

Part I Wellhead Protection Plan Update

Wellhead Protection Area Delineation

Drinking Water Supply Management Area Delineation

Well and Drinking Water Supply Management Area Vulnerability Assessments



Public Water Supplier 1270050

February 2015



Part I Wellhead Protection Plan Update
St. Louis Park, Minnesota
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Source Water Solutions, LLC

I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Geologist under the laws of the State of Minnesota.

Erik J. Tomlinson, PG, LEED AP

Date: _____ Lic. No.: 46739

Source Water Solutions, LLC
221 McCarron St.
Roseville, MN 55113

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Glossary of Terms

Data Element. A specific type of information required by the Minnesota Department of Health to prepare a wellhead protection plan.

Drinking Water Supply Management Area (DWSMA). The area delineated using identifiable land marks that reflects the scientifically calculated wellhead protection area boundaries as closely as possible (Minnesota Rules, part 4720.5100, subpart 13).

Drinking Water Supply Management Area Vulnerability. An assessment of the likelihood that the aquifer within the DWSMA is subject to impact from land and water uses within the wellhead protection area. It is based upon criteria that are specified under Minnesota Rules, part 4720.5210, subpart 3.

Emergency Response Area (ERA). The part of the wellhead protection area that is defined by a one-year time of travel within the aquifer that is used by the public water supply well (Minnesota Rules, part 4720.5250, subpart 3). It is used to set priorities for managing potential contamination sources within the DWSMA.

Inner Wellhead Management Zone (IWMZ). The land that is within 200 feet of a public water supply well (Minnesota Rules, part 4720.5100, subpart 19). The public water supplier must manage the IWMZ to help protect it from sources of pathogen or chemical contamination that may cause an acute health effect.

Wellhead Protection (WHP). A method of preventing well contamination by effectively managing potential contamination sources in all or a portion of the well's recharge area.

Wellhead Protection Area (WHPA). The surface and subsurface area surrounding a well or well field that supplies a public water system, through which contaminants are likely to move toward and reach the well or well field (Minnesota Statutes, section 103I.005, subdivision 24).

Well Vulnerability. An assessment of the likelihood that a well is at risk to human-caused contamination, either due to its construction or indicated by criteria that are specified under Minnesota Rules, part 4720.5550, subpart 2.

Acronyms

CWI - County Well Index

DNR - Minnesota Department of Natural Resources

EPA - United States Environmental Protection Agency

OPDC - Prairie du Chien Group

CJDN – Jordan Sandstone

CMTS – Mt. Simon Sandstone

MDA - Minnesota Department of Agriculture

MDH - Minnesota Department of Health

MGS - Minnesota Geological Survey

MnDOT - Minnesota Department of Transportation

MPCA - Minnesota Pollution Control Agency

PLS – Public Land Survey

SWCD - Soil and Water Conservation District

UMN - University of Minnesota

USGS - United States Geological Survey

1.0 Public Water Supply Profile

The following persons are the contacts for the St. Louis Park Wellhead Protection Plan.

1.1 Wellhead Protection Manager

Jay Hall
Utilities Superintendent
City of St. Louis Park
7305 Oxford Street
St. Louis Park, MN 55426
Telephone: 952.924.2557
Email: jhall@stlouispark.org

1.2 Wellhead Protection Plan Consultant

Erik J. Tomlinson, PG
Source Water Solutions, LLC
221 McCarron Street
Roseville, MN 55113
Telephone: 612.701.7343
Email: erik@sourcewater-solutions.com

2.0 Introduction

Source Water Solutions was retained by the City of St. Louis Park (City) (PWSID 1270050) to complete an update to the City's wellhead protection (WHP) plan. The work was performed in accordance with the Minnesota Wellhead Protection Rule, Parts 4720.5100 to 4720.5590.

This report presents the delineation of the wellhead protection area (WHPA), the drinking water supply management area (DWSMA), and the vulnerability assessments for the public water supply wells and DWSMAs. **Figure 1** shows the boundaries for the DWSMA and WHPA. The WHPAs are defined by a 10-year time of travel. **Figure 2** shows the emergency response areas (ERA), which are defined by a 1-year time of travel and the Inner Wellhead Protection Management Zone (IWMZ), a 200 foot radius around each well. Definitions of rule-specific terms that are used are provided in the "Glossary of Terms."

This report also documents the technical information that was required to prepare this portion of the WHP Plan in accordance with the Minnesota Wellhead Protection Rule. Additional technical information is available from MDH.

The municipal water supply wells included in the WHP Plan are listed in **Table 1**.

Table 1 - Water Supply Well Information

Well No.	Unique Well No.	Use/Status	Year Constructed	Casing Diam. (in)	Casing Depth (ft)	Total Depth (ft)	Aquifer Formation	Vulnerability
3	206440	Abandoned	8/1939	24	103	286	St. Peter	Vulnerable
4	200542	Primary	1946	24/18	304	510	Prairie du Chien-Jordan	Vulnerable
5	203196	Out of Service	1947	24/20	305	465	Prairie du Chien-Jordan	NA
6	206457	Emergency	1948	24/20	303	480	Prairie du Chien-Jordan	Vulnerable
7	206436	Out of Service	1952	24/20	274	450	Prairie du Chien-Jordan	NA
8	203678	Primary	1955	24/16	314	507	Prairie du Chien-Jordan	Not Vulnerable
9	206437	Out of Service	1956	24/16	289	473	Prairie du Chien-Jordan	NA
10	206442	Primary	1955	24/16	316	479	PDC-JDN	Vulnerable
11	206439	Primary	1960	24/16	880	1093	Mt. Simon	Not Vulnerable
12	206456	Primary	1965	30/24/16	900	1095	Mt. Simon	Not Vulnerable
13	206424	Primary	1964	30/24/16	891	1045	Mt. Simon	Not Vulnerable
14	227965	Primary	1955	30/24/16	389	485	Jordan	Vulnerable
15	215447	Primary	1969	30/24	398	503	Jordan	Vulnerable
16	203187	Primary	1973	30/24	425	510	Jordan	Vulnerable
17	147459	Out of Service	1983	36/30/24	818	1085	Mt. Simon	NA

3.0 Assessment of the Data Elements

MDH staff met with representatives of the public water supplier in August 2013 for a scoping meeting that identified the data elements required to prepare Part I of the WHP Plan Update. **Table 2** presents the assessment of these data elements, relative to the present and future implications of planning items, as specified in Minnesota Rules, part 4720.5210. The Scoping Decision Notice is provided as **Appendix A**.

Table 2 - Assessment of Data Elements

	Present and Future Implications				Data Source
	Use of the Well (s)	Delineation Criteria	Quality and Quantity of Well Water	Land and Groundwater Use in DWSMA	
Precipitation					
Average monthly and annual precipitation	L	M	L	M	Midwestern Regional Climate Center
Geology					
Maps and geologic descriptions	M	H	H	H	MGS, DNR, USGS, Consultant Reports
Subsurface data	M	H	H	H	MGS, MDH, MPCA, DNR, MDA
Borehole geophysics	M	H	H	H	MGS, Consultant Reports
Surface geophysics	L	L	L	L	DNR, MPCA, Consultant Reports
Maps and soil descriptions	L	M	L	M	USDA SURGGO
Water Resources					
Watershed units	L	M	L	M	DNR
List of public waters	L	M	L	M	DNR
Land Use					
Parcel boundaries map	L	H	L	M	Hennepin County
Political boundaries map	L	H	L	M	DNR
PLS map	L	H	L	L	DNR
Public Utility Services					
Transportation routes and corridors	L	H	M	M	Mn/DOT, City of St. Louis Park
Storm/sanitary sewers and PWS system map	L	L	M	M	City of St. Louis Park
Public drainage systems map or list	L	M	M	M	DNR, City of St. Louis Park
Records of well construction, maintenance, and use	H	H	H	H	City of St. Louis Park, CWI, MDH files
Surface Water Quantity					
Stream flow data	L	L	M	L	USGS, MPCA, DNR
Ordinary high water mark data	L	L	L	M	DNR
Permitted withdrawals	M	L	M	M	DNR, City of St. Louis Park
Protected levels/flows	M	L	M	M	DNR, MPCA
Water use conflicts	M	M	M	M	DNR, MPCA

	Use of the Well (s)	Delineation Criteria	Quality and Quantity of Well Water	Land and Groundwater Use in DWSMA	
Groundwater Quantity					
Permitted withdrawals	H	H	H	H	DNR
Groundwater use conflicts	H	H	H	H	DNR
Water levels	H	H	H	H	DNR, MPCA, MDA, MDH, City
Surface Water Quality					
Monitoring data summary	L	L	M	M	MPCA
Groundwater Quality					
Monitoring data	H	H	H	H	MPCA, MDH, MDA, USGS
Isotopic data	H	H	H	H	MPCA, MDH, MDA, USGS, County, UMN
Tracer studies	H	H	H	H	DNR, MPCA
Contamination site data	H	M	H	H	MPCA, MDA
MPCA and MDA spills/release reports	H	L	H	H	MPCA, MDA

Definitions Used for Assessing Data Elements:

High (H) - the data element has a direct impact

Moderate (M) - the data element has an indirect or marginal impact

Low (L) - the data element has little if any impact

Acronyms used in this report are listed on page ii, after the "Glossary of Terms."

3.1 Precipitation

Precipitation Data was obtained from the Midwestern Regional Climate Center website. Monthly data was available for the past five years at the MINNEAPOLIS/ST PAUL Airport station (USW00014922) and is provided below in **Table 3**. Precipitation data can be used for determining local recharge for the groundwater model.

Table 3 - Precipitation Data

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
2009	0.57	0.93	1.5	1.57	0.53	2.86	2.17	6.43	0.46	5.57	0.38	1.83	24.8
2010	0.45	0.75	0.69	2.32	2.5	6.25	3.03	4.91	5.52	1.61	2.07	2.79	32.89
2011	1	1.12	2.06	2.8	4.04	5.28	5.23	3.03	0.36	0.7	0.3	0.99	26.91
2012	0.36	1.71	1.4	3.04	9.34	3.59	4.9	1.38	0.3	1.3	0.63	1.64	29.59
2013	0.86	1.33	2.04	5.22	6.24	5.17	3.51	2.07	1.35	3	0.52	1.46	32.77

Note: All values are in inches.

3.2 Geological Information

The local and regional geologic and hydrogeologic conditions influence the delineation of the WHPAs for the public water supply wells. By characterizing these conditions, the geometry, location and magnitude of groundwater recharge and discharge areas, and the groundwater flow direction of the source water aquifer could be determined or estimated.

Existing geological maps, reports, and studies that were used are listed in the References section of the plan. Through the use of public-domain well records and local and regional geologic studies and

publications, the geology and hydrogeology of the area have been evaluated and reviewed to aid in the WHPA delineations and vulnerability assessments. These resources were provided by the City, the MDH, the Minnesota Geological Survey (MGS), and the USGS. These resources provided the basis for defining local geologic and hydrologic conditions but this interpretation was refined using the records of wells, borings, exploration test holes, and excavations. The City has no additional geologic information from logs or borehole geophysical records of wells, borings, or exploration test holes, nor additional information from surface geophysical studies. A surficial geology map is presented as **Figure 3** and a bedrock geologic map is presented as **Figure 4**. Geologic cross-sections were created through the study area and are provided as **Figures 5 and 6**. The cross-section locations are depicted on **Figure 4**.

Generally, the depth to bedrock in the St. Louis Park area ranges from 50 to 100 feet. However, there are areas surrounding St. Louis Park in which the depth to bedrock is 100 to 200 feet. The top of bedrock elevation ranges from 700 to 800 feet above mean sea level (MSL). According to the well records of the St. Louis Park municipal wells, bedrock was encountered at depths ranging from 69 (Municipal Well 9) to 127 feet (Municipal Well 12). Figures 2 and 3 are generalized geologic cross-sections through the St. Louis Park area. Figure 4 depicts the uppermost bedrock conditions in the St. Louis Park area and Figure 5 is a typical stratigraphic column for the St. Louis Park area.

The first bedrock unit in the St. Louis Park area is typically the Platteville and Glenwood Formations overlying the St. Peter Sandstone. The bedrock formations beneath the St. Peter Sandstone are (in descending order): the Prairie du Chien Group, the Jordan Sandstone, the St. Lawrence Formation, the Franconia Formation, the Ironston and Galesville Sandstones, the Eau Claire Formation, and the Mount Simon and Hinckley Sandstones.

The Platteville Formation is a fine-grained limestone containing thin shale partings near its top and base. It is underlain by the 0 – 5 feet thick, green sandy shale of the Glenwood Formation.

The upper half to two-thirds of the St. Peter Sandstone consists of fine- to medium-grained, friable quartz sandstone. The lower part of the formation contains multi-colored beds of mudstone, siltstone, and shale with interbedded very coarse sandstone. The typical thickness of the St. Peter Sandstone in Hennepin County is approximately 160 feet.

The Prairie du Chien Group is a dolostone that is sandy with minor amounts of shale in the upper third to half, and less sandy in the lower part. The formation is thin-bedded and contains thin beds of sandstone in the upper part, but is more massive- and thick-bedded in the lower part. Regionally, it is typically about 120 feet thick.

Below the Prairie du Chien Group is the Jordan Sandstone, a quartzose sandstone approximately 95 feet thick. The upper and middle portions of this formation are comprised of medium- and coarse-grained sandstone. The lower portion is massively bedded. The Prairie du Chien and Jordan are hydraulically connected.

The St. Lawrence Formation, a dolomitic siltstone and shale is below the Jordan Sandstone, and overlies the Tunnel City (formerly Franconia Formation), a glauconitic sandstone. The Wonewoc Sandstone (formerly Ironston and Galesville Sandstones) comprising of sandstone is found beneath the Tunnel City. Both the Tunnel City and Wonewoc are hydraulically connected.

The Eau Claire Formation - a siltstone, shale, and silty sandstone, which acts as a confining unit between the Mount Simon below, and the Wonewoc above. The Mount Simon aquifer consists of the Mount Simon Sandstone. In general, the Mount Simon is hydraulically isolated from the shallow groundwater systems and surface waters above it.

This geological information was used to define hydrogeologic boundaries that were incorporated into the delineation of the WHPA and used to assess DWSMA vulnerability. Also, the construction information about the public water supply wells was used in conjunction with groundwater quality data to assess well vulnerability.

3.3 Land Use Information

Parcel boundaries, road centerlines, and U.S. Public Land Survey coordinates were used to define the boundaries of the DWSMA.

Parcel and political boundaries are depicted in **Figure 1**. This information was primarily used to delineate the DWSMA and determine whether the limits of the DWSMA cross political boundaries. Specific land uses and zoning within and adjacent to the DWSMA will be reviewed, evaluated, assessed, and presented in Part II of the Plan.

Figures included in this Plan depict the major transportation routes and corridors within and surrounding St. Louis Park. However, sanitary and storm sewer coverage and presence of large-scale pipelines within the DWSMA will be examined in Part II of the Plan.

3.4 Water Quantity Information

Since other high capacity wells in the St. Louis Park area influence the groundwater flow field of the source water aquifer, high capacity private and public wells were evaluated and assessed in detail during the delineations of the WHPAs for the City's public water supply wells. In addition, specific information related to the construction, maintenance, and use of the municipal wells has been compiled, utilized, and presented in the Plan (**Table 1**). This information was also used in delineating the WHPAs and completing the vulnerability assessments.

Groundwater pumping information from high capacity wells was obtained from the State Water Use Data System (SWUDS) that is maintained by the DNR. The annual pumping reported by the Public Water Supplier was used in determining the daily volume of water that is discussed in Section 2 of this document (**Table 6**). Furthermore, SWUDS data, combined with well construction records from the CWI, were used to identify additional high capacity wells to be included in delineating the WHPA. The locations and daily volumes were cross checked with those in the Metro Model. The pumping volumes were updated as appropriate. These wells constitute flow boundaries (**Table 7**).

The primary wells used by the St. Louis Park public water supply system currently rely upon three source water aquifers – the Prairie du Chien, Jordan, and Mt. Simon aquifers. In 2014, the City abandoned Well 3 (206440) which had utilized the St. Peter sandstone.

Municipal Wells 4, 8 and 10 are multi-aquifer wells, open to both the Prairie du Chien and Jordan aquifers. Wells 14, 15, and 16 are completed in the Jordan sandstone and Wells 11, 12, and 13 are open to the Mt. Simon aquifer. Well 6 is also open to both the Prairie du Chien and Jordan aquifers, however it is classified as an emergency well and was not included in the WHPA delineations. Well logs are included as **Appendix B**. The existing groundwater wells appear adequate to meet the City's current and future water demand. The City has no immediate plans to replace or add municipal wells, or utilize any other source of water supply.

The City has provided the 2009-2013 water use and pumping volume records presented in this Plan to determine an appropriate discharge rate for the wells in delineating the WHPAs. In addition, the City has estimated a projected increase in groundwater use for 2017. These records are provided in **Table 6**.

Currently, there are no known, significant groundwater-use conflicts between the City and other parties.

3.5 Water Quality Information

Groundwater quality information was used to update well vulnerability. The quality of the groundwater in the source water aquifers, and in the St. Louis Park area specifically, must be evaluated and assessed for this Plan. Groundwater contamination and undesirable groundwater quality will directly impact the public water supply system. Certain naturally-occurring constituents in the groundwater also provide information that can be used to determine the vulnerability of the source water aquifer. The City publishes an annual consumer confidence report that contains water quality data collected over the course of the year.

The overall quality of groundwater in St. Louis Park is good. No contaminants were detected at levels that violated federal drinking water standards. Some were detected in trace amounts that were below legal limits. The St. Louis Park 2013 Consumer Confidence Report is available on the City website.

4.0 General Descriptions

4.1 Description of the Water Supply System

The public water supplier currently obtains its drinking water supply from nine primary groundwater wells and one emergency backup well. **Table 1** summarizes information regarding the City wells.

4.2 Description of the Hydrogeologic Setting

The description of the hydrologic setting for the aquifer used to supply drinking water is presented in **Table 4** and discussed in further detail below.

Table 4 - Description of Hydrogeologic Setting

Aquifer	Attribute	Descriptor	Data Source
Prairie du Chien (OPDC)	Aquifer Material	Dolostone	CWI Well Logs, MGS
	Porosity (type and value)	0.056	Metro Model 3.0
	Aquifer Thickness	110-121 ft.	City Well Logs
	Stratigraphic Top Elevation	623-637 ft. MSL	City Well Logs
	Stratigraphic Bottom Elevation	489-527 ft. MSL	City Well Logs
	Hydraulic Confinement	Confined	City Well Logs
	Transmissivity (T)	Reference Value/ Range: 13,100 ft ² /day (12,990-13,140 ft ² /day)	The reference value for the transmissivity of the Prairie du Chien Aquifer was determined from pumping tests on Minnetonka Well 6 and Meadowbrook Golf Course Well 2. The pump test analysis was provided as part of the Aquifer Test Plan for the OPDC and approved on December 10, 2015 .
	Hydraulic Conductivity (K)	Reference Value: 73.8 ft/day	The reference K value was calculated based upon the T value provided in the ATP divided by the aquifer thickness at the tested well.
Jordan Sandstone (CJDN)	Groundwater Flow Field	Flow to the southeast Hydraulic Gradient: 0.00083	Measured from model results. Flow generally to the southeast toward the Minnesota River.
	Aquifer Material	Sandstone	City Well Logs
	Porosity (type and value)	0.318	Metro Model 3.0
	Aquifer Thickness	67-100 ft.	City Well Logs
	Stratigraphic Top Elevation	489-527 ft. MSL	City Well Logs
	Stratigraphic Bottom Elevation	422-444 ft. MSL	City Well Logs
	Hydraulic Confinement	Confined	City Well Logs

Aquifer	Attribute	Descriptor	Data Source
	Transmissivity (T)	Reference Value/Range 2,400 ft ² /day (2,360-2,510 ft ² /day)	The reference value for the transmissivity of the Jordan Sandstone Aquifer was determined from pumping tests on Minnetonka Well 6. The pump test analysis was provided as part of the Aquifer Test Plan for the Jordan and approved on December 10, 2015.
	Hydraulic Conductivity (K)	Reference Value: 25.5 ft/day	The reference K value was calculated based upon the T value provided in the ATP divided by the aquifer thickness at the tested well.
	Groundwater Flow Field	Flow to the southeast Hydraulic Gradient: 0.0011	Measured from model results. Flow generally to the southeast toward the Minnesota River.
Mt. Simon Sandstone (CMTS)	Aquifer Material	Sandstone	City Well Logs
	Porosity (type and value)	0.233	Metro Model 3.0
	Aquifer Thickness	68-81 ft.	City Well Logs
	Stratigraphic Top Elevation	67-124 ft. MSL	City Well Logs
	Stratigraphic Bottom Elevation	(-138) - (-185) ft. MSL	City Well Logs
	Hydraulic Confinement	Confined	City Well Logs
	Transmissivity (T)	Reference Value: 1,970 ft ² /day	The reference value for the transmissivity of the Mt. Simon Aquifer was determined from pumping tests on St. Louis Park Well 11. The pump test analysis was provided as part of the Aquifer Test Plan for the Mt. Simon and approved on December 10, 2015.
	Hydraulic Conductivity (K)	Reference Value: 7.49 ft/day	The reference K value was calculated based upon the T value provided in the ATP divided by the aquifer thickness at the tested well.
	Groundwater Flow Field	Flow to the southeast Hydraulic Gradient: 0.0020	Modeled groundwater flow field.

The primary wells used by the St. Louis Park public water supply system currently rely upon three source water aquifers – the Prairie du Chien, Jordan, and Mt. Simon aquifers. In 2014, the City abandoned Well 3 (206440) which had previously utilized the St. Peter sandstone.

Municipal Wells 4, 8 and 10 are multi-aquifer wells, open to both the Prairie du Chien and Jordan aquifers. Wells 14, 15, and 16 are completed in the Jordan sandstone and Wells 11, 12, and 13 are open to the Mt. Simon aquifer. Well 6 is also open to both the Prairie du Chien and Jordan aquifers, however it is classified as an emergency well and was not included in the WHPA delineations. Well 15 is no longer in use and was not analyzed for this Update.

Municipal well information including location, construction information, and aquifer is presented in **Table 1.**

5.0 Delineation of the Wellhead Protection Area

5.1 Delineation Criteria

The boundary for the City's WHPA is shown in **Figure 1**. **Table 5** describes how the delineation criteria that are specified under Minnesota Rules, part 4720.5510, were addressed.

Table 5 - Description of WHPA Delineation Criteria

Criterion	Descriptor	How the Criterion was Addressed
Flow Boundary	Local Lakes and Rivers: Minnesota River, Lake Minnetonka and Minnehaha Creek	The rivers and lakes provided boundary conditions to the model that extended to and included these natural boundaries. They were included in the model and helped set the regional groundwater flow and water balance.
Flow Boundary	Other High-Capacity Wells Table 7	The pumping amounts were determined based on the averaged 2003-2011 pumped volumes. The pumping amounts of these high-capacity wells were included in the methods used for the delineation.
Daily Volume of Water Pumped	See Table 6	Pumping information was obtained from the Minnesota Department of Natural Resources Appropriations Permit 1973-1007. The annual pumped volumes were converted to a daily volume pumped by a well.
Groundwater Flow Field	Southeast Flow See Figures 8, 9, and 10	The model calibration process addressed the relationship between the calculated versus observed groundwater flow field.
Aquifer Transmissivity (T)	Reference Value: OPDC: 11,269 ft ² /day CJDN: 2,400 ft ² /day CMTS: 1,970 ft ² /day	The reference value for the transmissivity of the Jordan and Prairie du Chien Aquifers were determined from pumping tests and other data collected for the City of St. Louis Park's WHP Plan. Uncertainty regarding T was addressed as described in Section 5.4.
Time of Travel	10 years	The public water supplier selected a 10 year time of travel.

Information provided by the public water supplier was used to identify the maximum volume of water pumped annually by each well over the previous five-year period, as shown in **Table 6**. Also, the projected 2017 pumping rate is shown. Previous pumping values have been reported to the DNR, as required by the public water supply's Groundwater Appropriation Permit No. (1973-1007). Maximum daily volume of discharge, used as an input parameter in the model, was calculated by dividing the greatest annual pumping volume by 365 days.

Table 6 - Annual Volume of Water Discharged from Water Supply Wells

Well Name/ Number	Unique Number	Model Well Name	2009	2010	2011	2012	2013	Projected 2017 Year Withdrawal* (gal/yr)	Daily Volume max withdrawal (cubic meters)
Well 3**	206440	206440~1973- 1007_3_211	4,655,000	117,000	0	20,000	29,000	0	0.00
Well 4	200542	MNW_00420	513,012,000	525,041,000	521,918,000	443,539,000	491,993,000	573,888,542	5,959.01
Well 5	203196	MNW_00421	0	0	0	0	0	0	0.00
Well 6	206457	MNW_00422	257,000	246,000	184,000	471,000	94,000	109,647	1.14
Well 7	206436	MNW_00423	0	0	0	0	0	0	0.00
Well 8	203678	MNW_00424	296,189,000	545,933,000	530,319,000	457,559,000	522,378,000	609,331,330	6,327.03
Well 9	206437	MNW_00425	0	0	0	0	0	0	0.00
Well 10	206442	MNW_00419	206,959,000	133,248,000	245,767,000	331,570,000	279,588,000	326,127,302	3,386.36
Well 11	206439	206439~1973- 1007_11_211	122,233,000	58,707,000	53,806,000	116,691,000	77,031,000	89,853,328	933.00
Well 12	206456	206456~1973- 1007_12_211	362,056,000	307,158,000	213,246,000	187,409,000	292,369,000	341,035,786	3,541.17
Well 13	206424	206424~1973- 1007_13_211	211,310,000	228,064,000	79,131,000	178,301,000	26,290,000	30,666,147	318.42
Well 14	227965	227965~1973- 1007_14_211	214,874,000	82,696,000	185,172,000	200,316,000	262,638,000	306,355,861	3,181.06
Well 15	215447	215447~1973- 1007_15_211	55,240,000	0	0	0	0	0	0.00
Well 16	203187	203187~1973- 1007_16_211	375,759,000	273,452,000	262,047,000	306,562,000	257,731,000	300,632,058	3,121.63
Well 17	147459	147459~1973- 1007_17_211	0	0	0	0	0	0	0.00

Annual volumes expressed as gallons. **Bold** indicates greatest annual pumping volume.

* Total annual volume taken from St. Louis Park Water Supply Plan. Well volume ratio was calculated based upon 2013 pumping. Well 3 volume was taken out of this calculation.

**Well 3 was abandoned in Spring 2014.

In addition to the wells used by the public water supplier, **Table 7** shows other high-capacity wells, within one mile of the City wells, included in the delineation to account for their pumping impacts on the capture areas for the public water supply wells. Pumping data was obtained from the DNR State Water Use Database System.

Table 7 - Other Permitted High-Capacity Wells

Unique Number	Permittee	Permit	Use	Aquifer	Reported Withdrawal (MGY)				
					2011	2010	2009	2008	2007
206474	EDINA, CITY OF	1973- 1119	Municipal Waterworks	OPDC/CJDN	0	0	0	0	0
204054	MINNETONKA, CITY OF	1979- 6207	Municipal Waterworks	CJDN	134.2	110.7	98.0	146.9	163.3
208012	MINNETONKA, CITY OF	1979- 6207	Municipal Waterworks	CJDN	134.1	110.7	98.0	146.9	163.3
203183	MINNEAPOLIS GOLF CLUB	1986- 6083	Golf Course Irrigation	OPDC/CJDN	12.2	12.7	13.6	12.9	13.5
Unknown	MINNEAPOLIS GOLF CLUB	1986- 6083	Golf Course Irrigation	NA	21.5	21.1	26.6	26.0	26.0
Unknown	MINNEAPOLIS PARK & REC BOARD	1986- 6125	Golf Course Irrigation	MEADOWBROOK	3.4	12.8	21.5	16.6	22.1

Unique Number	Permittee	Permit	Use	Aquifer	Reported Withdrawal (MGY)				
					2011	2010	2009	2008	2007
216009	MINNEAPOLIS PARK & REC BOARD	1986-6125	Golf Course Irrigation	OPDC/CJDN	12.2	3.2	0	0	0
224098	GENERAL MILLS INC	2007-0209	Fire Protection	OPDC/CJDN	1.6	0.8	0.5	0.2	3.0
224099	GENERAL MILLS INC	2007-0210	Landscaping/Athletic Fields	OPDC/CJDN	23.4	23.2	32.2	31.3	30.5

5.2 Method Used to Delineate the Wellhead Protection Area

Conceptual Model

The City of St. Louis Park utilizes the Prairie du Chien, Jordan, and Mt. Simon aquifers for its water supply. The Metro Model Version 3, a recognized nine layer MODFLOW base model developed by the Metropolitan Council, was used as a base model and then refined in the vicinity of the St. Louis Park area (Metropolitan Council, 2014). The model grid, pumping rates, and hydraulic conductivity/transmissivity zones were refined to better represent the local geologic conditions. Model refinement focused primarily on the OPDC (Layer 3), CJDN (Layer 4), and CMTS (Layer 9) aquifers. The model refinement is described in more detail below.

Numerical Model

MODFLOW is the name that has been given the USGS Modular Three-Dimensional Ground-Water Flow Model. Because of its ability to simulate a wide variety of systems, its extensive publicly available documentation, and its rigorous USGS peer review, MODFLOW has become the worldwide standard ground-water flow model. MODFLOW is used to simulate systems for water supply, containment remediation, and mine dewatering. MODFLOW is most appropriate in those situations where a relatively precise understanding of the flow system is needed to make a decision. MODFLOW was developed using the finite-difference method. The finite-difference method permits a physical explanation of the concepts used in construction of the model.

Ground-water flow within the aquifer is simulated in MODFLOW using a block-centered finite-difference approach. Layers can be simulated as confined, unconfined, or a combination of both. Flows from external stresses such as flow to wells, areal recharge, evapotranspiration, flow to drains, and flow through riverbeds can also be simulated. The existing Metro Model 3, a nine layer model, was used as a base model. The model layers represented include the Quaternary, St. Peter Sandstone, Prairie du Chien Group, Jordan Sandstone, St. Lawrence Formation, Tunnel City Group (formerly known as the Ironston and Galesville Sandstones), Wonewoc Sandstone (formerly known as the Franconia Formation), Eau Claire Formation, and Mt. Simon-Hinkley Sandstones (Metropolitan Council, 2014). The model was refined around the St. Louis Park area using local data and focused primarily on the layers/aquifers that the City relies on for its water supply, the Prairie du Chien, Jordan, and Mt. Simon Aquifers. The Groundwater Vistas Version 6.74 Build 39 software package was used to model the system.

Grid Development/Refinement

Because MODFLOW is a block centered finite-difference model, a grid must be defined over the model domain. The grid spacing and size of cells varies across the model domain. The Metro Model 3 consists of a uniform 500 x 500 meter grid. In areas where impact from pumping and accuracy will not impact the capture zones, cells remained 500 x 500 meters. In areas where the accuracy of

groundwater contours and the delineation of particle tracks require greater accuracy (around pumping wells) the grid spacing is 15 x 15 meters.

Boundary Conditions

Constant head boundaries were used to represent water bodies in the model along northern sections of the St Croix River. **Figure 7** shows the boundary conditions used to represent natural features in the model in the Minnetonka area. River boundaries were used to represent the water bodies in the model. Boundary conditions for local lakes and rivers were not updated due to the confined nature of the OPDC and CJDN aquifers. The remaining boundary conditions from the original Metro Model were far enough from the area of study as to not impact the study area results. Model files are provided as **Appendix E**.

Transmissivity

Transmissivity values for the OPDC, CJDN, and CMTS were calculated based the analysis of well pump tests conducted on wells completed in each aquifer. An aquifer test plan for each aquifer was submitted to and approved by the MDH. The transmissivity values in the ATPs were used as a starting point for refining the model. Those values are referenced above in **Table 5**.

A polygon shapefile was created to differentiate areas of similar and dissimilar hydraulic conductivity values. Hydraulic conductivity zone values were calculated based upon the model layer/aquifer thickness and the transmissivity value calculated for each aquifer. The zones for Layer 3 are depicted in **Figure 8**, Layer 4 in **Figure 9**, and Layer 9 in **Figure 10**.

Porosity

A porosity of 0.056 was used for the OPDC, 0.318 for the CJDN, and 0.233 for the CMTS aquifers.

Aquifer Recharge

The USGS estimates annual recharge rates to surficial materials in the Twin Cities area to range between 3 and 9 inches per year (Delin 2007). The Metro Model 3 (Metropolitan Council, 2014) estimates infiltration using the Soil Water Balance (SWB) model developed by the Metropolitan Council. The aerial average infiltration for a period 1988-2011 was 8.2 inches per year and ranged between 2.7 and 13.0 inches per year. Due to the way that the Metro Model 3 handles this variable and that the aquifers utilized by the City of St. Louis Park are confined and not likely directly affected by recharge/infiltration, the values were not altered from those of the base Metro Model 3.

5.3 Fracture Flow Delineation Method

The Prairie du Chien formation is capable of rapidly transmitting water through its secondary porosity features (fractures and solution cavities) and can transmit water to the underlying Jordan aquifer, an additional delineation effort was required for the Prairie du Chien and Jordan aquifer wells. The Minnesota Department of Health has developed a guidance document and ArcGIS tool to assist in the delineation of the wellhead capture zone in fractured bedrock aquifers. The methodology is outlined in greater detail in *Guidance for Delineating Wellhead Protection Areas in Fractured and Solution-Weathered Bedrock in Minnesota* (MDH 2005).

Three (3) of St. Louis Park's nine (9) active wells are completed at least partially in the fractured Prairie du Chien aquifer. Guidance also requires the assessment of wells completed solely in porous media aquifers that are hydraulically connected to a fractured bedrock aquifer. The City has three (3) wells that are completed only in the Jordan, so these wells were assessed for fracture flow delineation.

St. Louis Park's wells 4, 8, and 10 are multi-aquifer wells, open to both the OPDC and CJDN aquifers. The MODFLOW model allocates flow from each layer based on aquifer properties and well elevations of the well's open interval in the model. The amount of flow from Layer 3 (OPDC) at each of these wells was used to calculate the fracture flow delineation for the PDC-JDN wells. **Appendix G** summarizes the information used in the fracture flow delineations.

Pumping volumes were extracted from the MODFLOW model for wells completed in the Prairie du Chien aquifer for the layer that represents the Prairie du Chien (Layer 3). This value along with the open interval thickness was input into the MDH ArcGIS delineation tool to determine if there was any overlap of capture zones. If there is overlap, additional analysis is completed to account for the volume of water "shared" by each well from the aquifer. There was no overlap of the calculated fixed radius (CFR) delineation of the OPDC wells.

The modified Metro Model 3 model was analyzed to determine the estimated recharge from the PDC into the JDN aquifer across the 10 year delineation areas for the wells completed only in the Jordan aquifer (Wells 14 and 16). Well 15 is no longer in use and was not analyzed for this WHPP Update. The analysis comparing the pumping volume generated by the MODFLOW model to the volume of water pumped by the wells completed in the Jordan aquifer met the 10% contribution threshold indicating that there is a highly leaking setting. The fractured aquifer is a major source of recharge to the Jordan aquifer and fracture flow delineation was completed for the City's Jordan wells. This was done by computing a water balance for the cells within the 10-year capture zone. The value contributed by the PDC was used as the flow value for the Jordan wells. **Appendix G** summarizes this information.

The CFR for Well 16 and Well 8 did overlap. A separate analysis to account for the overlapped volume was completed. The final fracture flow delineation area is represented on **Figure 1**. Summary tables of fracture flow input data and output results are provided in **Appendix G**.

The fracture flow capture zones were added to the area defined by the MODFLOW model and a composite delineation was created. The City's well capture zones can be found on **Figure 1** and the shapefiles can be found in **Appendix E**.

5.4 Results of Model Calibration and Sensitivity Analysis

Model calibration is a procedure that compares the results of a model based on estimated input values to measured or known values. This procedure can be used to define model validity over a range of input values, or it helps determine the level of confidence with which model results may be used. As a matter of practice, groundwater flow models are usually calibrated using water elevation or flux.

Hydraulic conductivity zones were refined while updating the Metro Model 3 during calibration and the sensitivity analysis. **Figures 8, 9, and 10** show the updated hydraulic conductivity zones for model layers 3, 4 and 9, representing the OPDC, CJDN and CMTS aquifers respectively. The calibration results for this model are presented in **Figure 11** and the resulting potentiometric surface depicts groundwater flow direction and gradient. Hydraulic conductivity was the primary variable used to calibrate the model in the local area surrounding St. Louis Park.

Model sensitivity is the amount of change in model results caused by the variation of a particular input parameter. The direction and extent of the modeled capture zone may be sensitive to any of the input parameters:

- The pumping rate directly affects the volume of the aquifer that contributes water to the well. An increase in pumping rate leads to an equivalent increase in the volume of aquifer

within the capture zone, proportional to the porosity of the aquifer materials. However, the pumping rate is based on the results presented in **Table 6** and, therefore, is not a variable factor that will influence the delineation of the WHPA.

- The direction of groundwater flow determines the orientation of the capture area. Variations in the direction of groundwater flow will not affect the size of the capture zone but are important for defining the areas that are the source of water to the well. The potentiometric map that is produced by the refined Metro Model 3 model closely matches that as seen by the calibration points of observed static water level data (**Figures 8, 9, and 10**). Therefore, the direction of groundwater flow should not have a significant effect on WHPA delineation given the current knowledge of hydraulic head distribution in the aquifer.
- A hydraulic gradient of zero produces a circular capture zone, centered on the well. As the hydraulic gradient increases, the capture zone changes into an elliptical shape, with the well centered on the down-gradient focal point. The hydraulic gradient was determined by using water level elevations and contoured by the calibrated Metro Model 3. Generally, the accuracy of the hydraulic gradient determination is directly proportional to the amount of available data that describes the distribution of hydraulic head in the aquifer.
- The aquifer thickness and porosity influence the size and shape of the capture zone. A decrease in either thickness or porosity causes a linear, proportional increase in the areal extent of the capture zone. Aquifer thickness was verified in the area of study based upon boring and geophysical log data. The aquifer thickness in the area of study is relatively well defined, therefore is not a variable that will change to influence the WHPA delineation. A change in porosity will affect the delineation of the WHPA, however, the value used in the model for the aquifers are relatively accepted, and therefore is not a variable that will change to influence the WHPA delineation.
- Aquifer permeability will influence the size and shape of the capture zone. Permeability defines the relative proportions of the capture zone width to length. A decrease in permeability decreases the length of the capture zone and increases the distance to the stagnation point, making the capture zone more circular in shape, centered at the well. The updated hydraulic conductivity zones (**Figures 8, 9, and 10**) appeared to represent the local OPDC, CJDN and CMTS conditions relatively well. During sensitivity analysis, as the K value increased, the capture zone increased slightly. Results of the sensitivity analysis are presented in **Figure 12**. The K values used during the sensitivity analysis are included below in **Table 8**.

