

WATER PERMIT NO. 8433-3

Name of Applicant: City of Lake Norden

Address: PO Box 213, Lake Norden SD

Phone: 605 758-3602

Amount of Water Claimed: 2.11 cfs (1,458 AF)

Total Acres: NA

Source of Water Supply: groundwater (3 wells)

Water to be used for: municipal

County: Hamlin

Type of Waste Disposal System:

Location: east side of Lake Norden

PRIORITY

Date Received: 6-29-20

Application/License Fee: \$ 2050

Corrected Application Received:

Period of Annual Use: January 1 – December 31

Remarks:

Diversion Point: SW 1/4 Sec 15-T113N-R53W

Land to be Irrigated:

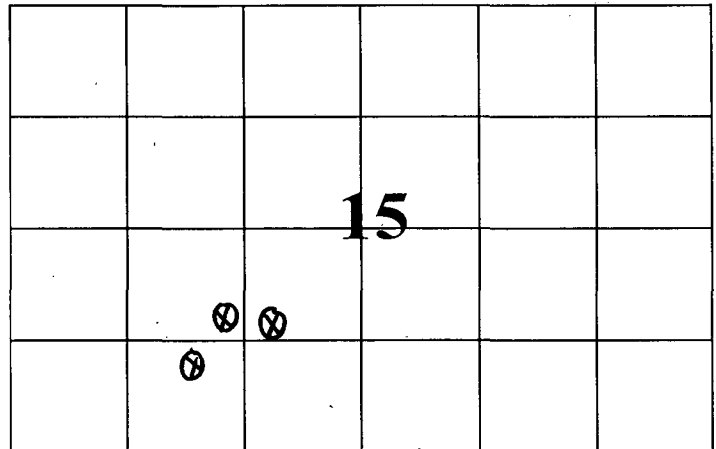
Depth of Well: 97 to 114 feet deep

Well Driller:

Remarks:

Type of Map: aerial

Prepared by:



Reviewed and the Number Assigned on: 6-29-20

By: **Karen Schlaak**

Notice of Hearing - date to intervene: _____

**SOUTH DAKOTA
WATER PERMIT NO. 8433-3**

Date of first receipt of application June 30, 2020.

Date of deferral by Water Management Board October 7, 2020.

The Water Management Board approved Water Permit No. 8433-3 on July 7, 2021 for the City of Lake Norden, Jason Aho, Mayor, PO Box 213, Lake Norden SD 57248 authorizing the construction of the water use system and the placing of water to beneficial use subject to the following limitations, conditions and qualifications:

1. Water Permit No. 8433-3 appropriates 967 acre-feet of water annually at a maximum pump rate of 1.34 cubic feet of water per second from three wells completed into the Prairie Coteau Aquifer (97-114 feet deep) located in the SW 1/4 Section 15-T113N-R53W. This site is located one mile east of the city of Lake Norden.
2. The water appropriated shall be used for the purpose of municipal use and may not exceed the amount of water needed for beneficial use.
3. The water is to be used during the following described annual period: January 1 – December 31.
4. The date from which applicant may claim right is June 30, 2020.
5. Water rights obtained in compliance with the laws of the State of South Dakota may not be unlawfully impaired by this appropriation.

QUALIFICATIONS

1. The wells approved under Water Permit No. 8433-3 will be located near domestic wells and other wells which may obtain water from the same aquifer. Water withdrawals under this Permit shall be controlled so there is not a reduction of needed water supplies in adequate domestic wells or in adequate wells having prior water rights.
2. The permit holder shall report to the Chief Engineer annually the amount of water withdrawn from the Prairie Coteau aquifer.
3. Water Permit No. 8433-3 authorizes a total annual diversion not exceeding 967 acre-feet of water annually from the Prairie Coteau aquifer.

