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Alluvium</td>
<td>Sand, gravel, silt and clay</td>
<td></td>
<td></td>
<td>Fair to large yields (25 to 50 gpm)</td>
</tr>
<tr>
<td></td>
<td>Glacial drift</td>
<td>Predominantly till containing scattered irregular bodies of sand and gravel</td>
<td>0-400 (feet)</td>
<td>Surficial aquifer</td>
<td>Low yields (less than 10 gpm)</td>
</tr>
<tr>
<td></td>
<td>Buried channel</td>
<td>Sand, gravel, silt and clay</td>
<td></td>
<td></td>
<td>Small to large yields</td>
</tr>
<tr>
<td></td>
<td>drift (undifferentiated)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marnaton Group</td>
<td>Alternating shale and limestone; thin coal and sandstone</td>
<td>100-500</td>
<td>Aquiclude</td>
<td>Low yields only from limestone and sandstone</td>
</tr>
<tr>
<td></td>
<td>Cherokee Group</td>
<td>Shale, clay, siltstone, sandstone and coal beds, mostly thin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meramec Series</td>
<td>Sandy limestone</td>
<td>400-500</td>
<td>Mississippian aquifer</td>
<td>Fair to low yields</td>
</tr>
<tr>
<td></td>
<td>Osage Series</td>
<td>Limestone and dolostone, cherty, shale</td>
<td>400-500</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kinderhook Series</td>
<td>Limestone, oolitic, and dolostone, cherty</td>
<td>400-500</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maple Mill Shale</td>
<td>Limestone in lower part</td>
<td>55-90</td>
<td>Devonian aquiclude</td>
<td>Does not yield water</td>
</tr>
<tr>
<td></td>
<td>Sheffield Formation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lime Creek Formation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cedar Valley Lime stone</td>
<td></td>
<td>400-500</td>
<td>Devonian aquiclude</td>
<td>Fair to low yields</td>
</tr>
<tr>
<td></td>
<td>Wapsipinicon Forma-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>tion</td>
<td>Limestone and dolostone, contains evaporites (gypsum) in southern half of Iowa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maquoketa Formation</td>
<td></td>
<td></td>
<td>Maquoketa aquiclude</td>
<td>Does not yield water</td>
</tr>
<tr>
<td></td>
<td>Galena Formation</td>
<td>Dolostone and chert</td>
<td>100-1000</td>
<td>Minor aquifer</td>
<td>Low yields</td>
</tr>
<tr>
<td></td>
<td>Decorah Formation-Platteville Formation</td>
<td></td>
<td></td>
<td>Aquiclude</td>
<td>Does not yield water</td>
</tr>
<tr>
<td></td>
<td>St. Peter Sandstone</td>
<td>Sandstone</td>
<td></td>
<td>Cambro-Ordovician aquifer</td>
<td>Fair yields (over 500 gpm)</td>
</tr>
<tr>
<td></td>
<td>Prairie du Chien Formation</td>
<td></td>
<td></td>
<td></td>
<td>High yields</td>
</tr>
<tr>
<td></td>
<td>Jordan Sandstone</td>
<td>Sandstone</td>
<td>30-50</td>
<td>Aquitard</td>
<td>No data</td>
</tr>
<tr>
<td></td>
<td>St. Lawrence Formation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Franconia Sandstone</td>
<td>Sandstone and shale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dresbach Group</td>
<td>Sandstone</td>
<td></td>
<td>Dresbach aquifer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Undifferentiated</td>
<td>Coarse sandstone: crystalline rocks</td>
<td></td>
<td>Base of ground water reservoir</td>
<td>Not known to yield water</td>
</tr>
</tbody>
</table>

Table 1

GEOLOGIC AND HYDROGEOLOGIC UNITS IN LUCAS COUNTY
Figure 2
SURFICIAL MATERIALS

[Map showing surficial materials with symbols for Alluvium, Glacial Drift, and Buried Channels]
Figure 3
GEOLOGIC MAP