Table 8- Sensitivity Analysis Variables

Model Run Name	Description	Layer	T Value (ft ² /d)	Kh Value (m/day)	Kv Value (m/day)	Results
Max T (Khigh)	The maximum T value (based upon pump test analysis) identified in the aquifer test plan was used.	L3	13,140	Zone 1 92.05 Zone 2 241.4 Zone 3 241.4	Zone 1 0.01 Zone 2 0.23 Zone 3 0.01	Slight shift in capture zone to the north east. Path lines extend slightly outside of the delineated DWSMA. Note: K zones are depicted in Figures

		L4	2,360	Zone 1 83.7	Zone 1 0.007	8 and 9.
Min T (Klow)	The minimum T value (based upon pump test analysis) identified in the aquifer test plan was used.	L3	12,990	Zone 1 59.6 Zone 2 156.3 Zone 3 156.3	Zone 1 0.007 Zone 2 0.23 Zone 3 0.007	Slight shift in capture zone to the north east. Path lines extend slightly outside of the delineated DWSMA. Note: K zones are depicted in Figures 8 and 9.
		L4	2,510	Zone 1 83.7	Zone 1 0.007	
K10x	The minimum T value (based upon pump test analysis) identified in the aquifer test plan was used.	L3	131,000	Zone 1 293.3 Zone 2 320.3 Zone 3 353.3	Zone 1 29.3 Zone 2 32.0 Zone 3 35.3	Dramatic increase in capture zone to the north west. Path lines extend well outside of the delineated DWSMA. Note: K zones are depicted in Figures 8 and 9.
		L4	24,000	Zone 1 88.8	Zone 1 8.88	

6.0 Delineation of the Drinking Water Supply Management Area

Boundaries used to delineate the Drinking Water Supply Management Area (DWSMA) are described above in Section 3.2. The DWSMA boundaries were defined using the following features (**Figure 1**):

- Road centerlines,
- public land surveys (including township, range, section, and ¼ section boundaries), and
- property lines (Hennepin County parcel data).

A GIS shapefile of the DWSMA is provided in **Appendix D**.

7.0 Vulnerability Assessments

The Part I wellhead protection plan includes the vulnerability assessments for the public water supply wells and the DWSMA. These vulnerability assessments are used to help define potential contamination sources within the DWSMA and to select appropriate measures for reducing the risk that they present to the public water supply.

7.1 Assessment of Well Vulnerability

The vulnerability assessment for each well used by the public water supplier is listed in **Table 1** and is based upon the following conditions:

- 1) Well construction meets current state Well Code specifications (Minnesota Rules, part 4725) and the well itself does not provide a pathway for contaminants to enter the aquifer used by the public water supplier;
- 2) The geologic conditions at the well site include a cover of geologic materials over the aquifer that is sufficient to retard or prevent the vertical movement of contaminants;
- 3) None of the human-caused contaminants regulated under the federal Safe Drinking Water Act have been detected at levels indicating that the well itself serves to draw contaminants into the aquifer as a result of pumping.
- 4) Tritium analysis of water from each well.

Results of the well vulnerability analysis – The MDH Source Water Protection (SWP) Vulnerability rating for St. Louis Park’s municipal wells determined Wells 8, 11, 12, and 13 to be not vulnerable and Wells 3, 4, 6, 10, 14, 15, and 16 to be vulnerable. In general, the wells identified as not vulnerable were the three Mt. Simon wells and Well 8 which did not have any detections of tritium or nitrate, a very low geologic sensitivity to pollution, and an L-Score of 10. These L-scores and sensitivity ratings are based upon the overlying surficial geology and the presence of any protective confining units. The wells identified as vulnerable may have a low geologic sensitivity and high L-score, however the vulnerability was overridden because the well water either had a detection of tritium or a nearby well within the same aquifer had a detection of tritium. The MDH scoring sheets are presented as **Appendix F**.

7.2 Assessment of Drinking Water Supply Management Area Vulnerability

The vulnerability of the DWSMA is shown in **Figure 11** and is based upon the following information:

Boring logs available for wells within both DWSMAs were reviewed for the presence of clay thicknesses. Geologic cross-sections were developed and are included as **Figures 5 and 6**.

MDH guidance (MDH, 1997) was followed in determining the DWSMA vulnerability. L-scores were provided by MDH staff and calculated based upon DNR geologic sensitivity guidelines for wells within the DWSMA that extended to the OPDC-OJDN. Geologic Sensitivities were also determined for each of those wells. In addition, the following criteria, incorporating available tritium data, were used to determine the vulnerability of the City’s DWSMA:

- 1) Areas of very low geologic sensitivity but tritium present should be of low vulnerability;
- 2) Areas of low geologic sensitivity but tritium present should be of moderate vulnerability; and
- 3) Areas of moderate geologic sensitivity but tritium present should be of high vulnerability.

A review of the geologic logs contained in the CWI database and geological maps and reports indicate that the OPDC and CJDN aquifers exhibit a low to moderate geologic sensitivity within the DWSMA. Boring logs available for wells within the DWSMA were reviewed for the presence of clay thicknesses and L-scores calculated.

8.0 Recommendations

The following plan implementation action item recommendations have been made for the Public Water Supplier to consider. Each recommendation is referenced to the plan implementation category under which it can be incorporated. Each recommendation will be further evaluated during the preparation of the Part II WHP Plan Update.

Plan Implementation Category – Data Collection

Item 1 – Work Cooperatively with Neighboring Municipalities Regarding Wellhead Protection

The DWSMA that was delineated as part of this project extends beyond the St. Louis Park municipal boundaries. While developing and implementing Part II of the City's WHPP, it is recommended that the City of St. Louis Park collaborate and cooperate with municipalities in which the City's DWSMA extends to. As the City cannot dictate landuse activities outside of its jurisdiction, it can work closely with surrounding municipalities as landuses change and decisions are made that may impact the City's water supply.

Item 2 – Work Cooperatively with Neighboring Stakeholder Groups and Local Governmental Units

There are many stakeholders and local governmental units (LGUs) that may be found within the City's DWSMA boundary. It is recommended that as the City and/or LGUs plan to make changes that may affect landuse within the DWSMA boundary, that attempts be made to work collaboratively together to meet each of their needs and/or goals.

Item 3 - Addressing deficiencies in the distribution and quality of subsurface geologic and hydrologic information.

The direction of groundwater flow and the hydraulic gradient used to determine the capture zones for the water supply wells are based on information from a limited number of water well, observation well, and well sealing records. The direction of groundwater flow determines the orientation of the capture zone and the hydraulic gradient affects the length of the capture zone. Generally, the accuracy of the flow direction and hydraulic gradient determination are directly proportional to the amount and quality of subsurface information. The MDH and the Public Water Supplier should continue to verify the locations of wells, sealed wells, and other borings that are constructed within a two-mile radius of the DWSMA as part of the process for amending the WHP plan. Additional subsurface information will provide insight into whether modifications to the delineation of the WHPA and the assessment of DWSMA vulnerability are warranted under the next plan amendment process.

Plan Implementation Category – Contingency Planning

Item 4 - Addressing the potential movement of contamination toward the community well(s).

The MDH recommends that if contaminants are ever detected in a municipal water supply well, the Public Water Supplier work with the MDH to perform an evaluation of whether to continue pumping the impacted well(s). Turning off a well may alter the movement of contamination to other pumping wells and compound the problem. Therefore, it is very important to include this recommendation in the Part II contingency plan.

9.0 Standard of Care

The interpretations presented in this report are based on local data collected during this study and previous studies, such as current and historical pumping tests and regional data collected from governmental agencies. Data collected and analyzed by others and used in this report may not be precise or accurate. This Plan does not account for any variations that may occur between points of exploration; geologic and hydrogeologic conditions likely differ across the study area. Also, it must be noted that seasonal and cyclical fluctuations in the hydrogeologic characteristics and properties of the aquifers will occur.

The scope of this report and the corresponding groundwater flow model and calculations is limited to the delineation of capture zones for the St. Louis Park municipal wells. Use of the groundwater flow model by other parties or for other purposes is not advised. Use or modification of the model for purposes other than the delineation of capture zones must be done with caution and a full understanding of the inherent assumptions and limitations of the data.

This Plan represents our understanding of the significant aspects of the local geologic and hydrogeologic conditions; the conclusions are based on our hydrogeologic and engineering judgment, understanding and perspective, and represent our professional opinions. These opinions were arrived at in accordance with the currently accepted standard of care for geologic and engineering practices at this time and location. No warranty is implied or intended.

10.0 Selected References

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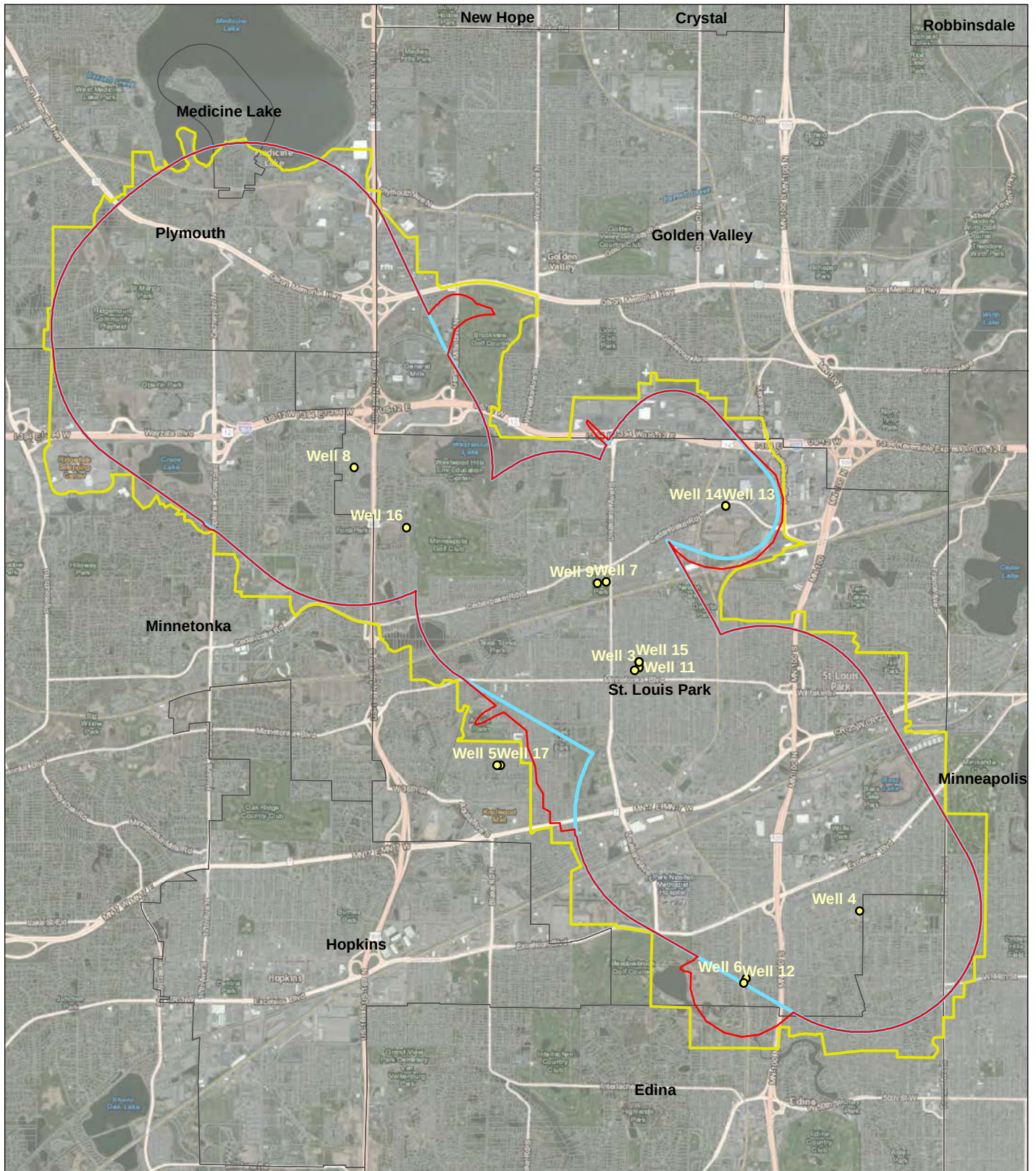
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Legend

- Municipal Wells
- Municipal Boundary
- Parcels
- WHPA (10-Yr)

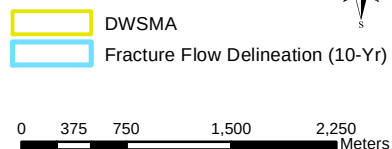
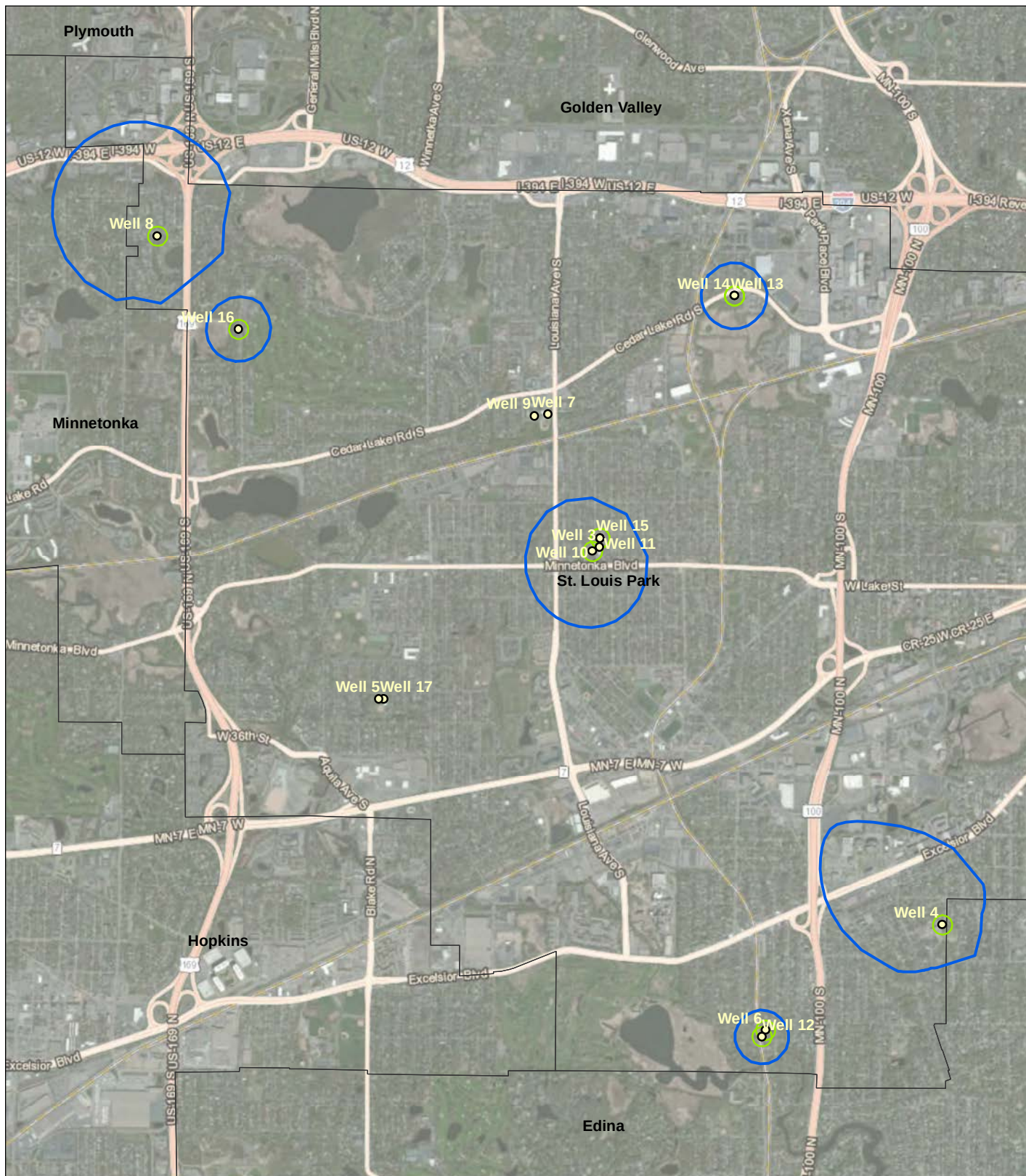


Figure 1

WHPA and DWSMA

St. Louis Park Wellhead
Protection Plan



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Legend

- Municipal Wells
- Fracture Flow Delineation (1-Yr)
- Municipal Boundary
- ERA (1-Yr)

IWMZ

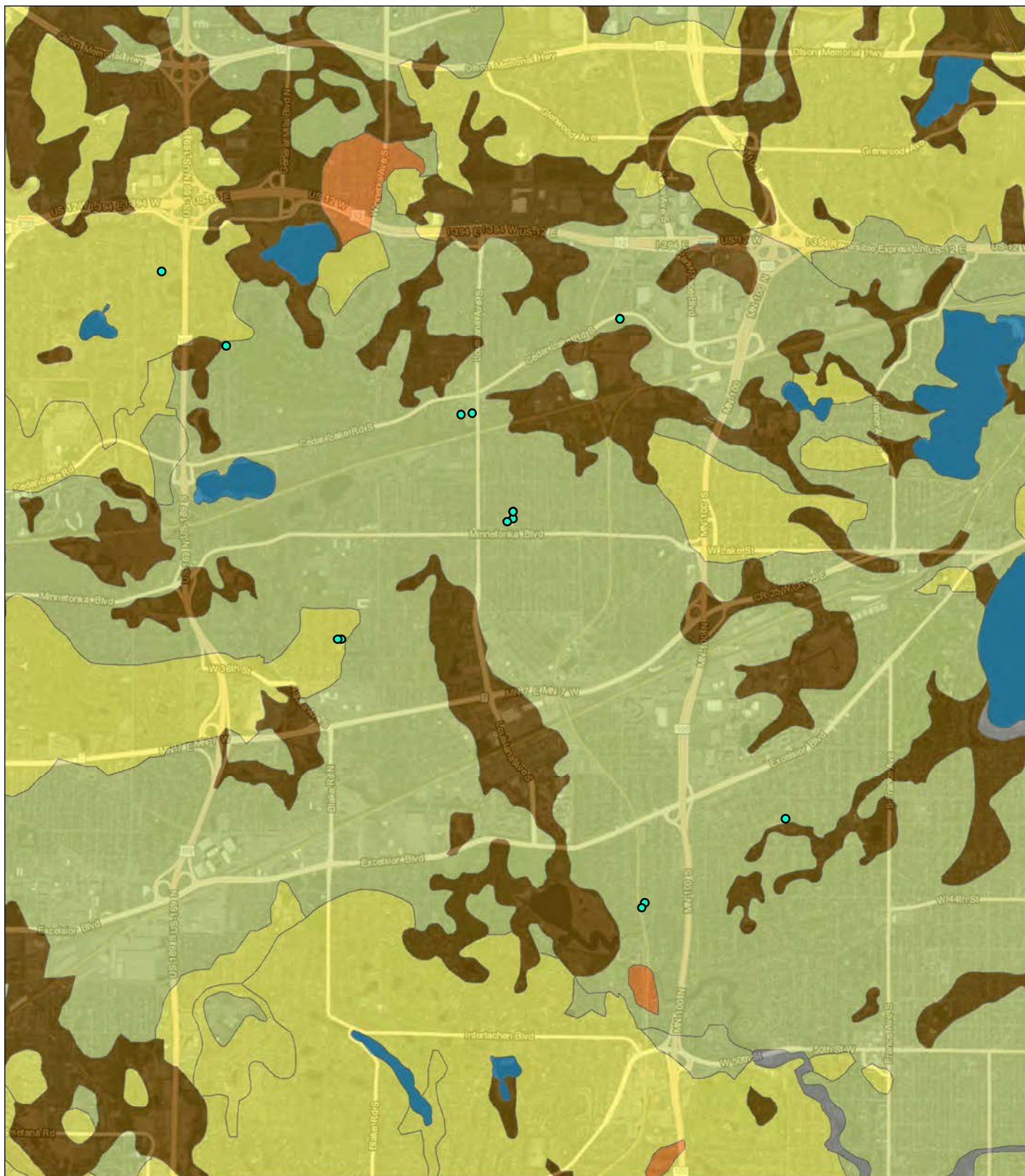


0 260 520 1,040 1,560 Meters

Figure 2

Emergency Response
Areas and Inner
Wellhead Management
Zones

St. Louis Park Wellhead
Protection Plan



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Legend

Surficial Geology

Boulders	Rock
Clay	Sand
Diamicton	Silt
Organic	Unspecified
	Water

Municipal Wells

DWSMA

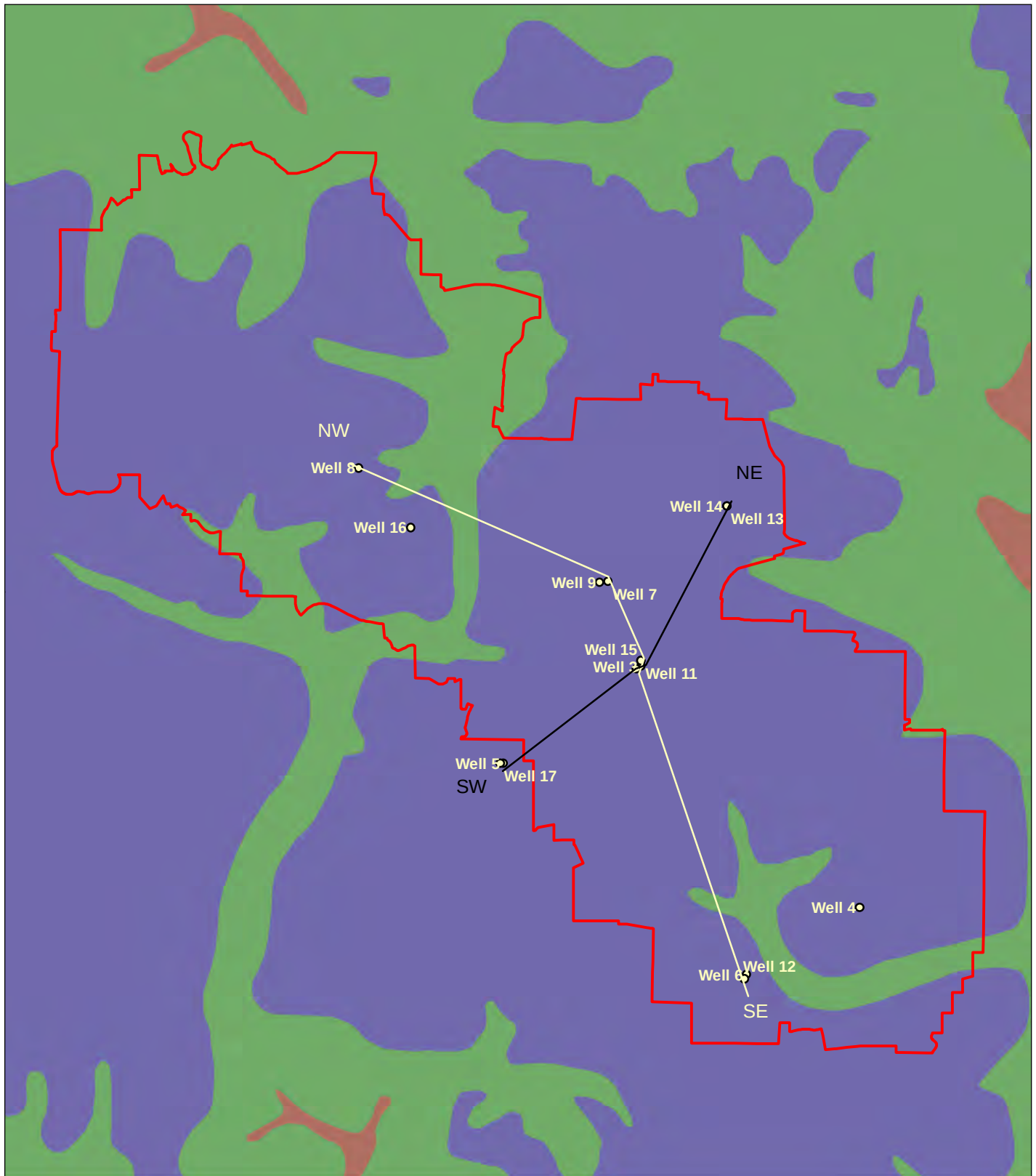


0 325 650 1,300 1,950 Meters

Figure 3

Surficial
Geology

St. Louis Park Wellhead
Protection Plan



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Legend

- Platteville-Glenwood
- St. Peter
- Prairie du Chein Group
- Jordan
- St. Lawrence Formation
- Franconia-Ironton-Galesville
- Eau Claire Formation

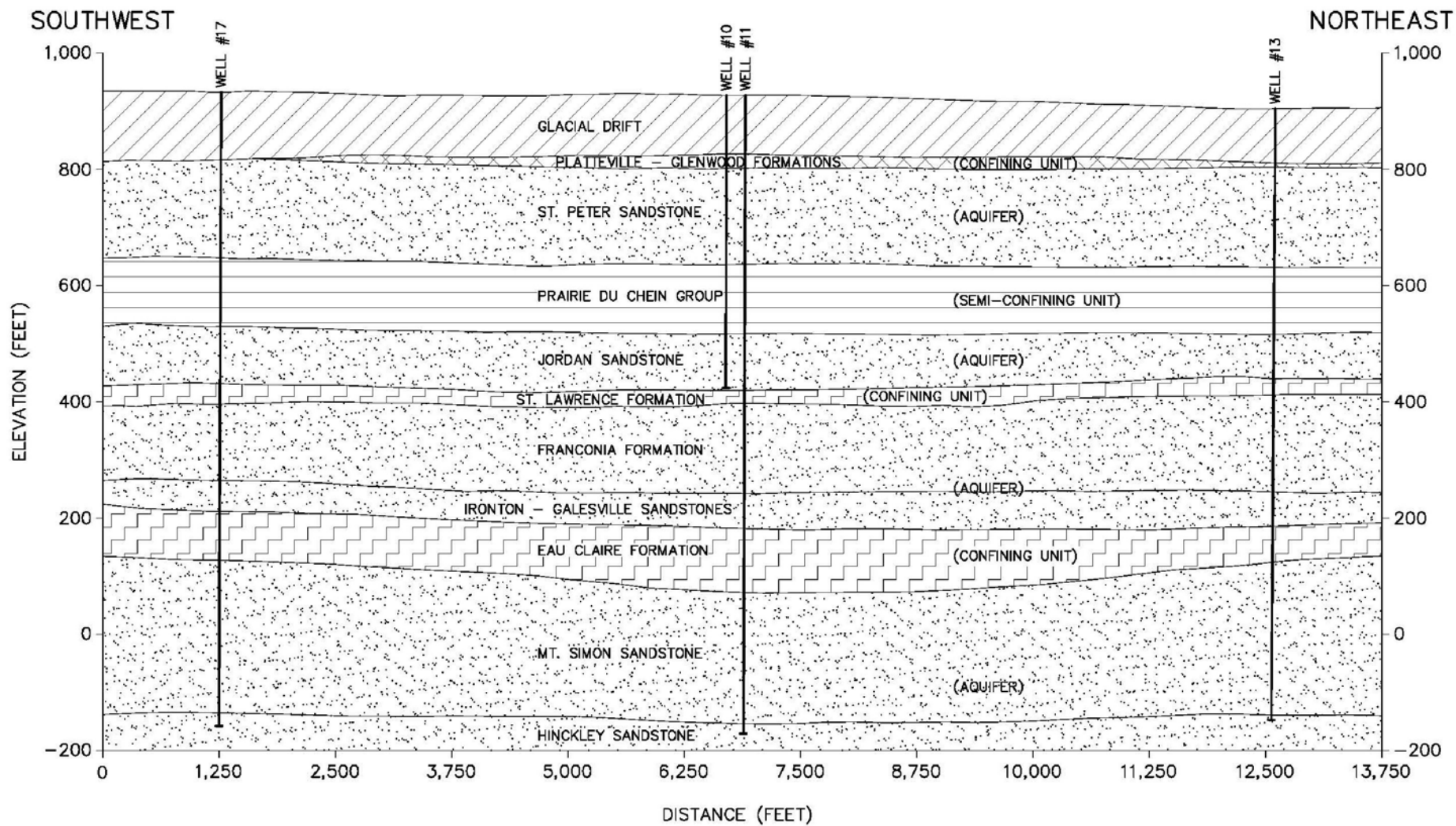
- DWSMA
- Municipal Wells



0 335 670 1,340 2,010 Meters

Figure 4
Bedrock
Geology

St. Louis Park Wellhead
Protection Plan

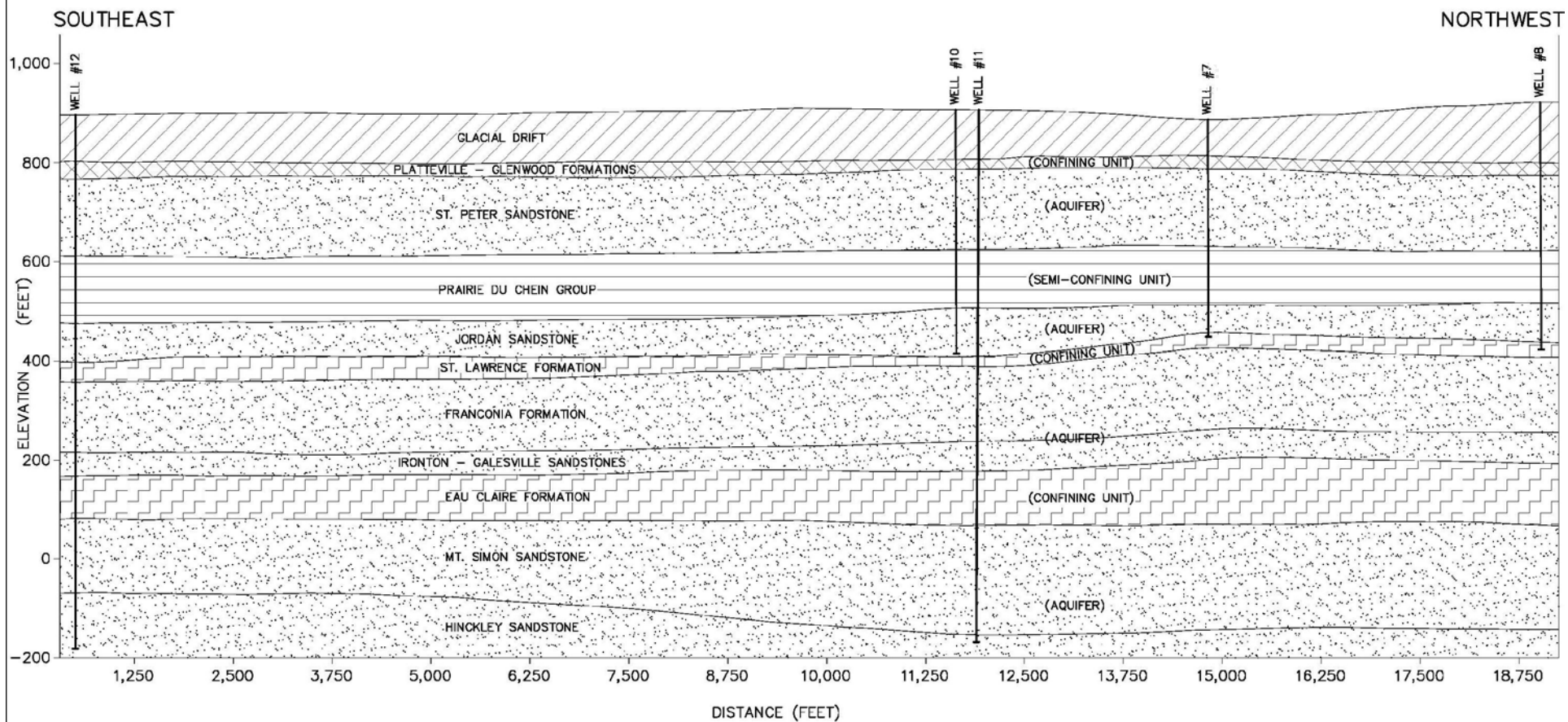


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Generalized Cross Section
SW - NE

Figure 5

St. Louis Park Wellhead Protection Plan

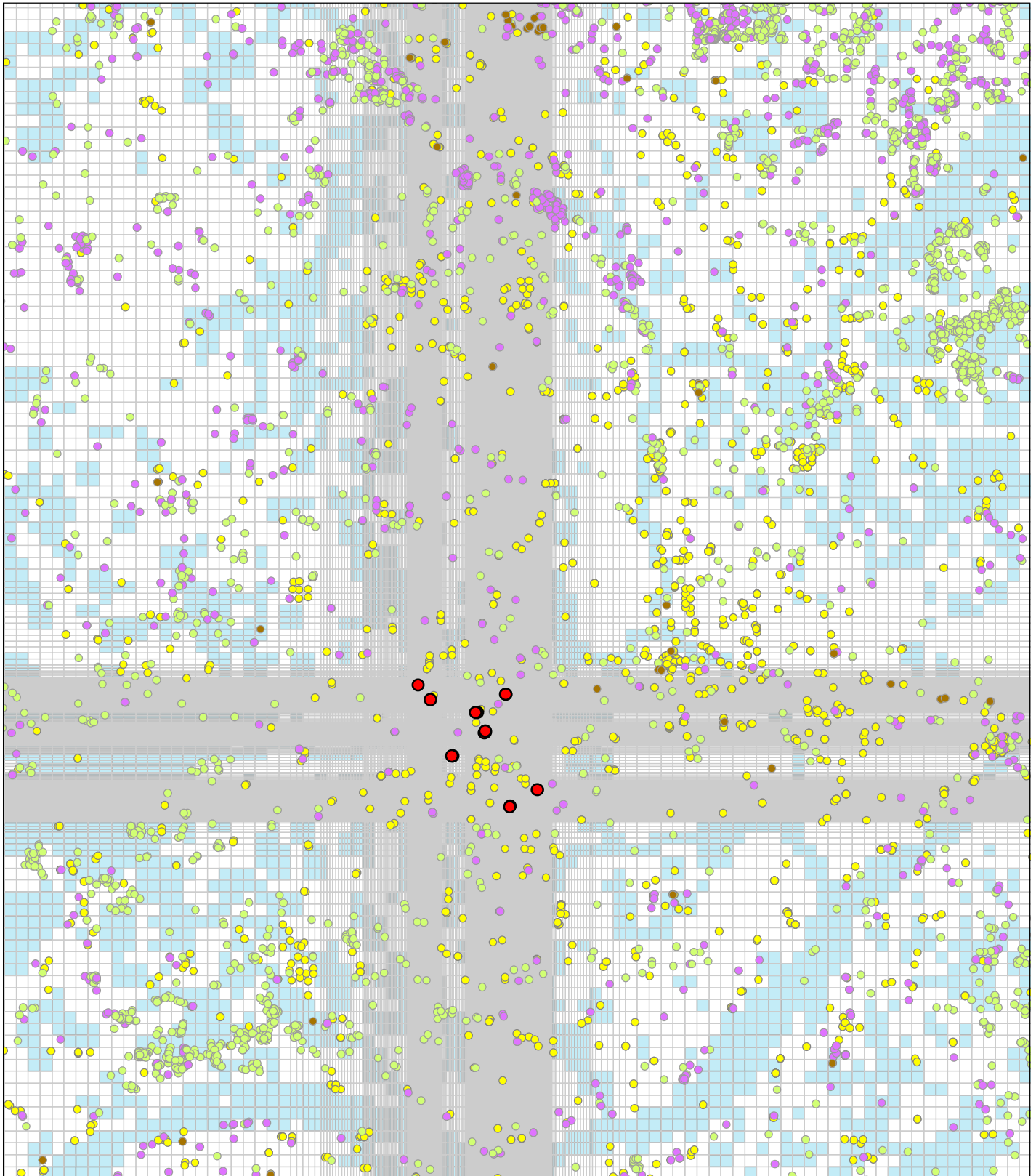


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Generalized Cross Section
SE - NW

Figure 6

St. Louis Park Wellhead Protection Plan



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Legend

Calibration Targets (Layer)

- 3
- 4
- 9
- High Capacity Wells

- Municipal Wells
- Model Grid
- River Boundaries

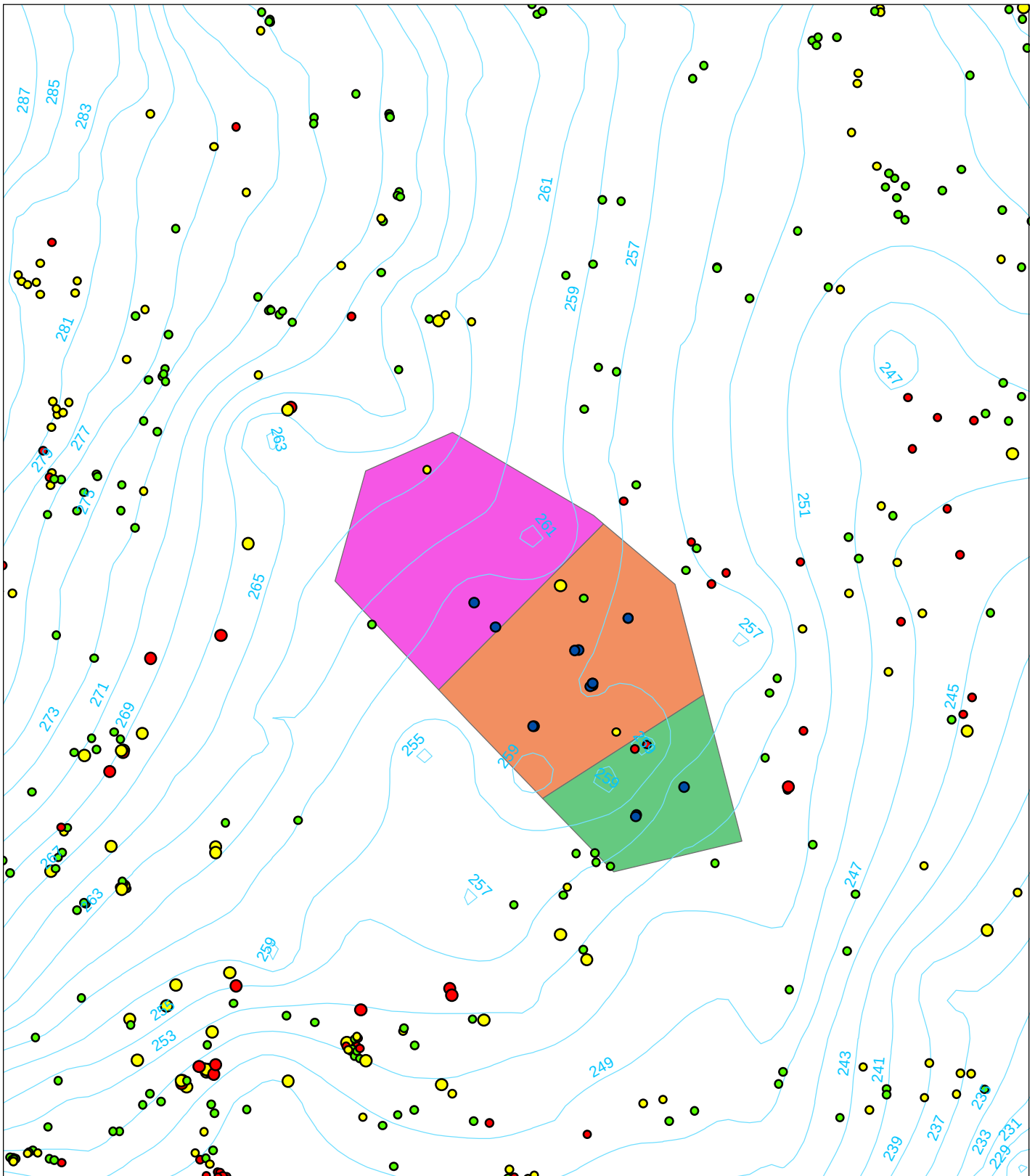


0 1,400 2,800 5,600 8,400 Meters

Figure 7

Model Boundary Conditions

St. Louis Park Wellhead Protection Plan



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Legend

Layer 3 Residual

- -54 - -10
- -9 - -5
- -4 - -5
- 6 - 10
- 11 - 40

- Municipal Wells
- Layer 3 Contours (m)

