

**Part 1**  
of the  
**Wellhead Protection Plan**  
For the  
**City of Rochester, Minnesota**

**Including:**  
**the Wellhead Protection Area Delineation,**  
**Drinking Water Supply Management Area Delineation,**  
**and Vulnerability Assessment**

**Todd Osweiler**  
**Rochester Public Utilities**  
**and**  
**Justin Blum**  
**Minnesota Department of Health**  
**June, 2004**

## Part 1 of the Wellhead Protection Plan For the City of Rochester, Minnesota

<u>Table of Contents</u>	<u>Page Number</u>
Source Water Assessment	1
Wellhead Protection Area (WHPA) Delineation	3
Hydrogeological Setting	3
Criteria Used to Delineate Wellhead Protection Areas	6
Methods Used to Delineate Wellhead Protection Areas	9
Prairie du Chein-Jordan Aquifer	10
Sensitivity Analysis and Model Calibration	10
Model Uncertainty Analysis	10
Franconia - Ironton Galesville Aquifer	11
Sensitivity Analysis and Model Calibration	11
Model Uncertainty Analysis	11
Mt. Simon Aquifer	11
Sensitivity Analysis and Model Calibration	11
Model Uncertainty Analysis	11
Capture Zone Analysis	12
Surface Water Contribution Area	12
Delineation of the Drinking Water Supply Management Area	13
Recommendations for Future Refinements and Use of the Model as a Planning Tool	14
Vulnerability Assessment	14
Well Vulnerability Assessment	14
Aquifer Vulnerability Assessment	14
Drinking Water Supply Management Area Vulnerability Assessment	16
References	23

### **TABLES**

Table 1.	Municipal Water Supply Well Information	1
Table 2.	Water Production from City Wells by Year	7
Table 3.	Water Production from Non-Community Wells	8
Table 4.	Modeled Aquifer Properties	10
Table 5.	Delineations with a Surface Water Component	12
Table 6.	Aquifer Vulnerability Assessment	15

### **FIGURES**

1 - 27	Source Water Protection Areas
28	Location Map
29	Regional Ground Water Elevation Contours and Approximate Directions of Ground Water Flow, Prairie du Chien - Jordan Aquifer
30	Geologic Map of Alluvial and Glacial Deposits of the Rochester Area

- 31 Bedrock Geologic Map of the Rochester Area
- 32 Geologic Cross Sections A – A' and B – B'
  
- 33 Map of Geological Confining Layers Over the Prairie du Chien Group
- 34 Groundwater Flow Directions and Gradients in the Franconia - Ironton Galesville Aquifer
- 35 Approximate Direction of Ground Water Elevation and Regional Directions of Ground Water Flow in the Mt. Simon Aquifer near Rochester, MN
- 36 - 90 Emergency Response Zone (ERZ), Wellhead Protection Area (WHPA) and Drinking Water Supply Management Area (DWSMA)
- 37 - 91 Drinking Water Supply Management Area Vulnerability

## **APPENDIX**

Public Water Supply Data Base Information

**SOURCE WATER ASSESSMENT  
for the City of Rochester, Minnesota**

**ID Number:** 1550010

**Facility Contact:** Joseph Hensel  
(507) 280-1500  
Rochester  
4000 East River Road NE  
Rochester, MN 55906-

**MDH Contact:** Art Persons  
(507) 292-5138  
18 Wood Lake Drive Southeast  
Rochester, MN 55904  
[art.persons@health.state.mn.us](mailto:art.persons@health.state.mn.us)

**Status of the Source Water Protection Plan:**

The water supply system is designating its wellhead protection area(s) and preparing assessments of well and aquifer vulnerability as specified under Minnesota Rules Chapter 4720.

**Source Water Protection Area -**

See the wellhead protection area maps for the wells in figures 1 through 28, as noted in Table 1.

**Description of the source water -** The water supply for Rochester is obtained from 28 primary wells. Well depth (in feet), well status, aquifer(s) used, and sensitivity of the source(s) of drinking water are listed in the following table.

**Table 1. Municipal Water Supply Well Information**

Unique Well No	Well ID	Depth	Well Use	Aquifer	Aquifer Sensitivity	*Well Sensitivity	WPA Figure No.
220666	Well #11	455	Primary	Bedrock	High	Low	1
220833	Well #12	442	Primary	Bedrock	High	Low	2
222525	Well #13	442	Primary	Bedrock	High	Low	3
222528	Well #15	432	Primary	Bedrock	Medium	Low	4
220822	Well #17	904	Primary	Bedrock	High	Low	5
222527	Well #18	806	Primary	Bedrock	High	Low	6
220681	Well #19	881	Primary	Bedrock	High	Low	7
220662	Well #20	912	Primary	Bedrock	High	Low	8
220625	Well #21	981	Primary	Bedrock	Low	Low	9
220818	Well #22	730	Primary	Bedrock	Medium	Low	10

Unique Well No	Well ID	Depth	Well Use	Aquifer	Aquifer Sensitivity	*Well Sensitivity	WPA Figure No.
220660	Well #23	806	Primary	Bedrock	High	Low	11
220819	Well #24	685	Primary	Bedrock	High	Low	12
220675	Well #25	850	Primary	Bedrock	High	Low	13
147451	Well #26	624	Primary	Bedrock	Low	Low	14
224212	Well #27	448	Primary	Bedrock	High	Low	15
180567	Well #28	389	Primary	Bedrock	Medium	Low	16
161425	Well #29	519	Primary	Bedrock	High	Low	17
239761	Well #30	402	Primary	Bedrock	High	Low	18
434041	Well #31	530	Primary	Bedrock	High	Low	19
506819	Well #32	540	Primary	Bedrock	Low	Low	20
220627	Well #33 Rose Harbor	605	Primary	Bedrock	Low	Low	21
463536	Well #34	465	Primary	Bedrock	Low	Low	22
601335	Well #35	457	Primary	Bedrock	High	Low	23
601336	Well #36	478	Primary	Bedrock	Medium	Low	24
409455	Well #70	580	Primary	Bedrock	Low	Low	25
219560	Well #71 Airport Well	801	Primary	Bedrock	Low	Low	26
220628	Well #72 Sandy Slopes	460	Primary	Bedrock	High	Low	27
228168	Well #73 Merrihills	675	Primary	Bedrock	High	Low	28

**Well construction assessment** - The water wells used by the Rochester meet current standards for construction and maintenance. These factors do not contribute to the susceptibility of the source water to contamination.

**Well Sensitivity** - Well sensitivity refers to the integrity of the well due to its construction and maintenance. It is based on the results of the well construction assessment.

The wells are not susceptible because they meet well construction standards and do not present a pathway for contamination to readily enter the water supply.

**Aquifer Sensitivity** - Aquifer sensitivity refers to the degree of geological protection afforded the aquifer(s) used by the public water supply. The aquifer sensitivity is rated as high, medium, or low, defined as follows.

High - The bedrock aquifer is considered to exhibit a high sensitivity to contamination because of the local geological setting. Or, aquifer sensitivity is considered high because either

insufficient geologic information is available or existing information indicates the presence of vulnerable geologic conditions.

Medium - The lateral extent of fine-grained materials between the land surface and the aquifer do not appear to be persistent throughout the drinking water protection area.

Low - The bedrock aquifer is covered by one or more layers of fine-grained material that probably protect it from potential sources of contamination.

**Source Water Susceptibility** - Source water susceptibility refers to the likelihood that a contaminant will reach the source of drinking water. It reflects the results of assessing well sensitivity, aquifer sensitivity, and water quality data.

High - The source of drinking water is considered to exhibit a high susceptibility to contamination because of the local geological setting. Or, The source water is considered to be susceptible because of the tritium content of the well water in bedrock.

Medium - The lateral extent of fine-grained materials between the land surface and the source of drinking water does not appear to be persistent throughout the source water protection area.

Low - The source of drinking water is covered by one or more layers of fine-grained material that probably protect it from potential sources of contamination.

**Contaminants of concern** - The following statement summarizes the potential contaminants for which a source of drinking water may be at risk:

One or more contaminants regulated under the federal Safe Drinking Water Act for this public water supply system have been detected in the source water. However, the water supplied to users meets state and federal drinking water standards for potability. For further information, please contact the MDH representative listed at the beginning of this assessment.