WATER MANAGEMENT BOARD

By: Eric Gronlund
Eric Gronlund, Chief Engineer
Water Rights Program
Department of Agriculture and Natural Resources

JUL 13 2021

date



RECEIVED

JUN 30 2020

SD EForm - 1585LD V5

FORM 2: Application for uses other than irrigation
(type or print)WATER RIGHTS
PROGRAM

Mail to:

DENR - Water Rights
523 E Capitol Ave
Pierre, SD 57501-3182
ph. (605) 773-3352No. 8433-3 (office use only)
Hydrologic Unit 10170201Basin Sioux RiverNewspaper Hamlin Co. Herald EnterprisePublic Opinion

PAID

JUN 30 2020

Ck# 023698

Application For Permit To Appropriate Water Within The State Of South Dakota

Check use(s) of water:



Municipal



Water Distribution System



Recreational



Institutional



Rural Water System



Commercial



Fish & Wildlife



Geothermal



Domestic (over 18 gpm)



Industrial



Other

Type of Application:

(check one)



New



Vested Right (Use predates Mar 2, 1955)



Future Use Reservation



Place to Beneficial Use Water Reserved by Future Use Permit No. _____



Amendment/Correction to Permit No. _____

Description of amendment/correction: (i.e. change diversion point(s), add diversion point(s), change use, etc.)

_____1. Name to Appear on Water Permit City of Lake NordenMailing Address PO Box 213

(Address)

Lake Norden

(City)

SD

(State)

57248

(Zip Code)

Phone 605-758-3602

Mobile _____

Email cityln@itctel.com2. Amount of water claimed 1.34 *CFS or 950 **GPM and 467 ***AF or 475M Gallons
Flow rate and volume are both required. (*Cubic Feet per Second) (**Gallons per Minute) (***)Acre Feet - storage capacity of dam/dugout or annual use)3. Source of water supply Ground Water - 3 wells4. Location of point of diversion SW 1/4 section 15-T113N-R53W (see map for detail) County Hamlin

(example - 3 wells in SW1/4 NE1/4 section 12-T104N-R53W)

If not a public water supply (e.g. municipal), will water be used outside of the area described above? ☐ Yes ☐ No

If "Yes," where will water be used? _____

(example - NW1/4 section 12-T104N-R53W)

5. County or counties where water will be used Hamlin6. Annual period during which water is to be used Year round

7. Give a description of the project. When available include any preliminary engineering report or other reports or information that will help explain the project. (Attach sheet if more space is needed)

The City of Lake Norden's Water Treatment Facility houses three filters with design capacity of 950 gpm at a filtration loading rate of 3 fps. Due to high iron and manganese raw water quality from the current well field, the plant operates well at 600gpm. Iron and manganese breakthrough is seen at filtration rates higher than this, reducing the treated raw water quality supplied to customers. The City is planning to add 3 new raw water wells to increase quantity and to improve raw water quality of the treated water to meet demand increases from Agropur industry and expected growth. SEE ADDTL ATTACHED.

I, [Signature] Mayor, the applicant, certify under
Name of Person Title (if applicable)

penalty of perjury that I have read this application, examined the attached map, and that the matters stated are true. I further certify, if acting on behalf of an entity or individual other than myself, that I am authorized to submit this application.

2015-10

Attachments: Attach Form 2A if diversion is from a well or dugout, or if storage of water is proposed. Also, attach map and any other technical information. (see instructions)

Supplemental Information

(type or print)

1. Well Information (check one or both as applicable) ☒ Drilling new well(s) ☐ Using existing well(s)a) If new wells, how many 3 Have test holes been drilled ☒ Yes ☐ No Drilled by Kaiser Well Drilling
(if yes, please provide copies of logs)b) If existing wells, how many Provide copy of log(s), if available. Drilled by

For either Existing or Proposed Wells:

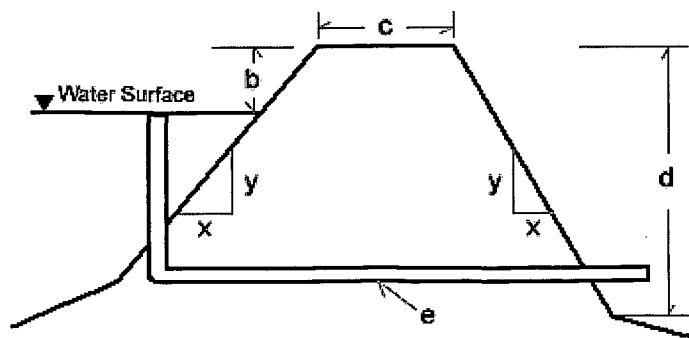
c) Well Depth (required) Depth to Top of Water Bearing Material Depth to Water from Surface d) Distance to nearest domestic well on applicant's property none Property owned by others to purchase**2. Wastewater Disposal System Information**a) Type of System (i.e. septic tank, drain field) Industrial Wastewater Treatment Facility (primarily)b) System Capacity (gallons) 2,000,000 Year Constructed 2004,2018c) Connected to the City of -stand alone- Sanitary System**3. Dugout Information**a) Surface Dimensions Depth b) Depth to water (ground surface to water level) **4. Water Storage Dams**