Layer 3 Kh (m/d)

- 29.33
- 32.03
- 35.33

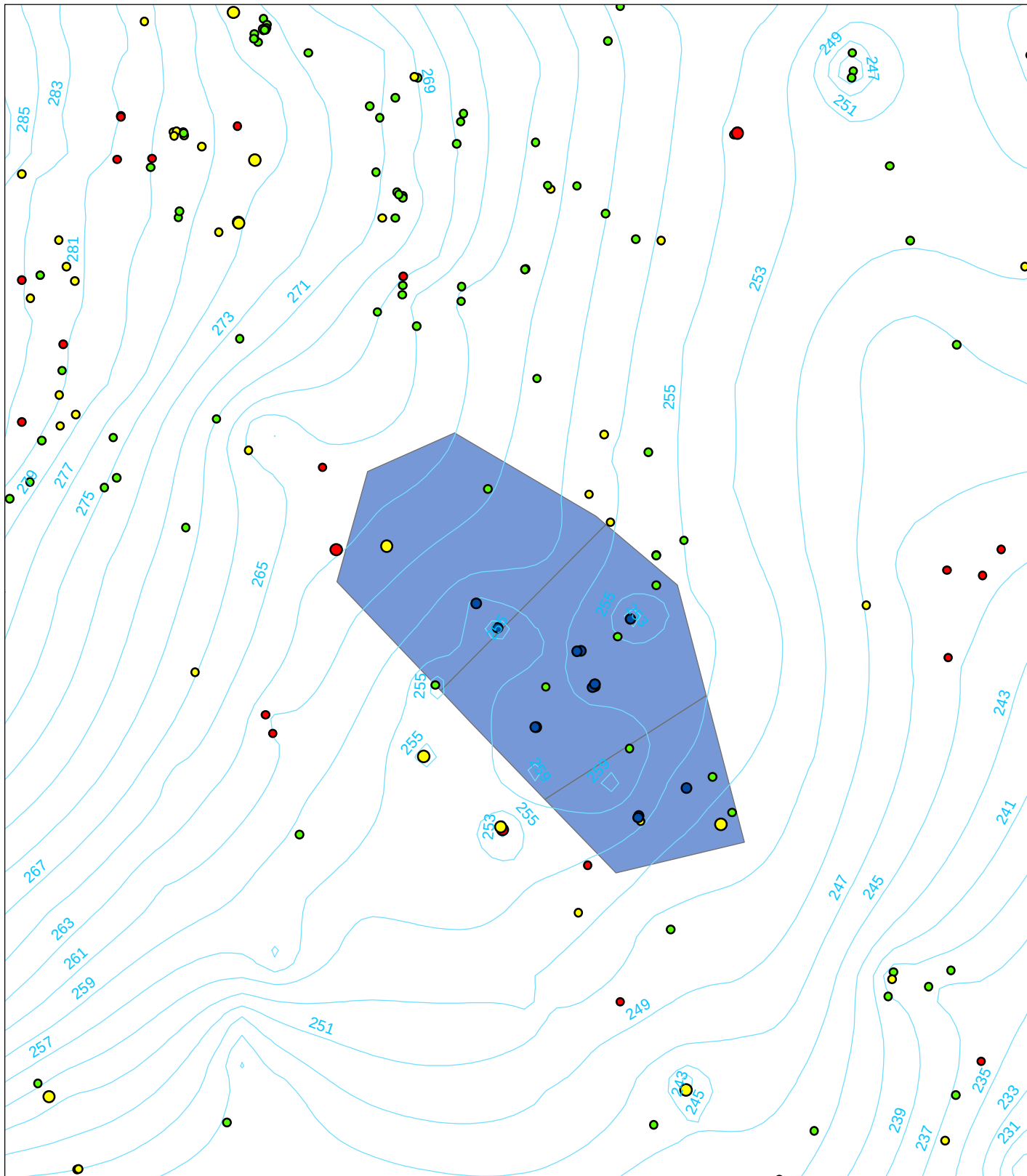
0 750 1,500 3,000 4,500 Meters



Figure 8

Layer 3 Results

St. Louis Park Wellhead Protection Plan



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Legend

Residual

- -54 - -10
- -9 - -5
- -4 - -5
- 6 - 10
- 11 - 40

Layer 4 Kh (m/d)

- 8.88
- Layer 4 Contours (m)
- Municipal Wells

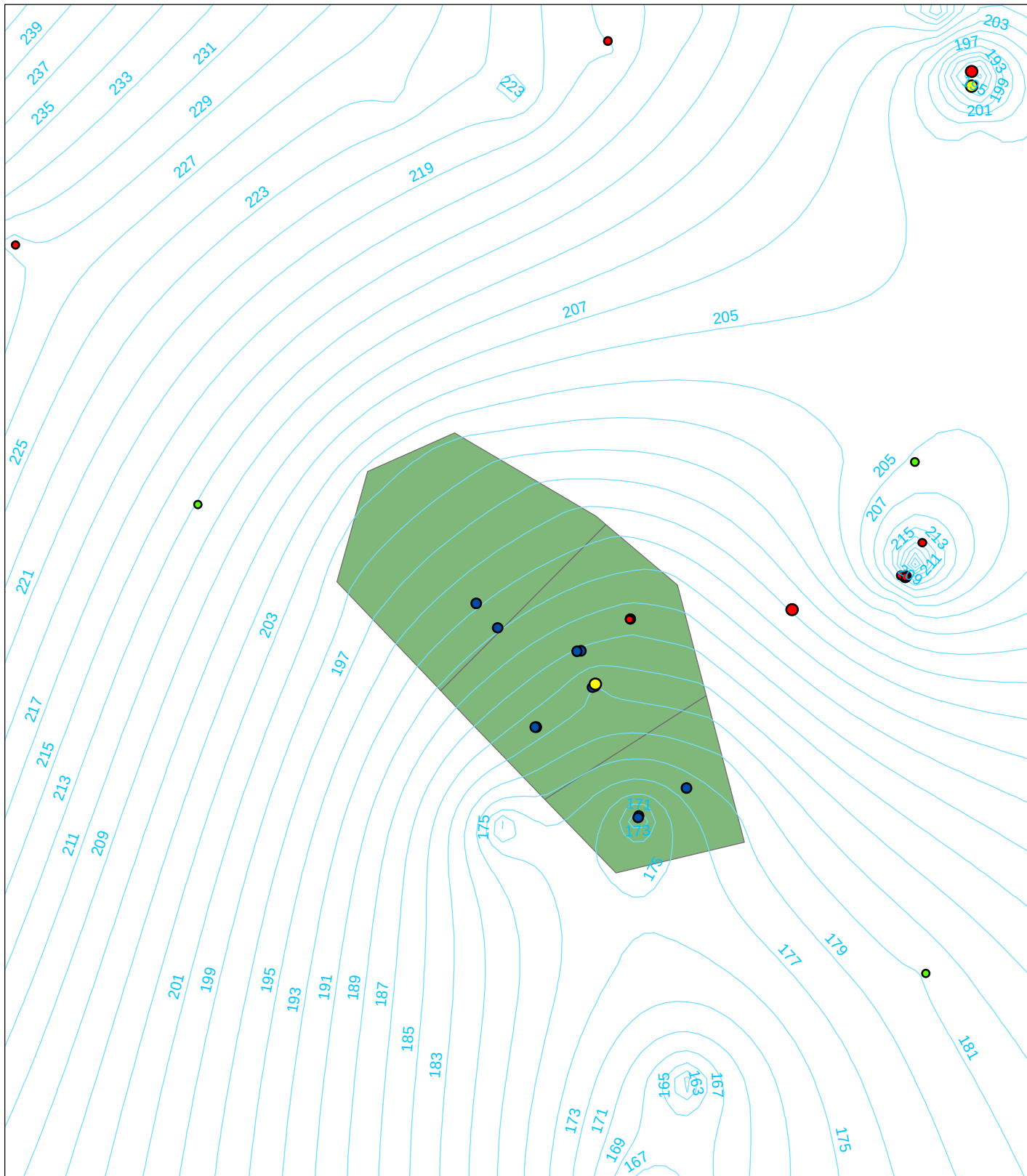


0 750 1,500 3,000 4,500
Meters

Figure 9

Layer 4 Results

St. Louis Park Wellhead Protection Plan



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Legend

Residual

- -54 - -10
- -9 - -5
- -4 - 5
- 6 - 10
- 11 - 40

- Municipal Wells
- Layer 9 Contours (m)

Layer 9 Kh (m/d)

- 3.05

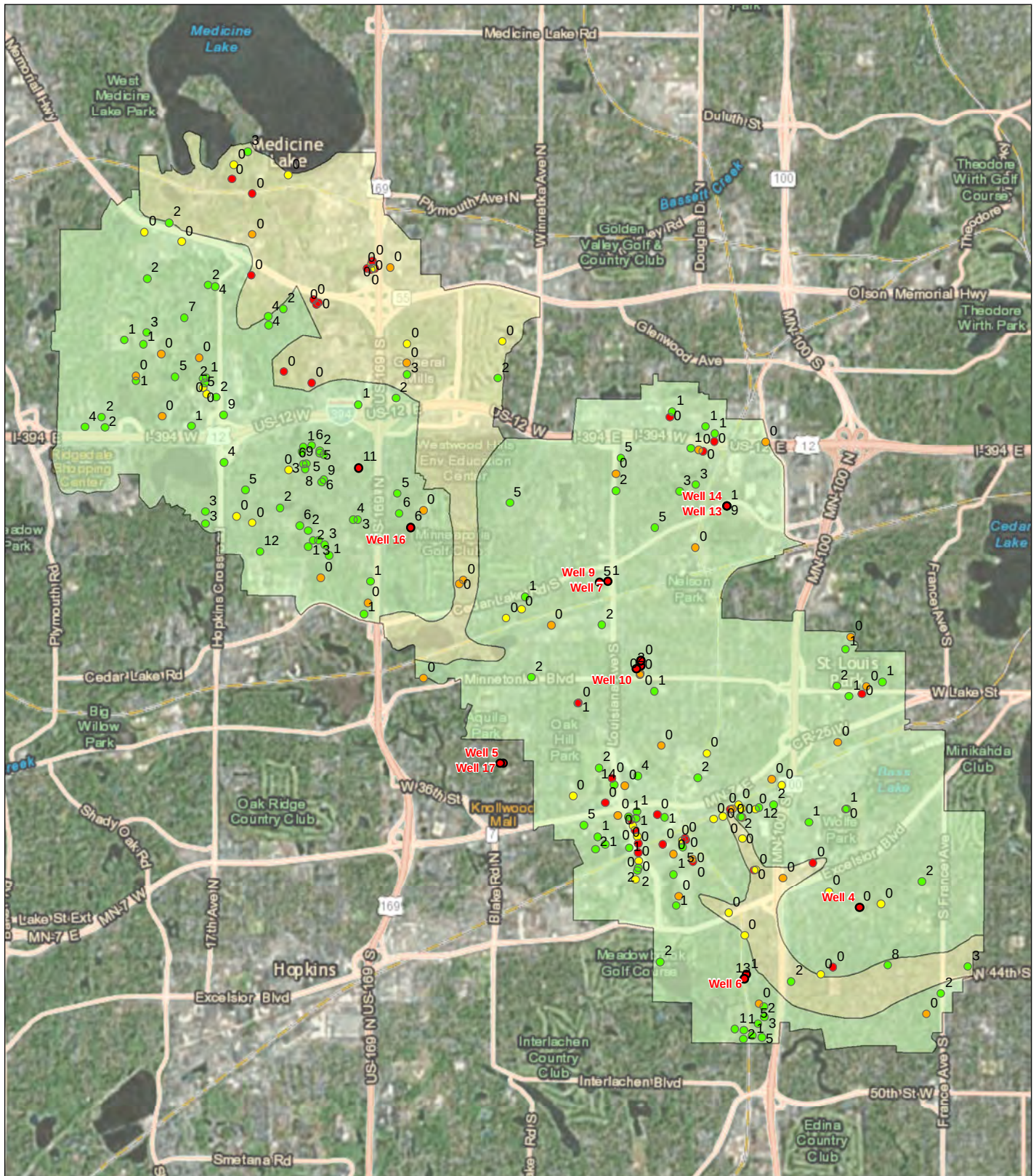


0 750 1,500 3,000 4,500
Meters

Figure 10

Layer 9 Results

St. Louis Park Wellhead
Protection Plan



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Legend

Geologic Sensitivity

- Very High
- High
- Moderate
- Low
- Very Low

- Municipal Wells
- L-Score

Vulnerability

- Moderate
- Low

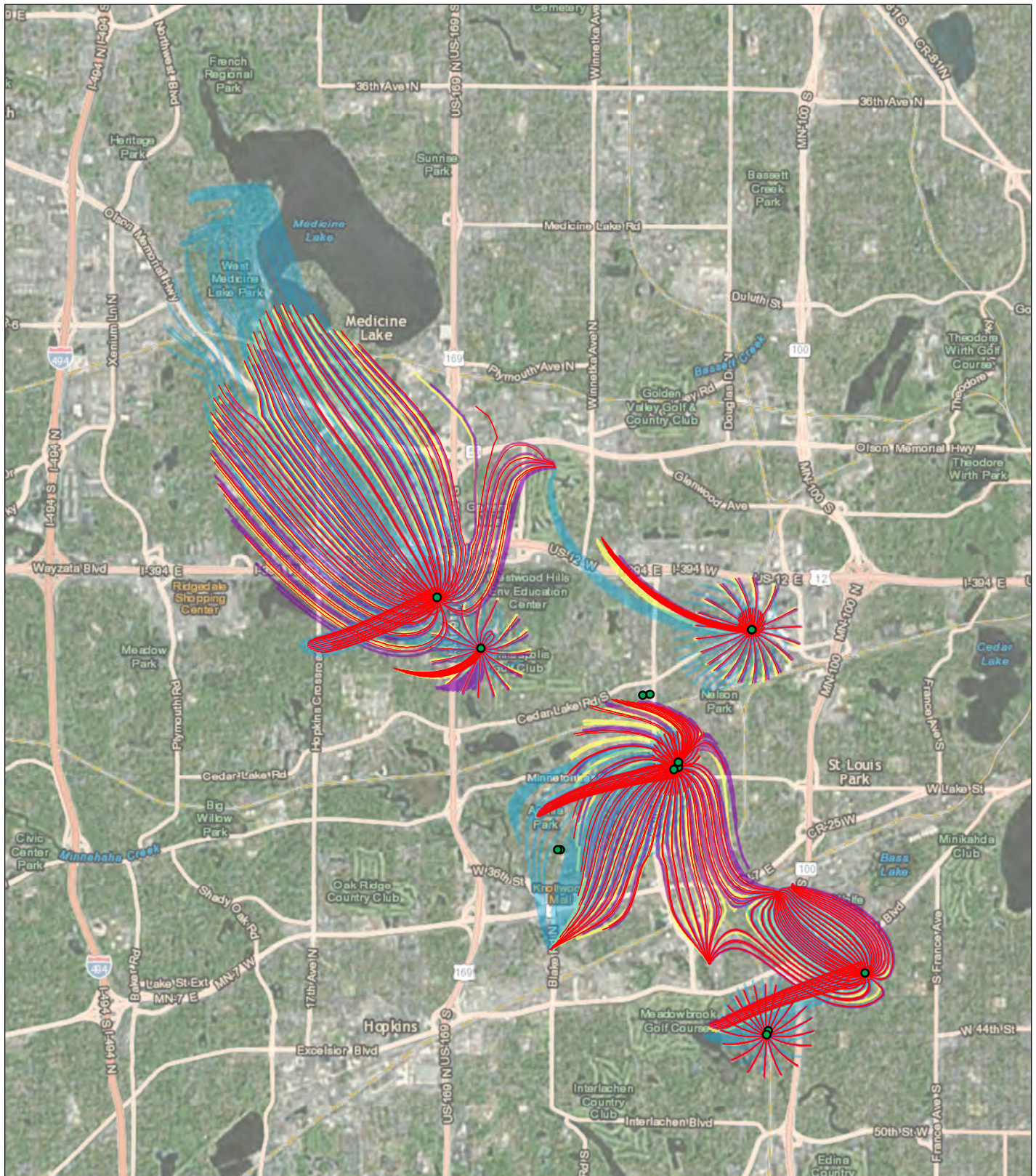


0 337.5 675 1,350 2,025 Meters

Figure 11

DWSMA
Vulnerability

St. Louis Park Wellhead
Protection Plan



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Legend

- Municipal Wells
- Modeled 10 Yr. Capture Zone
- K10x 10yr Capture Zone
- Klow 10yr Capture Zone
- Khigh 10yr Capture Zone



0 260 520 1,040 1,560
 Meters

Figure 12

Sensitivity Analysis
 Results

St. Louis Park Wellhead
 Protection Plan

Appendix A

Scoping Decision Notice



Protecting, maintaining and improving the health of all Minnesotans

August 23, 2013

Mr. Jay Hall, Utility Superintendent
City of St. Louis Park
Municipal Service Center
7305 Oxford Street
St. Louis Park, Minnesota 55426-4512

Dear Mr. Hall:

Subject: **Scoping Decision Notice No. 1 for the City of Saint Louis Park, PWSID 1270050, for Amending the Wellhead Protection Plan**

This letter provides notice of the results of the Scoping 1 meeting that Amal Djerrari and John Freitag (Minnesota Department of Health) held with you and Mark Hanson (city of Saint Louis Park) on July 24, 2013, to amend your wellhead protection plan. During the meeting, we discussed the preparation of Part I of a Wellhead Protection Plan that will document the 1) delineation of a wellhead protection area, 2) delineation of a drinking water supply management area, and 3) assessments of well and aquifer vulnerability related to these areas for the primary water supply wells that are used by the city of St. Louis Park. As you may remember, the wellhead protection area is the surface and subsurface area surrounding your public water supply wells through which contaminants are likely to move and affect your drinking water supply. The drinking water supply management area is the area delineated using identifiable landmarks that reflect the wellhead protection area boundaries as closely as possible.

It is our understanding that the city also retains Well 6 (206457) for emergency standby use. The city must manage an inner wellhead management zone that is defined by a 200-foot radius around each emergency standby well. A wellhead protection area is not defined for this well because the well only pumps during emergency water needs. The city also has four out long term wells [Well 5 (203196), Well 7 (206436), Well 9 (206437), and Well 17 (147459)]. No wellhead protection area is defined for these wells because the wells are not supposed to pump. We recommend sealing those wells if they are not in use anymore.

The city will have until April 22, 2016, to submit the amendment of its entire Wellhead Protection Plan, Part I and Part II. The Minnesota Department of Health (MDH) highly recommends that half of the time allotted be dedicated to completing Part II of the plan.

It is our understanding that you will be contracting a consultant to prepare the delineations and vulnerability assessments for the city for amending its Wellhead Protection Plan. MDH has a draft Request for Proposal (RFP) that can be used to help select a consultant that has experience in wellhead protection planning and, in particular, with preparing a Part I report. Please contact me at the phone number below if you want to discuss using the draft RFP.

Mr. Jay Hall
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August 23, 2013

At our meeting, we discussed rule requirements and the types of information needed to amend the Part I report. The Wellhead Protection Plan must be prepared in accordance with Minnesota Rules, parts 4720.5100 to 4720.5590. General wellhead protection requirements and criteria for delineating the wellhead protection area and data reporting are presented in Minnesota Rules, parts 4720.5500 to 4720.5510.

The enclosed Scoping Decision Notice No. 1 formally identifies the information the city must provide to MDH to meet rule requirements for amending and preparing Part I of the Wellhead Protection Plan. The wellhead rule refers to the existing information required for wellhead planning as data elements. Much of this information is available in the public domain, as described in the Scoping Decision Notice No. 1 form.

You only need to provide the information that is not in the public domain and, therefore, not available to MDH. The Scoping Decision Notice No. 1 form also 1) lists the Minnesota unique well number and well construction for each well that will be included in the Wellhead Protection Plan [Table 1]; 2) lists the pumping volumes for each well [Table 2]; and 3) includes a map of the well locations. A summary of the information that the PWS needs to provide is included at the end of the Scoping Decision Notice No. 1 form.

After we have had an opportunity to review the information listed in the Scoping Decision Notice No. 1 that you will be providing to MDH, we would appreciate the opportunity to again meet with you and select the appropriate method for delineating your wellhead protection area. We will also discuss how you can become involved in the preparation of amending the Part I report.

After your consultant has had an opportunity to develop a conceptual model of the local hydrogeologic setting, we would like to meet with your consultant to discuss the proposed delineation approach. This pre-delineation meeting may be accomplished by a conference call if 1) MDH approves, and 2) the consultant provides figures for the discussion beforehand. The porous media delineation could be performed using either new Metro Model that Barr Engineering developed for the Metro Council. Local detail and/or new information should be added as required and recalibration should be performed to reflect the hydrogeological conditions in Hennepin County.

A fracture flow delineation is necessary for Well 4 (200542), Well 6 (206457), Well 8 (203678) and Well 10 (206442), which are open to both the Prairie du Chien dolomite and Jordan sandstone.

Finally, it is our understanding that you will serve officially as the wellhead protection manager on behalf of the city. You are responsible for providing written notice to local units of government of the city's intent to amend the Wellhead Protection Plan, as required by the wellhead protection rule (part 4720.5300, subpart 3). A copy of this notice should be forwarded to MDH and must include a list of the city's wells, their unique well numbers, and contact information for you as Wellhead Protection manager. If you do not have a copy of your original notice from your previous WHP Plan, your Source Water Protection Unit Planner, John Freitag, can provide you with some examples of the notification of intent that other communities have used. Please contact him at 612/201-4669.

Mr. Jay Hall
Page 3
August 23, 2013

In closing, we look forward to working with you on amending your Wellhead Protection Plan. If you have any questions regarding our comments, please contact me at 651/201-4577 or at amal.djerrari@state.mn.us.

Sincerely,



Amal Djerrari, Hydrologist
Source Water Protection Unit
Environmental Health Division
P.O. Box 64975
St. Paul, Minnesota 55164-0975

AMD:ds-b

Enclosures: Scoping Decision Notice No. 1, Summary of Data Requested, Table 1 - Public Water Supply Well Information, Table 2 - Annual Volume of Water Pumped From PWS Wells, Table 3 - Permitted High-Capacity Wells, Map of Well Locations

cc: John Freitag, Source Water Protection Unit, St. Paul Office
Byron Adams, Water Monitoring Section, Minnesota Pollution Control Agency
Joe Richter, Division of Waters, Minnesota Department of Natural Resources
Ron Struss, Minnesota Department of Agriculture
Eric Mohring, Board of Water and Soil Resources
Mark Hanson, City of Saint Louis Park

SCOPING DECISION NOTICE No. 1 (Vulnerable Setting)

The purpose for the first Scoping Meeting, as required by Minnesota Rules, part 4720.5310, is to discuss the information necessary for preparing the Part I Report of a Wellhead Protection Plan. The Part I Report identifies the area that provides the source of drinking water for the public water supply (PWS) so that the PWS can develop land use or management practices to protect their groundwater resource from contamination. Specifically, the Part I Report documents the delineation of the wellhead protection area (WHPA), the delineation of the drinking water supply management area (DWSMA), and assesses the vulnerability of the PWS wells and DWSMA.

The wellhead rule (Minnesota Rules, part 4720.5310) refers to the information required for wellhead planning as data elements. This form lists the data elements stated in Minnesota Rules, part 4750.5400. The Minnesota Department of Health (MDH) uses this form to designate which data elements are needed to prepare the Part I Report, based on the hydrogeological setting, vulnerability of the wells, and aquifer information known at the time of the Scoping 1 Meeting.

Name of Public Water Supply		Date
City of Saint Louis Park (PWSID = 1270010)		August 23, 2013
Name of the Wellhead Protection Manager		
Mr. Jay Hall, Utility Superintendent		
Address	City	Zip
7305 Oxford Street	Saint Louis Park	55426-4512
Unique Well Numbers		Phone
206440 (Well 3), 200542 (Well 4), 203196 (Well 5), 206457 (Well 6-Emergency)*, 206436 (Well 7), 203678 (Well 8), 206437 (Well 9), 206442 (Well 10), 206439 (Well 11), 206456 (Well 12), 206424 (Well 13), 227965 (Well 14), 215447 (Well 15), 203187 (Well 16), 147459 (Well 17).		952/924-2557

*Emergency wells only use the IWMZ Form for data collection

Instructions for Completing the Scoping No. 1 Form

N	D	V	S	N = If this box is checked with an "X," this data element is NOT necessary for the Part I Report of your Wellhead Protection Plan. This data element may be identified later at the Scoping 2 Meeting and used for the Part 2 Report. Please go to the next data element.
X				

N	D	V	S	D = If this box is checked with an "X," the preparer of the Part I Report is required to use this information for the DELINEATION of the WHPA or the DWSMA. If there is no check in the "S" box, this information is available in the public domain or is at MDH.
	X			

N	D	V	S	V = If this box is checked with an "X," the preparer of the Part I Report is required to use this information for the VULNERABILITY assessment of the PWS well(s) or the DWSMA. If there is no check in the "S" box, this information is available in the public domain or is on file at MDH.
		X		

N	D	V	S	S = If this box is checked with an "X," the PWS must SUBMIT the information to the MDH.
			X	

DATA ELEMENTS ABOUT THE PHYSICAL ENVIRONMENT

A. PRECIPITATION				
N	D	V	S	A.1: An existing map or list of local precipitation gauging stations.
	X			
Technical Assistance Comments: Precipitation values can be used to determine the local recharge in the groundwater model. The map can be used to determine the closest gauging station. The locations of the gauging stations are available in the public domain.				
N	D	V	S	A.2: An existing table showing the average monthly and annual precipitation, in inches, for the preceding five years.
	X		X	
Technical Assistance Comments: This information may be used for determining local recharge for the groundwater model. This information may be available in the public domain if there is a local gauging station, or obtained from the local wastewater treatment plant.				
B. GEOLOGY				
N	D	V	S	B.1: An existing geologic map and a description of the geology, including aquifers, confining layers, recharge areas, discharge areas, sensitive areas as defined in Minnesota Statutes, section 103H.005, subdivision 13, and groundwater flow characteristics.
	X	X	X	
Technical Assistance Comments: Information of this type is required to characterize the geologic and hydrogeologic setting of the PWS well field(s). This information is used to define aquifer geometry, location and magnitude of the recharge and discharge areas, and groundwater flow information. Aquifer tests or alternatives listed in MN Rules, part 4720.5510, subpart 6, can be used to help characterize flow in the aquifer. Reference all information used to develop the conceptual model of the geologic setting and submit to MDH only the information that is not available in the public domain.				
N	D	V	S	B.2: Existing records of the geologic materials penetrated by wells, borings, exploration test holes, or excavations, including those submitted to the department.
	X	X	X	
Technical Assistance Comments: Information of this type may be useful to refine the understanding of the geologic and hydrogeologic setting on a local basis. Submit only if the PWS or city has information of test drilling or site investigations conducted by the city that is not available in the public domain.				
N	D	V	S	B.3: Existing borehole geophysical records from wells, borings, and exploration test holes.
	X	X	X	
Technical Assistance Comments: Information from geophysical records may provide additional information about aquifer thickness, well construction, and water level information at a local scale. Submit only if the information is not available in the public domain.				
N	D	V	S	B.4: Existing surface geophysical studies.
	X	X	X	
Technical Assistance Comments: Information from geophysical studies may be useful to refine the understanding of the geology on a local basis. Submit only if the information is not available in the public domain.				
C. SOILS				
N	D	V	S	C.1: Existing maps of the soils and a description of soil infiltration characteristics.
	X	X		
Technical Assistance Comments: This information is in the public domain and can be used to delineate the WHPA and assess the vulnerability of the DWSMA because it indicates the underlying geology.				
N	D	V	S	C.2: A description or an existing map of known eroding lands that are causing sedimentation problems.
X				
Technical Assistance Comments:				

D. WATER RESOURCES				
N	D	V	S	D.1: An existing map of the boundaries and flow directions of major watershed units and minor watershed units.
	X			
Technical Assistance Comments: This information is in the public domain and may be used to delineate the surface water contribution area of the WHPA.				
N	D	V	S	D.2: An existing map and a list of public waters as defined in Minnesota Statutes, section 103G.005, subdivision 15, and public drainage ditches.
	X	X		
Technical Assistance Comments: This information is in the public domain and may be used to delineate the surface water contribution area of the WHPA and determine the vulnerability of the DWSMA.				
N	D	V	S	D.3: The shoreland classifications of the public waters listed under sub-item (2), pursuant to part 6120.3000 and Minnesota Statutes, sections 103F.201 to 103F.221.
X				
Technical Assistance Comments:				
N	D	V	S	D.4: An existing map of wetlands regulated under Chapter 8420 and Minnesota Statutes, section 103G.221 to 103G.2373.
X				
Technical Assistance Comments:				
N	D	V	S	D.5: An existing map showing those areas delineated as floodplain by existing local ordinances.
X				
Technical Assistance Comments:				

DATA ELEMENTS ABOUT THE LAND USE

E. LAND USE				
N	D	V	S	E.1: An existing map of parcel boundaries.
	X		X	
Technical Assistance Comments: This information may be helpful in delineating the DWSMA, if available. If this information is provided, identification numbers must be provided for each parcel. An electronic format for the map is preferable.				
N	D	V	S	E.2: An existing map of political boundaries.
	X		X	
Technical Assistance Comments: Please provide this information if the boundaries have been updated/changed. This information may be helpful in delineating the DWSMA. An electronic format for the map is preferable.				
N	D	V	S	E.3: An existing map of public land surveys, including township, range, and section.
	X			
Technical Assistance Comments: This information is available in the public domain and may be helpful in delineating the DWSMA.				
N	D	V	S	E.4: A map and an inventory of the current and historical agricultural, residential, commercial, industrial, recreational, and institutional land uses and potential contaminant sources.
X				
Technical Assistance Comments:				

N	D	V	S	E.5: An existing, comprehensive land-use map.
X				
Technical Assistance Comments:				
N	D	V	S	E.6: Existing zoning map.
X				
Technical Assistance Comments:				
F. PUBLIC UTILITY SERVICES				
N	D	V	S	F.1: An existing map of transportation routes or corridors.
	X			
Technical Assistance Comments: This information is available in the public domain and may be helpful in delineating the DWSMA.				
N	D	V	S	F.2: An existing map of storm sewers, sanitary sewers, and the public water supply systems.
	X		X	
Technical Assistance Comments: Do not submit a map of the storm sewers and sanitary sewers. Describe the difference in how much water is pumped and how much is sold. The difference is the leakage that may be used as recharge in the groundwater model.				
N	D	V	S	F.3: An existing map of gas and oil pipelines used by gas and oil suppliers.
X				
Technical Assistance Comments:				
N	D	V	S	F.4: An existing map or list of public drainage systems.
	X	X		
Technical Assistance Comments: This information is available in the public domain and may be helpful in delineating the DWSMA.				
N	D	V	S	F.5: An existing record of construction, maintenance, and use of the public water supply well(s) and other wells within the DWSMA.
	X	X	X	
Technical Assistance Comments: If the information is different from that with MDH, please provide 1) the pumping rates for the current and previous years, and the projected annual pumping rates for the next five years for each well in the PWS; and 2) well record(s) for the PWS well(s). Information about the PWS well(s) may affect the vulnerability assessment due to rehabilitation/reconstruction of a well or changes in pumping rates.				

DATA ELEMENTS ABOUT WATER QUANTITY

G. SURFACE WATER QUANTITY				
N	D	V	S	G.1: An existing description of high, mean, and low flows on streams.
	X	X		
Technical Assistance Comments: This information is available in the public domain and may be used to determine hydraulic connections between surface water bodies and the aquifer(s) of concern.				
N	D	V	S	G.2: An existing list of lakes where the state has established ordinary high water marks.
	X			
Technical Assistance Comments: This information is available in the public domain. The information may be used to determine the WHPA.				
N	D	V	S	G.3: An existing list of permitted withdrawals from lakes and streams, including source, use, and amounts withdrawn.
	X	X	X	
Technical Assistance Comments: Only required if different from the DNR database. Surface water bodies may be in direct hydraulic connection with the aquifer(s) of concern and withdrawals may affect water levels in both the surface water and adjacent groundwater systems.				
N	D	V	S	G.4: An existing list of lakes and streams for which state protected levels or flows have been established.
	X			
Technical Assistance Comments: This information is available in the public domain and may be used to determine hydraulic connections between surface water bodies and the aquifer(s) of concern.				
N	D	V	S	G.5: An existing description of known water-use conflicts, including those caused by groundwater pumping.
	X	X	X	
Technical Assistance Comments: Please notify MDH of surface water/well interference problems of which the PWS is aware. Conflicts between use of groundwater resources and surface water bodies would indicate a hydrologic boundary that would need to be considered in delineating the WHPA.				
H. GROUNDWATER QUANTITY				
N	D	V	S	H.1: An existing list of wells covered by state appropriation permits, including amounts of water appropriated, type of use, and aquifer source.
	X	X	X	
Technical Assistance Comments: Please submit this information for wells not permitted by the DNR because this information may be useful in identifying the hydrologic boundary conditions that could affect the size and shape of the WHPA boundaries.				
N	D	V	S	H.2: An existing description of known well interference problems and water-use conflicts.
	X	X	X	
Technical Assistance Comments: Please notify MDH of well interference problems of which the PWS is aware. Interference problems with other wells, if present, likely indicate a hydrologic boundary that would need to be considered in making the WHPA delineation.				
N	D	V	S	H.3: An existing list of state environmental boreholes, including unique well number, aquifer measured, years of record, and average monthly levels.
	X	X	X	
Technical Assistance Comments: Only submit monthly water level measurements (with unique well numbers and dates) that are not in the public domain.				

DATA ELEMENTS ABOUT WATER QUALITY

I. SURFACE WATER QUALITY				
N	D	V	S	I.1: An existing map or list of the state water quality management classification for each stream and lake.
X				
Technical Assistance Comments:				
N	D	V	S	I.2: An existing summary of lake and stream water quality monitoring data, including:
		X	X	1. bacteriological contamination indicators; 4. sedimentation;
				2. inorganic chemicals; 5. dissolved oxygen; and
				3. organic chemicals; 6. excessive growth or deficiency of aquatic plants.
Technical Assistance Comments: This information can be used to evaluate surface water/groundwater interactions and aquifer water quality. Submit if the PWS has information that is not available in the public domain.				
J. GROUNDWATER QUALITY				
N	D	V	S	J.1: An existing summary of water quality data, including: 1) bacteriological contamination indicators;
	X	X	X	2) inorganic chemicals; and 3) organic chemicals.
Technical Assistance Comments: Submit if the PWS has information that is not available in the public domain because the information may help explain groundwater flow paths.				
N	D	V	S	J.2: An existing list of water chemistry and isotopic data from wells, springs, or other groundwater sampling points.
	X	X	X	
Technical Assistance Comments: Submit if the PWS has information that is not available in the public domain because the information may help explain groundwater flow paths.				
N	D	V	S	J.3: An existing report of groundwater tracer studies.
	X	X	X	
Technical Assistance Comments: Submit if the PWS has information that is not available in the public domain because the information may help explain groundwater flow paths.				
N	D	V	S	J.4: An existing site study and well water analysis of known areas of groundwater contamination.
		X	X	
Technical Assistance Comments: Submit if the PWS has information on contaminant sources not available in the public domain because these reports may contain additional geologic or hydrogeologic information.				
N	D	V	S	J.5: An existing property audit identifying contamination.
X				
Technical Assistance Comments:				
N	D	V	S	J.6: An existing report to the Minnesota Department of Agriculture and the Minnesota Pollution Control Agency of contaminant spills and releases.
	X	X		
Technical Assistance Comments: Notify MDH of reports on spills or contaminant releases that are with the PWS or city but are not in the public domain. These reports do not need to be submitted, but MDH staff would like to review reports.				

Summary of Data Request Specific Data to be Provided to MDH by PWS

As discussed during the first Scoping Meeting on July 24, 2013, the public water supply (PWS) will supply the following information for Part I of their Wellhead Protection Plan to the Minnesota Department of Health. The number of the data element that refers to the information needed to prepare the Part I Report is listed in the parenthesis at the end of each request.

- 1) PWS well information: Use Tables 1 and 2, the well records for the PWS wells, and a map showing the locations of all the PWS wells, to review the accuracy of 1) all PWS well construction, 2) well locations, and 3) pumping information. (F.5)

Table 1 lists well use and construction for each of the PWS wells. Have you reconstructed any wells? Are there well records for reconstructed wells?