## **WELLHEAD PROTECTION AREA (WHPA) DELINEATION**

This portion of the Wellhead Protection Plan documents the delineation of the wellhead protection area for the City of Rochester, Minnesota (city). These delineations were prepared in accordance with the Wellhead Protection Rule, MR 4720.5100 to 4720.5590 (rule).

The wellhead protection area(s) for the twenty-eight water supply wells used by the city were calculated using a three-layer finite difference ground water flow model described in this report. The delineation of the composite wellhead protection area included characterization of:

- the hydrogeologic setting,
- aquifer properties by analysis of aquifer tests,
- location and pumpage of other high capacity wells in the area,
- the City water demand (daily volume of water pumped), and
- selection of a time of travel for the capture zone analysis, not less than 10 years.

Rochester Public Utilities entered the Wellhead Protection Program because a new well was drilled that was placed on-line in 2000. According to the rule, communities drilling new wells are brought into the wellhead protection program as the wells start supplying water to the distribution system.

### **Hydrogeologic Setting**

The City of Rochester is located in central Olmsted County, Minnesota, Figure 29. Fortunately, several detailed geologic studies have been published describing the subsurface conditions around the city. The first of these studies is the Olmsted County Geologic Atlas (Balaban and Olsen, 1988). In addition to the county atlas, other important studies on the ground water hydrology are United States Geological Survey (USGS) Water-Resources Investigations Report, Delin (1991) and Open-File Report, Delin and Almendinger (1991). In addition to these USGS reports, later studies performed by the Minnesota Geological Survey (MGS) Runkel (1996) and Runkel and Mosler (2001) are important contributions to understanding the ground water flow system. These reports were the basis for the ground water flow model used for wellhead protection delineation in the shallow bedrock aquifers. Less is known about deeper bedrock aquifers and regional studies summarized in Seaberg (2000) and Hansen and Seaberg (2000) are the most important references. Because of the wealth of published reports, many of the details of the hydrogeology, computer model and modeling procedure are not presented here but are included by reference.

### **General Description of Physiography and Geology**

Rochester is situated on rolling till uplands, bedrock bluff lands, and alluvial terrain draining centrally to the City of Rochester and then to the north with the Zumbro River. Figure 30 shows the general directions of ground water flow in the Rochester Basin. Ground water flow is towards the Zumbro River in the upland and bluff areas, changing to be parallel to the direction of flow in the River in and under the alluvial sediments in the basin center.

Figure 31 shows the types of sediments in the shallow subsurface for the area. On the edge of

the basin, the subsurface deposits generally consist of clay-rich glacial sediments overlying older bedrock layers. Towards the center of the basin, these glacial materials have been removed by erosion and the bedrock layers are mantled with thin alluvial deposits associated with the Zumbro River.

Underlying the alluvium and glacial sediments are relatively flay-lying sedimentary bedrock layers, Figures 32 and 33. The uppermost bedrock layers exposed in the area are the Galena, Decorah, Platteville and Glenwood Formations consisting of relatively low permeability fractured dolomitic limestone and shales. The bedrock layers found at the edges of the basin are younger than those found at the center of the basin. Below the Glenwood is the St Peter Sandstone. This sandstone is not cemented and is easily eroded, forming the bluffs at the edge of the Rochester basin. Beneath the St Peter, at the center of the basin, is found the Prairie du Chien Group, a karstic dolomitic limestone. The community wells draw ground water primarily from the Jordan Sandstone below the Prairie du Chien Group. The hydraulic interconnection between the Prairie du Chien and Jordan Formations is such that they are considered to be one aquifer regionally, the Prairie du Chien - Jordan Aquifer. Locally, in the Rochester area, the St. Peter Sandstone Aquifer is also considered to be well connected to the Prairie du Chien Aquifer and is included in the ground water flow model with the water supply aquifers below.

The two most important complicating factors in the hydrogeology are the karstic features of the Prairie Du Chien, such as caves and sinkholes, and the “edge effect” of focused ground water recharge where younger bedrock layers have been removed by erosion.

The shales in the overlying younger bedrock units, Figures 32 and 33, are effective confining units that greatly slow the vertical movement of water recharging the Prairie du Chien Group. Focused recharge of the underlying Prairie du Chien Group occurs at the edge of these confining units, particularly where the Decorah and Glenwood Shales are exposed near the land surface. In the places where the confining units are absent, the Prairie du Chien Group is hydrologically well connected to the soils and thin glacial sediments; and, in particular, to alluvial sands and gravels in the valleys of the Zumbro River and other smaller drainages. However, the degree of interconnection between ground water in the bedrock layers and alluvial sediments to the rivers is almost never known exactly and is usually roughly estimated, at best. Figure 33 shows the area where the confining layers are present covering the aquifer, and where the confining layers have been removed by erosion. Some smaller areas in the northwest parts of the city are covered by lower permeability glacial till over the bedrock aquifers. These areas are also shown on Figure 34. This till provides some hydraulic confinement and limited protection to the bedrock aquifers in those locations.

Several of the older wells used by RPU are multi-aquifer wells that penetrate deeper aquifers, from the Prairie du Chien - Jordan to the Franconia Ironton - Galesville and Mt Simon Aquifers, as listed in Table 2. These deeper aquifers, the Franconia Ironton - Galesville and Mt. Simon, are treated separately from the Prairie du Chien - Jordan for delineating wellhead protection areas.

The basis for the Franconia Ironton - Galesville ground water flow model is three regional geologic studies, Kanivetsky (1978), Woodward (1986), and Ruhl, et. al. (1982). The Franconia Ironton - Galesville Aquifer is deeply confined in the area of Rochester and little detailed work

has been done, so regional studies are the best source of information.

Only one well remains actively used in the Mt. Simon Aquifer, #20 (Minnesota Unique Well No. 220662). The Mt. Simon Aquifer is deeply confined in the Rochester area and little detailed work has been done. The best and most recent regional study was performed by the Minnesota Pollution Control Agency as documented in the Metro Model project, Seaberg (2000).

## **Criteria Used to Delineate the Wellhead Protection Area**

### **Directions of Ground Water Flow**

Generally, the land surface slopes towards the center of Rochester and towards the north along the Zumbro River. The trend in static water level elevations reported in wells completed in the Prairie du Chien - Jordan Aquifer shows a corresponding decreasing water elevation towards the north, Figure 30. The variability in the water elevations is the result of the poor quality of the data available; however, the trend in water elevation is clear.

The deeper aquifers have much more limited information available and the directions of ground water flow are not as well defined as a result. However, the deep confined conditions provide a consistency not found in the shallower aquifers. Interpretations of the direction of ground water flow in the Franconia Ironton- Galesville from Kanivetsky (1978) are shown in Figure 35. Flow directions in the Mt. Simon are similar, Figure 36.

### **Ground Water Flow Boundaries**

The factors exerting the greatest influence on ground water flow in the Prairie du Chien - Jordan Aquifer in the area of Rochester are the Zumbro River and the effect of focused recharge at the bedrock bluff edge. There are no other types of geological boundaries present. Other types of flow boundaries, such as interference from other high capacity wells, were incorporated into the models.

The Franconia - Ironton Galesville and the Mt. Simon Aquifers have no local ground water flow boundaries. All boundaries are regional in extent. There are no nearby high production wells to cause interference with the community wells in these deeper aquifers.

### **Aquifer Transmissivity**

By the rule, the preferred method to obtain aquifer properties for wellhead protection delineations is by conducting an aquifer test. Twenty pumping tests were performed for the USGS Modeling study (Delin, 1991). The results of these tests were submitted with an Aquifer Test Plan and the plan was approved under MR4720.5320 subpart 5 was approved on April 25, 2001 for the Prairie du Chien - Jordan Aquifer. The public water supply system also includes wells in other aquifers, the Ironton - Galesville and the Mt. Simon. The aquifer test plans submitted for these wells were approved MR4720.5320 subpart 7 on April 25, 2001.

### **Volume of Water Pumped By Community Wells**

By rule requirements, the historic high pumpage must be used for each well from the last five years, or if projected pumping is higher, then that quantity must be used in the model. For this requirement, the DNR State Water Use Database was queried to obtain reported pumpage from 1999 and 2000. The public water supplier provided the information for the years 2001 through 2003. This information is shown below in Table 2. The highest pumpage for each well within the last five years is highlighted.