Pennsylvanian
Marmaton Group

Pennsylvanian
Cherokee Group
Figure 4

ELEVATION OF LAND SURFACE IN FEET ABOVE MEAN SEA LEVEL

[Map showing elevation contours]
Figure 5

ELEVATION OF BEDROCK SURFACE IN FEET ABOVE MEAN SEA LEVEL

Legend:
- 650-700
- 700-800
- 800-900
- 900-950
Figure 6
RANGE IN DEPTH TO LUCAS COUNTY'S PRINCIPAL ROCK AQUIFERS

<table>
<thead>
<tr>
<th>T 73 N</th>
<th>T 72 N</th>
<th>T 71 N</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. 23 W</td>
<td>R. 22 W</td>
<td>R. 21 W</td>
</tr>
<tr>
<td><strong>BEDROCK</strong></td>
<td><strong>BEDROCK</strong></td>
<td><strong>BEDROCK</strong></td>
</tr>
<tr>
<td>0-300</td>
<td>0-300</td>
<td>0-200</td>
</tr>
<tr>
<td>MISSISSIPPIAN</td>
<td>MISSISSIPPIAN</td>
<td>MISSISSIPPIAN</td>
</tr>
<tr>
<td>400-700</td>
<td>200-500</td>
<td>300-600</td>
</tr>
<tr>
<td>DEVONIAN</td>
<td>DEVONIAN</td>
<td>DEVONIAN</td>
</tr>
<tr>
<td>950-1150</td>
<td>900-1200</td>
<td>850-1150</td>
</tr>
<tr>
<td>CAMBRO-ORDOVICIAN</td>
<td>CAMBRO-ORDOVICIAN</td>
<td>CAMBRO-ORDOVICIAN</td>
</tr>
<tr>
<td>2300-2600</td>
<td>2300-2600</td>
<td>2250-2550</td>
</tr>
<tr>
<td><strong>BEDROCK</strong></td>
<td><strong>BEDROCK</strong></td>
<td><strong>BEDROCK</strong></td>
</tr>
<tr>
<td>0-200</td>
<td>0-200</td>
<td>0-300</td>
</tr>
<tr>
<td>MISSISSIPPIAN</td>
<td>MISSISSIPPIAN</td>
<td>MISSISSIPPIAN</td>
</tr>
<tr>
<td>400-700</td>
<td>400-700</td>
<td>300-600</td>
</tr>
<tr>
<td>DEVONIAN</td>
<td>DEVONIAN</td>
<td>DEVONIAN</td>
</tr>
<tr>
<td>1000-1200</td>
<td>950-1150</td>
<td>900-1200</td>
</tr>
<tr>
<td>CAMBRO-ORDOVICIAN</td>
<td>CAMBRO-ORDOVICIAN</td>
<td>CAMBRO-ORDOVICIAN</td>
</tr>
<tr>
<td>2300-2600</td>
<td>2300-2600</td>
<td>2250-2550</td>
</tr>
<tr>
<td><strong>BEDROCK</strong></td>
<td><strong>BEDROCK</strong></td>
<td><strong>BEDROCK</strong></td>
</tr>
<tr>
<td>100-400</td>
<td>100-400</td>
<td>100-300</td>
</tr>
<tr>
<td>MISSISSIPPIAN</td>
<td>MISSISSIPPIAN</td>
<td>MISSISSIPPIAN</td>
</tr>
<tr>
<td>500-800</td>
<td>400-700</td>
<td>300-600</td>
</tr>
<tr>
<td>DEVONIAN</td>
<td>DEVONIAN</td>
<td>DEVONIAN</td>
</tr>
<tr>
<td>1100-1350</td>
<td>1000-1300</td>
<td>950-1150</td>
</tr>
<tr>
<td>CAMBRO-ORDOVICIAN</td>
<td>CAMBRO-ORDOVICIAN</td>
<td>CAMBRO-ORDOVICIAN</td>
</tr>
<tr>
<td>2400-2700</td>
<td>2350-2650</td>
<td>2300-2500</td>
</tr>
</tbody>
</table>
Figure 7