The enclosed map shows the locations of the primary public water supply wells. Please let us know if you feel the wells are not correctly located. These locations must be used to delineate your wellhead protection areas.

Table 2 shows the available pumping information and indicates what information the PWS needs to provide for the delineation of the capture zone. Please provide 1) the pumping data for 2010 that was sent to the Minnesota Department of Natural Resources, 2) whether this rate was measured or estimated, and 3) the projected annual pumping amounts for the next five years.

- 2) Please provide a copy of any aquifer test or specific capacity information for the PWS wells that was obtained during well construction, maintenance, or repair. (B.1)
- 3) Is there an existing map of parcel and/or political boundaries that could be used for defining the Drinking Water Supply Management Area (DWSMA)? If you wish to use parcel lines, please provide the parcel identification number for each parcel boundary along with the map. Have the city boundaries changed? If the city boundaries have changed, please provide the new boundaries. The boundaries of the DWSMA may be larger if political boundaries are used instead of the parcel boundaries. (E.1 and E.2)
- 4) If there are private well records, soil boring reports, geophysical studies, or water level measurements in your files that MDH staff did not identify at the scoping meeting and that would be available for MDH staff to review and copy, please notify MDH. (B.2, B.3, B.4, and H.3)
- 5) Please identify reports that you have relating to leaks/contamination sites that may be of concern to your drinking water supply, that MDH may review and copy. (J.4)

Summary of Data Request

Page 2

- 6) If your files contain water chemistry data, such as bacteria, virus, inorganic, organic, or isotopic results from wells or other groundwater sampling points, not currently available to MDH that MDH may review and copy, please notify MDH. (J.1 and J.2)
- 7) Please identify reports that you have in your files relating to groundwater tracer studies that have been conducted. (J.3)
- 8) Please provide information about other high-capacity wells in your area that may not be permitted and are not listed on the attached Table 3. (H.1)
- 9) Please describe any conflicts over water use that the PWS has been involved with, such as 1) private wells that went dry (or well interference) or 2) springs or wetlands that were affected. Was the Department of Natural Resources involved in resolving the conflict? (G.5 and H.2)
- 10) Please describe the annual amount of water that is lost due to leaks in the distribution system. Can you identify specific parts of the distribution system where this loss occurs? (F.2)
- 11) If local precipitation information is not available in the public domain within a couple of miles and in the same geomorphic setting, please provide average monthly precipitation values from the wastewater treatment facility during the preceding five years. (A.2)
- 12) Please identify any other reports about surface water withdrawals or surface water monitoring data from lakes, streams, or wetlands that are not in the public domain that MDH staff could review and copy. (G.3 and I.2)

Table 1
Water Supply Well Information
City of Saint Louis Park

Local Well Name	Unique Number	Type	Casing Diameter (inches)	Casing Depth (feet)	Well Depth (feet)	Date Constructed	Well Vulnerability	Aquifer
Well 3	206440	Primary	24	103	286	1939	Vulnerable	OSTP - St.Peter
Well 4	200542	Primary	24 x 18	304	490	1946	Vulnerable	OPCJ - Prairie Du Chien-Jordan
Well 5	203196	Out Long Term ¹	24 x 20	305	465	1905	Vulnerable	OPCJ - Prairie Du Chien-Jordan
Well 6	206457	Emergency ¹	24 x 20	303	482	1948	Vulnerable	OPCJ - Prairie Du Chien-Jordan
Well 7	206436	Out Long Term ¹	24 x 20	274	446	1952	Not Vulnerable	OPCJ - Prairie Du Chien-Jordan
Well 8	203678	Primary	24 x 16	314	507	1905	Not Vulnerable	OPCJ - Prairie Du Chien-Jordan
Well 9	206437	Out Long Term ¹	24 x 16	289	473	1956	Not Vulnerable	OPCJ - Prairie Du Chien-Jordan
Well 10	206442	Primary	24 x 16	316	500	1955	Vulnerable	OPCJ - Prairie Du Chien-Jordan
Well 11	206439	Primary	24 x 16	880	1093	1960	Not Vulnerable	CMTS - Mt.Simon
Well 12	206456	Primary	30 x 24 x 16	900	1095	1965	Not Vulnerable	CMTS - Mt.Simon
Well 13	206424	Primary	30 x 24 x 16	891	1045	1964	Not Vulnerable	CMTS - Mt.Simon
Well 14	227965	Primary	30 x 24 x 16	389	485	1965	Vulnerable	CJDN - Jordan
Well 15	215447	Primary	30 x 24	398	503	1905	Vulnerable	CJSL - Jordan
Well 16	203187	Primary	30 x 24	425	500	1973	Vulnerable	CJDN - Jordan
Well 17	147459	Out Long Term ¹	36 x 30 x 24 x 18 x 12	818	1085	1983	Not Vulnerable	CMTS - Mt.Simon

¹ The rules do not require to define a wellhead protection area is not defined for those wells.

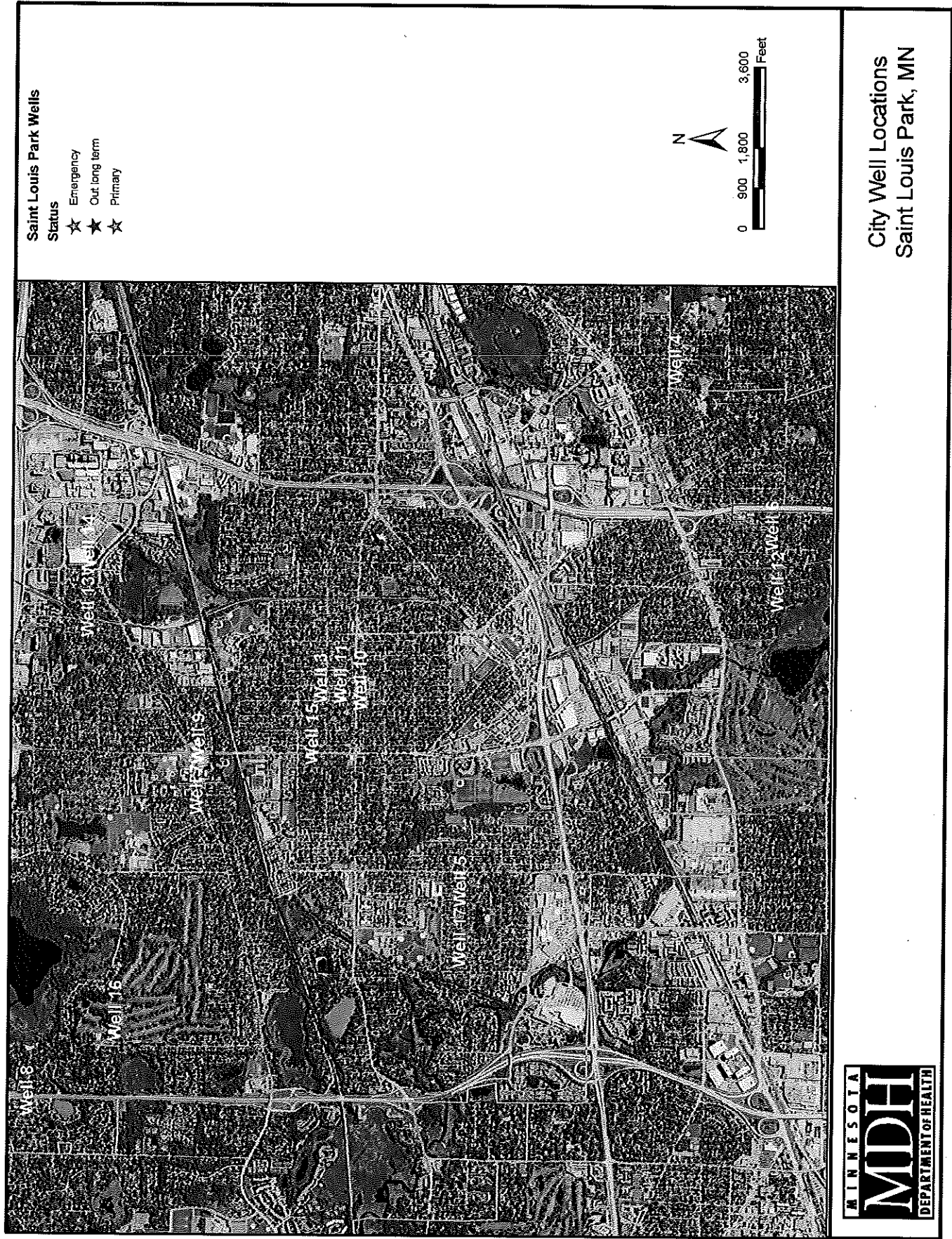
Table 2
Annual Volume of Water Pumped from Wells
City of Saint Louis Park

Well Name	Unique Number	Total Annual Withdrawal (gal/year)					Maximum Withdrawal 2008 - 2012 (gallons/year)	Projected 2016 Withdrawal (gallons/year)
		2008	2009	2010	2011	2012		
Well 3	206440	13,304,000	4,655,000	117,000	0	20,000	13,304,000	
Well 4	200542	483,350,000	513,012,000	525,041,000	521,918,000	443,539,000	525,041,000	
Well 5	203196	0	0	0	0	0	0	
Well 6	206457	188,000	257,000	246,000	184,000	471,000	257,000	
Well 7	206436	0	0	0	0	0	0	
Well 8	203678	292,233,000	296,189,000	545,933,000	530,319,000	457,559,000	545,933,000	
Well 9	206437	0	0	0	0	0	0	
Well 10	206442	351,748,000	206,959,000	133,248,000	245,767,000	331,570,000	351,748,000	
Well 11	206439	67,036,000	122,233,000	58,707,000	53,806,000	116,691,000	122,233,000	
Well 12	206456	357,570,000	362,056,000	307,158,000	213,246,000	187,409,000	362,056,000	
Well 13	206424	97,701,000	211,310,000	228,064,000	79,131,000	178,301,000	228,064,000	
Well 14	227965	345,326,000	214,874,000	82,696,000	185,172,000	200,316,000	345,326,000	
Well 15	215447	57,000	55,240,000	0	0	0	55,240,000	
Well 16	203187	371,318,000	375,759,000	273,452,000	262,047,000	306,562,000	375,759,000	
Well 17	147459	0	0	0	0	0	0	
Totals		2,379,831,000	2,362,544,000	2,154,662,000	2,091,590,000	2,222,438,000	2,924,961,000	

Source: The DNR State Water Use Database System (SWUDS), Permit Number 1973-1007.

Table 3
Permitted High-Capacity Wells Within 2.0 miles
DNR State Water Use Database System (SWUDS)
City of Saint Louis Park

Unique Number	Well Name	DNR Permit Number	Aquifer	Use	Annual Volume of Water Pumped*	Daily Volume*
204068	Hopkins, City Of	1975-6245	OPDCCJDN	Municipal Waterworks	476.926	1.307
203613	Edina, City Of	1973-1119	CJDN	Municipal Waterworks	381.803	1.046
208399	Edina, City Of	1973-1119	OPDCCJDN	Municipal Waterworks	362.299	0.993
112228	Hopkins, City Of	1975-6245	OPDCCJDN	Municipal Waterworks	317.123	0.869
200561	Edina, City Of	1973-1119	OPDCCJDN	Municipal Waterworks	250.601	0.687
200564	Edina, City Of	1973-1119	OPDCCJDN	Municipal Waterworks	218.278	0.598
204054	Minnetonka, City Of	1979-6207	CJDN	Municipal Waterworks	110.731	0.303
208012	Minnetonka, City Of	1979-6207	CJDN	Municipal Waterworks	110.725	0.303
203614	Edina, City Of	1973-1119	CMTS	Municipal Waterworks	105.59	0.289
578922	Honeywell Inc	1998-6076	OPDCCJDN	Non-Metallic Processing	66.615	0.183
240630	Edina, City Of	1973-1119	OPDCCJDN	Municipal Waterworks	45.79	0.125
434042	St Louis Park, City Of	1990-6036	OSTP	Pollution Containment	30.402	0.083
204072	Oak Ridge Country Club	1966-1167	OPDCCJDN	Golf Course Irrigation	29.105	0.08
216050	St Louis Park, City Of	1988-6213	OPCJ	Pollution Containment	28.876	0.079
434045	St Louis Park, City Of	1987-6212	QBAA	Pollution Containment	25.821	0.071
538134	St Louis Park, City Of	1995-6047	QWTA	Pollution Containment	25.326	0.069
206588	Edina, City Of	1973-1119	PMHNPMFL	Municipal Waterworks	19.54	0.054
200534	Minikahda Club	1975-6248	OPCJ	Golf Course Irrigation	19.27	0.053
236585	Golden Valley Country Club	1986-6180	OPDC	Golf Course Irrigation	16.364	0.045
236157	Edina Country Club	1972-1231	OPDCCJDN	Golf Course Irrigation	15.135	0.041
207674	Edina, City Of	1973-1119	OPDCCJDN	Municipal Waterworks	14.608	0.04
534115	Golden Valley Country Club	1986-6180	OPDCCJDN	Golf Course Irrigation	14.514	0.04
203183	Minneapolis Golf Club	1986-6083	OPDCCJDN	Golf Course Irrigation	12.734	0.035
453805	Interlachen Country Club	1969-0490	OPCJ	Golf Course Irrigation	12.511	0.034
434044	St Louis Park, City Of	1987-6212	OPVL	Pollution Containment	10.323	0.028
223780	General Mills Inc	1960-0603	OPDCCJDN	Agricultural Processing	9.464	0.026
161443	Edina Country Club	1972-1231	OPDCCJDN	Golf Course Irrigation	4.908	0.013
161436	Minikahda Club	1975-6248	OPDCCJDN	Golf Course Irrigation	4.746	0.013
255948	Sun Valley Mobile Home Park	1985-6006	OSTP	Private Waterworks	3.564	0.01
216009	Minneapolis Park & Rec Board	1986-6125	OPDCCJDN	Golf Course Irrigation	3.185	0.009
224098	General Mills Inc	2007-0209	OPDCCJDN	Fire Protection	0.764	0.002



Appendix B

Well Logs

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
147459		Quad Hopkins		WELL AND BORING RECORD				Update Date 2011/08/28			
		Quad Id 104B		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 17						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						1085.00 ft		1085.00 ft		1983/05/20	
117 21 W 18 DABBAC Elevation 920.00 ft.											
Well Address ST. LOUIS PARK 17						Drilling Method Cable Tool					
ST LOUIS PARK MN 55426 Changed						Drilling Fluid			Well Hydrofractured? ☐ YES ☐ NO		
Contact Address CITY OF ST. LOUIS PARK						From ft. to					
ST LOUIS PARK MN 55426						Use Community Supply					
						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO			Hole Diameter (in.)		
						Diameter 12 Depth 818			12.0(To 385.0		
						36.00 in. from 0.00 to 115.00 ft. lbs/ft					
						30.00 in. from 0.00 to 205.00 ft. lbs/ft					
						24.00 in. from 0.00 to 278.00 ft. lbs/ft					
						18.00 in. from 0.00 to 475.00 ft. lbs/ft					
						12.00 in. from 0.00 to 818.00 ft. lbs/ft					
Description Color Hardness From To (ft.)						Screen No Open Hole(ft.) From 818.0 to 1085.					
DRIFT						Make					
DRIFT WITH LIMEROCK						Diamter Slot Length Set Type					
SHALE BLUE											
ST. PETER SANDSTONE											
SHALE RED											
SHAKOPEE LIMESTONE											
SHAKOPEE LIMESTONE											
SHAKOPEE LIMESTONE											
JORDAN SANDSTONE											
SHALE RED/GRN											
SHALE RED/GRN											
SHALE RED/GRN											
SHALE RED/GRN											
SANDSTONE W/SHALE LAYERS											
SANDSTONE W/SHALE LAYERS											
SANDSTONE W/SHALE LAYERS											
SANDSTONE											
SANDSTONE											
RED CLASTICS											
						Static Water Level					
						315.00 ft. Land surface Date measured 1983/04/27					
						Pumping Level (below land surface)					
						439.00 ft. after 120.00 hrs. pumping 1200.00 g.p.m.					
						Wellhead Completion					
						Pitless adapter manufacturer Model					
						☐ Casing Protection ☐ 12 in. above grade					
						☐ At-grade (Environmental Wells and Borings ONLY) ☐ Basement offset					
						Grouting Information Well grouted? ☐ YES ☐ NO					
						Material Neat Cement From 0.0 To 818.0 ft. 510.00 Sacks					
						Nearest Known Source of Contamination					
						feet Direction Type					
						Well disinfected upon completion? ☐ YES ☐ NO					
						Pump					
						☐ Not Installed Date Installed					
						Manufacture's name					
						Model number HP 0.00 Volts					
						Length of drop pipe Material Capacity g.p.m					
						Type					
						Abandoned Wells					
						Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO					
						Variance					
						Was a variance granted from the MDH for this well? ☐ YES ☐ NO					
						Well Contractor Certification					
						Layne Well Co. 27010					
						License Business Name Lic. or Reg No.					
						HOLLEN, G					
Remarks											
M.G.S. NO. 1979 M.G.S. NO.1979. GAMMA LOGGED 2-25-1988 & 6-24-1988.											
First Bedrock OSTP						Aquifer Mt.Simon					
Last Strat PMSU						Depth to Bedrock 115.00 ft.					
County Well Index v.5						REPORT Printed on 12/13/2012					
						Name of Driller Date HE-01205-07 (Rev. 2/99)					

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
200542		Quad Minneapolis South		WELL AND BORING RECORD				Update Date 2011/08/24			
		Quad Id 104A		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 4						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						490.00 ft		490.00 ft		1946/09/00	
28 24 W 7 BDADAC Elevation 900.00 ft.											
Well Address ST. LOUIS PARK 4						Drilling Method Cable Tool					
41ST ST						Drilling Fluid			Well Hydrofractured? ☐ YES ☐ NO		
ST LOUIS PARK MN 55416 Changed									From ft. to		
Contact Address CITY OF ST. LOUIS PARK						Use Community Supply					
ST LOUIS PARK MN Changed						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO Hole Diameter (in.)					
						Diameter 18 Depth 304					
						24.00 in. from 0.00 to 90.00 ft. lbs/ft					
						18.00 in. from 0.00 to 304.00 ft. lbs/ft					
Description Color Hardness From To (ft.)						Screen No Open Hole(ft.) From 304.0 to 390.0					
FILL						Make					
SAND & GRAVEL						Diamter Slot Length Set Type					
PLATTEVILLE LIME											
ST PETER SAND											
HARD SANDSTONE & SHALE											
LIME											
LIME											
LIME MILKY CUTTINGS WHITE											
JORDAN SANDSTONE											
JORDAN SANDSTONE & HARD											
JORDAN SANDSTONE & HARD											
ST. LAWRENCE											
						Static Water Level					
						85.00 ft. Land surface Date measured 1946/09/27					
						Pumping Level (below land surface)					
						121.00 ft. after 24.00 hrs. pumping 2560.00 g.p.m.					
						Wellhead Completion					
						Pitless adapter manufacturer Model					
						☐ Casing Protection ☐ 12 in. above grade					
						☐ At-grade (Environmental Wells and Borings ONLY) ☐ Basement offset					
						Grouting Information Well grouted? ☐ YES ☐ NO					
						Nearest Known Source of Contamination					
						feet Direction Type					
						Well disinfected upon completion? ☐ YES ☐ NO					
						Pump					
						☐ Not Installed Date Installed					
						Manufacture's name					
						Model number HP 0.00 Volts					
						Length of drop pipe Material Capacity 1200 g.p.m					
						Type					
						Abandoned Wells					
						Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO					
						Variance					
						Was a variance granted from the MDH for this well? ☐ YES ☐ NO					
						Well Contractor Certification					
						Layne Well Co. 27010					
						License Business Name Lic. or Reg No.					
First Bedrock OPVL Aquifer Prairie Du Chien-Jordan											
Last Strat CSTL Depth to Bedrock 76.00 ft.											
Remarks											
County Well Index v.5						REPORT		Printed on 12/13/2012		Name of Driller	
										Date HE-01205-07 (Rev. 2/99)	

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
203187		Quad Hopkins		WELL AND BORING RECORD				Update Date 2012/09/17			
		Quad Id 104B		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 16						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						500.00 ft		500.00 ft		1973/07/31	
117 21 W 7 BBADBA Elevation 917.00 ft.											
Well Address ST. LOUIS PARK 16						Drilling Method Cable Tool					
ST LOUIS PARK MN 55416 Changed						Drilling Fluid			Well Hydrofractured? ☐ YES ☐ NO		
Contact Address CITY OF ST. LOUIS PARI						From ft. to					
ST LOUIS PARK MN 55416						Use Community Supply					
						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO			Hole Diameter (in.)		
						Diameter 24 Depth 425					
						30.00 in. from 0.00 to 310.00 ft. lbs/ft					
						24.00 in. from 0.00 to 425.00 ft. lbs/ft					
Description						Color		Hardness		From To (ft.)	
SAND & GRAVEL										0 60	
CLAY & BOULDERS										60 80	
COARSE SAND & GRAVEL										80 105	
BROKEN LIMESTONE										105 118	
PLATTVILLE LIMESTONE										118 128	
ST. PETER SANDSTONE										128 258	
SHALE						RED				258 294	
SHAKOPEE LIMESTONE										294 310	
JORDAN SANDSTONE										310 495	
ST. LAWRENCE SHALE										495 500	
						Screen No					
						Make			Open Hole(ft.) From 425.0 to 500.0		
						Diamter Slot Length Set			Type		
						Static Water Level					
						125.00 ft. Land surface			Date measured 1973/07/31		
						Pumping Level (below land surface)					
						238.00 ft. after			hrs. pumping 2000.00 g.p.m.		
						Wellhead Completion					
						Pitless adapter manufacturer			Model		
						☐ Casing Protection			☐ 12 in. above grade		
						☐ At-grate (Environmental Wells and Borings ONLY)			☐ Basement offset		
						Grouting Information					
						Well grouted? ☐ YES ☐ NO					
						Material Neat Cement			From To ft.		
						Nearest Known Source of Contamination					
						feet			Direction Type		
						Well disinfected upon completion? ☐ YES ☐ NO					
						Pump					
						☐ Not Installed			Date Installed		
						Manufacture's name					
						Model number			HP Volts		
						Length of drop pipe			Material Capacity g.p.m		
						Type					
						Abandoned Wells					
						Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO					
						Variance					
						Was a variance granted from the MDH for this well? ☐ YES ☐ NO					
						Well Contractor Certification					
						Tri-state Well Co.			27118		
						License Business Name			Lic. or Reg No.		
						BERTHIAUME, F					
First Bedrock OPVL						Aquifer Jordan					
Last Strat CSTL						Depth to Bedrock		105.00 ft.			
Remarks											
County Well Index v.5						REPORT		Printed on 12/13/2012		Name of Driller	
										Date	
										HE-01205-07 (Rev. 2/99)	

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
203196		Quad Hopkins		WELL AND BORING RECORD				Update Date 2011/08/28			
		Quad Id 104B		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 5						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						465.00 ft		465.00 ft		1947/00/00	
117 21 W 18 DABBAD Elevation 930.00 ft.											
Well Address ST. LOUIS PARK 5						Drilling Method Cable Tool					
ST LOUIS PARK MN 55426 Changed						Drilling Fluid			Well Hydrofractured? ☐ YES ☐ NO		
Contact Address CITY OF ST. LOUIS PARK						From ft. to					
ST LOUIS PARK MN 55426						Use Community Supply					
						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO			Hole Diameter (in.)		
						Diameter 20 Depth 305			20.0(To 465.0		
						24.00 in. from 0.00 to 115.00 ft. lbs/ft					
						20.00 in. from 0.00 to 305.00 ft. lbs/ft					
Description Color Hardness From To (ft.)						Screen Open Hole(ft.) From to					
SAND & GRAVEL						Make Type					
CLAY & BOULDERS						Diamter Slot Length Set					
SAND & GRAVEL											
COARSE GRAVEL											
PLATTEVILLE LIME											
ROCK & SHALE											
SANDROCK											
SHALE & ROCK											
LIMEROCK											
SANDSTONE											
ST. LAWRENCE											
						Static Water Level					
						91.00 ft. Land surface Date measured 1947/00/00					
						Pumping Level (below land surface)					
						116.00 ft. after hrs. pumping 1380.00 g.p.m.					
						Wellhead Completion					
						Pitless adapter manufacturer Model					
						☐ Casing Protection ☐ 12 in. above grade					
						☐ At-grade (Environmental Wells and Borings ONLY) ☐ Basement offset					
						Grouting Information Well grouted? ☐ YES ☐ NO					
						Material Neat Cement From To ft. 15.00 Cubic yards					
						Nearest Known Source of Contamination					
						feet Direction Type					
						Well disinfected upon completion? ☐ YES ☐ NO					
						Pump					
						☐ Not Installed Date Installed					
						Manufacture's name					
						Model number HP 0.00 Volts					
						Length of drop pipe Material Capacity g.p.m					
						Type					
						Abandoned Wells					
						Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO					
						Variance					
						Was a variance granted from the MDH for this well? ☐ YES ☐ NO					
						Well Contractor Certification					
						Layne Well Co. 27010					
						License Business Name Lic. or Reg No.					
						SHUEY, P.					
First Bedrock OPVL Aquifer Prairie Du Chien-Jordan											
Last Strat CSTL Depth to Bedrock 109.00 ft.											
Remarks											
County Well Index v.5						REPORT		Printed on 12/13/2012		Name of Driller	
										Date HE-01205-07 (Rev. 2/99)	

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
203678		Quad Hopkins		WELL AND BORING RECORD				Update Date 2011/08/29			
		Quad Id 104B		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 8						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						507.00 ft		507.00 ft		1955/00/00	
117 22 W 1 DACCBC Elevation 940.00 ft.											
Well Address ST. LOUIS PARK 8						Drilling Method Cable Tool					
ST LOUIS PARK MN 55426 Changed						Drilling Fluid			Well Hydrofractured? ☐ YES ☐ NO		
Contact Address CITY OF ST. LOUIS PARK						From ft. to					
ST LOUIS PARK MN 55426						Use Community Supply					
						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO			Hole Diameter (in.)		
						Diameter 16 Depth 314			23.0(To 507.0		
						24.00 in. from 0.00 to 253.00 ft. lbs/ft					
						16.00 in. from 0.00 to 314.00 ft. lbs/ft					
Description Color Hardness From To (ft.)						Screen No Open Hole(ft.) From 314.0 to 507.0					
PLATFORM						Make					
YELLOW CLAY, ROCKS & BOULI						Diamter Slot Length Set Type					
RED CLAY & ROCKS											
BROWN CLAY (GRAY) & ROCKS											
SAND & GRAVEL (DIRTY)											
CLAY, ROCKS & BROKEN LIMER											
SHALE YELLOW											
SANDROCK & SHALE											
SANDROCK											
SHALE											
SANDROCK											
SHALE & SANDROCK											
SHAKOPEE LIMEROCK											
SANDROCK CLEAN											
SANDROCK FINE RED HARD											
SANDROCK SHALEY											
SANDROCK COARSE WHITE M.HARD											
SANDROCK FINE WHITE M.HARD											
SHALEY SANDROCK											
						Static Water Level					
						95.00 ft. Land surface Date measured 1955/00/00					
						Pumping Level (below land surface)					
						130.00 ft. after hrs. pumping 0.00 g.p.m.					
						Wellhead Completion					
						Pitless adapter manufacturer Model					
						☐ Casing Protection ☐ 12 in. above grade					
						☐ At-grade (Environmental Wells and Borings ONLY) ☐ Basement offset					
						Grouting Information Well grouted? ☐ YES ☐ NO					
						Material From To 314.0 ft.					
						Nearest Known Source of Contamination					
						feet Direction Type					
						Well disinfected upon completion? ☐ YES ☐ NO					
						Pump					
						☐ Not Installed Date Installed					
						Manufacture's name					
						Model number HP 0.00 Volts					
						Length of drop pipe Material Capacity g.p.m					
						Type					
						Abandoned Wells					
						Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO					
						Variance					
						Was a variance granted from the MDH for this well? ☐ YES ☐ NO					
						Well Contractor Certification					
						Bergerson-Caswell 27058					
						License Business Name Lic. or Reg No.					
First Bedrock OSTP Aquifer Prairie Du Chien-Jordan											
Last Strat CSTL Depth to Bedrock 126.00 ft.											
Remarks											
COPIED FROM D.N.R.											
County Well Index v.5						REPORT Printed on 12/13/2012					
						Name of Driller Date HE-01205-07 (Rev. 2/99)					

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH		Entry Date 1991/08/24	
206424		Quad Minneapolis South		WELL AND BORING RECORD		Update Date 2011/08/26	
		Quad Id 104A		MINNESOTA STATUTES CHAPTER 1031		Received Date	
Well Name ST. LOUIS PARK 13				Well Depth		Depth Completed	
Township Range Dir Section Subsection Field Located MDH				1045.00 ft		1045.00 ft	
117 21 W 4 CCDACA Elevation 902.00 ft.						Date Well Completed 1964/07/01	
Well Address ST. LOUIS PARK 13				Drilling Method Cable Tool			
ST LOUIS PARK MN 55416 Changed				Drilling Fluid		Well Hydrofractured? ☐ YES ☐ NO	
Contact Address CITY OF ST. LOUIS PARK				From ft. to			
ST LOUIS PARK MN 55416				Use Community Supply			
				Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO		Hole Diameter (in.)	
				Diameter 16 Depth 891			
				30.00 in. from 0.00 to 95.00 ft. lbs/ft			
				24.00 in. from 0.00 to 212.00 ft. lbs/ft			
				16.00 in. from 0.00 to 891.00 ft. lbs/ft			
Description Color Hardness From To (ft.)				Screen No			
SAND, GRAVEL & ROCKS				Open Hole(ft.) From 891.0 to 1045.			
CLAY AND BOULDERS				Make			
SAND AND CLAY				Diamter Slot Length Set Type			
CLAY							
ROCKS AND CLAY MIXED							
PLATTEVILLE ROCK							
ST. PETER SAND							
RED SHALE AND ST. PETER SAI							
BLUE SHALE & ST. PETER SANI							
SHAKOPEE ROCK							
JORDAN SANDSTONE							
ST. LAWRENCE							
FRANCONIA							
DRESBACH							
DRESBACH HARD RUBBER SH/							
MT. SIMON SANDSTONE							
SHALE + SANDSTONE							
HINCKLEY							
RED CLASTIC							
				Static Water Level			
				255.00 ft. Land surface Date measured 1964/07/01			
				Pumping Level (below land surface)			
				ft. after hrs. pumping g.p.m.			
				Wellhead Completion			
				Pitless adapter manufacturer Model			
				☐ Casing Protection ☐ 12 in. above grade			
				☐ At-grade (Environmental Wells and Borings ONLY) ☐ Basement offset			
				Grouting Information			
				Well grouted? ☐ YES ☐ NO			
				Material Well known to be not From To ft. 105.00 Sacks			
				Nearest Known Source of Contamination			
				feet Direction Type			
				Well disinfected upon completion? ☐ YES ☐ NO			
				Pump			
				☐ Not Installed Date Installed			
				Manufacture's name			
				Model number HP 0.00 Volts			
				Length of drop pipe Material Capacity g.p.m			
				Type			
				Abandoned Wells			
				Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO			
				Variance			
				Was a variance granted from the MDH for this well? ☐ YES ☐ NO			
				Well Contractor Certification			
				Layne Well Co. 27010			
				License Business Name Lic. or Reg No.			
				HOLLEN, G			
First Bedrock OPVL Aquifer Mt.Simon							
Last Strat PMSU Depth to Bedrock 94.00 ft.							
Remarks							
County Well Index v.5				REPORT		Printed on 12/13/2012	
				Name of Driller		Date	
						HE-01205-07 (Rev. 2/99)	

Unique Well Number				County Hennepin				MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24							
206436				Quad Minneapolis South				WELL AND BORING RECORD				Update Date 2011/08/26							
				Quad Id 104A				MINNESOTA STATUTES CHAPTER 1031				Received Date							
Well Name ST. LOUIS PARK 7								Well Depth				Depth Completed				Date Well Completed			
Township Range Dir Section Subsection Field Located MDH								446.00 ft				446.00 ft				1952/05/09			
117 21 W 8 BDDAAC Elevation 905.00 ft.																			
Well Address ST. LOUIS PARK 7								Drilling Method Cable Tool											
2500 LOUISIANA AV								Drilling Fluid								Well Hydrofractured? YES NO			
ST LOUIS PARK MN 55416 Changed																From ft. to			
Contact Address CITY OF ST. LOUIS PARK								Use Community Supply											
ST LOUIS PARK MN 55416								Casing Type Steel (black or low alloy) Drive Shoe? YES NO								Hole Diameter (in.)			
								Diameter 20 Depth 274											
								24.00 in. from 0.00 to 80.00 ft. lbs/ft											
								20.00 in. from 0.00 to 274.00 ft. lbs/ft											
Description Color Hardness From To (ft.)								Screen No Open Hole(ft.) From 274.0 to 446.0											
SAND GRAVEL & BOULDERS								Make Type											
LIMEROCK								Diamter Slot Length Set											
SHALE																			
SANDSTONE																			
SHALE & SANDSTONE																			
DOLOMITE																			
JORDAN SANDSTONE																			
FINE SAND & SHALE																			
JORDAN SAND																			
ST. LAWRENCE																			
								Static Water Level											
								58.00 ft. Land surface Date measured 1952/05/09											
								Pumping Level (below land surface)											
								ft. after hrs. pumping 1200.00 g.p.m.											
								Wellhead Completion											
								Pitless adapter manufacturer Model											
								Casing Protection 12 in. above grade											
								At-grate (Environmental Wells and Borings ONLY) Basement offset											
								Grouting Information Well grouted? YES NO											
								Nearest Known Source of Contamination											
								feet Direction Type											
								Well disinfected upon completion? YES NO											
								Pump											
								Not Installed Date Installed											
								Manufacture's name											
								Model number HP 0.00 Volts											
								Length of drop pipe Material Capacity g.p.m.											
								Type											
								Abandoned Wells											
								Does property have any not in use and not sealed well(s)? YES NO											
								Variance											
								Was a variance granted from the MDH for this well? YES NO											
								Well Contractor Cerfication											
								Layne Well Co. 27010											
								License Business Name Lic. or Reg No.											
								SHUEY, P.											
First Bedrock OPVL Aquifer Prairie Du Chien-Jordan								Name of Driller								Date			
Last Strat CSTL Depth to Bedrock 75.00 ft.								HE-01205-07 (Rev. 2/99)											
County Well Index v.5								REPORT Printed on 12/13/2012											

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
206437		Quad Minneapolis South		WELL AND BORING RECORD				Update Date 2011/08/28			
		Quad Id 104A		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 9						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						473.00 ft		473.00 ft		1956/06/06	
117 21 W 8 BDDBAC Elevation 899.00 ft.											
Well Address ST. LOUIS PARK 9						Drilling Method Cable Tool					
2500 NEVADA						Drilling Fluid			Well Hydrofractured? ☐ YES ☐ NO		
ST LOUIS PARK MN 55426 Changed									From ft. to		
Contact Address CITY OF ST. LOUIS PARK						Use Community Supply					
ST LOUIS PARK MN 55426						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO Hole Diameter (in.)					
						Diameter 16 Depth 289					
						24.00 in. from 0.00 to 81.00 ft. lbs/ft					
						16.00 in. from 0.00 to 289.00 ft. lbs/ft					
Description						Color		Hardness		From To (ft.)	
DRIFT										0 69	
LIMESTONE										69 120	
SHALE AND SANDSTONE										120 220	
SHALE										220 275	
LIMEROCK										275 339	
SANDSTONE						RED				339 345	
LIMEROCK										345 380	
SANDSTONE										380 473	
Remarks						Screen No					
						Open Hole(ft.) From 289.0 to 473.0					
						Make					
						Type					
						Diamter Slot Length Set					
Static Water Level											
70.00 ft. Land surface Date measured 1956/06/06											
Pumping Level (below land surface)											
ft. after hrs. pumping g.p.m.											
Wellhead Completion											
Pitless adapter manufacturer Model											
☐ Casing Protection ☐ 12 in. above grade											
☐ At-grate (Environmental Wells and Borings ONLY) ☐ Basement offset											
Grouting Information											
Well grouted? ☐ YES ☐ NO											
Material Neat Cement From To ft. 414.00 Sacks											
Nearest Known Source of Contamination											
feet Direction Type											
Well disinfected upon completion? ☐ YES ☐ NO											
Pump											
☐ Not Installed Date Installed											
Manufacture's name											
Model number HP 0.00 Volts											
Length of drop pipe Material Capacity g.p.m											
Type											
Abandoned Wells											
Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO											
Variance											
Was a variance granted from the MDH for this well? ☐ YES ☐ NO											
Well Contractor Cerfication											
Layne Well Co. 27010											
License Business Name Lic. or Reg No.											
LAFONTAINE, W											
First Bedrock OPSP		Aquifer Prairie Du Chien-Jordan		Depth to Bedrock 69.00 ft.		Last Strat CJDN					
County Well Index v.5		REPORT		Printed on 12/13/2012		Name of Driller		Date		HE-01205-07 (Rev. 2/99)	

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
206439		Quad Minneapolis South		WELL AND BORING RECORD				Update Date 2011/08/28			
		Quad Id 104A		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 11						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						1093.00 ft		1093.00 ft		1960/11/01	
117 21 W 8 DCDBAB Elevation 920.00 ft.											
Well Address ST. LOUIS PARK 11						Drilling Method Cable Tool					
ST LOUIS PARK MN 55426 Changed						Drilling Fluid			Well Hydrofractured? ☐ YES ☐ NO		
Contact Address CITY OF ST. LOUIS PARK						From ft. to					
5925 37TH ST W						Use Community Supply					
MINNEAPOLIS MN 55426 Changed						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO Hole Diameter (in.)					
						Diameter 16 Depth 880					
						24.00 in. from 0.00 to 103.00 ft. lbs/ft					
						16.00 in. from 0.00 to 880.00 ft. lbs/ft					
Description Color Hardness From To (ft.)						Screen No Open Hole(ft.) From 880.0 to 1093.					
GLACIAL DRIFT						Make					
LIMEROCK						Diameter Slot Length Set Type					
SANDROCK											
LIMEROCK											
LIMEROCK											
SANDROCK											
SANDROCK											
LIMEROCK & SHALE											
SHALE GREEN HARD 530 683						Static Water Level					
CLEAN SANDROCK & SHALE						221.00 ft. Land surface Date measured 1960/11/01					
SHALE GRAY HARD 745 805						Pumping Level (below land surface)					
SHALE & SANDROCK YELLOW 805 813						355.50 ft. after hrs. pumping 1500.00 g.p.m.					
SHALE GREEN 813 817						Wellhead Completion					
SANDROCK & SHALE 817 853						Pitless adapter manufacturer Model					
SANDROCK & SHALE HARD 853 955						☐ Casing Protection ☐ 12 in. above grade					
SANDROCK & SHALE PNK/RED 955 1050						☐ At-grade (Environmental Wells and Borings ONLY) ☐ Basement offset					
CLEAN COARSE SANDROCK 1050 1078						Grouting Information Well grouted? ☐ YES ☐ NO					
RED CLASTIC RED 1078 1093											
						Nearest Known Source of Contamination					
						feet Direction Type					
						Well disinfected upon completion? ☐ YES ☐ NO					
						Pump					
						☐ Not Installed Date Installed					
						Manufacture's name					
						Model number HP 0.00 Volts					
						Length of drop pipe Material Capacity g.p.m					
						Type					
						Abandoned Wells					
						Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO					
						Variance					
						Was a variance granted from the MDH for this well? ☐ YES ☐ NO					
						Well Contractor Certification					
						Bergerson-Caswell 27058					
						License Business Name Lic. or Reg No.					
First Bedrock OPVL Aquifer Mt.Simon											
Last Strat PMSU Depth to Bedrock 101.00 ft.											
Remarks						Name of Driller					
COPIED FROM D.N.R. M.G.S. NO.167. GAMMA LOGGED 2-24-1984.						Date					
County Well Index v.5						HE-01205-07 (Rev. 2/99)					
REPORT						Printed on 12/13/2012					

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH		Entry Date 1991/08/24	
206440		Quad Minneapolis South		WELL AND BORING RECORD		Update Date 2011/08/28	
		Quad Id 104A		MINNESOTA STATUTES CHAPTER 1031		Received Date	
Well Name ST. LOUIS PARK 3				Well Depth		Depth Completed	
Township Range Dir Section Subsection Field Located MDH				286.00 ft		286.00 ft	
117 21 W 8 DCDBDB Elevation 925.00 ft.						Date Well Completed 1939/08/00	
Well Address ST. LOUIS PARK 3				Drilling Method Cable Tool			
2924 IDAHO AV				Drilling Fluid		Well Hydrofractured? ☐ YES ☐ NO	
ST LOUIS PARK MN 55426 Changed						From ft. to	
Contact Address CITY OF ST. LOUIS PARK				Use Community Supply			
ST LOUIS PARK MN 55426				Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO		Hole Diameter (in.)	
				Diameter 24 Depth 103			
				24.00 in. from 0.00 to 103.00 ft. lbs/ft			
Description				Color			
DRIFT				Hardness			
				From To (ft.)			
LIMEROCK				0 103			
SANDROCK				103 118			
SHALE				118 230			
SHALE				230 245			
SHALE				245 286			
				Screen No			
				Make		Open Hole(ft.) From 103.0 to 286.0	
				Diamter Slot Length Set		Type	
				Static Water Level			
				60.00 ft.		Land surface Date measured 1959/00/00	
				Pumping Level (below land surface)			
				114.00 ft. after		hrs. pumping 0.00 g.p.m.	
				Wellhead Completion			
				Pitless adapter manufacturer		Model	
				☐ Casing Protection		☐ 12 in. above grade	
				☐ At-grate (Environmental Wells and Borings ONLY)		☐ Basement offset	
				Grouting Information			
				Well grouted? ☐ YES ☐ NO			
				Nearest Known Source of Contamination			
				feet		Direction	
				Well disinfected upon completion? ☐ YES ☐ NO		Type	
				Pump			
				☐ Not Installed		Date Installed	
				Manufacture's name			
				Model number		HP 0.00 Volts	
				Length of drop pipe		Material Capacity g.p.m	
				Type			
				Abandoned Wells			
				Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO			
				Variance			
				Was a variance granted from the MDH for this well? ☐ YES ☐ NO			
				Well Contractor Certification			
				Mccarthy Well Co.		27022	
				License Business Name		Lic. or Reg No.	
First Bedrock OPVL				Aquifer St.Peter			
Last Strat OSTP				Depth to Bedrock 103.00 ft.			
Remarks							
County Well Index v.5				REPORT		Printed on 12/13/2012	
				Name of Driller		Date	
				HE-01205-07 (Rev. 2/99)			

Unique Well Number

206442

County

Hennepin

Quad

Minneapolis South

Quad Id

104A

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

MINNESOTA STATUTES CHAPTER 1031

Entry Date

1991/08/24

Update Date

2011/08/28

Received Date

Well Name

ST. LOUIS PARK 10

Township

Range

Dir

Section

Subsection

Field Located

MDH

117

21

W

8

DCDCBC

Elevation

925.00

ft.