**Table 2.**  
**Water Production from Community Wells by Year**  
**(Amounts in Millions of Gallons)**

<b>Well</b>	<b>Aquifer</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
11 (220666)	Prairie du Chien – Jordan	206.7	305.5	<b>384.2</b>	360.5	316.5
12 (220833)	Jordan - Ironton Galesville	10.5	6.4	16.4	1.2	<b>19.5</b>
13 (222525)	Prairie du Chien – Jordan	<b>268.8</b>	152.3	195.3	59.5	88.1
15 (222528)	Prairie du Chien – Jordan	173.5	<b>210.5</b>	85.0	23.9	85.8
17 (220822)	Prairie du Chien - Ironton Galesville	101.4	106.6	97.7	207.6	<b>217.9</b>
18 (222527)	Jordan - Ironton Galesville	235.6	149.5	162.7	<b>241.4</b>	154.7
19 (220681)	Jordan - Ironton Galesville	<b>292.7</b>	205.9	72.8	39.6	116.4
20 (220662)	Prairie du Chien - Mt. Simon	132.3	106.9	<b>181.5</b>	113.8	133.5
21 (220625)	Jordan - Ironton Galesville	28.2	32.2	47.1	67.2	<b>86.2</b>
22 (220818)	Prairie du Chien - Ironton Galesville	<b>302.1</b>	211.0	241.3	164.9	195.3
23 (220660)	Prairie du Chien - Ironton Galesville	<b>212.5</b>	51.1	45.1	43.0	164.6
24 (220819)	Jordan - Ironton Galesville	<b>82.3</b>	68.5	32.8	21.0	38.0
25 (220675)	Prairie du Chien - Ironton Galesville	260.3	217.1	<b>304.9</b>	257.6	155.1
26 (147451)	Prairie du Chien – Jordan	134.9	218.9	<b>227.3</b>	160.2	107.6
27 (224212)	Prairie du Chien – Jordan	302.5	<b>547.4</b>	528.0	507.8	442.6
28 (180567)	Jordan	396.6	493.8	<b>552.2</b>	443.0	446.2
29 (161425)	Jordan	<b>447.9</b>	400.5	285.0	290.0	287.5
30 (239761)	Jordan	310.4	400.4	<b>459.0</b>	427.1	339.8
31 (434041)	Jordan	139.5	209.4	258.8	265.2	<b>275.0</b>
32 (506819)	Jordan	151.3	156.3	161.5	177.1	<b>197.0</b>
33 (220627)	Jordan	0.1	0.5	<b>7.0</b>	1.6	5.1
34 (463536)	Jordan	<b>362.0</b>	331.6	257.3	197.9	193.9
35 (601335)	Jordan	-	-	142.2	292.4	<b>377.5</b>
36 (601336)	Jordan	-	-	-	144.1	<b>384.0</b>
70 (409455)	Jordan	1.4	1.5	1.8	1.9	<b>2.4</b>
71 (219560) Airport	Prairie du Chien – Jordan	17.8	21.9	31.3	40.7	<b>68.8</b>

Well	Aquifer	1999	2000	2001	2002	2003
72 (220628) Sandy Slopes	Jordan	4.1	4.1	4.0	4.0	4.7
73 (228168) Merrihills	Jordan	3.0	2.7	3.1	2.8	4.2

### Other High Capacity Wells

Wells for five other public water suppliers were included in the model as a way to gain some efficiencies in delineating wellhead protection areas for non-community wells. The DNR data set of high capacity wells was also queried for nearby wells that may influence the capture zones of the community wells.

**Table 3.**  
**Water Production from Non-Community Wells**  
**(Gallons Per Minute)**

Wellname	Well id	Unique No.	Discharge
AMPI – 1	A	228636	452
AMPI – 2	B	228365	300
AMPI – 3	C	233030	4
Franklin Htng	D	220664	269
Franklin Htng 2	E	220665	307
IBM	F	220817	97
Leitzen Concrete	G		11
Lenwood Heights	H	220687	10
OSJOR Well Corp.	J	220776	8
Olmsted Cnty 1	K	220784	82
Olmsted Cnty 2	L	220785	85
Peoples Coop	M	220629	5
Birdseye, Art	N	624447	3
Rochester Welding	P	248438	2
Seneca	Q	242118	131
Rochester Golf & CC	R	227828	22
St Marys Hosp.	S	231890	256
Sargents Landscaping	T	119813	24
Superior Service	U	449365	1
Domaille Engineering	V	150217	1
Quest International	W	228150	187
Willow Creek Golf Course	X	120022	31
Mathy Const. 1	Y		226
Mathy Const. 2	Z		230

Theses wells are included in the model and are pumped at their five-year high value also. Other, more distant, high capacity wells were judged to not influence the community wells and as such

were not included in the model. Annual pumping rates were obtained from the DNR water use database (SWUDS) and converted to an average daily rate.

### **Methods Used to Delineate Wellhead Protection Areas**

The input data sets for models used for delineation are on file at the MDH and at RPU and are available on request.

Delineation of the wellhead protection areas for the Prairie du Chien - Jordan Aquifer was performed using a three-layer finite difference model, MODFLOW. This model is described in detail in Delin (1991). The data set used for this model was updated for current pumping conditions and ported to the graphical pre-post processing package, Visual MODFLOW, Version 3.1.

Multi-aquifer wells extending into the deeper Franconia - Ironton Galesville Aquifer were modeled with the US EPA WHPA code by Rochester Public Utility staff with assistance from the MDH. One third of the water pumped from the well was assumed to come from the deeper aquifer based on the contrast in transmissivities of the aquifers.

The multi-aquifer well extending to the Mt. Simon Aquifer was modeled with the MPCA metro model data set for layers 4 and 5. The data set was modified slightly for aquifer thickness and base elevation. The model code used for the delineations was the code MLAEM, Version 5.1.08, written by Dr. Otto Strack at the University of Minnesota, Strack (1989). This code was chosen because of the existing calibrated data set for the Mt. Simon Aquifer in southeastern Minnesota. The amount of water produced by the Mt. Simon was prorated by the contrast in transmissivities of the aquifers penetrated by this well.

The geographic projection and datum for the MODFLOW and WHPA code models is Olmsted County Coordinates. Model distance and time units are in feet and days. These delineations produced by these models were converted to the state standard for GIS, UTM Zone 15 NAD83, for inclusion into state data sets. The metro model data sets are natively in appropriate GIS units and this delineation did not require conversion. The metro model distance and time units are in meters and days.

### **Characteristic Model Assumptions**

The models used to delineate the wellhead protection area is based on several assumptions that affect its applicability to hydrogeologic conditions. These assumptions are listed along with an examination of the impacts on the delineation.

1) The wells are assumed to be screened across the entire thickness of the aquifer. This is not true for the community wells. However, the differences in model results caused by this assumption are not large and disappear within about 600 feet of the wells (twice the thickness of the aquifer).

2) The wells pump at a constant rate and do not turn on and off. This is not true and is a common problem in modeling the spread of ground water contamination. As for modeling

community wells, use of the largest historical pumping rate helps produce a capture zone that includes any part of the aquifer volume affected by the transient effects of cycling pumps.

As the MODFLOW model uses local information for each well, a single “representative” value for base elevation, permeability and thickness for the aquifer as a whole is not appropriate for describing this model. However, for comparison to other regional steady-state regional models, the table below is presented. The range of permeabilities used in the model is shown with a representative value transmissivity for the central portion of the Rochester Basin.

**Table 4.  
Representative Aquifer Properties**

Aquifer	Thickness		Base Elevation		Permeability Range		Transmissivity	Porosity
	Meters	feet	meters	feet	0.3 - 11 m/day	1 - 35 ft/day		
<b>Layers above modeled as a variable infiltration based on cover type</b>								
St. Peter Sandstone	30.5	100	293	960	3.05	10	1000	0.25
Prairie du Chien Group	91.5	300	262	860	2.44	8	2400	0.05
Jordan Sandstone	30.5	100	171	560	2.29	7.5	750	0.25
<b>No-flow boundary representing the St. Lawrence Shale, a regional aquitard.</b>								
Franconia - Ironton - Galesville	73	240	78	245	0.15	0.5	120	0.25
<b>No-flow boundary representing the Eau Claire Shale, a regional aquitard.</b>								
Mt. Simon Sandstone	60	200	-65	-213	4.2	13.8	2760	0.25
<b>No-flow boundary representing undivided Proterozoic rocks, a regional aquitard</b>								

### **Prairie du Chien - Jordan Aquifer**

### **MODFLOW Model Sensitivity Analysis and Calibration**

Delin (1991) describes quite detailed sensitivity analysis and calibration studies performed to validate this model. In this analysis various parameters were changed over reasonable ranges to determine the effect on the model errors. Specifically, the parameters used were recharge from the Decorah edge, hydraulic conductivity and bed conductance of the Zumbro River. It was found that the model was most sensitive to variations in recharge and slightly less sensitive to horizontal hydraulic conductivity and river bed conductance. It is insensitive to changes in vertical hydraulic conductivity. In his analysis, Delin found that the focused recharge from the

Decorah edge is critical for the calibration of the model.