INDEX MAPS FOR TYPICAL WELLS IN LUCAS COUNTY
Figure 8

TYPICAL WELLS IN LUCAS COUNTY

EXPLANATION

- Water Producing Unit

Y Yield in gal/min

Qp Quaternary-Pleistocene
P Pennsylvanian
M Mississippian
D Devonian
O Ordovician
C Cambrian
Water levels in the surficial aquifers are difficult to analyze, water rises to different levels in wells drilled into alluvial, buried-channel, and drift aquifers. The water table in the drift aquifer generally slopes from high land areas toward the streams and, changes noticeably throughout the year. Levels in drift and buried-channel aquifers respond rapidly to recharge from precipitation. Water levels in the alluvial aquifer fluctuate somewhat in the same way as those in the drift and buried-channel aquifers; however, the main influence on the alluvial aquifer is the stage (level) of the associated streams. Water levels will be high during periods of high stream stage and low during the low-stage periods.

Water levels in the drift aquifers commonly are from 10 to 50 feet below the land surface, and those in the buried-channel aquifers have been reported to be as low as 150 feet below the land surface. The water levels in alluvial wells are from 4 to 20 feet below the flood-plain surface and the depth to the water surface will be accordingly deeper in wells located on terrace surfaces.

Water yields to wells in gallons per minute

<table>
<thead>
<tr>
<th>Alluvial aquifers</th>
<th>Drift aquifer</th>
<th>Buried channel and drift aquifers</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-25 (35)*</td>
<td>1-5 (10)</td>
<td>5-10 (25)</td>
</tr>
<tr>
<td>25-50 (75)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*(35) number is maximum yield that is occasionally available but probably not on a sustained basis.
The Pennsylvanian Aquiclude generally underlies the whole county and is thickest in the western and central portions of the county. Pennsylvanian strata consist of a succession of predominantly shale beds of the Marmaton Group and Cherokee Group, with occasional thin layers of sandstone (in the Cherokee) which locally function as aquifers. Coal is present both in the Marmaton and Cherokee groups and is present as thin beds or lenses which range in thickness from a few inches up to 5 feet.
Figure 11

MISSISSIPPIAN AQUIFER

Elevation of Mississippian Aquifer in feet above mean sea level

Water levels in wells in feet above mean sea level

General direction of gradient (water levels in wells) to west, increases to 900' in Clarke and adjacent counties.

Water yields to wells in gallons per minute

Range estimated to be from 5 - 100 gpm

Dissolved solids content in milligrams per liter (mg/l)*

- 3000-5000
- 5000

*Other water quality data in Table 4
Figure 12
DEVONIAN AQUIFER

Elevation of Devonian Aquifer in feet above mean sea level

Water levels in wells in feet above mean sea level

Estimated to be in a range between 50 and 75 feet higher than the Cambro-Ordovician aquifer (see Figure 13).

Water yields to wells in gallons per minute

Dissolved solids content in milligrams per liter (mg/l)*

Can be anticipated to range between 5,000 and 10,000.
Figure 13
CAMBRO-ORDOVICIAN (JORDAN) AQUIFER

Elevation of Jordan Aquifer in feet above sea level

Water levels in wells in feet above mean sea level
Water levels gradually decrease to 650 feet in central Monroe County.

Water yields of wells in gallons per minute

Dissolved solids content in milligrams per liter (mg/l)*

*Other water quality data in Table 4
To the user, the quality of ground water is as important as the amount of water that an aquifer will yield. As ground water moves through soil and rock materials, it dissolves some of the minerals which, in turn, affect water quality. In addition to mineral content, bacterial and chemical contamination may be introduced through poorly constructed wells and seepage from other pollution sources.

Recommended standards for common water constituents are described in the table above. These are rationally accepted as guidelines for acceptable drinking water supplies. Limits for uses other than drinking often differ from these. For instance, water that is unacceptable for drinking and household use may be completely satisfactory for industrial cooling.