Well Address

ST. LOUIS PARK 10

ST LOUIS PARK

MN

55426

Changed

Contact Address

CITY OF ST. LOUIS PARK

ST LOUIS PARK

MN

55426

Description

Color

Hardness

From

To (ft.)

SAND & GRAVEL

0

83

CLAY

83

103

LIMEROCK

103

123

ST. PETER SANDROCK

123

288

SHAKOPEE

288

407

JORDAN SANDROCK

407

500

Remarks

GAMMA LOGGED 2-24-1984.

First Bedrock

OPVL

Aquifer

Prairie Du Chien-Jordan

Last Strat

CJDN

Depth to Bedrock

103.00

ft.

Well Depth

Depth Completed

Date Well Completed

500.00

ft

500.00

ft

1955/09/15

Drilling Method

Cable Tool

Drilling Fluid

Well Hydrofractured?

YES

NO

From

ft. to

Use

Community Supply

Casing

Type

Steel (black or low

Drive Shoe?

YES

NO

Hole Diameter (in.)

23.0

To

500.0

Diameter

16

Depth

316

24.00

in. from

0.00

to

106.00

ft.

lbs/ft

16.00

in. from

0.00

to

316.00

ft.

lbs/ft

Screen

No

Open Hole(ft.)

From

316.0

to

500.0

Make

Type

Diamter

Slot

Length

Set

Static Water Level

104.00

ft.

Land surface

Date measured

1955/09/15

Pumping Level (below land surface)

199.00

ft. after

hrs. pumping

2005.00

g.p.m.

Wellhead Completion

Pitless adapter manufacturer

Model

Casing Protection

12 in. above grade

At-grate (Environmental Wells and Borings ONLY)

Basement offset

Grouting Information

Well grouted?

YES

NO

Material

Neat Cement

From

To

ft.

550.00

Sacks

Nearest Known Source of Contamination

feet

Direction

Type

Well disinfected upon completion?

YES

NO

Pump

Not Installed

Date Installed

Manufacture's name

Model number

HP

0.00

Volts

Length of drop pipe

Material

Capacity

g.p.m

Type

Abandoned Wells

Does property have any not in use and not sealed well(s)?

YES

NO

Variance

Was a variance granted from the MDH for this well?

YES

NO

Well Contractor Cerfication

Keys Well Co.

62012

License Business Name

Lic. or Reg No.

JOHNSON, R.

County Well Index v.5

REPORT

Printed on

12/13/2012

Name of Driller

Date

HE-01205-07 (Rev. 2/9

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
206456		Quad Minneapolis South		WELL AND BORING RECORD				Update Date 2011/08/29			
		Quad Id 104A		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 12						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						1095.00 ft		1095.00 ft		1965/08/00	
117 21 W 21 CDBDCD Elevation 910.00 ft.											
Well Address ST. LOUIS PARK 12						Drilling Method Cable Tool					
ST LOUIS PARK MN 55426 Changed						Drilling Fluid		Well Hydrofractured? ☐ YES ☐ NO			
Contact Address CITY OF ST. LOUIS PARK						From ft. to					
ST LOUIS PARK MN 55426						Use Community Supply					
						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO		Hole Diameter (in.)			
						Diameter 16 Depth 900		24.0(To 395.0			
						30.00 in. from 0.00 to 99.00 ft. lbs/ft					
						24.00 in. from 0.00 to 270.00 ft. lbs/ft					
						16.00 in. from 0.00 to 900.00 ft. lbs/ft					
Description Color Hardness From To (ft.)						Screen No Open Hole(ft.) From 900.0 to 1095.					
DRIFT						Make					
PLATTEVILLE						Diamter Slot Length Set Type					
SHALE (GLENWOOD)											
ST. PETER											
SHAKOPEE											
JORDAN											
ST. LAWRENCE											
FRANCONIA											
IRONTON											
GALESVILLE											
EAU CLAIRE											
MT. SIMON											
HINCKLEY											
						Static Water Level					
						245.00 ft. Land surface Date measured 1965/08/00					
						Pumping Level (below land surface)					
						353.00 ft. after 1.00 hrs. pumping 1300.00 g.p.m.					
						Wellhead Completion					
						Pitless adapter manufacturer Model					
						☐ Casing Protection ☐ 12 in. above grade					
						☐ At-grate (Environmental Wells and Borings ONLY) ☐ Basement offset					
						Grouting Information Well grouted? ☐ YES ☐ NO					
						Material Neat Cement From To 900.0 ft. 360.00 Sacks					
						Nearest Known Source of Contamination					
						feet Direction Type					
						Well disinfected upon completion? ☐ YES ☐ NO					
						Pump					
						☐ Not Installed Date Installed					
						Manufacture's name					
						Model number HP 0.00 Volts					
						Length of drop pipe Material Capacity g.p.m					
						Type					
						Abandoned Wells					
						Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO					
						Variance					
						Was a variance granted from the MDH for this well? ☐ YES ☐ NO					
						Well Contractor Certification					
						Keys Well Co. 62012					
						License Business Name Lic. or Reg No.					
						KEMPER, R.					
Remarks											
M.G.S. NO. 279. OLD P.A. 63-0083.											
First Bedrock OPVL						Aquifer Mt.Simon					
Last Strat CMTS						Depth to Bedrock 96.00 ft.					
County Well Index v.5						REPORT Printed on 12/13/2012					
						Name of Driller Date					
						HE-01205-07 (Rev. 2/99)					

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date 1991/08/24			
206457		Quad Minneapolis South		WELL AND BORING RECORD				Update Date 2011/08/29			
		Quad Id 104A		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name ST. LOUIS PARK 6						Well Depth		Depth Completed		Date Well Completed	
Township Range Dir Section Subsection Field Located MDH						482.00 ft		482.00 ft		1948/02/19	
117 21 W 21 CDBDBD Elevation 915.00 ft.											
Well Address ST. LOUIS PARK 6						Drilling Method Cable Tool					
ST LOUIS PARK MN 55426 Changed						Drilling Fluid			Well Hydrofractured? ☐ YES ☐ NO		
Contact Address CITY OF ST. LOUIS PARK						From ft. to					
ST LOUIS PARK MN 55426						Use Community Supply					
						Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO			Hole Diameter (in.)		
						Diameter 20 Depth 303					
						24.00 in. from 0.00 to 107.50 ft. lbs/ft					
						20.00 in. from 0.00 to 303.00 ft. lbs/ft					
Description Color Hardness From To (ft.)						Screen No Open Hole(ft.) From 303.0 to 482.0					
SAND & GRAVEL						Make					
LIMEROCK						Diameter Slot Length Set Type					
SHALE BLUE											
ST. PETER SAND											
SHAKOPEE LIME											
JORDAN SANDSTONE											
ST. LAWRENCE											
						Static Water Level					
						60.00 ft. Land surface Date measured 1948/01/19					
						Pumping Level (below land surface)					
						ft. after hrs. pumping g.p.m.					
						Wellhead Completion					
						Pitless adapter manufacturer Model					
						☐ Casing Protection ☐ 12 in. above grade					
						☐ At-grade (Environmental Wells and Borings ONLY) ☐ Basement offset					
						Grouting Information Well grouted? ☐ YES ☐ NO					
						Material Neat Cement From To ft. 24.00 Cubic yards					
						Nearest Known Source of Contamination					
						feet Direction Type					
						Well disinfected upon completion? ☐ YES ☐ NO					
						Pump					
						☐ Not Installed Date Installed					
						Manufacture's name					
						Model number HP 0.00 Volts					
						Length of drop pipe Material Capacity 1200 g.p.m					
						Type					
						Abandoned Wells					
						Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO					
						Variance					
						Was a variance granted from the MDH for this well? ☐ YES ☐ NO					
						Well Contractor Certification					
						Layne Well Co. 27010					
						License Business Name Lic. or Reg No.					
						SHUEY, P.					
First Bedrock OPVL Aquifer Prairie Du Chien-Jordan											
Last Strat CSTL Depth to Bedrock 90.00 ft.											
Remarks											
County Well Index v.5						REPORT		Printed on 12/13/2012		Name of Driller	
										Date HE-01205-07 (Rev. 2/99)	

Unique Well Number		County Hennepin		MINNESOTA DEPARTMENT OF HEALTH		Entry Date 1991/08/24	
215447		Quad Minneapolis South		WELL AND BORING RECORD		Update Date 2011/08/28	
		Quad Id 104A		MINNESOTA STATUTES CHAPTER 1031		Received Date	
Well Name ST. LOUIS PARK 15				Well Depth		Depth Completed	
Township Range Dir Section Subsection Field Located MDH				503.00 ft		503.00 ft	
117 21 W 8 DCDBAB Elevation 920.00 ft.						Date Well Completed 1969/00/00	
Well Address ST. LOUIS PARK 15				Drilling Method Cable Tool			
ST LOUIS PARK MN 55426 Changed				Drilling Fluid		Well Hydrofractured? ☐ YES ☐ NO	
Contact Address CITY OF ST. LOUIS PARK				From ft. to			
ST LOUIS PARK MN 55426				Use Community Supply			
				Casing Type Steel (black or low Drive Shoe? ☐ YES ☐ NO		Hole Diameter (in.)	
				Diameter 24 Depth 398			
				30.00 in. from 0.00 to 102.00 ft. lbs/ft			
				24.00 in. from 0.00 to 398.00 ft. lbs/ft			
Description Color Hardness From To (ft.)				Screen No			
DRIFT				Open Hole(ft.) From 398.0 to 503.0			
LIMESTONE				Make			
SANDSTONE				Diamter Slot Length Set Type			
LIMESTONE							
SANDSTONE							
SHALE							
				Static Water Level			
				115.00 ft. Land surface Date measured 1977/00/00			
				Pumping Level (below land surface)			
				183.00 ft. after hrs. pumping 1200.00 g.p.m.			
				Wellhead Completion			
				Pitless adapter manufacturer Model			
				☐ Casing Protection ☐ 12 in. above grade			
				☐ At-grade (Environmental Wells and Borings ONLY) ☐ Basement offset			
				Grouting Information Well grouted? ☐ YES ☐ NO			
				Nearest Known Source of Contamination			
				feet Direction Type			
				Well disinfected upon completion? ☐ YES ☐ NO			
				Pump			
				☐ Not Installed Date Installed			
				Manufacture's name			
				Model number HP 0.00 Volts			
				Length of drop pipe Material Capacity g.p.m			
				Type			
				Abandoned Wells			
				Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO			
				Variance			
				Was a variance granted from the MDH for this well? ☐ YES ☐ NO			
				Well Contractor Certification			
				Bergerson-Caswell 27058			
				License Business Name Lic. or Reg No.			
First Bedrock OPVL Aquifer Jordan							
Last Strat CSTL Depth to Bedrock 102.00 ft.							
Remarks							
County Well Index v.5				REPORT		Printed on 12/13/2012	
				Name of Driller		Date	
				HE-01205-07 (Rev. 2/99)			

Unique Well Number

227965

County

Hennepin

Quad

Minneapolis South

Quad Id

104A

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

MINNESOTA STATUTES CHAPTER 1031

Entry Date

1991/08/24

Update Date

2011/08/26

Received Date

Well Name

ST. LOUIS PARK 14

Township

Range

Dir

Section

Subsection

Field Located

MDH

117

21

W

4

CCDACA

Elevation

902.00

ft.

Well Address

ST. LOUIS PARK 14

ST LOUIS PARK

MN

55416

Changed

Contact Address

CITY OF ST. LOUIS PARK

ST LOUIS PARK

MN

55416

Description

Color

Hardness

From

To (ft.)

GLACIAL DRIFT

0

94

PLATTEVILLE LIMESTONE

94

98

GLENWOOD SHALE

98

101

ST. PETER SANDROCK

101

265

SHAKOPEE/ONEOTA DOLOMITE

265

375

CLEAN COARSE SANDROCK

HARD

375

410

SANDROCK

RED

V.HARD

410

420

SHALEY SANDROCK

HARD

420

440

FINE SANDROCK

TAN

HARD

440

450

FINE SANDROCK

WHITE

HARD

450

475

FINE SHALEY SANDROCK

GREEN

HARD

475

485

Well Depth

Depth Completed

Date Well Completed

485.00

ft

485.00

ft

1965/02/15

Drilling Method

Cable Tool

Drilling Fluid

Well Hydrofractured?

YES

NO

From

ft. to

Use

Community Supply

Casing

Type

Steel (black or low

Drive Shoe?

YES

NO

Diameter

16

Depth

389

30.00

in. from

0.00

to

94.00

ft.

lbs/ft

24.00

in. from

0.00

to

253.00

ft.

lbs/ft

16.00

in. from

0.00

to

389.00

ft.

lbs/ft

Hole Diameter (in.)

Screen

No

Open Hole(ft.)

From

389.0

to

485.0

Make

Type

Diamter

Slot

Length

Set

Static Water Level

80.00

ft.

Land surface

Date measured

1965/02/15

Pumping Level (below land surface)

129.50

ft. after

hrs. pumping

1000.00

g.p.m.

Wellhead Completion

Pitless adapter manufacturer

Model

Casing Protection

12 in. above grade

At-grate (Environmental Wells and Borings ONLY)

Basement offset

Grouting Information

Well grouted?

YES

NO

Material

Neat Cement

From

To

ft.

710.00

Sacks

Nearest Known Source of Contamination

feet

Direction

Type

Well disinfected upon completion?

YES

NO

Pump

Not Installed

Date Installed

Manufacture's name

Model number

HP

0.00

Volts

Length of drop pipe

Material

Capacity

g.p.m

Type

Abandoned Wells

Does property have any not in use and not sealed well(s)?

YES

NO

Variance

Was a variance granted from the MDH for this well?

YES

NO

Well Contractor Cerfication

Bergerson-Caswell

27058

License Business Name

Lic. or Reg No.

Remarks

CEDAR LAKE ROAD & ALABAMA AVE.

First Bedrock

OPVL

Aquifer

Jordan

Last Strat

CSTL

Depth to Bedrock

94.00

ft.

County Well Index v.5

REPORT

Printed on

12/13/2012

Name of Driller

Date

HE-01205-07 (Rev. 2/9/07)

Appendix C

Aquifer Test Plans



Environmental Health Division
Drinking Water Protection Section
Source Water Protection Unit
P.O. Box 64975
St. Paul, Minnesota 55164-0975

Determination of Aquifer Properties and Aquifer Test Plan (DAP-ATP) Form

Public Water Supply ID:	12070050	PWS Name:	City of St. Louis Park, MN
Contact Information for Person Completing this Form			
Name:	Erik J. Tomlinson, PG		
Address:	Source Water Solutions, LLC 221 McCarron St.		
City, State, Zip:	St. Paul, MN 55113		
Phone, Fax, e-mail:	Phone: 612.701.7343 Email: erik@sourcewater-solutions.com		
Aquifer Properties Determination Methods			
<p>☒ 1) An existing pumping test that meets the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on a well connected to the public water supply system.</p> <p>☐ 2) An existing pumping test that meets the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on another well in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☐ 3) A proposed new test to be conducted on a new or existing well connected to the public water supply system and that meets the requirements for larger-sized water systems (wellhead protection rule part 4720.5520). A test plan must be approved before conducting the test.</p> <p>☐ 4) A proposed new test to be conducted on a new or existing public well connected to the public water supply system and that meets the requirements for smaller-sized water systems (wellhead protection rule part 4720.5530). A test plan must be approved before conducting the test.</p> <p>☐ 5) An existing pumping test that does not meet the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on: 1) a public water supply well or 2) another well in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☐ 6) Existing specific capacity test(s) conducted on the public water supply well(s) or specific capacity tests conducted on other wells in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☒ 7) An existing published transmissivity value.</p> <ul style="list-style-type: none">▪ Include all test data and analysis documentation with the estimated transmissivity, ft²/day, when the aquifer properties determination method is; 1, 2, 5, 6, or 7, listed above.▪▪ Attach detailed aquifer test plan for methods 3 or 4.			
Submitted by: Erik J. Tomlinson, PG		Prof. License: PG46739	Date: 12/29/2014
To request this document in another format, please call our Section Receptionist (651/201-4700) or Division TTY (651/201-5797).			



Rationale for: 1) Aquifer Properties Determination or 2) Proposed New Test

Briefly describe the rationale for: 1) selected method to determine aquifer properties from existing data, or 2) a new aquifer test to be conducted on the pumped well referenced below. Include unique well numbers of all wells that were (or will be) monitored during data collection. How does the existing or proposed test deviate from the ideal. (e.g. rate, duration, no. of obwells, interfering wells, etc.) Attach documentation as necessary.

Aquifer Name: Jordan

Confined



Unconfined



Fractured Rock

The attached aquifer test for Minnetonka Well #6 (Unique ID: 208012 (number is incorrect on pump test analysis)) (**Attachment 1**) was completed with MDH oversight and review. Although the pump test analysis report identifies the aquifer as PDCJ, the observation well where measurements were made is only open to the Jordan Aquifer. It has been determined that the values derived from this pump test are appropriate to represent the Jordan Aquifer. Representative aquifer values are best shown by the early pumping and recovery value from the observation well, giving an average T of 2,400 ft²/d, S of 0.000015, and r/B of 0.07. Aquifer thickness at Well #6 is 94 ft.

A starting horizontal hydraulic conductivity value proposed for use in the groundwater modeling for the Jordan aquifer is 25.5 ft/day.

A starting vertical hydraulic conductivity value proposed for use in the groundwater model for the Jordan aquifer is 2.55 ft/day.

Proposed New Test Information Summary

Pumped Well Name (Unique Number):	208012 (Minnetonka Well 6A)	Test Duration (Hours):	24 hours pumping, 32 recovery
Location: X, Y (meters) UTM-Z15N <u>or</u> Lat-Lon (decimal degrees) datum: NAD83	UTM-Z15N X:1532864.17 Y:16330554.46	Pump Type:	NA
		Discharge Rate:	1,000 gpm
Number of Observation Wells:	1 (Minnetonka Well 6)	Flow Rate Measuring Device Type:	Electronic Flow Meter

- A map showing the location of the pumping well and observation well(s) must be included.

List the unique number of each public water supply well to which this DAP-ATP Form applies

200542 (Well 04)	203187 (Well 16)				
203678 (Well 08)					
206442 (Well 10)					
227965 (Well 14)					
215447 (Well 15)					

Reviewed by:**Approved:** ☒ Yes ☐ No**Approval Date:**

Memo



Date: December 13, 2005

To: Steve Robertson / Project File

From: Betty Wheeler

Subject: Pumping Test of St. Louis Park Well 11 (206439) on 10/07/2003

Test ID: 2220

The pumping test performed on Well 11 (206439) was conducted as described below, Tables 1 and 2. The data were analyzed using standard methods cited in the references. Analysis graphs are presented in Appendix 1 and are summarized in Table 3.

Table 1. Aquifer Test Information

Test Location	St. Louis Park 11
Well Owner	City of St. Louis Park
Test Conducted By	SEH
Aquifer	CMTS
Confined / Unconfined	Confined
Date/Time Monitoring Start	10/06/2003 09:00:00 (approximately)
Date/Time Pump off Before Test	10/05/2003 afternoon
Date/Time Test Start	10/07/2003 08:41
Date/Time Recovery Start	10/09/2003 09:21
Date/Time Test Finish	10/11/2003 11:00
Flow Rate	1,203
WL Data Collection Method	Pressure transducer / datalogger
Number of Observation Wells	1

Test Type:

☒ Constant Rate ☐ Variable Rate ☐ Recovery ☐ Step Drawdown

☐ Other (Describe) _____

☐ Data scanned

☒ Data entered into database

Table 2. Wells Monitored for the Test

Well Name	Unique Well No.	Radial Distance	Static Water Levels			Aquifer
			Start	Mid-test	End	
Pumped Well: St. Louis Park 11	206439	NA	NA	NA	NA	CMTS
Ob Wells: St. Louis Park 17	147459	5,700 ft.	385	392.6	385.2	CMTS

Table 3. Analysis Results

Unique Well No.	Transmissivity ft ² /day	Storage Coefficient	Analysis Method	Time Period Emphasis	Remarks
Pumped Well: 206439	NA	NA			
Ob Wells: 147459	1,970	1.7E-4	Theis	Mid- to Late Time	

Note 1: The water levels in the pumped well (206439) could not be determined because the well's casing was inaccessible.

Note 2: The pressure transducer in the observation well (147459) malfunctioned during the pumping phase of the test, so the data was unusable. The transducer was serviced at that point, so the groundwater level data collected during the recovery phase of the test was usable.

Representative Aquifer Characteristics:

Transmissivity: 1,970 ft²/day

Storage Coefficient: 1.7E-4

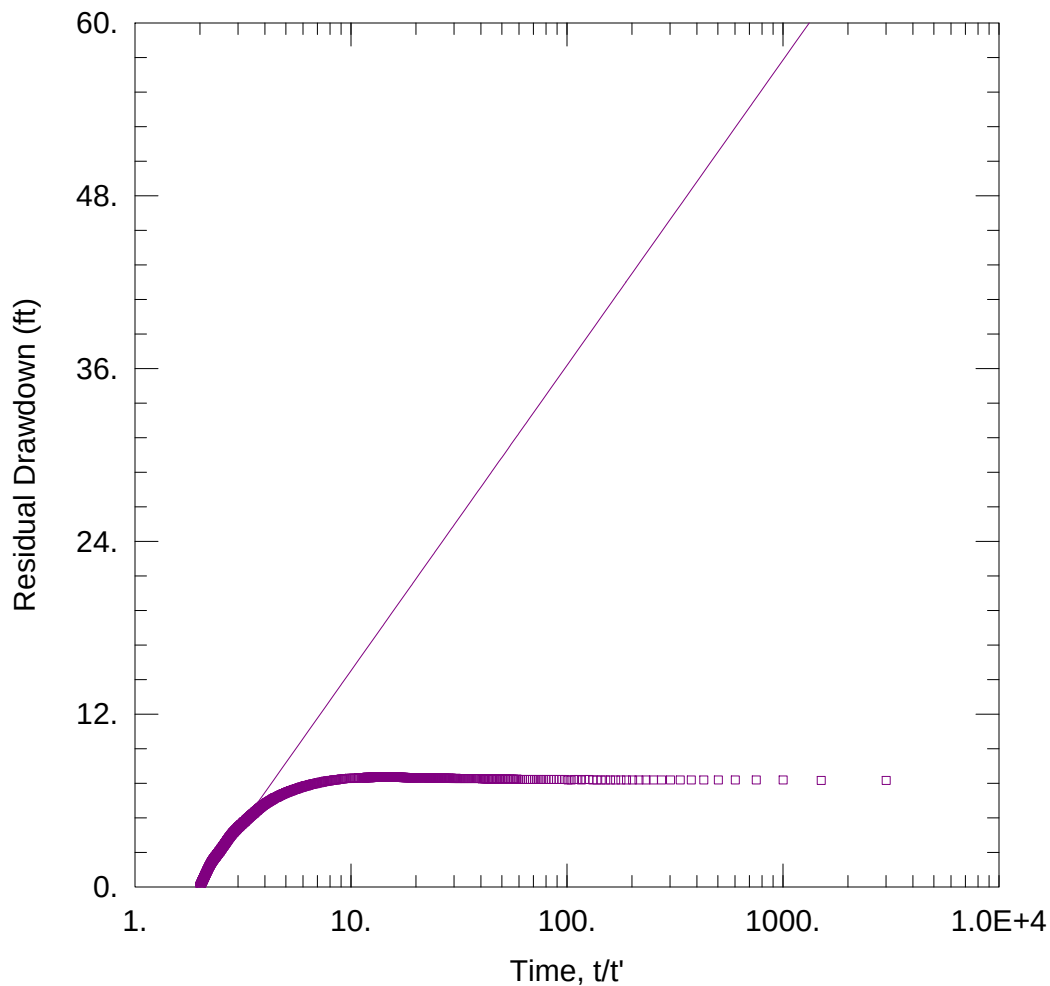
References

Confined Aquifer

Early-Time: (Log-log)

Non-Leaky

Theis, C.V., April 1935, "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage," Trans. American Geophysical Union, 16th Annual Meeting, pp. 519-24.



CITY OF ST LOUIS PARK

Data Set: O:\...\Pumping Test of St. Louis Park Well 11 (206439) - Obswell Well 17 (147459) - Theis Recovery.ac

Date: 09/02/14

Time: 08:40:52

PROJECT INFORMATION

Company: SEH

Project: Mt Simon Aquifer

Location: City of St Louis Park

Test Well: Well 11 (206439)

Test Date: October 9, 2003

AQUIFER DATA

Saturated Thickness: 263. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Well 11 (206439)	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ <u>147459 - Well 17</u>	5700	0

SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 1970. \text{ ft}^2/\text{day}$

$S/S' = 1.96$



Environmental Health Division
Drinking Water Protection Section
Source Water Protection Unit
P.O. Box 64975
St. Paul, Minnesota 55164-0975

Determination of Aquifer Properties and Aquifer Test Plan (DAP-ATP) Form

Public Water Supply ID:	12070050	PWS Name:	City of St. Louis Park, MN
Contact Information for Person Completing this Form			
Name:	Erik J. Tomlinson, PG		
Address:	Source Water Solutions, LLC 221 McCarron St.		
City, State, Zip:	St. Paul, MN 55113		
Phone, Fax, e-mail:	Phone: 612.701.7343 Email: erik@sourcewater-solutions.com		
Aquifer Properties Determination Methods			
<p>☒ 1) An existing pumping test that meets the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on a well connected to the public water supply system.</p> <p>☐ 2) An existing pumping test that meets the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on another well in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☐ 3) A proposed new test to be conducted on a new or existing well connected to the public water supply system and that meets the requirements for larger-sized water systems (wellhead protection rule part 4720.5520). A test plan must be approved before conducting the test.</p> <p>☐ 4) A proposed new test to be conducted on a new or existing public well connected to the public water supply system and that meets the requirements for smaller-sized water systems (wellhead protection rule part 4720.5530). A test plan must be approved before conducting the test.</p> <p>☐ 5) An existing pumping test that does not meet the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on: 1) a public water supply well or 2) another well in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☐ 6) Existing specific capacity test(s) conducted on the public water supply well(s) or specific capacity tests conducted on other wells in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☒ 7) An existing published transmissivity value.</p> <ul style="list-style-type: none">▪ Include all test data and analysis documentation with the estimated transmissivity, ft²/day, when the aquifer properties determination method is; 1, 2, 5, 6, or 7, listed above.▪▪ Attach detailed aquifer test plan for methods 3 or 4.			
Submitted by: Erik J. Tomlinson, PG		Prof. License: PG46739	Date: 12/29/2014
To request this document in another format, please call our Section Receptionist (651/201-4700) or Division TTY (651/201-5797).			



Rationale for: 1) Aquifer Properties Determination or 2) Proposed New Test

Briefly describe the rationale for: 1) selected method to determine aquifer properties from existing data, or 2) a new aquifer test to be conducted on the pumped well referenced below. Include unique well numbers of all wells that were (or will be) monitored during data collection. How does the existing or proposed test deviate from the ideal. (e.g. rate, duration, no. of obwells, interfering wells, etc.) Attach documentation as necessary.

Aquifer Name: Jordan ☒ Confined ☐ Unconfined ☐ Fractured Rock

The attached aquifer test for Minnetonka Well #6 (Unique ID: 208012 (number is incorrect on pump test analysis)) (**Attachment 1**) was completed with MDH oversight and review. Although the pump test analysis report identifies the aquifer as PDCJ, the observation well where measurements were made is only open to the Jordan Aquifer. It has been determined that the values derived from this pump test are appropriate to represent the Jordan Aquifer. Representative aquifer values are best shown by the early pumping and recovery value from the observation well, giving an average T of 2,400 ft²/d, S of 0.000015, and r/B of 0.07. Aquifer thickness at Well #6 is 94 ft.

A starting horizontal hydraulic conductivity value proposed for use in the groundwater modeling for the Jordan aquifer is 25.5 ft/day.

A starting vertical hydraulic conductivity value proposed for use in the groundwater model for the Jordan aquifer is 2.55 ft/day.

Proposed New Test Information Summary

Pumped Well Name (Unique Number):	208012 (Minnetonka Well 6A)	Test Duration (Hours):	24 hours pumping, 32 recovery
Location: X, Y (meters) UTM-Z15N <u>or</u> Lat-Lon (decimal degrees) datum: NAD83	UTM-Z15N X:1532864.17 Y:16330554.46	Pump Type:	NA
		Discharge Rate:	1,000 gpm
Number of Observation Wells:	1 (Minnetonka Well 6)	Flow Rate Measuring Device Type:	Electronic Flow Meter

- A map showing the location of the pumping well and observation well(s) must be included.

List the unique number of each public water supply well to which this DAP-ATP Form applies

200542 (Well 04)	203187 (Well 16)				
203678 (Well 08)					
206442 (Well 10)					
227965 (Well 14)					
215447 (Well 15)					

Reviewed by:

Approved: ☒ Yes ☐ No

Approval Date:

Memo



Date: May 22, 2014

To: St. Louis Park WHP Project File (PWSID: 1270050)

From: Justin Blum

Subject: Analysis of the Meadowbrook Golf Course 2 (802162) Production and Pumping Tests, May 1 - 6, 2014, Prairie du Chien - Jordan Aquifer

Test No. 2462

The pumping test performed on Meadowbrook Golf Course 2 (802162) was conducted as described below and summarized in Tables 1 and 2. The data were analyzed using standard methods cited in the references. Analysis graphs are presented in Appendix 1 and are summarized in Table 3. Appendix 2 contains observations, field notes, and any other documentation.

Result Summary

Conceptual model: leaky confined - radial porous media flow

Representative aquifer values:

Transmissivity (T):	15,500	ft ² /day
Aquifer Thickness (b):	254	Feet
Hydraulic Conductivity (k):	58.9	ft/day
Storativity (S):	3.1e-4	
Leakage (L):	--	Feet
Hydraulic Resistance (c):	--	Days

Boundaries: leakage, fracture/conduit flow

Remarks:

Open conduits and/or bedding-plane fractures within the dolostone - sandstone aquifer transmit pumping stresses very quickly over a wide area. Other pumping wells influence water levels in later portions of test, particularly at the distant obwell. Transmissivity is fairly well constrained, +/- 20%, but there is significant uncertainty in the storativity because of the secondary porosity developed within the aquifer system.

Test Type:

☒ Constant Rate ☐ Variable Rate ☐ Recovery ☐ Step Drawdown ☐ Other (Describe)

☐ Data scanned ☒ Data entered

Table 1. Aquifer Test Information

Test No.	2462
Test Location	Meadowbrook Golf Course Irrigation 2
Well Owner	Minneapolis Park Board
Test Conducted By / For	Traut Well Drilling
Aquifer	Prairie du Chien –Jordan
Confined / Unconfined	Confined
Data Collection Methods	Manual, transducer
Number of Observation Wells	2
Date/Time Monitoring Start	04/18/2014 12:20
Production Test	
Date/Time Start	05/02/2014 09:49
Step Rates (units)	500, 800, 1100, 1400, 1700 gpm
Step Times	10:30, 11:30, 12:31, 13:31, 15:03
Date/Time End	05/02/2014 16:57
Constant Rate Test	
Date/Time Pump off Before Test	05/02/2014 16:57
Date/Time Pumping Start	05/05/2014 09:30:05
Date/Time Recovery Start	05/06/2014 09:35:01
Date/Time Test Finish	05/08/2014 09:10
Flow Rate (units)	1100 gpm

Table 2. Wells Monitored During the Test

Well Name (Unique Well No.)	Radial Distance (feet)	Static Water Levels (feet below measuring point)			Change in Water Level (feet)	Aquifer
		Start	Mid- test	End		
Pumped Well:						
GC 2 (802162)	1	82.0	95.85	89.20	13.85	Prairie du Chien -Jordan
Ob Wells:						
GC 1 (216009)	133	84.60	98.16	87.00	13.56	Prairie du Chien –St. Lawrence
MH (216067)	2072	81.33	86.98	81.15	5.65	Prairie du Chien -Jordan

Table 3. Analysis Results

Transient Analysis					
Well Name (Unique Well No.)	Transmissivity, T (ft²/day)	Storage Coefficient, S	Analysis Method	Time Period Emphasis	Plot No. Remarks
Pumped Well:					
GC 2 (802162)	12,950		Theis	20-400 minutes	A1-1 poor match
Ob Wells:					
GC 1 (216009)	12,000	7.2e-5	Theis	20-400 minutes	A1-2
MH (216067)	18,700	2.8e-5	Theis	5-400 minutes	A1-3
Distance Drawdown Analysis	--	--	Theis t/r^2	pumping	A1-4 poor match to Theis curve
	18,700	2.8e-5	Theis t/r^2	Pumping	A1-5 adjusted radial distance
GC 1 (216009)	15,600	1.6e-5	Cooper-Jacob	2-400 minutes	A1-6 projected drawdown to 10k min
GC 2 (216009) GC 1 (216009)	15,470	3.1e-4	Agarwal recovery	2-300	A1-9, r = 20 ft.

Steady-state Analysis				
Transmissivity, T (ft²/day)	Characteristic Leakage, L (feet)	Hydraulic Resistance, c (days)	Analysis Method	Plot No. Remarks
10,900	13,500	16,800	de Glee	A1-7, low T - unreasonable large L
19,200	47,000	114,800	de Glee	A1-8, reasonable T - absurdly large L

Test Description

Purpose of test: production and constant rate tests were performed by Traut Well to qualify a new irrigation well for Meadowbrook Golf Course, St. Louis Park. The MDH Source Water Protection Unit considered the test of this new well to be a rare opportunity to support wellhead protection efforts of St. Louis Park and adjacent communities.

Test setup: Traut monitored the new irrigation well manually and with a transducer during the tests. Two existing wells were instrumented with transducer-data logger equipment by MDH for water level monitoring, Table 2 and Appendix 2.

Hydrogeologic setting: leaky confined bedrock aquifer, fractured and karsted. The Prairie du Chien-Jordan Aquifer System is extensively used for drinking water and industrial/commercial supply in Hennepin County.

Well construction: the well was blasted and bailed during construction and development to enhance the production capability. Approximately 150 to 200 cubic yards of sand were removed from the borehole, resulting in an effective radius of the pumped well that is substantially larger than the original borehole radius.