The model calibrates to within 10 feet of water levels collected for the Delin (1991), model.

### **MODFLOW Model Uncertainty Analysis**

The uncertainty analysis of capture zones is the subject of another paper, Delin and Almendinger (1991). Various methods for capture zone analysis were employed and results compared. The MODFLOW model results were most conservative, that is, covered the largest area. The reason for this is the level of detail that the MODFLOW model incorporates particularly in regards to recharge.

### **Franconia Ironton - Galesville Aquifer**

#### **WHPA code sensitivity analysis and calibration**

This model is conservative in that no recharge is assumed. The input parameters, flow direction, gradient and permeability are the only variables in this model. The model results are quite sensitive to variations in these parameters. The sensitivity of this model and the use of regional values for input parameters cause there to be a larger uncertainty associated with the delineation.

#### **WHPA code Model Uncertainty Analysis**

Two ground water flow directions and gradients were used to account for uncertainty in flow direction, Figure 35. Aquifer permeability was varied by +/- 50% in model runs to account for uncertainty in permeability. The results for the runs were composited to make the wellhead protection area for the Franconia - Ironton Galesville Aquifer.

### **Mt. Simon Aquifer**

#### **Metro Model sensitivity analysis and calibration**

The regional direction of ground water flow in the Mt. Simon Aquifer in the Rochester area is shown in Figure 36. Seaberg (2000) and Hansen and Seaberg (2000) describe the sensitivity analysis and calibration process used for this model. As with the MODFLOW model, the model for the Mt. Simon is most sensitive to recharge and discharge (river bed) resistance. The permeability of the St. Simon Aquifer is fairly uniform over a large area and does not vary significantly in tests from the Metro Area south to the City of Winona. (MDH, 2001) Therefore, the range of reasonable transmissivity for this unit is estimated at 2760 ft<sup>2</sup>/day plus or minus 10 percent.

#### **Metro Model Uncertainty Analysis**

The deep confined conditions, low ground water gradient and consistent aquifer properties produce a low uncertainty for delineations in this aquifer. The largest uncertainty is results from the estimate of discharge from the aquifer.

## Capture Zone Analysis

Capture zones were developed for the community wells for a range of times of travel, from one to ten years for all of the models.

### **Delineation of the emergency response zone (one year time of travel)**

The rule requires that a one year time of travel be delineated so as to serve as an emergency response zone for the community wells. These areas are shown on odd numbered figures, Figure 37 through 92, one figure for each well in the system.

### **Wellhead Protection Area Delineation**

The longer time of travel zones define the wellhead protection area for each well. When the wells are spaced in such a way that the capture zones merge, then one area of contribution is defined. The composite ten-year Wellhead Protection Areas delineated for the community wells are also shown on the odd numbered figures, Figures 37 through 92. Ten years is a minimum time of travel required in the rule. For multi-aquifer wells, this composite is the overlay of capture zones computed for the different aquifers. Additional requirements for a surface water component are included for vulnerable wells based on the amount of geological protection over the aquifer confirmed with ground water age dating.

### **Surface Water Component Delineation**

The rule requires the inclusion of a surface water component to the wellhead protection area if the well is considered vulnerable to contamination. The surface water component is the area of overland flow that is upgradient or uphill of the delineated well capture zone. Several wells are considered vulnerable based on water chemistry and ground water age dating. Table 5, below, shows the wells for which a surface water component of the wellhead protection area is required. The aquifer vulnerability assessment from which the list of vulnerable well was taken is shown in Table 6.

**Table 5. Delineations with a Surface Water Component**

<b>MN Unique Number</b>	<b>Well Name</b>	<b>Aquifer</b>
<b>220666</b>	<b>11</b>	<b>Prairie du Chien – Jordan</b>
<b>220833</b>	<b>12</b>	<b>Jordan - Ironton Galesville</b>
<b>222525</b>	<b>13</b>	<b>Prairie du Chien – Jordan</b>
<b>222527</b>	<b>18</b>	<b>Jordan - Ironton Galesville</b>
<b>220681</b>	<b>19</b>	<b>Jordan - Ironton Galesville</b>
<b>220662</b>	<b>20</b>	<b>Prairie du Chien - Mt. Simon</b>
<b>220818</b>	<b>22</b>	<b>Prairie du Chien - Ironton Galesville</b>
<b>147451</b>	<b>26</b>	<b>Prairie du Chien – Jordan</b>
<b>224212</b>	<b>27</b>	<b>Prairie du Chien – Jordan</b>

<b>MN Unique Number</b>	<b>Well Name</b>	<b>Aquifer</b>
<b>180567</b>	<b>28</b>	<b>Jordan</b>
<b>239761</b>	<b>30</b>	<b>Jordan</b>
<b>434041</b>	<b>31</b>	<b>Jordan</b>
<b>506819</b>	<b>32</b>	<b>Jordan</b>

The surface water component of the delineation for these wells was straightforward except in the cases of Wells #11 and #27. For these wells the surface water contribution area delineation was modified based on additional information.

A larger surface water component for Rochester #27 was included because of Prairie du Chien exposures in bed of Silver Creek. To verify the possibility of the connection of ground water to surface water, a preliminary stream gauging study was performed on the Silver Creek drainage close to well #27 in the fall of 2002. The gauging study showed that there was a significant loss in stream flow over this reach while the well was pumping. The implication is that the surface waters directly impact the ground water in the area close to the well and that the quality of the surface waters is a concern for this well.

A smaller surface water component for Rochester #11 was delineated because water chemistry information indicates that 1) the amount of surface water recharging the aquifer from the Zumbro River in the reach is minimal or 2) that the assimilative capacity of the materials sealing the fractures in the bedrock where they intersect the river is high enough to prevent detectable levels of nitrate and pesticides in the water from Well #11. It is well established that Well #11 intercepts ground water from the other side of the Zumbro River because of detectable levels of volatile organic chemicals known to have been spilled on the opposite side.

### **DRINKING WATER SUPPLY MANAGEMENT AREA (DWSMA) DELINEATION**

This portion of the Wellhead Protection Plan documents the delineation of the drinking water supply management areas for the City of Rochester, Minnesota (City). These delineations were prepared in accordance with the Wellhead Protection Rule, MR 4720.5100 to 4720.5590 (rule). Rochester Public Utilities was responsible for the DWSMA delineation and used land parcel maps, topographic features, and the ten-year well capture zones to delineate this boundary. All properties directly overlying the capture zones of the wells were included in the DWSMA.

The Drinking Water Source Management Area(s) are shown on the odd numbered figures, Figures 37 through 92. This is the area that can be easily identified using local landmarks and includes all of the wellhead protection area(s) for each well. This is the area where activities of the second phase of the wellhead plan will be concentrated.

### **Recommendations for Future Refinements and Use of the Model as a Planning Tool**

This model could be improved by the collection of accurate long term water level data in and around Rochester. Further stream gauging efforts to document the connection surface waters to ground water and the Prairie du Chien - Jordan Aquifer system would also be very helpful.

Additional isotopic data is in the process of being collected. As the model stands, it is a valuable tool to predict the impacts of changes in pumping for industry and agriculture or other large-scale land use changes in the area.

## VULNERABILITY ASSESSMENT

### Well Vulnerability

The well vulnerability assessments generated by the MDH Public Water Supply database are referenced in the Appendix. The construction information available for the wells indicates that they meet current construction standards specified in the state well code. Therefore, these wells are not considered vulnerable to potential contamination sources due to their construction.

### Aquifer Vulnerability

The large number of wells used for public water supply and the varied geological setting over the Rochester Basin cause there to be significant differences between the vulnerability of wells in the system. The aquifer vulnerability assessment for each well is presented below in Table 6. The Prairie du Chien and Jordan Aquifers are generally considered to be vulnerable to contamination. Deeper aquifers, the Franconia - Ironton Galesville and Mt. Simon are considered to be not vulnerable by virtue of protective low permeability layers.