From analyses of ground water averages (A) and ranges (R) of values in milligrams per liter (mg/l) for several constituents are summarized in Tables 3 and 4 for the surficial and bedrock aquifers in Lucas County. Recommended concentrations for some constituents are often exceeded without obvious ill effects, although the water may be unpalatable. Water quality analyses for individual wells should be obtained to determine if concentrations of constituents that affect health are exceeded.
Table 3
CHEMICAL CHARACTER OF GROUND WATER

<table>
<thead>
<tr>
<th>Surficial Aquifers</th>
<th>Average (A) and range (R)</th>
<th>Dissolved solids</th>
<th>Hardness (as CaCO₃)</th>
<th>Sulfate (SO₄²⁻)</th>
<th>Chloride (Cl⁻)</th>
<th>Fluoride (F⁻)</th>
<th>Nitrate (NO₃⁻)</th>
<th>Sodium (Na⁺)</th>
<th>Iron (Fe)</th>
<th>Manganese (Mn)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alluvial Aquifer</strong></td>
<td>A 417 R 165-1000</td>
<td>288 124-762</td>
<td>105 3-350</td>
<td>13 0.5-180</td>
<td>0.3 0.1-0.45</td>
<td>4.2 0.1-1.7</td>
<td>20.2 4.1-85</td>
<td>9.4 0.04-51</td>
<td>1.5 0.05-17</td>
<td></td>
</tr>
<tr>
<td><strong>Shallow drift aquifer</strong></td>
<td>A 736 R 220-2840</td>
<td>480 153-1710</td>
<td>177 12-1470</td>
<td>37 0.5-200</td>
<td>0.3 0.2-0.8</td>
<td>81 0.1-570</td>
<td>68 7.3-710</td>
<td>1.1 0.02-30</td>
<td>0.13 0.05-1.9</td>
<td></td>
</tr>
<tr>
<td><strong>Intermediate drift aquifer</strong></td>
<td>A 1030 R 261-2726</td>
<td>569 150-1518</td>
<td>397 7-1520</td>
<td>9 0.5-49</td>
<td>0.5 0.2-1.0</td>
<td>6 0.1-570</td>
<td>108 17-368</td>
<td>5 0.04-24</td>
<td>0.09 0.05-0.37</td>
<td></td>
</tr>
<tr>
<td><strong>Deep drift and Buried-channel aquifers</strong></td>
<td>A 2346 R 383-3657</td>
<td>868 140-1640</td>
<td>1254 42-1990</td>
<td>30 0.1-110</td>
<td>0.6 0.1-2.0</td>
<td>6.7 0.0-82</td>
<td>334 54-568</td>
<td>3.4 0-18</td>
<td>0.24 0.05-1.4</td>
<td></td>
</tr>
</tbody>
</table>

The alluvial aquifers yield the least mineralized water of all ground water sources in south central Iowa. In the alluvial aquifers, manganese and iron concentrations are well above recommended standards, but all other constituents are well below. Water temperatures average 55°F (13°C) and the range of these temperatures is from 46°F to 60°F (8°C to 16°C).

In the shallow drift aquifers, the water is hard and contains undesirable concentrations of iron, sulfate, chloride and dissolved solids. High concentrations of nitrate, chloride and bacteria are directly due to contamination of wells or the infiltration of agricultural waste water and runoff into shallow drift aquifers. The water from shallow drift aquifers is usually acceptable for most purposes if wells are constructed properly, and located a suitable distance from sources of contamination. Nitrate content should be checked carefully in these wells, and any water supply containing over 45 mg/l should not be used for infant feeding. Water temperatures average 54°F (12°C) and the range of these temperatures is from 50°F to 60°F (10°C to 16°C).

In the intermediate drift aquifer, water is more highly mineralized than the shallow drift aquifer, with iron concentrations high and nitrate low. The fluoride content, hardness and temperature are similar to the shallow drift aquifer.

In the deep drift and buried-channel aquifers, the water is highly mineralized and contains high concentrations of dissolved solids, sulfate and iron. Water temperatures range between 54°F and 57°F (12°C to 14°C).
Table 4

CHEMICAL CHARACTER OF GROUND WATER

Bedrock Aquifers

<table>
<thead>
<tr>
<th>Average (A)</th>
<th>Range (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved solids</td>
<td>Hardness (as CaCO₃)</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>Pennsylvanian (Cherokee Group) aquifers</strong></td>
<td></td>
</tr>
<tr>
<td>A 4531</td>
<td>869</td>
</tr>
<tr>
<td>R 251-7092</td>
<td>44-1559</td>
</tr>
<tr>
<td><strong>Mississippian aquifer</strong></td>
<td></td>
</tr>
<tr>
<td>A 4274</td>
<td>923</td>
</tr>
<tr>
<td>R 1210-8400</td>
<td>60-1580</td>
</tr>
<tr>
<td><strong>Cambro-Ordovician aquifer</strong></td>
<td></td>
</tr>
<tr>
<td>A 1998</td>
<td>370</td>
</tr>
<tr>
<td>R 614-2560</td>
<td>246-1100</td>
</tr>
</tbody>
</table>