Other interfering wells: because of the heavy use of the Prairie du Chien-Jordan Aquifer System, the daily fluctuation in static water levels is large - even in times of low demand. Therefore, a 'static' level is known only within a reasonable range in this aquifer system. The long pre-test monitoring record from the Methodist Hospital well (216067) documents this variability. During the fourteen days prior to the test, the mean water elevation in this

well was 808.9 ft. (MSL). The daily variation in water elevation was +/- 0.78 feet with a standard deviation of 0.39 feet.

Weather conditions: a large precipitation event, 3+ inches of rainfall, occurred during the pre-test monitoring period. This recharge event is reflected in the arithmetic plot of water elevations, Appendix 2. Total April precipitation in the Metro Area was the second highest on record. During the test period the weather was clear and cool.

Data collection, reporting, and analysis:

Data were collected with little problem from wells that were accessible for measurement. Time synchronization between the three data loggers was the most problematical issue. In the field, time of day of the Traut data logger differed from MDH time by more than 8 minutes. However, this was corrected by Traut when the data were transferred from the data logger. The subsequent adjustment to match time of MDH loggers (GPS-time) was small, +13 seconds.

Cable stretch of transducers was on the order of 0.2 feet and could be assumed to have occurred before the start of the test because of the influence of the production (step) test on transducer position within the vent tube and the length of pre-test monitoring.

There is intimate connection between the pumped well and the nearest obwell that complicates the analysis of these data. The obwell reacted within tenths of seconds to any disturbance in the pumped well. This is assumed to result from conduits within the Prairie du Chien Group, bedding-plane fractures, and well development techniques employed by the drillers.

Transient analyses

- Theis analyses generally show the expected increase in transmissivity with radial distance from the pumped well. However, the storage coefficient calculated from transient methods (plots A1-1, 6) of 10^{-5} is representative of a highly confined system. The leaky system that is known to exist in this area is expected to produce storativity values in the range of 10^{-4} . Also, a storativity of 10^{-5} is sufficiently isolated from precipitation events that no detectable recharge should occur as a result of infiltration. This is contradicted by pretest monitoring data, Appendix 2.
- The poor match to the Theis curve on A1-4 demonstrates 1) the enhanced efficiency of the pumped well and 2) the apparent negative efficiency in the nearby obwell. Both of these effects are removed when an identical radial distance of 20 feet is used to adjust the plots, A1-5. This is a further demonstration of the interconnection of the boreholes.
- The response in the most distant obwell determines the storage coefficient on plot A1-5. In order to obtain a minimum reasonable storage coefficient of 10^{-4} , this well would have to be located ~700 feet from the pumped well, 1/3 of the actual radial distance. The magnitude of this difference in length indicates an inhomogeneity which can have a large scale effect such as; conduit flow and/or bedding-plane fractures, rather than grain-size variation or other types of depositional fabric which tend to have more local effects.

Steady-state analyses

- For the steady-state analysis, drawdown was projected to 10,000 minutes of pumping, plot A1-6. These values were used for the distance-drawdown plots, A1-7 & 8. The steady-state analyses are problematical. On A1-7, when actual radial distance is used – T is unrealistically low and the characteristic leakage factor is quite large for this setting; neither value is acceptable. Whereas on A1-8, the T is reasonable but the leakage factor is truly unreasonably large (physically impossible).

The recovery analysis, plot A1-9, produces a more reasonable transmissivity and storage coefficient that is considered representative of the aquifer properties in this area, assuming a radial distance of 20 feet. However, the characteristic leakage factor is not provided by this type of analysis.

Evaluation of Test Results

Hydraulic response affected by:

- Well construction techniques and the geological character of aquifer materials cause a very large effective radius of the pumped well;
- The connection between the pumped well and nearest obwell was such that the hydraulic response of the obwell was essentially identical to that of the pumped well, even though the radial distance between the wells was 133 feet.
- Open conduits and/or bedding-plane fractures within the dolostone - sandstone aquifer transmit pumping stresses very quickly over a wide area.
- Other pumping wells influenced water levels in later portions of test, particularly at the distant obwell.

Consistency with conceptual model:

Neither of the distance-drawdown analyses can be considered to produce reasonable results because the storage coefficient and characteristic leakage factor are representative of more highly confined systems. In a highly confined system, pumping stress is transmitted very efficiently over a wide area. In Hennepin County, this aquifer system is leaky (semi-confined). Therefore, modification of both the transient or steady-state conceptual models to incorporate fracture/conduit flow is required to accurately represent aquifer conditions within the Prairie du Chien –Jordan system.

The fact that the standard porous media conceptual models do not produce consistent results implies a low level of confidence for predictive modeling of this aquifer system, particularly when flow models do not incorporate other flow types. Improved understanding of this flow system (fracture flow analysis) is not possible without many more wells and a great deal of testing.

Representative aquifer properties best represented by: the Agarwal recovery analysis, plot A1-9. Based on this storativity and other tests performed in this aquifer system, the characteristic leakage factor is roughly estimated to be in the range of 1000 to 3000 feet and certainly no larger.

References:

Agarwal, R.G., (1980) A new method to account for producing time effects when drawdown type curves are used to analyze pressure buildup and other test data. SPE Paper 9289, presented at the 55th SPE Annual Technical Conference and Exhibition, Dallas, Texas, September 21–24, 1980.

Cooper, H.H. and Jacob, C.E. (1946) A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well-filed History, Trans. American Geophysical Union, V. 27, pp. 526 – 534.

deGlee, G. (1930) Over grondwaterstroomingen bij wateronttrekking door middle van putten. Ph.D. thesis, Delft Technische Hogeschool, Delft.

Jacob, C. E., (1947) Drawdown Test to Determine the Effective Radius of Artesian Wells, Trans. ASCE, pp.1047-70

deGlee Method [English] in:

Kruseman and De Ridder, (1991) Analysis and Evaluation of Pumping Test Data (2nd Edition), Publication 47, International Institute for Land Reclamation and Improvement, P.O. Box 45, 6700 AA Wageningen, The Netherlands, pp. 76-78.

Hantush, M. S., (1960) Modification of the Theory of Leaky Aquifers, Journal of Geophysical Research, Vol. 65, pp. 3713-25.

Theis, C. V., (1935) The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage, Trans. American Geophysical Union, 16th Annual Meeting, April, 1935, pp. 519-24.

Appendix 1

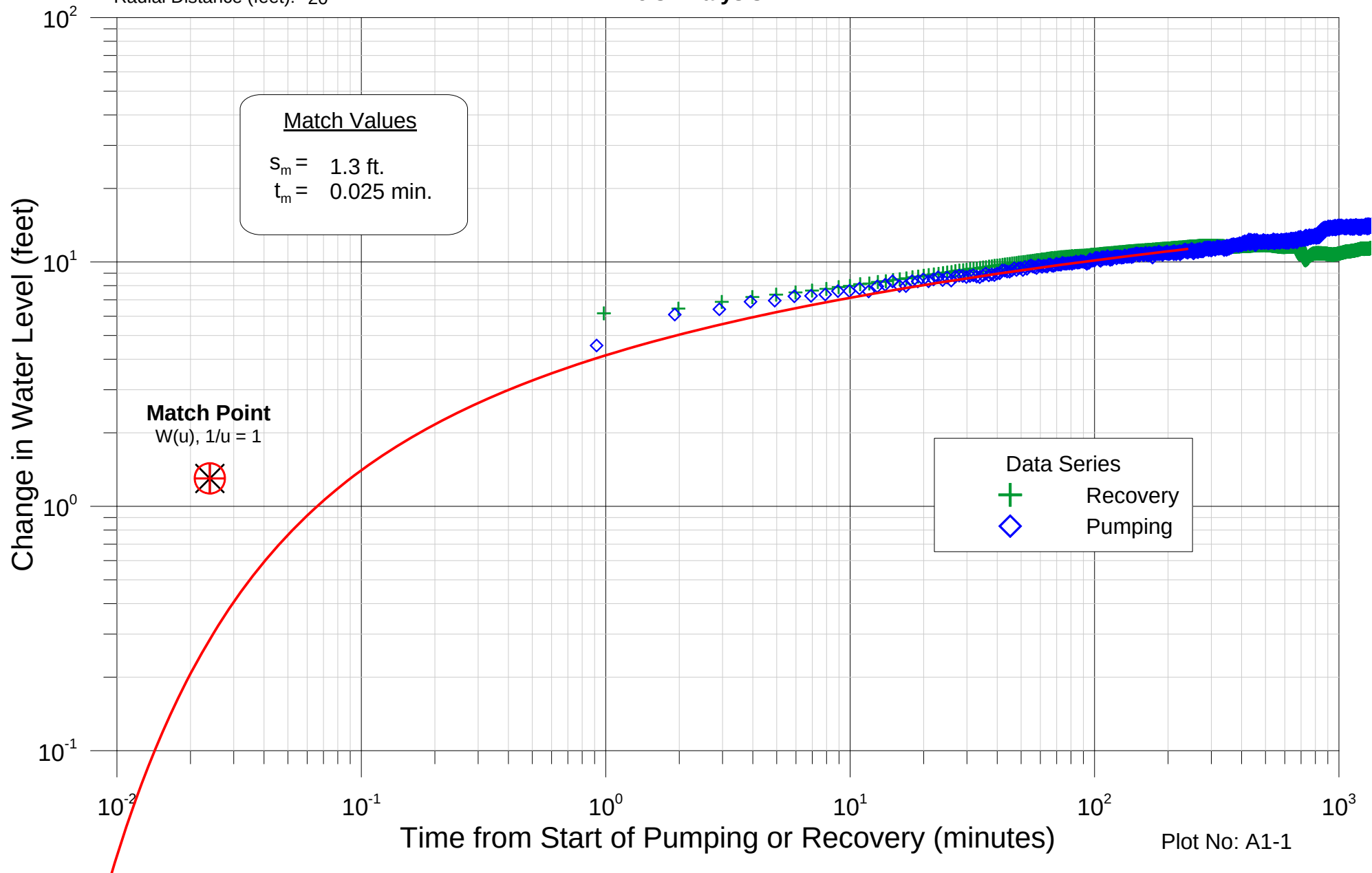
Graphical Analysis

MDH Test No: 2462
Pumped Well: GC 2 (802162)
Obwell: --
Test Date: 5/5/2014
Data Series: Composite pumping and recovery
Discharge Rate (gpm): 1100
Radial Distance (feet): 20

Theis Analysis

$$T = 15.3 \cdot Q \cdot W(u) / s_m$$
$$S = T \cdot t_m \cdot 1/u / r^2 \cdot 360$$

$$T = 15.3 \cdot 1100 / 1.3 = 12946.2 \text{ ft}^2/\text{day}$$
$$S = \text{Not Applicable}$$



MDH Test No: 2462
Pumped Well: GC 2 (802162)
Obwell: GC 1 (216009)
Test Date: 5/5/2014
Data Series: Composite pumping and recovery
Discharge Rate (gpm): 1100
Radial Distance (feet): 133

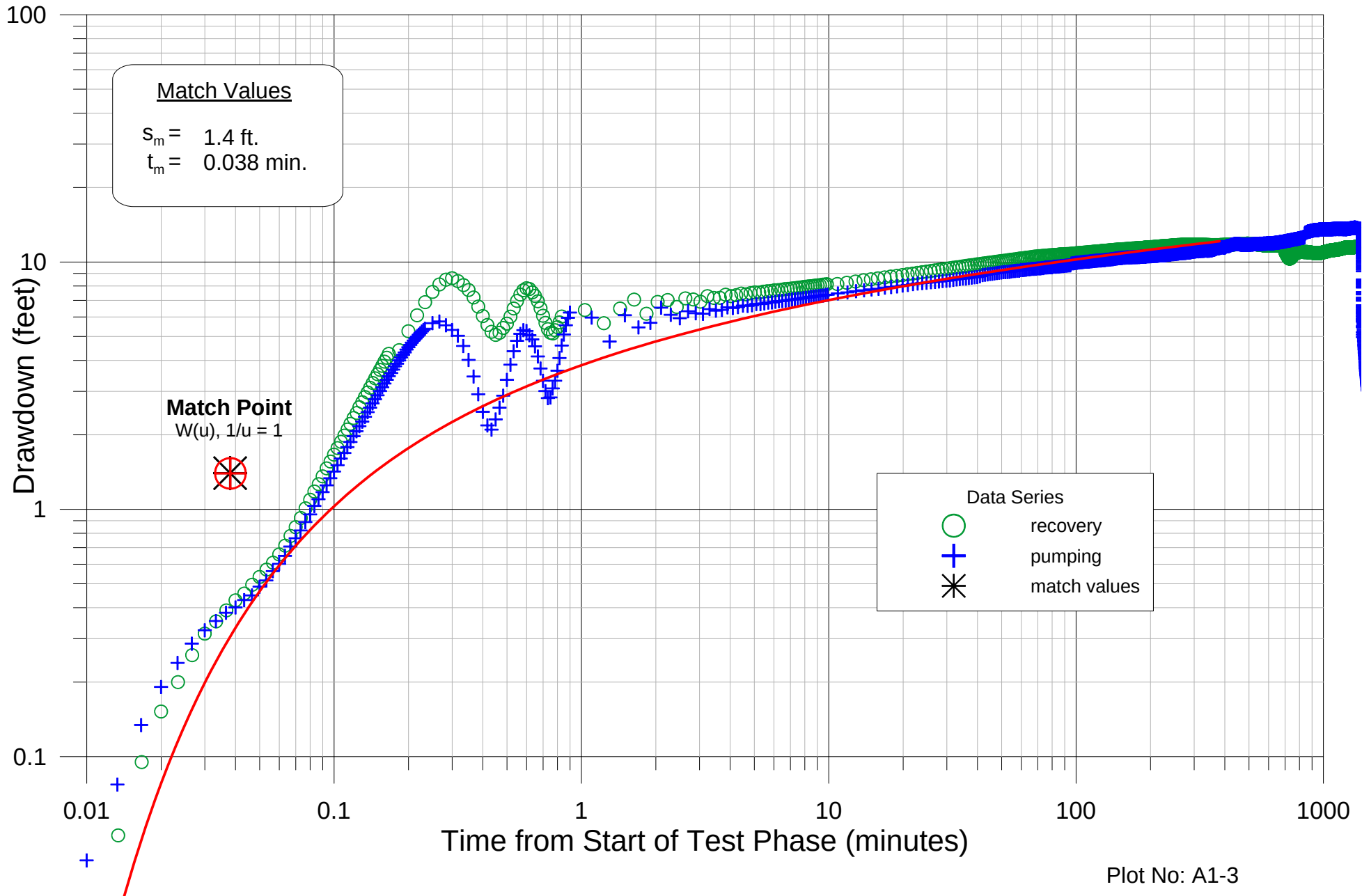
Theis Analysis

$$T = 15.3 \cdot Q \cdot W(u) / s_m$$

$$S = T \cdot t_m \cdot 1/u / r^2 \cdot 360$$

$$T = 15.3 \cdot 1100 / 1.4 = 12021.4 \text{ ft}^2/\text{day}$$

$$S = 12021.4 \cdot 0.038 / (133^2 \cdot 360) = 7.17355\text{e-}005$$

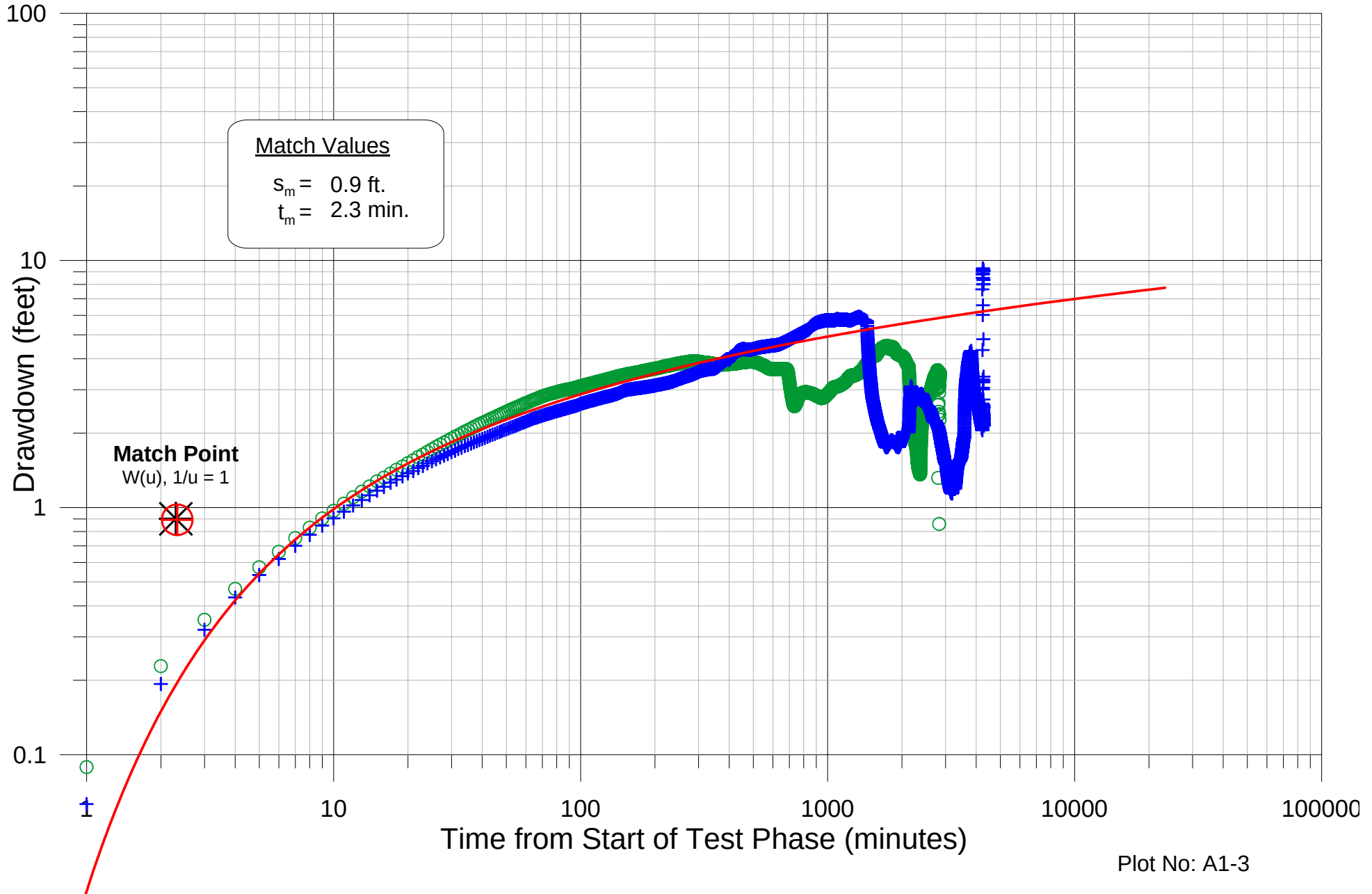


MDH Test No: 2462
Pumped Well: GC 2 (802162)
Obwell: MH (216067)
Test Date: 5/5/2014
Data Series: Composite pumping and recovery
Discharge Rate (gpm): 1100
Radial Distance (feet): 2072

Theis Analysis

$$T = 15.3 \cdot Q \cdot W(u) / s_m$$
$$S = T \cdot t_m \cdot 1/u / r^2 \cdot 360$$

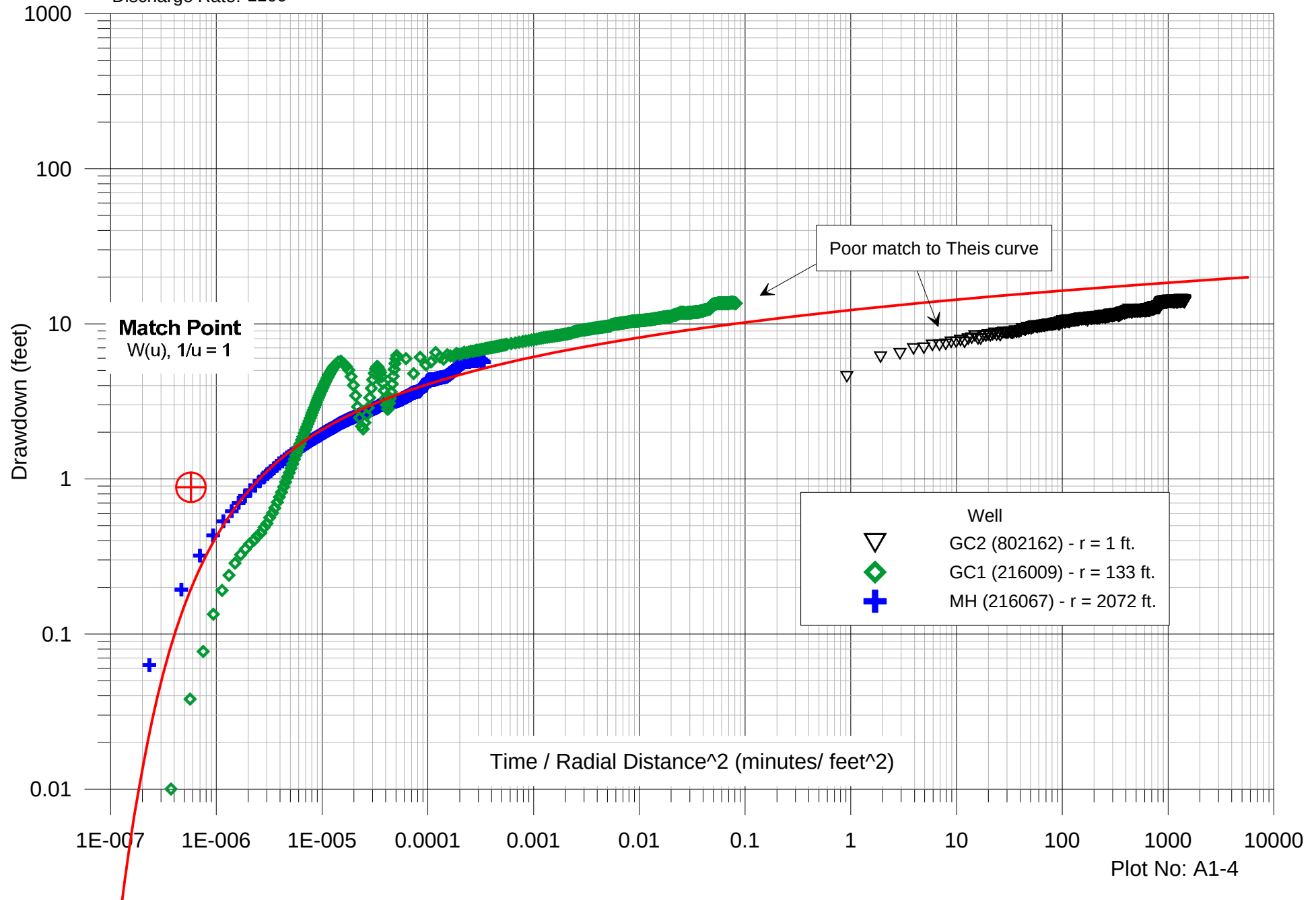
$$T = 15.3 \cdot 1100 / 0.9 = 18700 \text{ ft}^2/\text{day}$$
$$S = 18700 \cdot 2.3 / (2072^2 \cdot 360) = 2.78283\text{e-}005$$



MDH Test No: 2462
Pumped Well: GC 2 (802162)
Test Date: 5/5/2014
Data Series: Pumping
Discharge Rate: 1100

Theis Distance-Drawdown Analysis - actual radial distance

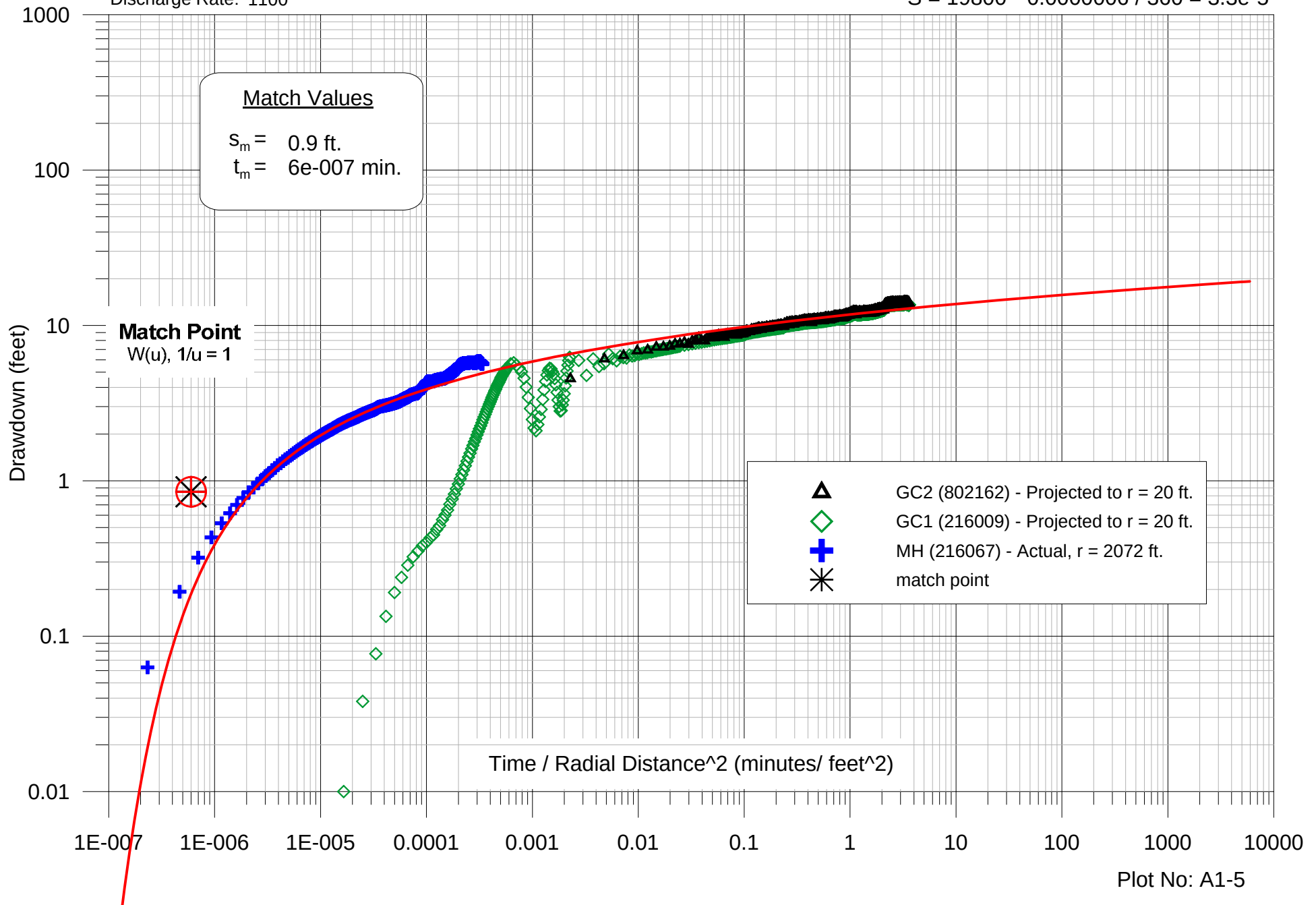
$$T = 15.3 \cdot Q \cdot W(u) / s_m$$
$$S = T \cdot t_m \cdot 1/u / 360$$



MDH Test No: 2462
Pumped Well: GC 2 (802162)
Test Date: 5/5/2014
Data Series: Pumping
Discharge Rate: 1100

Theis Distance-Drawdown Analysis Projected to r = 20 ft.

$$T = 15.3 \cdot Q \cdot W(u) / s_m$$
$$S = T \cdot t_m \cdot 1/u / 360$$
$$T = 15.3 \cdot 1100 / 0.9 = 19800 \text{ ft}^2/\text{day}$$
$$S = 19800 \cdot 0.0000006 / 360 = 3.3\text{e-}5$$

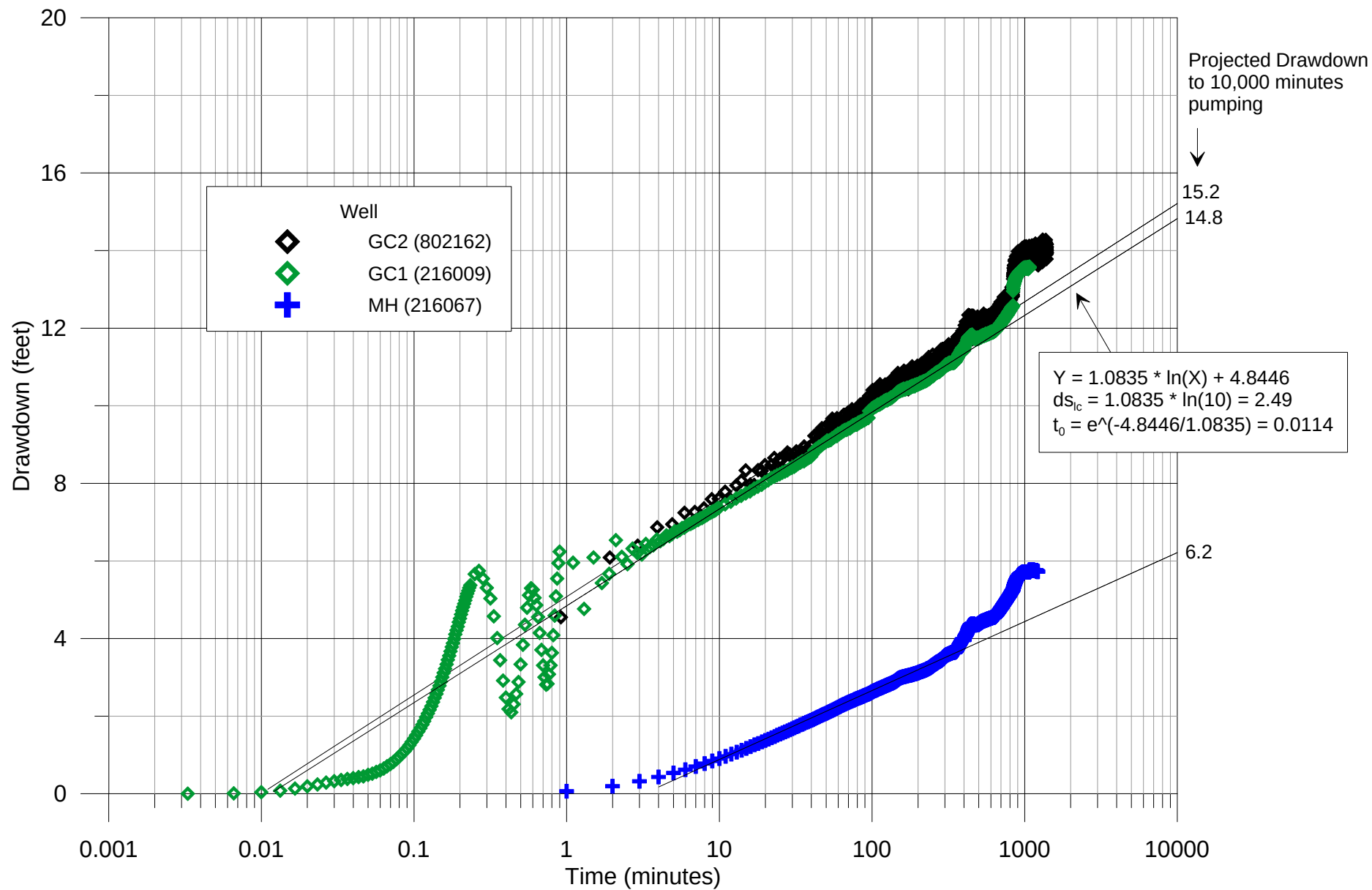


MDH Test No: 2462
Pumped Well: GC 2 (802162)
Test Date: 5/5/2014
Data Series: Pumping
Discharge Rate: 1100 gpm

$$T = (2.303 * 1440 / 7.48 / 4 / \pi()) * Q / ds'_{lc}$$
$$S = T * t_0 / (r^2 * 640)$$

$$T = 35.3 * 1100 / 2.49 = 15600 \text{ ft}^2/\text{day}$$
$$S = 15600 * 0.01143 / (133^2 * 640) = 1.6e-5$$

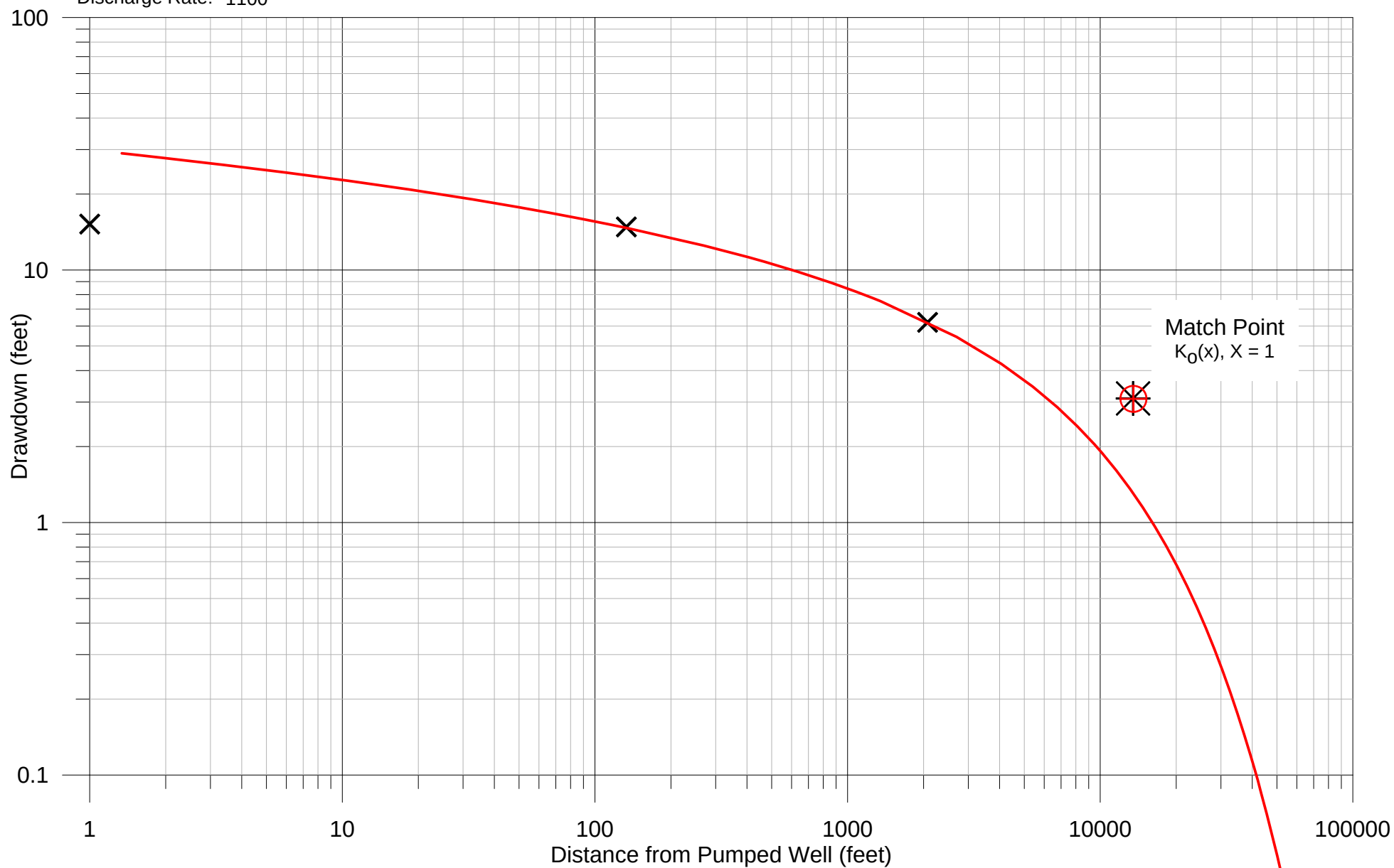
Cooper-Jacob Analysis



MDH Test No: 2462
Pumped Well: GC 2 (802162)
Test Date: 5/5/2014
Data Series: Pumping
Discharge Rate: 1100

de Glee Analysis
projected pumping to 10,000 minutes

$T = 30.6 \cdot 1100 / 3.1 = 10858.1 \text{ ft}^2/\text{day}$
 $L = 13500$
 $c = (13500^2 / 10858.1) = 16784.8 \text{ days}$

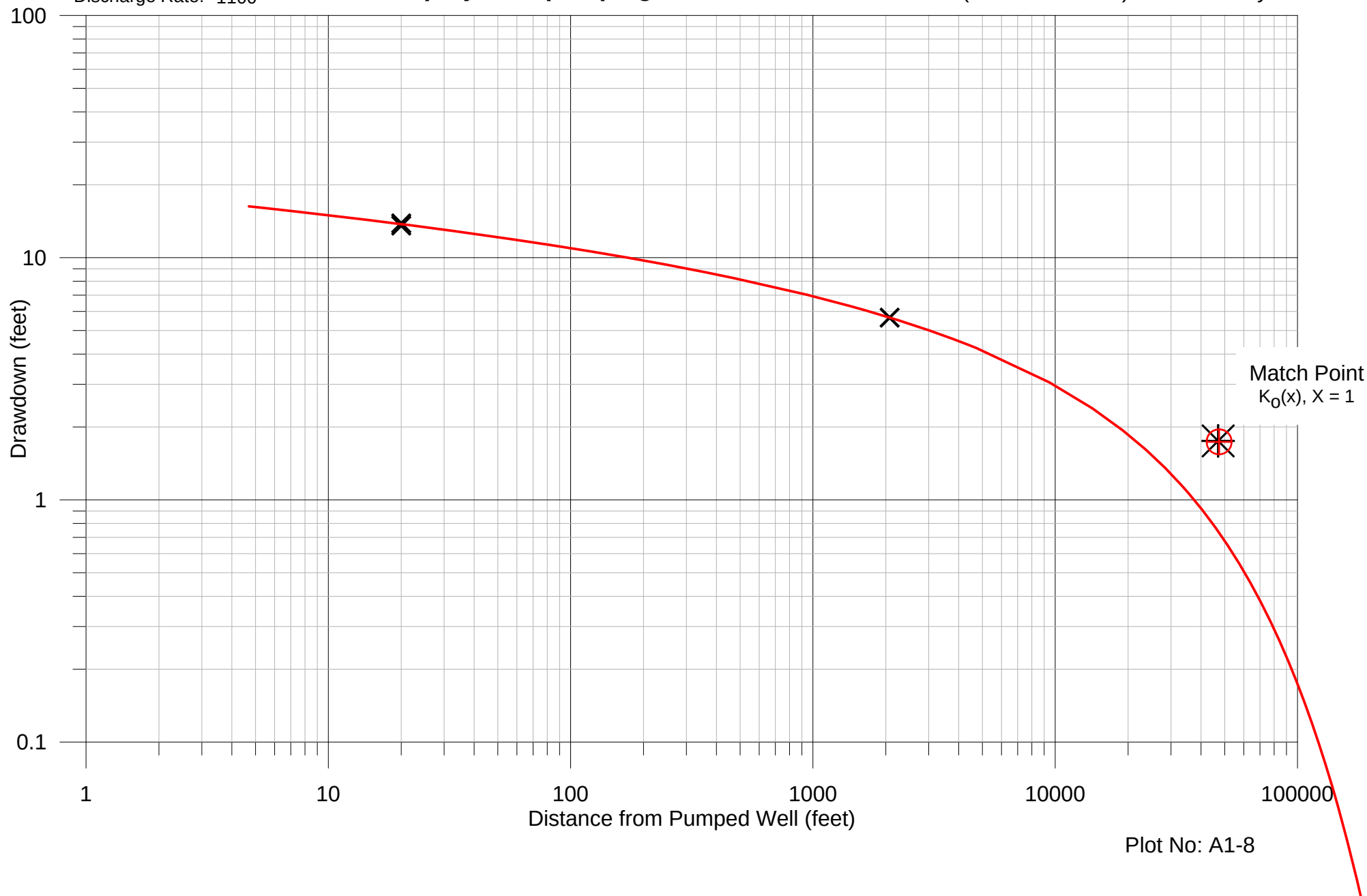


Plot No: A1-7

MDH Test No: 2462
Pumped Well: GC 2 (802162)
Test Date: 5/5/2014
Data Series: Pumping
Discharge Rate: 1100

de Glee Analysis
adjusted radial distance and
projected pumping to 10,000 minutes