For wells constructed in vulnerable aquifers and where well construction records indicate a large cumulative thickness of clay-rich deposits between the ground surface and the aquifer there is a lower chance of contamination of the water from surface land uses. However, because of peculiarities of the ground water flow system in the Rochester Basin, the depth of burial of the aquifer is not as reliable indicator of vulnerability as in other hydrogeological settings. Therefore, water age dating and chemistry indicators of vulnerability are very important for an accurate assessment. Several wells are considered vulnerable based on water chemistry and ground water age dating. The opposite is also true, that some wells presumed to be vulnerable because of the geological setting have proved to contain older water and are thus regarded as being protected from most sources of contamination.

In general, the wells can be grouped as having a high, moderate, or low vulnerability to contamination by the types of geological protection present at the well site and water quality indicators found in the well water.

#### Aquifer Vulnerability Types:

- High - Little to no clay or other protective low permeability material between the aquifer and the ground surface and indication of susceptibility to contamination by the presence of various chemicals or Tritium.
- Moderate - Some overlying materials which may be protective and/or no chemical detections or Tritium in the well water.
- Low - Forty or more feet of low permeability materials are present and/or no chemicals

or Tritium have been detected.

**Table 6.**  
**Aquifer Vulnerability Assessment**

MN Unique Number	Well Name	Aquifer	First Bedrock	Feet to Bedrock	Feet of clay in drillers log	Tritium	Nitrate	Chemical Detections	Aquifer Vulnerability
220666	11	Prairie du Chien - Jordan	Opdc	15	0	3.9	x	x	high
220833	12	Jordan - Ironton Galesville	Opdc	51	0	4.6	x	x	high
222525	13	Prairie du Chien - Jordan	Opdc	6	5	11.4	1.1	No	high
222528	15	Prairie du Chien - Jordan	Opdc	40	x	6.5	<0.4	x	high
220822	17	Prairie du Chien - Ironton Galesville	Ostp	0	0	1.4	<1.0	x	moderate
222527	18	Jordan - Ironton Galesville	Ostp	4	0	7.1	<1.0	Yes	high
220681	19	Jordan - Ironton Galesville	Ostp	0	0	9.3	<1.0	Yes	high
220662	20	Prairie du Chien - Mt. Simon	Opdc	70	x	6.9	<1.0	Yes	high
220625	21	Jordan - Ironton Galesville	Odec	0	18	< 0.8	<0.1	No	low
220818	22	Prairie du Chien - Ironton Galesville	Opdc	32	x	9.3	<1.0	x	high
220660	23	Prairie du Chien - Ironton Galesville	Opdc	20	x	< 0.8	<0.4	No	low
220819	24	Jordan - Ironton Galesville	Opdc			1.3			low
220675	25	Prairie du Chien - Ironton Galesville	Opdc	65	x	< 0.8	<1.0	No	low
147451	26	Prairie du Chien - Jordan	Opvl	82	x	14.5	0.8	x	high
224212	27	Prairie du Chien - Jordan	Opdc	32	x	9.5	<0.1	No	high
180567	28	Jordan	Opdc	24	x	3	<0.1	Yes	high
161425	29	Jordan	Ostp	18	x	1.8	0.1	No	moderate
239761	30	Jordan	Opdc	5	x	7.4	0.2	No	high
434041	31	Jordan	Ostp	27	x	2.5	x	x	high
506819	32	Jordan	Odc	5	x	4.4	<0.4	No	high

MN Unique Number	Well Name	Aquifer	First Bedrock	Feet to Bedrock	Feet of clay in drillers log	Tritium	Nitrate	Chemical Detections	Aquifer Vulnerability
220627	33	Jordan	Odcr	2	58	2.6	<0.4	No	moderate
463536	34	Jordan	Ostp	86	x	1.8	<0.4	No	moderate
601335	35	Jordan	Opdc	40	x	3.8	x	x	high
601336	36	Jordan	Opdc	77	25	x	x	x	moderate
409455	70	Jordan	Odcr	20	x	<0.8	0.1	x	low
219560	71	Prairie du Chien - Jordan	Ogal	36	x	<0.8	<0.1	x	low
220628	72	Jordan	Ostp	40	x	<0.8	x	x	low
228168	73	Jordan	Ogal	20	0	<0.8	x	x	low

Key: x = unknown

Ogal Galena Group

Odcr Decorah Shale

Opvl Plateville Limestone

Ostp St. Peter Sandstone

Opdc Prairie du Chien Group

### DWSMA Vulnerability

In addition, each of the DWSMAs were analyzed for the vulnerability of the groundwater. This was done with respect to the soils, geology, and hydrology of the area. The area of each DWSMA was overlain by the landform data to determine the sensitivity to infiltration. These maps are shown on even numbered figures for each well in the system, Figures 37 through 92.

#### Well #11 (220666)

Aquifer vulnerability

High - because of the lack of the low permeability clay layers between bedrock and clay layers. There are 3.9 tritium units detected in the well water.

DWSMA vulnerability

Low to High vulnerability. Low where soils are developed on younger bedrock and high where soils are developed on alluvium and river terrace deposits, Figure 38.

#### Well #12 (220833)

Aquifer vulnerability

High - because of lack of protective clay layers. There were 4.6 tritium units detected in the well water.

DWSMA vulnerability

High - because of permeable soils developed on river terrace and alluvial deposits, Figure 40.

**Well #13 (222525)**

Aquifer vulnerability

High - because there is no protective clay from the bedrock to the surface.

DWSMA vulnerability

High - permeable soils are developed on river terrace deposits and shallow St. Peter bedrock, Figure 42.

**Well #15 (222528)**

Aquifer vulnerability

High - because there are 6.5 tritium units detected in the well water.

DWSMA vulnerability

Vulnerability is low because of the low permeability soils developed on till, Figure 44.

**Well #17 (220822)**

Aquifer vulnerability

Moderate - Tritium was found at 1.4 TU in the well water.

DWSMA vulnerability

Moderate to Low - moderately vulnerable where the St. Peter exists and low vulnerability where younger bedrock exists, Figure 46.

**Well #18 (222527)**

Aquifer vulnerability

High - because of lack of protective clay layers. There were 7.1 tritium units detected in the well water.

DWSMA vulnerability

High - because of permeable soils developed on alluvium and St. Peter sandstone, Figure 48.

**Well #19 (220681)**

Aquifer vulnerability

High - because of lack of protective clay layers. There were 9.3 tritium units detected in the well water.

DWSMA vulnerability

Low to Moderate - low where soils are developed on glacial till and moderate where soils are developed on the St. Peter Sandstone, Figure 50.

**Well #20 (220662)**

Aquifer vulnerability

High - because of lack of protective clay layers. There were 6.9 tritium units detected in the well water.

DWSMA vulnerability

High - because of permeable soils developed on alluvium, river terrace, and shallow bedrock, Figure 52.

**Well #21 (220625)**

Aquifer vulnerability

Low - because of protective low permeability bedrock layers. Tritium is not detectable.

DWSMA vulnerability

Low - because of soils developed on low permeability bedrock, Figure 54.

**Well #22 (220818)**

Aquifer vulnerability

High - because the existing till between the surface and the 1<sup>st</sup> bedrock is inadequate protection from the lateral movement of recently recharge ground water. There are 9.3 tritium units detected in the well water.

DWSMA vulnerability

Low - because of the soils developed on clay, Figure 56.

**Well #23 (220660)**

Aquifer vulnerability

The vulnerability is low because of the tritium was not detected even though there is no protective clay layers between bedrock and surface.

DWSMA vulnerability

High - because of permeable soils developed on alluvium and river terrace deposits, Figure 58.

**Well #24 (220819)**

Aquifer vulnerability

Moderate - because of the low levels of tritium (1.3 TU) in the water.

DWSMA vulnerability

Moderate - because of the permeable soils developed on bedrock and alluvium, Figure 60.

**Well #25 (220675)**

Aquifer vulnerability

Low - because tritium was not detected in the well water even though there are no protective clay layers between bedrock and the surface.

DWSMA vulnerability

High - because of permeable soils developed on river terrace deposits, Figure 62.

**Well #26 (147451)**

Aquifer vulnerability

High - because of the 14.5 tritium units even though there is protective younger bedrock between the surface and the aquifer.

DWSMA vulnerability

High - vulnerability because of permeable soils developed on younger bedrock, Figure 64.

**Well #27 (224212)**

Aquifer vulnerability

High - because of lack of protective clay layers. There were 9.5 tritium units detected in the well water.