Because it is highly mineralized, water in the bedrock aquifers is of limited use in many parts of southeast Iowa. Only under extensive treatment is it suitable for domestic and industrial uses, but without treatment it can be used for washing, cooling and fire fighting.

Pennsylvanian sources in Lucas County yield highly mineralized water. Sulfate concentrations are very high, as are sodium and total dissolved solids. Water temperatures average 56°F (14°C) and range between 52°F to 61°F (11°C to 16°C).

Water from the Mississippian Aquifer is highly mineralized with dissolved solids concentrations generally exceeding 3000 mg/l. Water temperatures average 57°F (14°C) and range between 52°F and 64°F (11°C to 18°C).

Chemical quality data is available from only two wells in the Devonian Aquifer in the vicinity, but from these some general assumptions can be made. The sulfate content of the aquifer is high, due to the occurrence of evaporite minerals (gypsum and anhydrite). Water obtained from the Devonian Aquifer can be expected to contain dissolved solids concentrations in a range from 5,000 to 10,000 mg/l, with chloride, sodium and sulfate concentrations that are as high as 1,000, 2,000, and 2,500 mg/l respectively or higher.

Water from the Cambrian-Ordovician Aquifer is of consistently better quality than the water from the over-lying bedrock aquifers. Sulfate, iron, and fluoride concentrations are high and temperatures range from 73°F to 76°F (23°C to 24°C).
RECOMMENDATIONS FOR PRIVATE WATER WELLS

Contracting for Well Construction

To protect your investment and guarantee satisfactory well completion, it is a good idea to have a written agreement with the well driller. The agreement should specify in detail:

- size of well, casing specifications, and types of screen and well seal
- methods of eliminating surface and subsurface contamination
- disinfection procedures to be used
- type of well development if necessary
- test pumping procedure to be used
- date for completion
- itemized cost list including charges for drilling per foot, for materials per unit, and for other operations such as developing and test pumping
- guarantee of materials, workmanship, and that all work will comply with current recommended methods
- liability insurance for owner and driller

Well Location

A well should be located where it will be least subject to contamination from nearby sources of pollution. The Iowa State Department of Health recommends minimum distances between a new well and pollution sources, such as cesspools (150 ft.), septic tanks (50 ft.), and barnyards (50-100 ft. and downslope from well). Greater distances should be provided where possible.

The well location should not be subject to flooding or surface water contamination. Select a well-drained site, extend the well casing a few feet above the ground, and mound earth around it. Diversion terraces or ditches may be necessary on slopes above a well to divert surface runoff around the well site.

In the construction of all wells care should be taken to seal or grout the area between the well bore and the well casing (the annulus) as appropriate so that surface water and other pollutants cannot seep into the well and contaminate the aquifer.

Locate a well where it will be accessible for maintenance, inspection, and repairs. If a pump house is located some distance from major building and wired separately for power, continued use of the water supply will not be jeopardized by fire in major buildings.
Water Treatment

Water taken from a private well should ideally be tested every six months. The University Hygienic Laboratory will do tests for coliform bacteria, nitrate, iron, hardness, and iron bacteria in drinking water for private individuals. Special bottles must be used for collecting and sending water samples to the laboratory. A sample kit can be obtained by writing to the University Hygienic Laboratory, University of Iowa, Oakdale Campus, Iowa City, Iowa 52242. Indicate whether your water has been treated with chlorine, iodine, or bromine; as different sample bottles must be used for treated and untreated water. The charge for the bacterial test is $3.00; for iron, hardness and nitrate, it is $3.00; and for iron bacteria, $5.00. If your well is determined to be unsafe, advice for correcting the problem can be obtained from your county or state Department of Health. Several certified private laboratories also run water analyses.