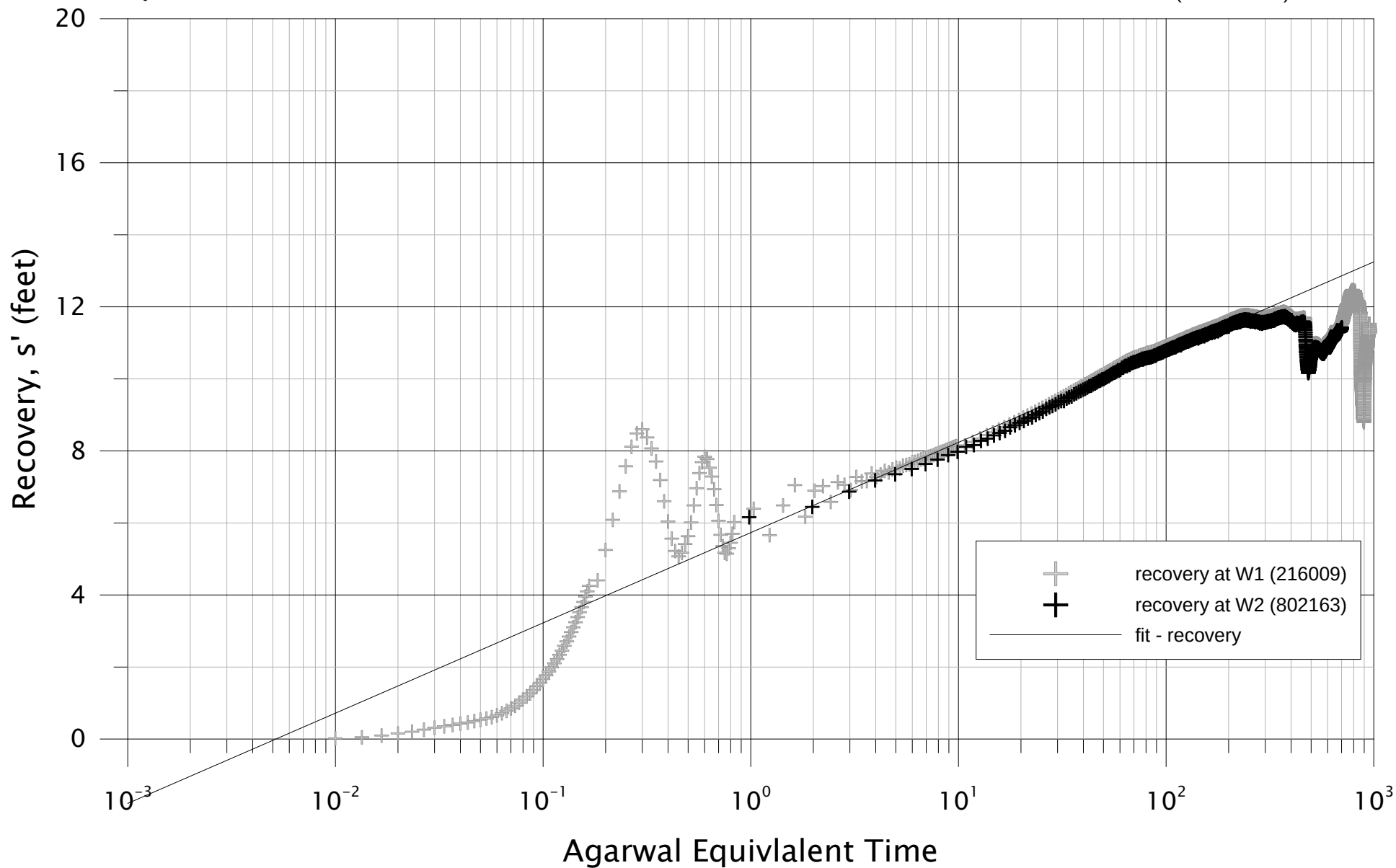
$T = 30.6 \cdot 1100 / 1.75 = 19234.3 \text{ ft}^2/\text{day}$
 $L = 47000$
 $c = (47000^2 / 19234.3) = 114847 \text{ days}$



$Q = 1100 \text{ gpm}$
 $\text{Fit} = 1.0884 * \ln(X) + 5.7296$
 $ds'_{lc} = 1.0884 * \ln(10) = 2.51$
 $t_0 = e^{(-5.7296/1.0884)} = 0.00517$

Test of Meadowbrook 2 (802162)
05/05/2014
Recovery

$T = (2.303 * 1440 / 7.48 / 4 / \pi()) * Q / ds'_{lc}$
 $S = 2.25 * T * t_0 / (r^2 * 1440)$
 $T = 35.3 * 1100 / 2.51 = 15470 \text{ ft}^2/\text{day}$
 $S = 2.25 * 15470 * 0.00517 / (20^2 * 1440) = 3.1e-4$



t_p =pumping time (fixed), t' =elapsed recovery time

Plot No: A1-9

$(t_p * t') / (t_p + t')$

Appendix 2

Documentation

Test No.
2462

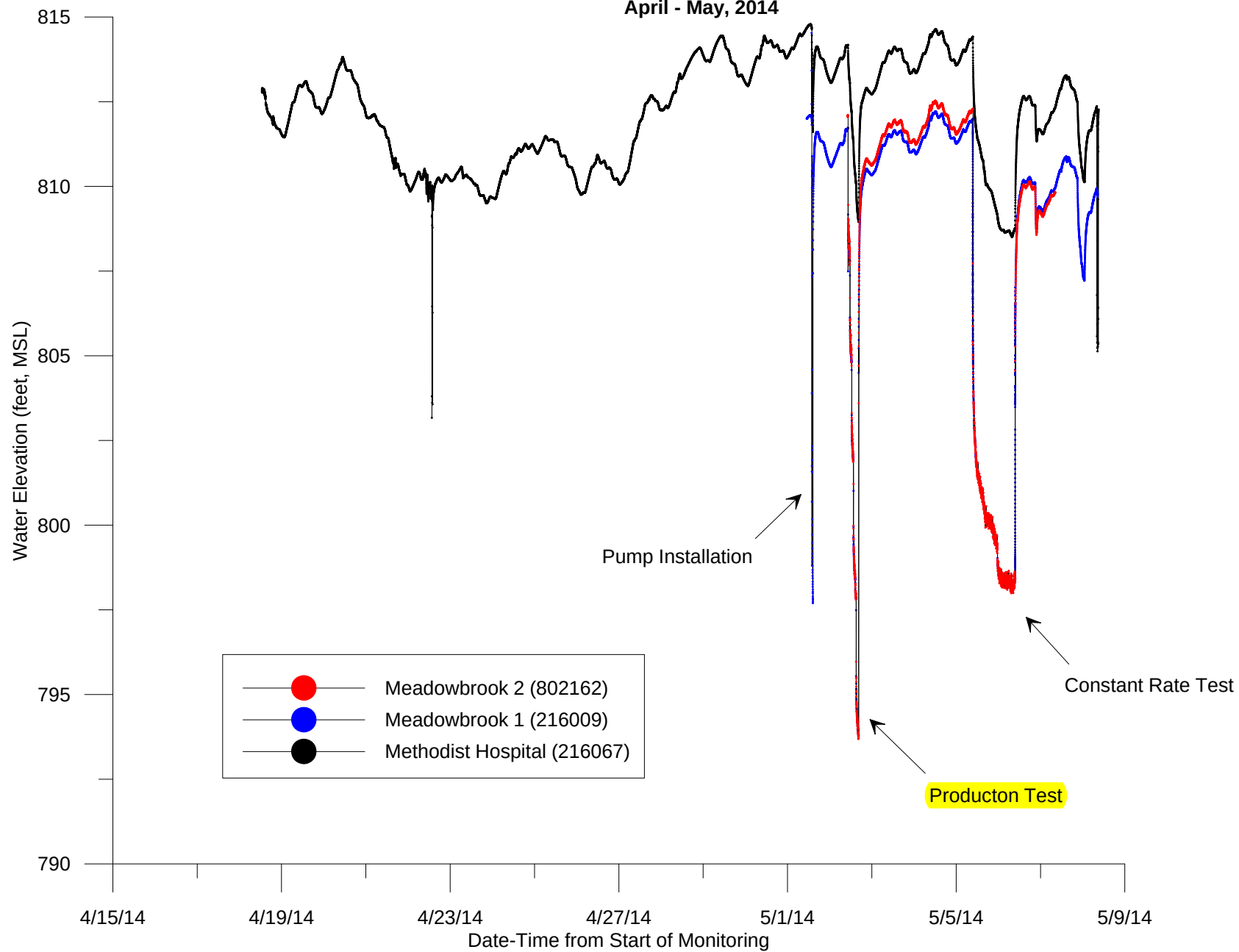
Aquifer Test Information

Page 1 of ____

A – Test Information								
Test Location Meadowbrook Golf Course 2		Well Owner Minneapolis Park Board		Test Conducted By Traut Well Drilling / MDH				
Aquifer Prairie du Chien-Jordan		Confined/Unconfined confined		Flow Rate (Units) 1100 gpm				
Date/Time - Monitoring Start 04/18/2014 12:51:06		Pump Type submersible		Flow Rate Measuring Device turbine				
Date/Time - Test Start 05/05/2014 09:30:05		Drop Pipe Length (Pump Intake)		Totalizer: End 68535050				
Date/Time - Recovery Start 05/06/2014 09:35:01		Pumped Well Inner Casing Diameter		Totalizer: - Start 66926450				
Date/Time - Test Finish 05/08/2014 09:10		Pump Pre-lube Time: NA		= Total Pumped (Units) 1608600				
B – Well Information								
Well Name (Unique Number)	Location		Radial Distance (feet)	Ground Surface Elevation (ft.) GSE	Measuring Point Desc. GSE + (stick-up)	Open Interval (feet, MSL)	Aquifer	
	Easting (m)	Northing (m)						
Meadowbrook GC 2 (802162)	417218	4974638	~20	894.5	+ 3.27 ft. Vent Tube	from 634 to 380	Prairie du Chien - Jordan	
Meadowbrook GC 1 (216009)	417229	4974599	133	893.6	+~ 1 ft. Vent Tube	from 582 to 337	Prairie du Chien –St. Lawrence	
Methodist Hospital (216067)	417392	4975245	2072	891.1	+~ 2 ft. Vent Tube	from 636 to 406	Prairie du Chien - Jordan	
						from to		
						from to		
C – Data Collection								
Data File Name: Well Name_Unique Number	Data Logger Type, SN:	Probe Id., Range (psi)	Installation		Removal		Difference	
			Static WL	Transducer Setting	Static WL	Transducer Setting	Static WL	XD Setting
GC2_802162.xlsx	Traut in-situ troll	SN:118832 100 psi	82	181.8				
GC1_216009.xlsx	MDH box 3 Hermit 1K	9 - 30 psi	84.60	-55.72	87.00	XD _r -53.85 XD _o -53.52	2.40	2.20
MH_216067.xlsx	MDH box 5 Hermit 3K	4 - 20 psi	81.33	-19.57	81.15	XD _r -19.81 XD _o -same	-0.17	0.24

Test Notes: 150 to 200 yd³ blasted & bailed from well during development. GSE from Lidar +1 ft. to account for fill at wellhead for drilling platform.

Production Test Data
Meadowbrook Golf Course Irrigation Well 2 (802162)
April - May, 2014



Notes:

STEP TEST

PROJECT: MEADOWBROOK GOLF COURSE

Well # N/A

Uniq # 802162

Test By: BRIAN TRAUT

Job # 3010588

Meter Reading Beginning: 66504500

Meter Reading Ending: 66926500

Well Information:

Transducer set at: 181.8 ft. (From Grade)

Length of Casing: 260' from grade

Length of Screen: N/A Hp of Pump: 150

Total Well Depth: 465' Model of Pump: AMERICAN MARSH

Static Water Level: 82.2' ft (From Grade)

Well Capacity: 1700 GPM @ 101 PWL 89 G.P.F.D.D.

Page 1 of 2

Date	Time	AM	PM	GPM	PWL	Sand/Gal	COMMENTS
1/2/2001	12:34	X	X	123	12'3"	4" c/g	This is a sample
5/2/2014	9:49	X					
	10:30	X		500			
	10:36	X				clear/few grains	
	10:40	X			85.35		
	10:54	X			85.65		
	11:00	X			85.85		
	11:15	X			86.00		
	11:30	X		800	88.70	clear/few grains	
	11:41	X			89.08		
	12:29		X		89.61		
	12:31		X	1100			
	12:35		X		91.46	clear/few grains	
	12:40		X		91.69		
	1:00		X		92.14		
	1:16		X		92.59		
	1:29		X		92.45		
	1:31		X	1400			
	1:35		X		94.96	clear/few grains	
	1:47		X		95.62		
	2:09		X		95.80		
	2:12		X		95.00		
	2:24		X		95.99		
	2:31		X		95.98		
	2:36		X		96.04		

The data stated above is representative of the time spent pumping at the capacities stated. Deviation from either time spent pumping or both could change the outcome if these results.

NOTE: On RECOVERY need: 5-1 minute checks
5-5 minute checks

2-30 minute checks
1-per hour as needed

Notes:

24-HR TEST PUMP

PROJECT: MEADOWBROOK GOLF COURSEWell # N/AUniq # 802162Test By: BRIAN TRAUTJob # 3010588Meter Reading Beginning: 66926500Meter Reading Ending: 68535000**Well Information:**Transducer set at: 181.8 ft. (From Grade)Length of Casing: 260'Length of Screen: N/ATotal Well Depth: 465Hp of Pump: 150Model of Pump: AMERICAN MARSHStatic Water Level: 82' (From Grade)Well Capacity: 1100 GPM @ 90.34 PWL 76.55 G.P.F.D.D.

Page 1 of 1

Date	Time	AM	PM	GPM	PWL	Sand/Gal	COMMENTS
1/2/2001	12:34	X	X	123	12'3"	4" c/g	This is a sample
5/5/2014	9:00	X					
	9:30	X		1100			
	9:32	X			88.78	clear, few grains fo sand	
	9:40	X			90.04		
	10:10	X					
	10:17	X			91.58		
	11:06	X			92.36		
	3:22		X		93.81		
	11:30		X		95.33		
5/6/2014	8:36	X		1100	96.27		
	9:35	X		SHUT DOWN			
	9:36	X			90.34		
	9:45	X			87.90		

The data stated above is representative of the time spent pumping at the capacities stated. Deviation from either time spent pumping or both could change the outcome if these results.

NOTE: On RECOVERY need: 5-1 minute checks
5-5 minute checks

2-30 minute checks
1-per hour as needed

Notes:

Minnesota Unique Well No.

802162

County Hennepin
Quad Minneapolis South
Quad ID 104A

MINNESOTA DEPARTMENT OF
HEALTH
**WELL AND BORING
RECORD**

Entry Date 03/26/2014
Update Date 04/21/2014
Received Date

Minnesota Statutes Chapter 103I

Well Name MEADOWBROOK GOLF COURSE		Well Depth	Depth Completed	Date Well Completed
Township Range Dir Section Subsections Elevation		465 ft.	465 ft.	
117	21 W 20 DACCAD	Elevation Method LiDAR 1m DEM (MNDNR)		
Drilling Method --				
Geological Material		Drilling Fluid	Well Hydrofractured? ☐ Yes ☐ No	
		--	From Ft. to Ft.	
		Use Irrigation		
		Casing Type Steel (black or low carbon) Joint Welded Drive Shoe? ☐ Yes ☐ No Above/Below ft.		
		Casing Diameter		
		18 in. to ft. lbs./ft.		
		24 in. to ft. lbs./ft.		
		Open Hole from ft. to ft.		
		Screen NO Make Type		
		Diameter Slot/Gauze Length Set Between		
Static Water Level				
104 ft. from Land surface Date Measured 04/01/2014				
PUMPING LEVEL (below land surface)				
ft. after hrs. pumping g.p.m.				
Well Head Completion				
Pitless adapter manufacturer Model				
☐ Casing Protection ☐ 12 in. above grade				
☐ At-grade (Environmental Wells and Borings ONLY)				
Grouting Information Well Grouted? ☐ Yes ☐ No				
Nearest Known Source of Contamination				
_feet _direction _type				
Well disinfected upon completion? ☐ Yes ☐ No				
Pump ☐ Not Installed Date Installed				
Manufacturer's name Model number __ HP _ Volts				
Length of drop Pipe _ft. Capacity _g.p.m. Type Material				
Abandoned Wells Does property have any not in use and not sealed well(s)? ☐				
Yes ☐ No				
Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No				
Well Contractor Certification				
Mark J Traut Wells, Inc. 1404 BRIAN/JOSH				
License Business Name Lic. Or Reg. No. Name of Driller				
County Well Index Online Report		802162	Printed 5/7/2014 HE-01205-07	

Unique Well Number

216009

County

Hennepin

Quad

Minneapolis South

Quad Id

104A

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

MINNESOTA STATUTES CHAPTER 1031

Entry Date

1991/08/24

Update Date

2014/03/26

Received Date

Well Name

MEADOWBROOK GOLF COURSE

Township

Range

Dir

Section

Subsection

Field Located

MGS

117

21

W

20

DACCDD

Elevation

890.00

ft.

Well and Contact Address

MEADOWBROOK GOLF COURSE

ST LOUIS PARK

MN

Changed

Description

Color

Hardness

From

To (ft.)

COARSE SAND & GRAVEL

0

74

LIMEROCK

74

82

SHALE

82

90

SANDROCK

90

92

SANDROCK

92

190

SHALE

RED

190

200

SANDROCK

200

252

SHAKOPEE DOLOMITE

252

253

SHAKOPEE DOLOMITE

253

375

SANDROCK

375

376

SANDROCK

376

440

SANDROCK & SHALE

440

465

SHALE

GRAY

465

502

Well Depth

Depth Completed

Date Well Completed

502.00

ft

502.00

ft

1935/06/27

Drillhole Angle

Drilling Method

Cable Tool

Drilling Fluid

Well Hydrofractured?

☐ YES

☐ NO

From

ft. to

Use

Public Supply/non-community

Casing

Type

Steel (black or low

Drive Shoe?

☐ YES

☐ NO

Hole Diameter (in.)

Diameter

12

Depth

257

16.00

in. from

0.00

to

77.00

ft.

lbs/ft

12.00

in. from

77.00

to

257.00

ft.

lbs/ft

Screen

No

Open Hole(ft.)

From

257.0

to

502.0

Make

Type

Diamter

Slot

Length

Set

Static Water Level

55.00

ft.

Land surface

Date measured

1935/06/27

Pumping Level (below land surface)

ft. after

hrs. pumping

g.p.m.

Wellhead Completion

Pitless adapter manufacturer

Model

☐ Casing Protection

☐ 12 in. above grade

☐ At-grate (Environmental Wells and Borings ONLY)

☐ Basement offset

Grouting Information

Well grouted?

☐ YES

☐ NO

Nearest Known Source of Contamination

feet

Direction

Type

Well disinfected upon completion?

☐ YES

☐ NO

Pump

☐ Not Installed

Date Installed

Manufacture's name

Model number

HP

0.00

Volts

Length of drop pipe

Material

Capacity

g.p.m.

Type

Abandoned Wells

Does property have any not in use and not sealed well(s)?

☐ YES

☐ NO

Variance

Was a variance granted from the MDH for this well?

☐ YES

☐ NO

Well Contractor Cerfication

Minnesota Geological Survey

MGS

License Business Name

Lic. or Reg No.

First Bedrock

OPVL

Aquifer

Multiple

Last Strat

CSTL

Depth to Bedrock

74.00

ft.

County Well Index v.5

REPORT

Printed on

5/7/2014

Name of Driller

Date

HE-01205-07 (Rev. 2/9/2014)

Unique Well Number		County		Hennepin		MINNESOTA DEPARTMENT OF HEALTH				Entry Date		1991/08/24	
216067		Quad		Minneapolis South		WELL AND BORING RECORD				Update Date		2014/04/14	
		Quad Id		104A		MINNESOTA STATUTES CHAPTER 1031				Received Date			
Well Name						METHODIST HOSPITAL		Well Depth		Depth Completed		Date Well Completed	
Township		Range		Dir		Section		Subsection		Field Located		MGS	
117		21		W		20		ADACAD		Elevation		890.00 ft.	
Well and Contact Address						METHODIST HOSPITAL							
ST LOUIS PARK						MN		Changed					
Description						Color		Hardness		From		To (ft.)	
DRIFT										0		85	
PLATTEVILLE LIMESTONE										85		94	
ST. PETER SANDSTONE										94		257	
PRAIRIE DU CHIEN										257		262	
PRAIRIE DU CHIEN										262		368	
PRAIRIE DU CHIEN										368		377	
JORDAN FORMATION										377		466	
ST. LAWRENCE FORMATION										466		485	
Remarks													
U.S.G.S. W-48 U.S.G.S. W-48 OLD P.A. 66-5517 127104A													
1172120ADACA GAMMA LOGGED & TV 2-11-1989.													
First Bedrock						OSTP		Aquifer		Multiple			
Last Strat						CSTL		Depth to Bedrock		94.00		ft.	
County Well Index v.5						REPORT		Printed on		5/7/2014			
Name of Driller								Date				HE-01205-07 (Rev. 2/9/9	



Environmental Health Division
Drinking Water Protection Section
Source Water Protection Unit
P.O. Box 64975
St. Paul, Minnesota 55164-0975

Determination of Aquifer Properties and Aquifer Test Plan (DAP-ATP) Form

Public Water Supply ID:	12070050	PWS Name:	City of St. Louis Park, MN
Contact Information for Person Completing this Form			
Name:	Erik J. Tomlinson, PG		
Address:	Source Water Solutions, LLC 221 McCarron St.		
City, State, Zip:	St. Paul, MN 55113		
Phone, Fax, e-mail:	Phone: 612.701.7343 Email: erik@sourcewater-solutions.com		
Aquifer Properties Determination Methods			
<p>☒ 1) An existing pumping test that meets the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on a well connected to the public water supply system.</p> <p>☐ 2) An existing pumping test that meets the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on another well in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☐ 3) A proposed new test to be conducted on a new or existing well connected to the public water supply system and that meets the requirements for larger-sized water systems (wellhead protection rule part 4720.5520). A test plan must be approved before conducting the test.</p> <p>☐ 4) A proposed new test to be conducted on a new or existing public well connected to the public water supply system and that meets the requirements for smaller-sized water systems (wellhead protection rule part 4720.5530). A test plan must be approved before conducting the test.</p> <p>☐ 5) An existing pumping test that does not meet the requirements of wellhead protection rule part 4720.5520 and that was previously conducted on: 1) a public water supply well or 2) another well in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☐ 6) Existing specific capacity test(s) conducted on the public water supply well(s) or specific capacity tests conducted on other wells in a hydrogeologic setting determined by the department to be equivalent.</p> <p>☒ 7) An existing published transmissivity value.</p> <ul style="list-style-type: none">▪ Include all test data and analysis documentation with the estimated transmissivity, ft²/day, when the aquifer properties determination method is; 1, 2, 5, 6, or 7, listed above.▪▪ Attach detailed aquifer test plan for methods 3 or 4.			
Submitted by: Erik J. Tomlinson, PG		Prof. License: PG46739	Date: 12/29/2014
To request this document in another format, please call our Section Receptionist (651/201-4700) or Division TTY (651/201-5797).			



Rationale for: 1) Aquifer Properties Determination or 2) Proposed New Test

Briefly describe the rationale for: 1) selected method to determine aquifer properties from existing data, or 2) a new aquifer test to be conducted on the pumped well referenced below. Include unique well numbers of all wells that were (or will be) monitored during data collection. How does the existing or proposed test deviate from the ideal. (e.g. rate, duration, no. of obwells, interfering wells, etc.) Attach documentation as necessary.

Aquifer Name: Jordan ☒ Confined ☐ Unconfined ☐ Fractured Rock

The attached aquifer test for Minnetonka Well #6 (Unique ID: 208012 (number is incorrect on pump test analysis)) (**Attachment 1**) was completed with MDH oversight and review. Although the pump test analysis report identifies the aquifer as PDCJ, the observation well where measurements were made is only open to the Jordan Aquifer. It has been determined that the values derived from this pump test are appropriate to represent the Jordan Aquifer. Representative aquifer values are best shown by the early pumping and recovery value from the observation well, giving an average T of 2,400 ft²/d, S of 0.000015, and r/B of 0.07. Aquifer thickness at Well #6 is 94 ft.

A starting horizontal hydraulic conductivity value proposed for use in the groundwater modeling for the Jordan aquifer is 25.5 ft/day.

A starting vertical hydraulic conductivity value proposed for use in the groundwater model for the Jordan aquifer is 2.55 ft/day.

Proposed New Test Information Summary

Pumped Well Name (Unique Number):	208012 (Minnetonka Well 6A)	Test Duration (Hours):	24 hours pumping, 32 recovery
Location: X, Y (meters) UTM-Z15N <u>or</u> Lat-Lon (decimal degrees) datum: NAD83	UTM-Z15N X:1532864.17 Y:16330554.46	Pump Type:	NA
		Discharge Rate:	1,000 gpm
Number of Observation Wells:	1 (Minnetonka Well 6)	Flow Rate Measuring Device Type:	Electronic Flow Meter

- A map showing the location of the pumping well and observation well(s) must be included.

List the unique number of each public water supply well to which this DAP-ATP Form applies

200542 (Well 04)	203187 (Well 16)				
203678 (Well 08)					
206442 (Well 10)					
227965 (Well 14)					
215447 (Well 15)					

Reviewed by:

Approved: ☐ Yes ☒ No

Approval Date:

12
Analysis of the Minnetonka #6A (208021) Pumping Test
August 15, 1994
Confined Prairie du Chien - Jordan Aquifer

Introduction

The MDH was requested to assist in the delineation of wellhead protection areas by the City of Minnetonka, Minnesota, around the public water supply wells serving the community. An important part of the delineation process is to determine aquifer properties at the well site as accurately as possible. This is normally accomplished by performing a pumping test. Because of the need to test most public water supply wells, the MDH agreed to help with the pumping test as a part of technical assistance for communities, and program and staff development.

The pumping test conducted by the MDH at Minnetonka #6A was conducted as described below. The only problem in conducting the test was that data from the first three minutes of the recovery period were lost. The results were analyzed using standard nonequilibrium and semisteady-state methods, cited in references. Data plots are included in Appendix 1 and test results are summarized on Table 1. The analysis shows that the aquifer responds as generally expected from the geologic setting.

Description of the Test

One nearby public supply well, #6 (204054), was used as a monitoring point for this test because there was no access to the pumped well for water level measurements. There were no other nearby wells to cause well interference for this test. All wells were turned off at 12:00 on August 12, 1994, providing a sixty-eight hour resting period before the start of the test. A pressure transducer was placed in Well 6A at this time to obtain background readings.

The test started at 08:40 on August 15, 1994. Well #6A was pumped at an average rate of 1000 gallons per minute. The flowmeter on the well was not used because the flowmeter data was recorded electronically and displayed at the Minnetonka City public works offices.

The pump was turned off at 08:50 on August 16, 1994 to start the recovery period. The recovery was extended to 16:43 on August 17th and about 90 percent of full recovery was obtained.

Summary of Results

A transmissivity value of 2,400 ft²/day and a storativity value of 0.000015 are chosen as being representative of aquifer properties in the area of the well field for the capture zone analysis.

The results are also consistent with the conceptual model of a confined aquifer receiving water from adjacent leaky layers.

Problems with the Analysis

None of the problems that occurred during this test affected the analysis and the analysis is quite straight forward.

References:

- Jacob, C. E. and Lohman, S. W., (1952) Nonsteady Flow to a Well of Constant Drawdown in an Extensive Aquifer. Trans. American Geophysical Union, Vol. 33, No. 4. August. 1952. pp. 559-69.
- Theis, C. V., (1935) The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage, Trans. American Geophysical Union. 16th Annual Meeting. April. 1935. pp. 519-24.

Table 1.

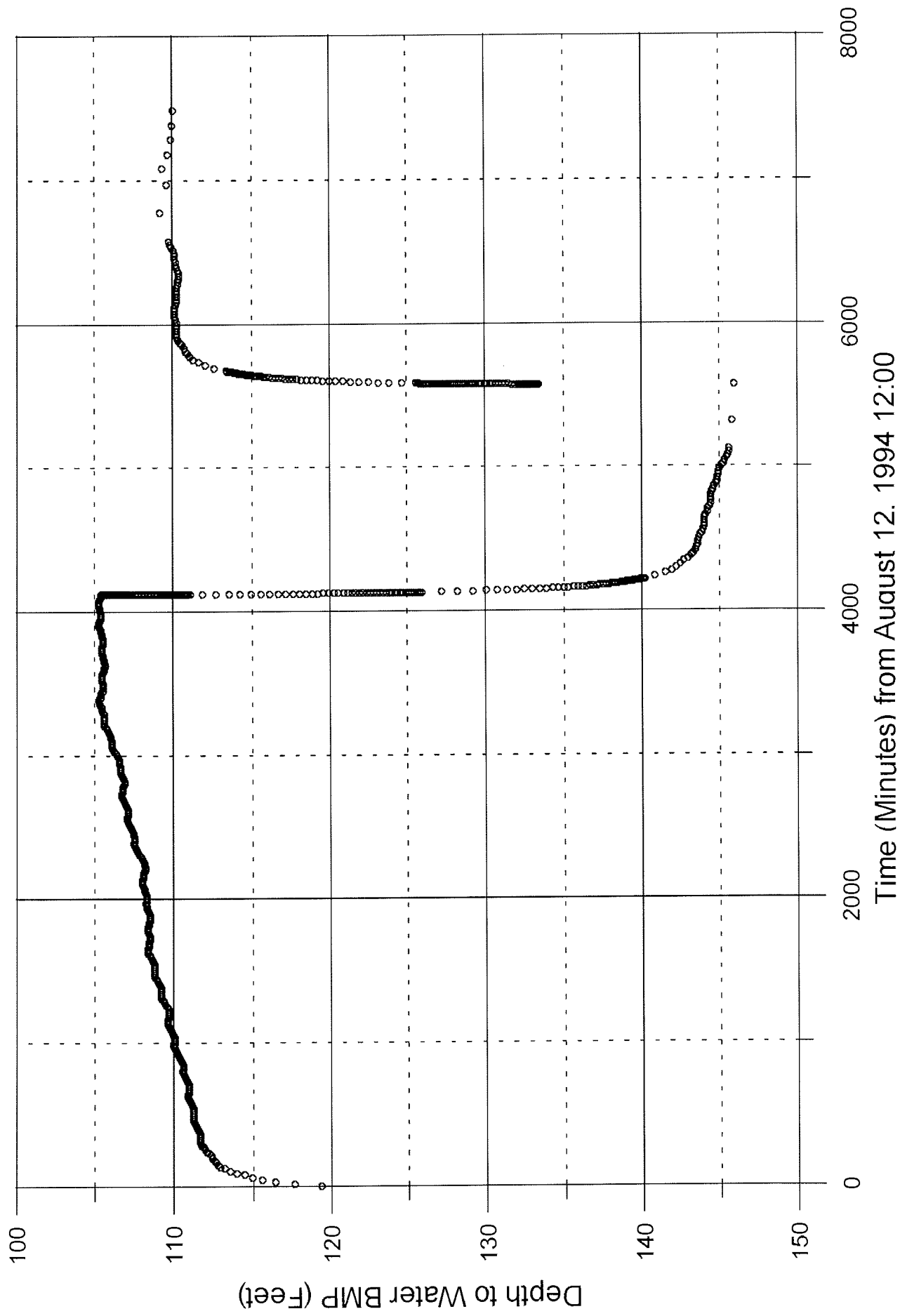
Minnetonka #6A Pumping Test
August 15, 1994

	Transmissivity T (gpd/ft) -----	Storage Coefficient S -----	Time Period Emphasized -----	Analysis Method -----
Pumping Well #6A (208012)	No data			
Observation Wells				
#6 (204054)	2,360	0.000015	Early Pumping	Theis
	11,800		Late Pumping	Jacob
	2,510	0.000015	Early Recovery	Theis
	5,430		Late Recovery	Jacob t/t'

Representative aquifer values are best shown by the early pumping and recovery value from the observation well, giving an average T of 2,400, S of 0.000015, and r/B of 0.07.