DWSMA vulnerability

Low to High - low vulnerability where soils are developed on glacial till and younger bed rock layers, moderately vulnerable where soils are developed on the shallow St. Peter bedrock and river terrace deposits, and highly vulnerable where soils are developed on the alluvium, Figure 66.

**Well #28 (180567)**

Aquifer vulnerability

High - because of the lack of low permeability clay or younger bedrock layers over most the area. There are 3 tritium units detected in the well water.

DWSMA vulnerability

Low to High - depending on the soil type. The low vulnerability area has soils developed on glacial till. The areas of high permeability soils developed on glacial outwash, river terrace deposits, and alluvium have a high vulnerability, Figure 68.

**Well #29 (161425)**

Aquifer vulnerability

Moderate - because of the concentration of tritium (1.8 TU) in the water. Low permeability younger bedrock layers exist over parts of the area.

DWSMA vulnerability

The vulnerability is high because of permeable soils developed on shallow bedrock, Figure 70.

**Well #30 (239761)**

Aquifer vulnerability

High - because of lack of low permeability clay layers. There were 7.4 tritium units detected in the well water.

DWSMA vulnerability

Moderate to High - moderate where soils are developed on younger bedrock and high where developed on river terrace and alluvium layers, Figure 72.

**Well #31 (434041)**

Aquifer vulnerability

High - because of lack of low permeability clay layers. There were 2.5 tritium units detected in the well water.

DWSMA vulnerability

Moderate to High - moderate where soils are developed on younger bed rock and high where soils are developed on St. Peter Sandstone and river terrace and alluvium, Figure 74.

**Well #32 (506819)**

Aquifer vulnerability

High - because of lack of low permeability clay layers. There are 4.4 tritium units detected in the well water.

DWSMA vulnerability

Moderate to High - moderate where soils are developed on younger bedrock and high where developed on St. Peter Sandstone and alluvium, Figure 76.

**Well #33 (220627)**

Aquifer vulnerability

Moderate - because of the presence of younger bedrock layers. Tritium was detected at 2.6 TU.

DWSMA vulnerability

Moderate - because of lower permeability soils developed on younger bedrock layers, Figure 78.

**Well #34 (463536)**

Aquifer vulnerability

Moderate - because of protective clay layers between the 1<sup>st</sup> bedrock and the surface. There are 1.8 tritium units detected in the well water.

DWSMA vulnerability

Low to High - low where soils are developed on till and high where soils are developed on alluvium, Figure 80.

**Well #35 (601335)**

Aquifer vulnerability

High - because presence of protective clay layers. There are 3.6 tritium units detected in the well water.

DWSMA vulnerability

High - because of low permeability soils developed on glacial till, Figure 82.

**Well #36 (601336)**

Aquifer vulnerability

Moderate - because presence of clay layers at the well site.

DWSMA vulnerability

Moderate to High - moderate where developed on shallow bed rock and high where developed on river terrace and alluvial deposits, Figure 84.

**Well #70 (409455)**

Aquifer vulnerability

Low - because of the presence of low permeability younger bedrock layers. The tritium in the well water was less than 0.8 tritium units, not detectable.

DWSMA vulnerability

Low to High - low where soils are developed on low permeability bedrock layers and high where developed on alluvium, Figure 86.

**Well #71 (219560)**

Aquifer vulnerability

Low - because of the presence of low permeability younger bedrock layers. The tritium in the well water was less than 0.8 tritium units, not detectable.

DWSMA vulnerability

Low - because of low permeability soils developed on glacial till, Figure 88.

**Well #72 (220628)**

Aquifer vulnerability

Low - the tritium in the well water was less than 0.8 tritium units, not detectable. There is a lack of low permeability younger bedrock layers or clay over the aquifer to support the low vulnerability.

DWSMA vulnerability

Low to High - low where soils are developed on younger bedrock layers and high where developed on permeable St. Peter Sandstone and river terrace deposits, Figure 90.

**Well #73 (228168)**

Aquifer vulnerability

Low - because of presence of low permeability younger bed rock layers. The tritium in the well water was less than 0.8 tritium units, not detectable.

DWSMA vulnerability

Low - because of low permeability soils developed on glacial till, Figure 92.

## References:

- Balaban, N.H. and Olsen, B.M. (1988), Geologic atlas of Olmsted County, Minnesota., Minnesota Geological Survey Document C-3, 9 pls. Scale 1:100,000.
- Delin, G. N. (1991), Hydrogeology and Simulation of Ground Water Flow in the Rochester Area, Southeastern Minnesota, 1987-88, US Geological Survey Water-Resources Investigations Report 90-4081
- Delin, G. N. and Almendinger, J.E. (1991), Delineation of Recharge Areas for Selected Wells in the St.Peter -Paririe du Chien-Jordan Aquifer, Rochester, Minnesota, 1987-88, US Geological Survey Open-File Report 90-397.
- Delin, G.N., and D.G. Woodward. (1984). Hydrogeologic Setting and the Potentiometric Surfaces of Regional Aquifers in the Hollandale Embayment, Southeastern Minnesota, 1970-80, U.S. Geological Survey Water-Supply Paper 2219, 56 p.
- Hansen, D.D. and J.K. Seaberg, (2000). Lower Aquifers Model, Layers 4 and 5, Ver. 1.00, Metropolitan Area Groundwater Model Project Summary, <http://www.pca.state.mn.us/water/groundwater/mm-layer45.pdf>, 76 p.
- Minnesota Department of Health (2001) Memo to file: Analysis of the Winona #16 (486405) Aquifer test, April 4, 2001, Confined Mt. Simon Aquifer
- R. Kanavetsky (1978), Bedrock Hydrogeology, Minnesota Geological Survey, Map S-2.
- Paillet, F.L. et. al. (2000) Hydrogeologic Characterization of Six Sites in Southeastern Minnesota Using Borehole Flowmeters and Other Geophysical Logs, USGS Water-Resources Investigations Report 00-4142., pp. 33.
- Ruhl, J.F., Wolf, R.J. and Adolphson, D.G. (1982) Hydrogeologic and Water-Quality Characteristics of the Ironton-Galesville Aquifer, Southeast Minnesota, US Geological Survey Water-Resources Investigations Report 82-4080
- Runkel, A.C. (1996) Geologic Investigations Applicable to Ground-Water Management, Rochester Metropolitan Area, Minnesota, Minnesota Geological Survey Open-File Report 96-1.
- Runkel, A.C. and Mossler, J.H. (2001) Hydrostratigraphic and Hydraulic Characterization of Paleozoic Bedrock at Nine Southeastern Minnesota Communities: Research in Support of Wellhead Protection, Minnesota Geological Survey Open-File Report 01-1.
- Schoenberg, M.E., 1990. Effects of Present and Projected Ground-Water Withdrawals on the Twin Cities Aquifer System, Minnesota, USGS Water Resources Investigations Report, 90-4001.
- Seaberg, J.K., 2000. Overview of the Twin Cities Metropolitan Groundwater Model, Ver. 1.00, Metropolitan Area Groundwater Model Project Summary,

<http://www.pca.state.mn.us/water/groundwater/mm-overview.pdf>, 62 p.

Strack, O.D.L., 1989, Groundwater Mechanics, Prentice Hall, Englewood Cliffs, New Jersey, 732p.

US E.P.A. (1993), WHPA Version 2.2, <http://www.epa.gov/ada/csmos/models/whpa.html>

Wolf, R.J., Ruhl, J.F., and Adolphson, D.G., (1983) Hydrogeologic and Water Quality Characteristics of the Mt. Simon-Hinkley Aquifer, Southeast Minnesota, US Geological Survey Water-Resources Investigations Report 83-4031.

Woodward, D.G. (1986) Hydrogeologic Framework and Properties of Regional Aquifers in the Hollandale Embayment, Southeastern Minnesota, US Geological Survey Atlas, HA-667 Scale 1:1,000,000.