Shock chlorination is recommended following the construction and installation of a well and distribution system and any time these are opened for repairs or remodeling a strong chlorine solution is placed in the well and complete distribution system to kill nuisance and disease-causing organisms. If the first shock chlorination does not rid the water supply of bacteria it should be repeated, if this does not solve the problem the well should be abandoned or the water should be continuously disinfected with proper chlorination equipment.

Since most of the ground waters in Lucas County are mineralized, water softening and iron removal equipment may make water more palatable and pleasant to use. Softened water contains increased sodium; contact your physician before using a softener if you are on a sodium-restricted diet. Chlorination followed by filtration will remove most forms of iron and iron bacteria. Iron bacteria has no adverse effect on health but will plug wells, water lines, and equipment and cause tastes and odors. Iron removal equipment can be used if problems persist.

Well Abandonment

Wells taken out of service provide easy access for pollution to enter aquifers supplying water to other wells in the vicinity. Unprotected wells may also cause personal injury. Proper abandonment procedures should be followed to restore conditions to those that existed before the well was constructed, and to prevent source contamination. Permanent abandonment requires careful sealing. The well should be filled with concrete, cement grout, or sealing clays throughout its entire length. Before dug or bored wells are filled at least the top 10 feet of lining should be removed so surface waters will not penetrate the subsurface through a porous lining or follow cracks in or around the lining. The site should be completely filled and mounded with compacted earth.

ABANDONED WELLS SHOULD NEVER BE USED FOR DISPOSAL OR SEWAGE OR OTHER WASTES.
In planning the development of a ground water supply or contracting for the drilling of a new well additional or more specific information is often required. This report section lists several sources and types of additional information.

State Agencies That May Be Consulted

Iowa Geological Survey¹
123 North Capitol
Iowa City 52242
(319) 338-1173

State Health Department²,⁶
Lucas Building
Des Moines 50319
(515) 281-5787

Iowa Natural Resources Council³
Wallace Building
Des Moines 50319
(515) 281-5914

Iowa Dept. of Environ. Quality⁴
Wallace Building
Des Moines 50319
(515) 281-8854

University Hygienic Laboratory⁵
U. of IA, Oakdale Campus
Iowa City 52242
(319) 353-5990

Cooperative Extension Service in Agriculture and Home Economics⁶
110 Curtis Hall, ISU
Ames 50011
(515) 294-4569

Functions:

1 Geologic and ground water data repository, consultant on well problems, water development and related services

2 Drinking water quality, public and private water supplies

3 Water withdrawal regulation and Water Permits for wells withdrawing more than 5000 gpd

4 Municipal supply regulation and well construction permits

5 Water quality analysis

6 Advice on water systems design and maintenance
Well Drillers and Contractors

The listing provided here was drawn from an Iowa Geological Survey mailing list and yellow pages of major towns in phone books. Those selected are within an approximate radius of 50 miles of Lucas County. For a statewide listing contact either the Iowa Water Well Drillers Association, 4350 Hopewell Ave., Bettendorf, Iowa 51712, (319) 355-7528 or the Iowa Geological Survey, (319) 338-1173.

Baker Well Service
Hwy. 169 North
Mount Ayr, IA 50854

Brooks Well and Pump Co.
Knoxville, IA 50138

Douglas Bruinekool
Bruinekool Well Co.
Pella, IA 50219

Dwayne Bruinekool
Bruinekool Well Co.
Oskaloosa, IA 52577

Campbell Well
701 South Columbia
Bloomfield, IA 52537

Huff Well Drilling Co.
RR #1
Winterset, IA 50273

Hughes Well Co.
4120 73rd
Des Moines, IA 50322

Moorhead Well Co.
R.R. 1
Indianola, IA 50125

Newton-Whalen Well Co.
1407 1st Ave.
Newton, IA 50208

Snook Well Co.
R.R. 1
Promise City, IA 52583

Doyle Van De Kro1
Sully, IA 50251

Verwers Well Co.
Sully, IA 50251

24
Topographic Maps (Available from the Iowa Geological Survey)

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Useful Reference Materials