Appendix 1.
Graphical Analysis

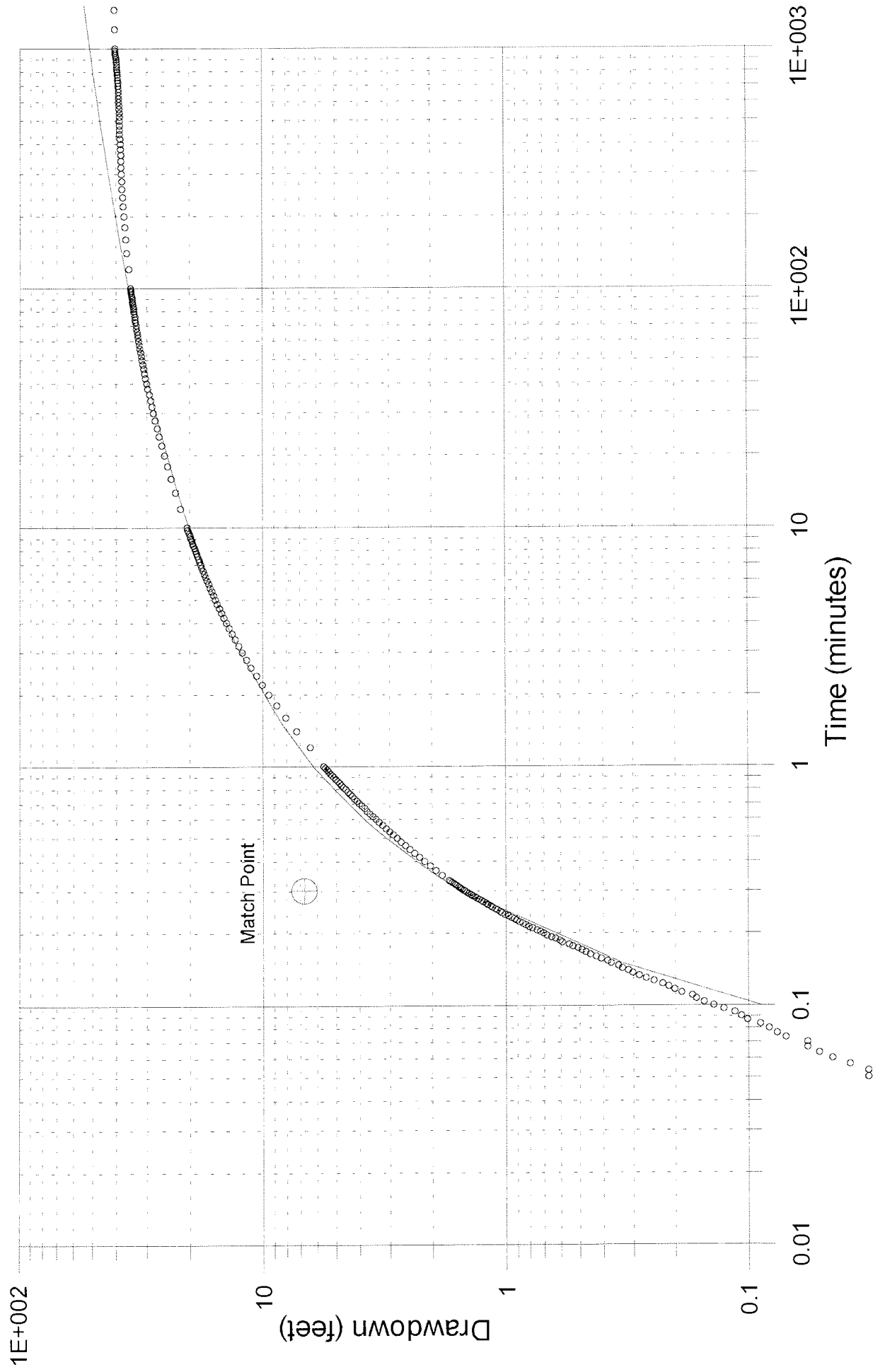
Test of Minnetonka #6A (208021)
at #6 (204054)
August 15, 1994



Test of Minnetonka #6A (208021)
 at #6 (204054)
 August 15, 1994
 Pumping Data

$$T = 15.32 \text{ } 1000 \text{ } 1 / 6.5 = 2,360 \text{ ft}^2/\text{day}$$

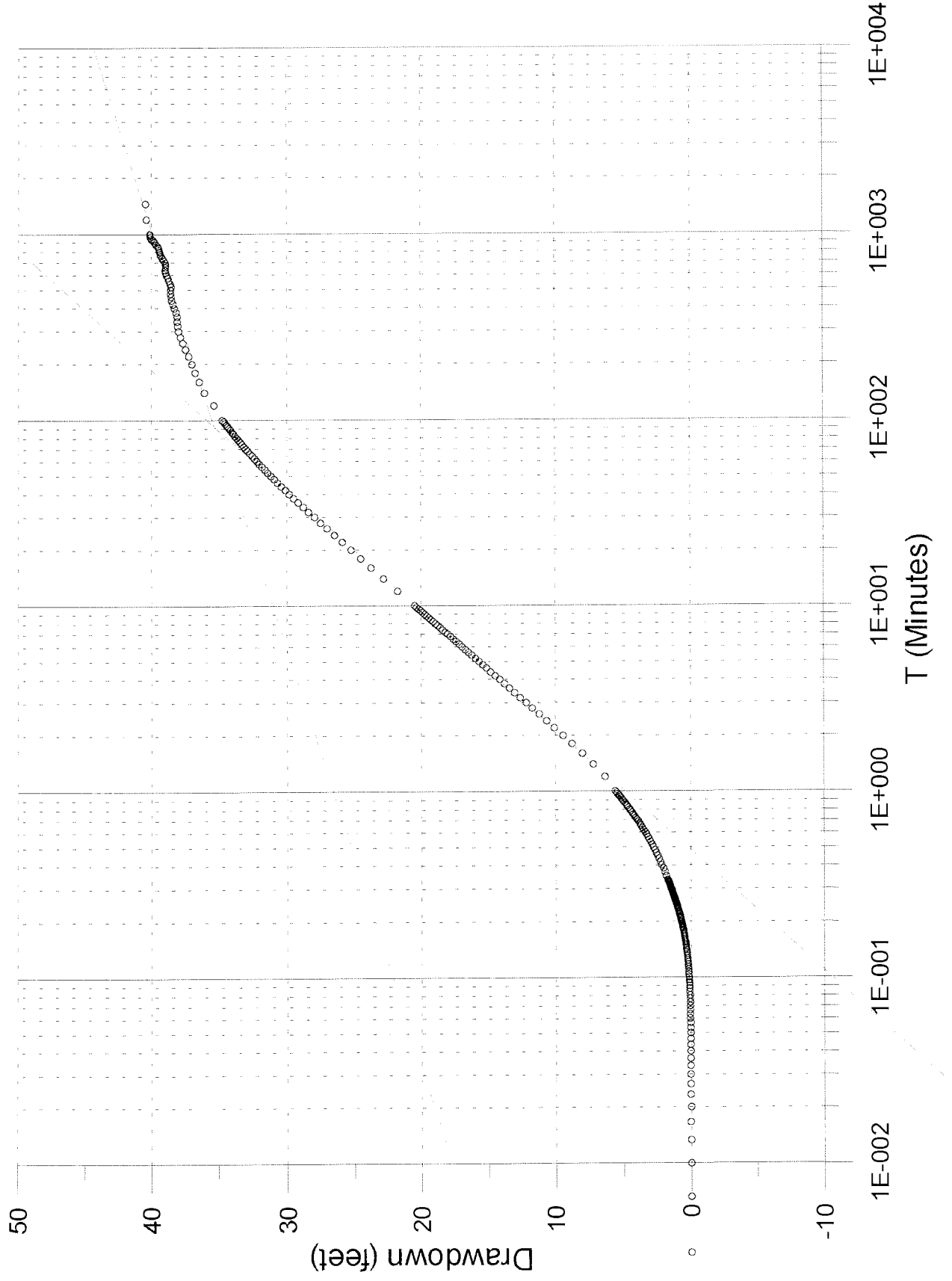
$$S = 2,360 \text{ } 0.3 \text{ } 1 / (359)^2 \text{ } 360 = 0.000015$$



Test of Minnetonka #6A (208021)
at #6 (204054)
August 15, 1994
Pumping

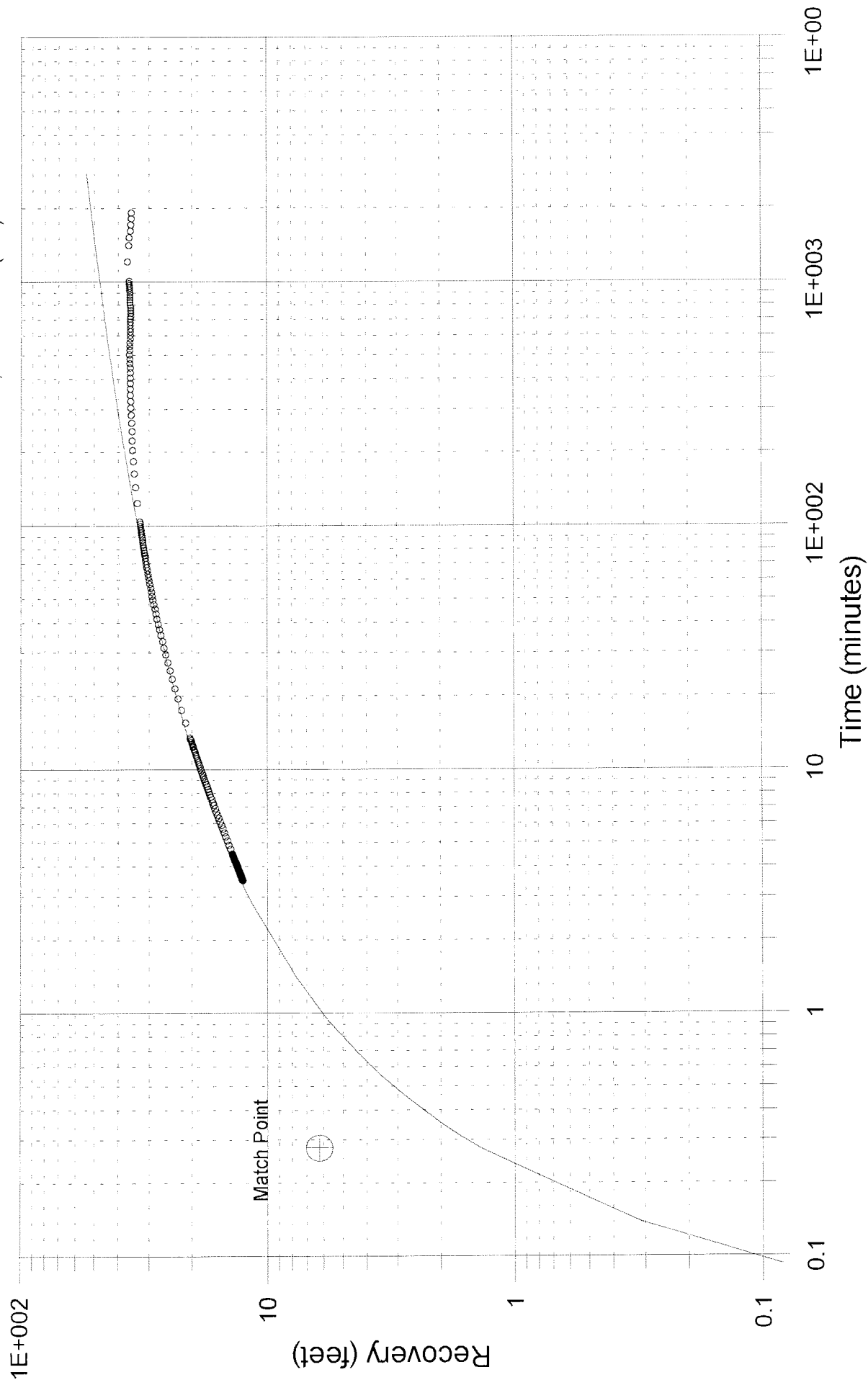
$$T1 = 35.3 \text{ 1000} / 15.7 = 2,250 \text{ ft}^2/\text{day}$$
$$S1 = 2,250 \text{ 0.5} / 359 \text{ 2 640} = 0.00013$$

$$T2 = 35.3 \text{ 1000} / 3 = 11,800 \text{ ft}^2/\text{day}$$



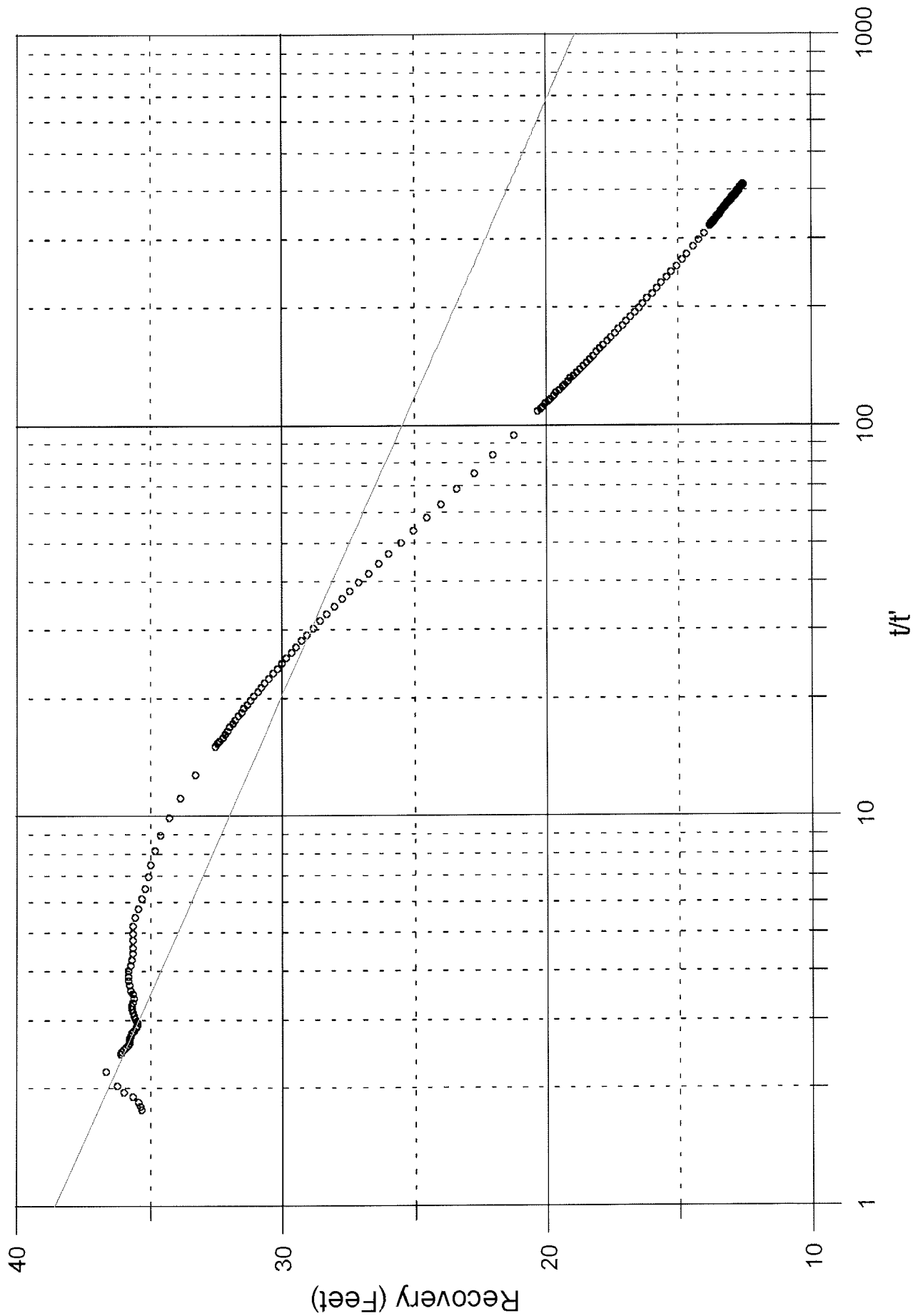
Test of Minnetonka #6A (208021)
 at #6 (204054)
 August 15, 1994
 Recovery

$T = 15.32 \text{ } 1000 \text{ } 1/6.1 = 2,510 \text{ ft}^2/\text{day}$
 $S = 2,510 \text{ } 0.27 \text{ } 1 / (359)^2 \text{ } 360 = 0.000015$



Test of Minnetonka #6A (208021)
at #6 (204054)
August 15, 1994

$T = 35.3 \times 1000 / 6.5 = 5,430 \text{ ft}^2/\text{day}$



Unique No. 00208012		MINNESOTA DEPARTMENT OF HEALTH				Update Date 2005/06/22		
County Name Hennepin		WELL AND BORING RECORD				Entry Date 1991/08/24		
		Minnesota Statutes Chapter 1031						
Township Name	Township	Range	Dir	Section	Subsection	Well Depth	Depth Completed	Date Well Completed
	117	22	W	12	CDCBCD	486 ft.	486 ft.	1967/07/00
Well Name MINNETONKA 6A						Drilling Method		
Contact's Name MINNETONKA 7 10701 CEDAR LAKE RD MINNETONKA MN						Drilling Fluid		Well Hydrofractured? Yes No
						From ft. to ft.		
						Use Community Supply (municipal)		
						Casing	Drive Shoe?	Yes No
GEOLOGICAL MATERIAL COLOR HARDNESS FROM TO						Casing Diameter		Weight(lbs/ft)
						24 in. to 114 ft.		
DRIFT 0 104						20 in. to 315 ft.		
SHALE 104 112						16 in. to 341 ft.		
LIMEROCK 112 121								
SHALE 121 136								
SANDROCK SOFT 136 248						Screen Open Hole From ft. to ft.		
SHALE 248 261						Make Type		
SANDROCK 261 304								
SHAKOPEE BROKEN 304 315								
SHAKOPEE SANDY 315 392						Static Water Level 86 ft. from Land surface Date 1967/07/00		
JORDAN SANDROCK 392 485						PUMPING LEVEL (below land surface)		
SHALE 485 486						157 ft. after hrs. pumping 1571 g.p.m.		
						Well Head Completion		
						Pitless adapter mfr Model Casing Protection 12 in. above grade At-grade(Environmental Wells and Borings ONLY)		
						Grouting Information Well grouted? Yes No		
						Nearest Known Source of Contamination		
						ft. direction. type Well disinfected upon completion? Yes No		
						Pump Not Installed Date Installed		
						Mfr name Model HP 0 Volts Drop Pipe Length ft. Capacity g.p.m. Type		
REMARKS, ELEVATION, SOURCE OF DATA, etc.						Any not in use and not sealed well(s) on property? Yes No		
CASING: 024 TO 0114;020 TO 0315;016 TO 0341;012 TO 0397.						Was a variance granted from the MDH for this Well? Yes No		
USGS Quad: Hopkins Elevation: 912						Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 62012		
Aquifer: CJDN Alt Id: 79-6207						License Business Name Name of Driller		
Report Copy								

Unique No. 00204054		MINNESOTA DEPARTMENT OF HEALTH				Update Date 2004/12/29					
County Name Hennepin		WELL AND BORING RECORD				Entry Date 1991/08/24					
		Minnesota Statutes Chapter 1031									
Township Name		Township	Range	Dir	Section	Subsection	Well Depth	Depth Completed	Date Well Completed		
		117	22	W	12	CDCBDB	488 ft.	488 ft.	1967/06/00		
Well Name MINNETONKA 6							Drilling Method				
Contact's Name MINNETONKA 6 10701 CEDAR LAKE RD MINNETONKA MN							Drilling Fluid		Well Hydrofractured?	Yes	No
									From	ft. to	ft.
							Use Community Supply (municipal)				
							Casing	Drive Shoe?	Yes	No	Hole Diameter
GEOLOGICAL MATERIAL COLOR HARDNESS FROM TO							Casing Diameter		Weight(lbs/ft)		
							24 in. to 103 ft.				
DRIFT 0 101							23 in. to 52 ft.				
							19 in. to 165 ft.				
LIMEROCK 101 117							0 in. to 394 ft.				
SHALE 117 133							Screen				
							Open Hole		From	ft. to	ft.
SANDROCK SOFT 133 248							Make				
							Type				
SHALE 248 261							Static Water Level 90 ft. from Land surface Date 1967/06/00				
							PUMPING LEVEL (below land surface)				
SANDROCK SOFT 261 310							160 ft. after 2 hrs. pumping 2103 g.p.m.				
							Well Head Completion				
SHAKOPEE BROKEN 310 322							Pitless adapter mfr Model				
							Casing Protection 12 in. above grade				
SHAKOPEE SANDY 322 392							At-grade(Environmental Wells and Borings ONLY)				
							Grouting Information				
JORDAN SOFT 392 435							Well grouted? Yes No				
JORDAN SHALE 435 442							Nearest Known Source of Contamination				
							ft. direction. type				
JORDAN 442 486							Well disinfected upon completion? Yes No				
SHALE 486 488							Pump Not Installed Date Installed				
							Mfr name				
REMARKS, ELEVATION, SOURCE OF DATA, etc.							Model HP 0 Volts				
							Drop Pipe Length ft. Capacity g.p.m				
16" CASING FROM 312' TO 394'.							Type				
CASING: 024 TO 0103;020 TO 0320;016 TO 0394.							Any not in use and not sealed well(s) on property? Yes No				
CASING: 026 TO 0103;020 TO 0320;016 TO 0394.							Was a variance granted from the MDH for this Well? Yes No				
USGS Quad: Hopkins Elevation: 915							Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 62012				
							License Business Name				
Aquifer: CJDN Alt Id: 79-6207							Name of Driller				

Unique No. 00204054	MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD						Update Date 2004/12/29	
County Name Hennepin	Minnesota Statutes Chapter 1031						Entry Date 1991/08/24	
Township Name	Township	Range	Dir	Section	Subsection	Well Depth	Depth Completed	Date Well Completed
	117	22	W	12	CDCBDB	488 ft.	488 ft.	1967/06/00
Well Name	MINNETONKA 6			Lic. Or	Reg. No.	62012	Name of Driller	
USGS Quad	Hopkins	Elevation	915	Aquifer	CJDN	Alternative Id	79-6207	

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO	STRAT	LITH PRIM	LITH SEC	LITH MINOR
DRIFT			0	101	QUUU	DRFT		
QUUU = Unknown deposit type	DRFT = Drift							
LIMEROCK			101	117	OPVL	LMSN		
OPVL = Platteville	LMSN = Limestone							
SHALE			117	133	OGWD	SHLE		
OGWD = Glenwood	SHLE = Shale							
SANDROCK		SOFT	133	248	OSTP	SNDS		
OSTP = St.Peter	SNDS = Sandstone							
SHALE			248	261	OSTP	SHLE		
OSTP = St.Peter	SHLE = Shale							
SANDROCK		SOFT	261	310	OSTP	SNDS		
OSTP = St.Peter	SNDS = Sandstone							
SHAKOPEE BROKEN			310	322	OPDC	DLMT		
OPDC = Prairie Du Chien Group	DLMT = Dolomite							
SHAKOPEE SANDY			322	392	OPDC	DLMT		
OPDC = Prairie Du Chien Group	DLMT = Dolomite							
JORDAN		SOFT	392	435	CJDN	SNDS		
CJDN = Jordan	SNDS = Sandstone							
JORDAN SHALE			435	442	CJDN	SHLE		
CJDN = Jordan	SHLE = Shale							
JORDAN			442	486	CJDN	SNDS		
CJDN = Jordan	SNDS = Sandstone							
SHALE			486	488	CSTL	SHLE		
CSTL = St.Lawrence	SHLE = Shale							

Unique No. 00208012				MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD <i>Minnesota Statutes Chapter 1031</i>					Update Date 2005/06/22		
County Name Hennepin									Entry Date 1991/08/24		
Township Name		Township	Range	Dir	Section	Subsection	Well Depth		Depth Completed	Date Well Completed	
		117	22	W	12	CDCBCD	486	ft.	486	ft.	1967/07/00
Well Name		MINNETONKA 6A				Lic. Or	Reg. No.	62012	Name of Driller		
USGS Quad		Hopkins	Elevation	912	Aquifer		CJDN	Alternative Id		79-6207	

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO	STRAT	LITH PRIM	LITH SEC	LITH MINOR
DRIFT			0	104	QUUU	DRFT		
QUUU = Unknown deposit type	DRFT = Drift							
SHALE			104	112	OPVL	SHLE	LMSN	
OPVL = Platteville	SHLE = Shale				LMSN = Limestone			
LIMEROCK			112	121	OPVL	LMSN		
OPVL = Platteville	LMSN = Limestone							
SHALE			121	136	OGWD	SHLE		
OGWD = Glenwood	SHLE = Shale							
SANDROCK		SOFT	136	248	OSTP	SNDS		
OSTP = St.Peter	SNDS = Sandstone							
SHALE			248	261	OSTP	SHLE		
OSTP = St.Peter	SHLE = Shale							
SANDROCK			261	304	OSTP	SNDS		
OSTP = St.Peter	SNDS = Sandstone							
SHAKOPEE BROKEN			304	315	OPDC	DLMT		
OPDC = Prairie Du Chien Group	DLMT = Dolomite							
SHAKOPEE SANDY			315	392	OPDC	DLMT		
OPDC = Prairie Du Chien Group	DLMT = Dolomite							
JORDAN SANDROCK			392	485	CJDN	SNDS		
CJDN = Jordan	SNDS = Sandstone							
SHALE			485	486	CSTL	SHLE		
CSTL = St.Lawrence	SHLE = Shale							



"Djerrari, Amal (MDH)"
<Amal.Djerrari@state.mn.us>
05/10/2010 08:59 AM

To Erik Tomlinson <etomlinson@sehinc.com>
cc
bcc
Subject Jordan T

For Follow Up:  Normal Priority

History:  This message has been forwarded.

Hi Erik

Here is the aquifer test report for Minnetonka Well 7 (6A in the report). Although the report says that the aquifer is the Prairie du Chien/Jordan, in fact both wells (6 and 7) are open to the Jordan only. I think you could use this value for the Jordan.

I had a look at your minutes. They look good, except that you did not mention the calibration. You should look at how the model represents heads in observation wells at the regional level, but more importantly verify the calibration at the local level.

I checked also the refinement that Barr did. They used the refine grid command in GWV, using a spacing of 20 m as a base. You can do the same and use a 1.35 ratio for adjacent cells.

Let me know if you have any question.

Amal



mtka_aquifer_test.pdf

Appendix D

Model Files (CD)

Appendix E

GIS Shapefiles (CD)

Appendix F

Vulnerability Assessments



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #10

TIER: 2
WHP RANK:
UNIQUE WELL #: 00206442

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 8 QUARTERS: DCDB

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Prairie Du Chien-Jordan	
DNR Geologic Sensitivity Rating	Very low	0
L Score	0	
Geologic Data From	Well Record	
Year Constructed	1955	
Construction Method	Cable Tool/Bored	0
Casing Depth	316	5
Well Depth	500	
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?		0
Pumping Rate	800	10
Pathogen Detected?		0
Surface Water Characteristics?		0
Maximum nitrate detected	<.4 08/14/1991	0
Maximum tritium detected	Unknown	0
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	Unknown	0
Wellhead Protection Score		15
Wellhead Protection Vulnerability Rating		VULNERABLE
Vulnerability Overridden		Jim Walsh

COMMENTS

Very low rating is based on the presence of the Glenwood and St. Peter confining layers. Drift rating is L-2. VULNERABLE RATING BASED ON TRITIUM DATA FROM OTHER CITY WELLS.



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #11

TIER: 2
WHP RANK:
UNIQUE WELL #: 00206439

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 8 QUARTERS: DCDB

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Mt. Simon	
DNR Geologic Sensitivity Rating	Very low	0
L Score	14	
Geologic Data From	Well Record	
Year Constructed	1960	
Construction Method	Cable Tool/Bored	0
Casing Depth	880	0
Well Depth	1093	
Casing grouted into borehole?	Unknown	0
Cement grout between casings?	Unknown	5
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?		0
Pumping Rate	1000	10
Pathogen Detected?		NOT VULNERABLE
Surface Water Characteristics?		NOT VULNERABLE
Maximum nitrate detected	.1 01/15/1987	NOT VULNERABLE
Maximum tritium detected	<.8 07/23/2009	NOT VULNERABLE
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	A	-20
Wellhead Protection Score		-5
Wellhead Protection Vulnerability Rating		NOT VULNERABLE
Vulnerability Overridden		

COMMENTS



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #12

TIER: 2
WHP RANK:
UNIQUE WELL #: 00206456

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 21 QUARTERS: CDBD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Mt. Simon	
DNR Geologic Sensitivity Rating	Very low	0
L Score	12	
Geologic Data From	Well Record	
Year Constructed	1965	
Construction Method	Cable Tool/Bored	0
Casing Depth	900	0
Well Depth	1095	
Casing grouted into borehole?	Unknown	0
Cement grout between casings?	Unknown	5
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?		0
Pumping Rate	1000	10
Pathogen Detected?		NOT VULNERABLE
Surface Water Characteristics?		NOT VULNERABLE
Maximum nitrate detected	<.4 04/12/1990	NOT VULNERABLE
Maximum tritium detected	<.8 12/17/2009	NOT VULNERABLE
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	A	-20
Wellhead Protection Score		-5
Wellhead Protection Vulnerability Rating		NOT VULNERABLE
Vulnerability Overridden		

COMMENTS



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #13

TIER: 2
WHP RANK:
UNIQUE WELL #: 00206424

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 4 QUARTERS: CCDA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Mt. Simon	
DNR Geologic Sensitivity Rating	Very low	0
L Score	14	
Geologic Data From	Well Record	
Year Constructed	1964	
Construction Method	Cable Tool/Bored	0
Casing Depth	891	0
Well Depth	1045	
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?		0
Pumping Rate	1000	10
Pathogen Detected?		0
Surface Water Characteristics?		0
Maximum nitrate detected	<.4 04/12/1990	0
Maximum tritium detected	Unknown	0
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	A	-20
Wellhead Protection Score		-10
Wellhead Protection Vulnerability Rating		NOT VULNERABLE
Vulnerability Overridden		

COMMENTS



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #14

TIER: 2
WHP RANK:
UNIQUE WELL #: 00227965

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 4 QUARTERS: CCDA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Jordan	
DNR Geologic Sensitivity Rating	Low	20
L Score	1	
Geologic Data From	Data Inferred From Nearby Wells	
Year Constructed	1964	
Construction Method	Cable Tool/Bored	0
Casing Depth	389	5
Well Depth	485	
Casing grouted into borehole?	Yes	0
Cement grout between casings?	Yes	0
All casings extend to land surface?	No	10
Gravel - packed casings?	No	0
Wood or masonry casing?	No	0
Holes or cracks in casing?	Unknown	0
Isolation distance violations?		0
Pumping Rate	1000	10
Pathogen Detected?		0
Surface Water Characteristics?		0
Maximum nitrate detected	<.4 04/12/1990	0
Maximum tritium detected	10.1	VULNERABLE
Non-THMS VOCs detected?	cis-1,2-Dichloroethene 06/06/1992 Trichloroethene (TCE) 06/06/1992 trans-1,2-Dichloroethene 06/06/1992	VULNERABLE
Pesticides detected?		0
Carbon 14 age	M	0
Wellhead Protection Score		45
Wellhead Protection Vulnerability Rating		VULNERABLE
Vulnerability Overridden		

COMMENTS

L score is taken from the geologic log of city well # 13.



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #15

TIER: 2
WHP RANK:
UNIQUE WELL #: 00215447

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 8 QUARTERS: DCDB

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Jordan-St. Lawrence	
DNR Geologic Sensitivity Rating	Very low	0
L Score	0	
Geologic Data From	Data Inferred From Nearby Wells	
Year Constructed	1969	
Construction Method	Cable Tool/Bored	0
Casing Depth	402	0
Well Depth	503	
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?		0
Pumping Rate	1200	20
Pathogen Detected?		0
Surface Water Characteristics?		0
Maximum nitrate detected	<1 08/01/1975	0
Maximum tritium detected	Unknown	0
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	Unknown	0
Wellhead Protection Score		20
Wellhead Protection Vulnerability Rating		VULNERABLE
Vulnerability Overridden		Jim Walsh

COMMENTS

Very low rating is based on the presence of the Glenwood and St. Peter confining layers. VULNERABLE BASED ON TRITIUM DATA FROM OTHER CITY WELLS.



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #16

TIER: 2
WHP RANK:
UNIQUE WELL #: 00203187

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 7 QUARTERS: BBAA

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Jordan	
DNR Geologic Sensitivity Rating	Very low	0
L Score	0	
Geologic Data From	Well Record	
Year Constructed	1973	
Construction Method	Cable Tool/Bored	0
Casing Depth	425	0
Well Depth	500	
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?		0
Pumping Rate	1000	10
Pathogen Detected?		NOT VULNERABLE
Surface Water Characteristics?		NOT VULNERABLE
Maximum nitrate detected	.06 07/18/2006	NOT VULNERABLE
Maximum tritium detected	3 12/17/2009	VULNERABLE
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	Unknown	0
Wellhead Protection Score		10
Wellhead Protection Vulnerability Rating		VULNERABLE
Vulnerability Overridden		Jim Walsh

COMMENTS

Very low rating is based on the presence of the Glenwood and St. Peter confining layers. Drift score is L-2. VULNERABLE RATING BASED ON TRITIUM DATA FROM OTHER CITY WELLS.



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #3

TIER: 2
WHP RANK:
UNIQUE WELL #: 00206440

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 8 QUARTERS: DCDB

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	St. Peter	
DNR Geologic Sensitivity Rating	High	0
L Score	0	
Geologic Data From	Well Record	
Year Constructed	1939	
Construction Method	Cable Tool/Bored	0
Casing Depth	103	10
Well Depth	286	
Casing grouted into borehole?	Unknown	0
Cement grout between casings?	Unknown	5
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?		0
Pumping Rate	900	10
Pathogen Detected?		0
Surface Water Characteristics?		0
Maximum nitrate detected	<1 08/01/1975	0
Maximum tritium detected	1.3 07/23/2009	VULNERABLE
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	Unknown	0
Wellhead Protection Score		25
Wellhead Protection Vulnerability Rating		VULNERABLE
Vulnerability Overridden		

COMMENTS

High score is based on the well is cased only to the top of the Platteville and open hole into the St. Peter.



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #4

TIER: 2
WHP RANK:
UNIQUE WELL #: 00200542

COUNTY: Hennepin TOWNSHIP NUMBER: 28 RANGE: 24 W SECTION: 7 QUARTERS: BDAD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Prairie Du Chien-Jordan	
DNR Geologic Sensitivity Rating	Very low	0
L Score	0	
Geologic Data From	Well Record	
Year Constructed	1946	
Construction Method	Cable Tool/Bored	0
Casing Depth	304	5
Well Depth	503	
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?		0
Pumping Rate	900	10
Pathogen Detected?		0
Surface Water Characteristics?		0
Maximum nitrate detected	.31 04/16/2013	0
Maximum tritium detected	Unknown	0
Non-THMS VOCs detected?	Vinyl chloride 11/02/1996	VULNERABLE
Pesticides detected?		0
Carbon 14 age	Unknown	0
Wellhead Protection Score		15
Wellhead Protection Vulnerability Rating		VULNERABLE
Vulnerability Overridden		Jim Walsh

COMMENTS

Very low score is based on the presence of the Glenwood and basal St. Peter confining layers. VULNERABLE BASED ON TRITIUM DATA FROM OTHER CITY WELLS.



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #6

TIER: 2
WHP RANK:
UNIQUE WELL #: 00206457

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 21 W SECTION: 21 QUARTERS: CDBD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Prairie Du Chien-Jordan	
DNR Geologic Sensitivity Rating	Very low	0
L Score	1	
Geologic Data From	Well Record	
Year Constructed	1948	
Construction Method	Cable Tool/Bored	0
Casing Depth	303	5
Well Depth	482	
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?		0
Pumping Rate	1000	10
Pathogen Detected?		0
Surface Water Characteristics?		0
Maximum nitrate detected	<.4 04/12/1990	0
Maximum tritium detected	9.5 12/17/2009	VULNERABLE
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	Unknown	0
Wellhead Protection Score		15
Wellhead Protection Vulnerability Rating		VULNERABLE
Vulnerability Overridden		

COMMENTS

Very low rating is based on the presence of the Glenwood and basal St.Peter confining layers. Previous tritium result of 8.0 TU on 12/17/1991.



MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating



625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1270050
SYSTEM NAME: Saint Louis Park
WELL NAME: Well #8

TIER: 2
WHP RANK:
UNIQUE WELL #: 00203678

COUNTY: Hennepin TOWNSHIP NUMBER: 117 RANGE: 22 W SECTION: 1 QUARTERS: DACD

CRITERIA	DESCRIPTION	POINTS
Aquifer Name(s)	Prairie Du Chien-Jordan	
DNR Geologic Sensitivity Rating	Very low	10
L Score	10	
Geologic Data From	Well Record	
Year Constructed	1955	
Construction Method	Cable Tool/Bored	0
Casing Depth	314	5
Well Depth	507	
Casing grouted into borehole?	Unknown	0
Cement grout between casings?	Unknown	5
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?		0
Pumping Rate	1000	10
Pathogen Detected?		0
Surface Water Characteristics?		0
Maximum nitrate detected	<.4 04/12/1990	0
Maximum tritium detected	Unknown	0
Non-THMS VOCs detected?		0
Pesticides detected?		0
Carbon 14 age	Unknown	0
Wellhead Protection Score		30
Wellhead Protection Vulnerability Rating		NOT VULNERABLE
Vulnerability Overridden		

COMMENTS

Appendix G

Fracture Flow Calculations

Well 16			
Description	Inflow	Outflow	
Xmin	493.23	24.69	
Xmax	472.52	12.93	
Y top	626.81	10.18	
Y bottom	448.78	38.74	
Z top	612.24	0.00	
Z bottom	64.29	1.41	
Recharge	0.00	0.00	
ET	0.00	0.00	
Constant Head	0.00	0.00	
River	0.00	0.00	
Lake	0.00	0.00	
Drain	0.00	0.00	
GHB	0.00	0.00	
Well	490.81	3,121.63	2,630.82
Stream	0.00	0.00	
Storage	0.00	0.00	
TOTAL	3,208.68	3,209.58	
ERROR	-0.03		

% from OPDC 19.61% 23.27%

Well 14			
Description	Inflow	Outflow	
Xmin	893.37	0.00	
Xmax	407.01	269.95	
Y top	797.99	0.00	
Y bottom	603.26	180.10	
Z top	863.38	0.00	
Z bottom	65.98	0.91	
Recharge	0.00	0.00	
ET	0.00	0.00	
Constant Head	0.00	0.00	
River	0.00	0.00	
Lake	0.00	0.00	
Drain	0.00	0.00	
GHB	0.00	0.00	
Well	0.00	3,181.06	
Stream	0.00	0.00	
Storage	0.00	0.00	
TOTAL	3,631.00	3,632.02	
ERROR	-0.03		

% from OPDC 27.14%

Well# = 10
X = 470,979.000, Y = 4,977,506.000

5 Year Pumping Volume (1825 days)

Pumping Volume (Q):	2,938.50 m ³ /day	103,772.15 cu.ft./day	539.076 gal./min.	776,269.57 gal./day
Water Producing Zone Thickness (L):	36.271 m	119 ft.		
Effective Porosity (n):	0.056			
Original (Calculated) Radius:	916.736 m	3,007.67 ft.		

1st Bearing from Well = 310° from North.

2nd Bearing from Well = 320° from North.

Well# = 4
X = 473,203.000, Y = 4,975,132.000

5 Year Pumping Volume (1825 days)

Pumping Volume (Q):	5,061.00 m ³ /day	178,727.53 cu.ft./day	928.455 gal./min.	1,336,974.75 gal./day
Water Producing Zone Thickness (L):	36.881 m	121 ft.		
Effective Porosity (n):	0.056			
Original (Calculated) Radius:	1,193.11 m	3,914.40 ft.		

1st Bearing from Well = 310° from North.

2nd Bearing from Well = 320° from North.

Well# = 8
X = 468,215.000, Y = 4,979,510.000

5 Year Pumping Volume (1825 days)

Pumping Volume (Q):	5,465.70 m ³ /day	193,019.37 cu.ft./day	1,002.70 gal./min.	1,443,885.18 gal./day
Water Producing Zone Thickness (L):	33.528 m	110 ft.		
Effective Porosity (n):	0.056			
Original (Calculated) Radius:	1,300.41 m	4,266.45 ft.		

1st Bearing from Well = 315° from North.

2nd Bearing from Well = 325° from North.

Well# = 14
X = 471,881.000, Y = 4,979,130.000

5 Year Pumping Volume (1825 days)

Pumping Volume (Q):	863.4 m ³ /day	30,490.68 cu.ft./day	158.393 gal./min.	228,086.15 gal./day
Water Producing Zone Thickness (L):	33.528 m	110 ft.		
Effective Porosity (n):	0.056			
Original (Calculated) Radius:	516.85 m	1,695.70 ft.		

1st Bearing from Well = 300° from North.

2nd Bearing from Well = 310° from North.

Unique Well# = 8
X = 468,215.000, Y = 4,979,510.000

5 Year Pumping Volume (1825 days)

Pumping Volume (Q):	5,465.70 m ³ /day	193,019.37 cu.ft./day	1,002.70 gal./min.	1,443,885.18 gal./day
Water Producing Zone Thickness (L):	33.528 m	110 ft.		
Effective Porosity (n):	0.056			
Original (Calculated) Radius:	1,300.41 m	4,266.45 ft.		
New Radius:	1,358.89 m	4,458.29 ft.		

Unique Well# = 16
X = 468,730.000, Y = 4,978,917.000

5 Year Pumping Volume (1825 days)

Pumping Volume (Q):	612.24 m ³ /day	21,621.05 cu.ft./day	112.317 gal./min.	161,736.70 gal./day
Water Producing Zone Thickness (L):	40.843 m	134 ft.		
Effective Porosity (n):	0.056			
Original (Calculated) Radius:	394.333 m	1,293.74 ft.		
New Radius:	394.333 m	1,293.74 ft.		

OVERLAP SUMMARY INFORMATION

Original (Calculated) Area for Well# :	5,312,671.94 m ²	57,185,069.44 sq.ft.
New Area for Well# :	5,801,185.69 m ²	62,443,382.63 sq.ft.

Original (Calculated) Area for Well# :	488,513.75 m ²	5,258,313.19 sq.ft.
New Area for Well# :	488,513.75 m ²	5,258,313.19 sq.ft.

Overlap Area to Well# :	488,513.75 m ²	5,258,313.19 sq.ft.
Overlap Area to Well# :	0 m ²	0 sq.ft.
Total Overlap Area:	488,513.75 m ²	5,258,313.19 sq.ft.

UP-GRADIENT EXTENSION (UGE)
(area beyond the New Areas of both Wells)
(area beyond the New Areas of both Wells)
Bearing from Well# = 320° from North +/- 10°.
Bearing from Well# = 320° from North +/- 10°.
Up-Gradient Extension Area:

7,115,784.19 m ²	76,593,589.40 sq.ft.
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