# Figures

# Appendix

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Merrihills Well

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00228168

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 14 SECTION: 15 QUARTERS: CDCD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating: H L	Score: 0	vulnerable
Geologic Data From	Other	
Year Constructed	1965	
Construction Method	Unknown	5
Casing Depth	575	0
Well Depth	675	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Not Applicable	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	Unknown	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	60	5
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.4 02/06/1990	0
Maximum tritium detected	Unknown	0
Carbon-14 age	Unknown	0

Wellhead Protection Score : 15  
Wellhead Protection Vulnerability Rating: VULNERABLE

COMMENTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Sandy Slopes Well

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220628

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 13 SECTION: 9 QUARTERS: DDAC

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating: H L	Score: 0	vulnerable
Geologic Data From	Other	
Year Constructed	1968	
Construction Method	Unknown	5
Casing Depth	375	5
Well Depth	460	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	208	5
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.4 03/19/1990	0
Maximum tritium detected	Unknown	0
Carbon-14 age	Unknown	0
Wellhead Protection Score		20
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #11

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220666

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 14 SECTION: 2 QUARTERS: CADA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN-JORDAN	
DNR Geologic Sensitivity Rating: H L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1948	
Construction Method	Unknown	5
Casing Depth	140	10
Well Depth	455	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Not Applicable	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	954	10
Non-THMS VOCs detected?	No	0
Pesticides detected?	No	0
Maximum nitrate detected	<0.4 12/01/1973	0
Maximum tritium detected	3.9	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		30
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS  
WELL OPEN TO CSTL

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #12

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220833

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 36 QUARTERS: ADDA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: H L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1960	
Construction Method	Unknown	5
Casing Depth	305	5
Well Depth	752	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Not Applicable	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	978	10
Non-THMS VOCs detected?	Cis-1,2-Dichloroethylene 05/13/1991	vulnerable
Pesticides detected?	No	0
Maximum nitrate detected	<0.1 09/27/1994	0
Maximum tritium detected	4.6	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		25
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #13

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00222525

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 26 QUARTERS: DADA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN-JORDAN	
DNR Geologic Sensitivity Rating: VH L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1954	
Construction Method	Unknown	5
Casing Depth	141	10
Well Depth	442	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Unknown	5
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	978	10
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	1.1 07/09/1997	10
Maximum tritium detected	11.4	vulnerable
Carbon-14 age	Modern	0

Wellhead Protection Score : 45  
Wellhead Protection Vulnerability Rating: VULNERABLE

COMMENTS  
WELL OPEN TO CSTL

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #15

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00222528

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 27 QUARTERS: BABB

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN-JORDAN	
DNR Geologic Sensitivity Rating: M L	Score: 0	25
Geologic Data From	Well Record	
Year Constructed	1957	
Construction Method	Unknown	5
Casing Depth	154	10
Well Depth	432	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Unknown	5
All casings extend to land surface?	Unknown	5
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	Unknown	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1033	20
Non-THMS VOCs detected?	Unknown	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.4 12/01/1973	0
Maximum tritium detected	Unknown	0
Carbon-14 age	Unknown	0
Wellhead Protection Score		75
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS  
SENSITIVITY OF DRIFT MATERIAL ESTIMATED FROM OLMSTED CO.

GEOLOGIC ATLAS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #16

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220827

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 32 QUARTERS: DADC

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	IRONTON GALESVILLE - MT. SIMON	
DNR Geologic Sensitivity Rating: L L	Score: 4	15
Geologic Data From	Well Record	
Year Constructed	1958	
Construction Method	Unknown	5
Casing Depth	532	0
Well Depth	1045	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Not Applicable	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	417	5
Non-THMS VOCs detected?	Unknown	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<1.0 12/01/1973	not vulnerable
Maximum tritium detected	<0.8	not vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		25
Wellhead Protection Vulnerability Rating:		NOT VULNERABLE

COMMENTS  
CSTL-CMTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #17

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220822

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 26 QUARTERS: BCAA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: H L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1960	
Construction Method	Cable Tool/Bored	0
Casing Depth	429	0
Well Depth	904	
Casing grouted into borehole?	Unknown	0
Cement grout between casings?	Unknown	5
All casings extend to land surface?	Unknown	5
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	600	10
Non-THMS VOCs detected?	Unknown	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<1.0 12/01/1973	0
Maximum tritium detected	1.4	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		20
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #18

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00222527

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 34 QUARTERS: DCCA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: VH L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1963	
Construction Method	Unknown	5
Casing Depth	340	5
Well Depth	806	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Unknown	5
All casings extend to land surface?	Unknown	5
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	Unknown	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	759	10
Non-THMS VOCs detected?	Trichloroethylene	09/27/1990 vulnerable
Pesticides detected?	Unknown	0
Maximum nitrate detected	<1.0 12/01/1973	0
Maximum tritium detected	7.1	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		35
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS  
CJDN-CECR

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #19

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220681

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 14 SECTION: 12 QUARTERS: CBBC

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: VH L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1963	
Construction Method	Unknown	5
Casing Depth	343	5
Well Depth	881	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Not Applicable	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	952	10
Non-THMS VOCs detected?	1,2-Dichloropropane 09/25/1990	vulnerable
Pesticides detected?	Unknown	0
Maximum nitrate detected	<1.0 12/01/1973	0
Maximum tritium detected	9.3	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		25
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS  
CJDN-CECR

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #20

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220662

COUNTY: Olmsted TOWNSHIP NUMBER: 104 RANGE: 14 SECTION: 1 QUARTERS: BBBC

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN - MT. SIMON	
DNR Geologic Sensitivity Rating: H L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1964	
Construction Method	Unknown	5
Casing Depth	299	5
Well Depth	912	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1069	20
Non-THMS VOCs detected?	Tetrachloroethylene 09/25/1990	vulnerable
Pesticides detected?	Unknown	0
Maximum nitrate detected	<1.0 12/01/1973	0
Maximum tritium detected	6.9	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		30
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS  
CJDN-CMTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #21

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220625

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 13 SECTION: 5 QUARTERS:

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: VL L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1965	
Construction Method	Unknown	5
Casing Depth	458	0
Well Depth	981	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Not Applicable	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	550	10
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.1 12/09/1993	not vulnerable
Maximum tritium detected	<0.8	not vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		20
Wellhead Protection Vulnerability Rating:		NOT VULNERABLE

COMMENTS

CJDN-CECR, VL SCORE BASED ON PRESENCE OF ODCR + OGWD

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #22

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220818

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 22 QUARTERS: BBDA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: M L	Score: 0	25
Geologic Data From	Well Record	
Year Constructed	1966	
Construction Method	Rotary/Drilled	0
Casing Depth	344	5
Well Depth	730	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Unknown	5
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	744	10
Non-THMS VOCs detected?	Unknown	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<1.0 12/01/1973	0
Maximum tritium detected	9.3	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		50
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS

CJDN-CECR, GEOLOGIC SENSITIVITY OF DRIFT ESTIMATED FROM ATLAS

OLMSTED CO. GEOLOGIC

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #23

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220660

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 14 SECTION: 1 QUARTERS: DBDC

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: VH L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1967	
Construction Method	Unknown	5
Casing Depth	326	5
Well Depth	806	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Unknown	5
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	976	10
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.4 12/01/1973	not vulnerable
Maximum tritium detected	<0.8	not vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		30
Wellhead Protection Vulnerability Rating:		NOT VULNERABLE

COMMENTS  
CJDN-CECR

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #24

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220819

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 23 QUARTERS: CDAD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: VH L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1968	
Construction Method	Rotary/Drilled	0
Casing Depth	309	5
Well Depth	685	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Not Applicable	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1070	20
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<1.0 12/01/1973	0
Maximum tritium detected	1.3	vulnerable
Carbon-14 age	Unknown	0

Wellhead Protection Score : 30  
Wellhead Protection Vulnerability Rating: VULNERABLE

COMMENTS  
CJDN-CECR

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #25

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220675

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 14 SECTION: 10 QUARTERS: AAAB

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN - IRONTON GALESVILLE	
DNR Geologic Sensitivity Rating: H L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1969	
Construction Method	Unknown	5
Casing Depth	343	5
Well Depth	850	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1306	20
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<1.0 12/01/1973	not vulnerable
Maximum tritium detected	<0.8	not vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		30
Wellhead Protection Vulnerability Rating:		NOT VULNERABLE

COMMENTS

CJDN-CECR, GEOLOGIC SENSITIVITY OF DRIFT ESTIMATED FROM ATLAS

OLMSTED CO. GEOLOGIC

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #26

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00147451

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 32 QUARTERS: CDAA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN-JORDAN	
DNR Geologic Sensitivity Rating: L L	Score: 1	20
Geologic Data From	Well Record	
Year Constructed	1978	
Construction Method	Cable Tool/Bored	0
Casing Depth	364	5
Well Depth	624	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1087	20
Non-THMS VOCs detected?		vulnerable
Pesticides detected?	Unknown	0
Maximum nitrate detected	0.8 06/12/1996	0
Maximum tritium detected	14.5	vulnerable
Carbon-14 age	Modern	0
Wellhead Protection Score		45
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS

WELL OPEN TO CSTL, GEOLOGIC SENSITIVITY OF L BASED ON

PRESENCE OF OGWD

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #27

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00224212

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 13 SECTION: 31 QUARTERS: BCCD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN-JORDAN	
DNR Geologic Sensitivity Rating: H L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1979	
Construction Method	Cable Tool/Bored	0
Casing Depth	345	5
Well Depth	448	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1200	20
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.1 12/09/1993	0
Maximum tritium detected	9.5	vulnerable
Carbon-14 age	Unknown	0

Wellhead Protection Score : 25  
Wellhead Protection Vulnerability Rating: VULNERABLE

COMMENTS

WELL OPEN TO CSTL, GEOLOGIC SENSITIVITY OF DRIFT ESTIMATED  
ATLAS AND WELL 220783 IN CWI

FROM OLSMTED CO.

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #28

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00180567

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 15 QUARTERS:

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating: M L	Score: 0	25
Geologic Data From	Well Record	
Year Constructed	1981	
Construction Method	Cable Tool/Bored	0
Casing Depth	305	5
Well Depth	389	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1200	20
Non-THMS VOCs detected?	Trichloroethylene	09/27/1990 vulnerable
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.1 12/09/1993	0
Maximum tritium detected	3.0	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		50
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS

MODERATE RATING BASED ON ASSUMPTION THAT MUD DESCRIBED IN  
TILL OR JUST LOESS

LOG IS LOESS OVER

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #29

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00161425

COUNTY: Olmsted                      TOWNSHIP NUMBER:                      RANGE:                      SECTION:                      QUARTERS:

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating:	H L Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1982	
Construction Method	Cable Tool/Bored	0
Casing Depth	422	0
Well Depth	519	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1200	20
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	: 0.1 10/20/1986	0
Maximum tritium detected	: 1.8 10/20/1986	vulnerable
Carbon-14 age	: Unknown	0

Wellhead Protection Score : 20  
Wellhead Protection Vulnerability Rating: VULNERABLE

COMMENTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #30

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00239761

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 36 QUARTERS: ABBC

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating: H L	Score: 0	0
Geologic Data From	Well Record	
Year Constructed	1984	
Construction Method	Unknown	5
Casing Depth	319	5
Well Depth	402	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	0	0
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	0.2 10/20/1986	0
Maximum tritium detected	7.4 10/20/1986	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		10
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #32

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00506819

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 13 SECTION: 30 QUARTERS: AC

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating: L L	Score: 1	20
Geologic Data From	Well Record	
Year Constructed	1989	
Construction Method	Rotary/Drilled	0
Casing Depth	453	0
Well Depth	540	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	0	0
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.4 09/19/1990	0
Maximum tritium detected	4.4	vulnerable
Carbon-14 age	Unknown	0

Wellhead Protection Score : 20  
Wellhead Protection Vulnerability Rating: VULNERABLE

COMMENTS  
L RATING BASED ON PRESENCE OF OGWD

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #33 Rose Harbor

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00220627

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 13 SECTION: 8 QUARTERS: BBDD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating: VL L	Score: 5	15
Geologic Data From	Well Record	
Year Constructed	1958	
Construction Method	Rotary/Drilled	0
Casing Depth	509	0
Well Depth	605	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	375	5
Non-THMS VOCs detected?	No	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.4 04/01/1982	0
Maximum tritium detected	2.6	vulnerable
Carbon-14 age	Unknown	0
Wellhead Protection Score		20
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS  
L SCORE DOES NOT REFLECT PRESENCE OF OGWD

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #34

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00463536

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 17 QUARTERS: ACDD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating: L L	Score: 0	20
Geologic Data From	Well Record	
Year Constructed	1991	
Construction Method	Cable Tool/Bored	0
Casing Depth	369	5
Well Depth	465	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	1200	20
Non-THMS VOCs detected?	No	0
Pesticides detected?	No	0
Maximum nitrate detected	<0.4	0
Maximum tritium detected	Unknown	0
Carbon-14 age	Unknown	0
Wellhead Protection Score		45
Wellhead Protection Vulnerability Rating:		VULNERABLE

COMMENTS

GEOLOGIC SENSITIVITY RATING BASED ON OLMSTED COUNTY ATLAS, DRIFT DESCRIPTION IN WELL RECORD INADEQUATE FOR PROVIDING L SCORE. NITRATE DETECTION LIMIT SHOWN A GUESS, HALVERSON SAYS NO NO3 DETECTED BY CITY.

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #35

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00601335

COUNTY: Olmsted TOWNSHIP NUMBER: 107 RANGE: 14 SECTION: 20 QUARTERS: AAAD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN-ST. LAWRENCE	
DNR Geologic Sensitivity Rating: H L	Score: 0	vulnerable
Geologic Data From	Well Record	
Year Constructed	1999	
Construction Method	Rotary/Drilled	0
Casing Depth	369	5
Well Depth	457	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	2000	20
Non-THMS VOCs detected?	Unknown	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	Unknown	0
Maximum tritium detected	Unknown	0
Carbon-14 age	Unknown	0

Wellhead Protection Score : 25  
Wellhead Protection Vulnerability Rating: VULNERABLE

COMMENTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #36

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00601336

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 14 SECTION: 4 QUARTERS: CD

CRITERIA	DESCRIPTION	POINTS
-----	-----	-----
Aquifer Name :	JORDAN-ST. LAWRENCE	
DNR Geologic Sensitivity Rating: M L	Score: 0	25
Geologic Data From :	Well Record	
Year Constructed :	2000	
Construction Method :	Rotary/Drilled	0
Casing Depth :	397	5
Well Depth :	478	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	2030	20
Non-THMS VOCs detected?	Unknown	0
Pesticides detected?	Unknown	0
Maximum nitrate detected :	Unknown	0
Maximum tritium detected :	Unknown	0
Carbon-14 age :	Unknown	0
Wellhead Protection Score :		50
Wellhead Protection Vulnerability Rating:		VULNERABLE
Assessed By:		WALSHJ1

COMMENTS

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #70

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00409455

COUNTY: Olmsted TOWNSHIP NUMBER: 106 RANGE: 14 SECTION: 27 QUARTERS: DDBB

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	JORDAN	
DNR Geologic Sensitivity Rating: L L	Score: 2	20
Geologic Data From	Well Record	
Year Constructed	1984	
Construction Method	Unknown	5
Casing Depth	515	0
Well Depth	580	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	Yes	0
Gravel-packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	0	0
Non-THMS VOCs detected?	Unknown	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	0.1 06/30/1999	0
Maximum tritium detected	Unknown	0
Carbon-14 age	Unknown	0
Wellhead Protection Score		25
Wellhead Protection Vulnerability Rating:		NOT VULNERABLE

COMMENTS

L SCORE OF 2 DERIVED FROM 20 FOOT THICKNESS OF DECORAH SHALE. THE GLENWOOD SHALE AND BASAL ST. PETER FORMATION ARE NOT REFLECTED IN THIS L SCORE.

11/04/2002

PWSID : 1550010  
SYSTEM NAME: Rochester  
WELL NAME : Well #71 (Airport Well)

TIER : 2  
WHP RANK : 0  
UNIQUE WELL #: 00219560

COUNTY: Olmsted TOWNSHIP NUMBER: 105 RANGE: 14 SECTION: 10 QUARTERS: CADB

CRITERIA	DESCRIPTION	POINTS
Aquifer Name	PRAIRIE DU CHIEN-JORDAN	
DNR Geologic Sensitivity Rating: VL L	Score: 8	10
Geologic Data From	Well Record	
Year Constructed	1961	
Construction Method	Unknown	5
Casing Depth	418	0
Well Depth	801	
Casing grouted into borehole?	Unknown	5
Cement grout between casings?	Unknown	5
All casings extend to land surface?	Unknown	5
Gravel-packed casings?	Unknown	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?	Unknown	0
Pumping Rate:	250	5
Non-THMS VOCs detected?	Unknown	0
Pesticides detected?	Unknown	0
Maximum nitrate detected	<0.1 07/09/1997	0
Maximum tritium detected	Unknown	0
Carbon-14 age	Unknown	0
Wellhead Protection Score		35
Wellhead Protection Vulnerability Rating:		NOT VULNERABLE

COMMENTS