If the proposed water use system contains one or more storage dams, please furnish the information requested below for each dam. The locations of the dams need to be shown on the map submitted with the application.

a) If a private engineering firm or government agency was involved in the design of this dam, please give their name and address:

b) Freeboard c) Crest Width Crest Length d) Height e) Primary Outlet Capacity If pipe, diameter f) Secondary Spillway Capacity Spillway Width

g) X & Y Slope (e.g. 3 to 1 is a typical slope)

Upstream Downstream h) Surface Area of Impoundment i) Storage Acre Feetj) Drainage Area Above Dam Acres



PROJECT / SHEET TITLE	WELL LOCATION MAP SHOWING WELLS IN THE SW 1/4 OF SECTION 15, TOWNSHIP 113 NORTH, RANGE 53 WEST, OF THE 5TH PM, HAMLIN COUNTY, SOUTH DAKOTA
DATE	2/2/2010
DESIGNED BY	BMG
CHECKED BY	BMG
DRAWN BY	CAN
DATE	2/2/2010
SHEET No.	1

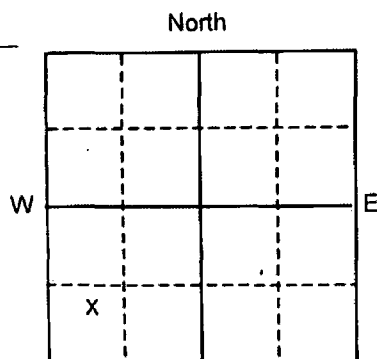
REV	DATE	DESCRIPTION

BANNER
engineering a better community
www.bannerassociates.com - Toll Free: 1.855.323.8342

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53W

County HAMLIN

Please mark well location with an "X"



Well Completion Date

10-1-2018

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?

 ft. from (identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40.0 LB/FT	10.00 IN	0.0 FT	83.0 FT	16.00 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWELDF	32	54.0 Lb/gal	0.0 Ft	80.0 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

SCREEN:

☐ Perforated pipe ☒ Manufactured

Diameter 10.00 Inches Length 20.0 Feet

Material SS

Slot Size .30 Set From 83.0 Feet to 97.0 Feet

Other information

WAS A PACKER OR SEAL USED? ☐ Yes ☒ No

If so, what material?

Describe packer(s) and location

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How?

☐ No, Why Not?

Lab to which water quality sample sent for analysis

Well Owner: CITY OF LAKE NORDEN

Business Name: City well # JL#1

Address: PO BOX 213

City, State, Zip: LAKE NORDEN SD 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
YELLOW MIXED SAND fine-med	2	18
BLUE CLAY	18	24
GREY FINE SAND	24	29
BLUE CLAY soft	29	35
GREY MED-COURSE	35	57
BLUE CLAY SOFT	57	83
YELLOW MED-COURSE	83	97

STATIC WATER LEVEL FEET

If flowing: closed in pressure PSI

GPM flow 40 through 10 Inch pipe

Controlled by ☒ Valve ☐ Reducers ☐ Other

Reduced flow rate GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe:

☐ Bailed

☐ Other

Pumping Level Below Land Surface

 Ft. After Hrs. pumped GPM

 Ft. After Hrs. pumped GPM

If pump installed, pump rate: GPM

REMARKS JL#1

well on west side of Pelican Pass

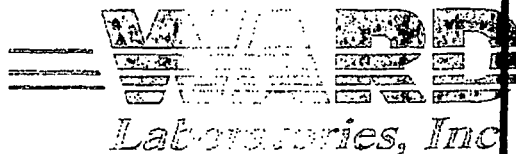
This well was drilled under license # 689 and this report is true and accurate.

Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder:

Date:



Ag Testing - Consulting

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN SD 57248

Invoice No. : 1273100
Date Received : 10/05/2018
Date Reported : 10/08/2018

Lab Number : 22444

Results For : CITY OF LAKE NORDEN

Location : PELICAN PASS WEST SIDE

Sample ID : WELL #2 (Indicated as WELL No. L1 on Map)

pH	8.0	
Electrical Conductivity, mmho/cm	1.81	
Cations / Anions, me/L	22.3 / 20.9	
	ppm	lbs / Acre 9 inch
Sodium, Na	47	94
Molybdenum, Mo	0.01	< 0.02
Potassium, K	6	12
Calcium, Ca	264	528
Magnesium, Mg	83	166
Total Hardness, CaCO ₃	1006	2012
Nitrate, NO ₃ -N	< 0.1	< 0.2
Sulfate, SO ₄ -S	228	456
Chloride, Cl	5	10
Carbonate, CO ₃	< 1.0	< 2
Bicarbonate, HCO ₃	396	792
Total Alkalinity, CaCO ₃	328	650
Boron, B	0.22	0.44
Total Nitrogen, N	0.3	
Ammonium, NH ₄ -N	0.1	0.2
Total Phosphorus, P	0.05	0.10
Zinc, Zn	0.07	0.14
Total Iron, Fe	0.03	0.06
Manganese, Mn	0.22	0.44
Copper, Cu	0.01	0.02

<" - Not Detected / Below Detection Limit

Reviewed By : Nick Ward

10/10/2018

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 Fax: 308-234-1940

web site
www.wardlab.com

4007 Cherry Ave., P.O. Box 788
 Kearney, Nebraska 68848-0788

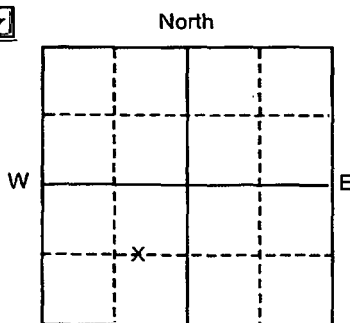
SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53W

County HAMLIN ☒

Please mark well location with an "X"



Well Completion Date

5-8-2018

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock Irrigation ☒ Municipal Industrial ☐ Business Institutional ☐ Test holes Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
<u>sch40</u> LB/FT	<u>10</u> IN	<u>+2</u> FT	<u>83</u> FT	<u>16 3/4</u> IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
<u>GrtweIDF</u>	<u>30</u>	<u>54</u> Lb/gal	<u>0</u> Ft	<u>80</u> Ft
		Lb/gal	Ft	Ft

Describe grouting procedure _____

SCREEN:

☐ Perforated pipe ☒ Manufactured

Diameter 10 Inches Length 20 Feet

Material Stainless Steel

Slot Size 30 Set From 83 Feet to 103 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☒ Yes, How? HTH

☐ No, Why Not? _____

Lab to which water quality sample sent for analysis

SDPHL

Well Owner: City of Lake Norden

Business Name: City well # JL #2

Address: PO Box 213

City, State, Zip: Lake Norden ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	1
YELLOW SANDYCLAY	1	3
YELLOW SAND	3	8
YELLOW CLAY	8	10
YELLOW SAND	10	13
BLUE CLAY	13	34
YELLOW CLAY	34	85
GREY SAND FINE	85	103
BLUE CLAY	103	

STATIC WATER LEVEL 5 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ Pumped Describe: SUBMERSIBLE

☐ Bailed

☐ Other _____

Pumping Level Below Land Surface

51.7 Ft. After 26 Hrs. pumped 500 GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

well #1 east side of Pelican Pass

JL #2

This well was drilled under license # 689 and this report is true and accurate.

Drilling firm: Kaiser Well Drilling Inc.

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

Date: _____



Ag Testing - Consulting

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN SD 57248

Invoice No. : 1255969
Date Received : 02/05/2018
Date Reported : 02/06/2018

Lab Number : 914

Results For : CITY OF LAKE NORDEN

Location :

Sample ID : JON LARSON PELICAN PASS
(Indicated as WELL No. L2 on Map)

pH	7.8
Total Dissolved Solids (TDS) Est, ppm	1054
Electrical Conductivity, mmho/cm	1.76
Cations / Anions, me/L	23.5 / 22.0

	ppm
Sodium, Na	44
Potassium, K	6
Calcium, Ca	271
Magnesium, Mg	94
Total Hardness, CaCO ₃	1069
Nitrate, NO ₃ -N	< 0.1 (SAFE)
Sulfate, SO ₄ -S	252
Chloride, Cl	5
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	372
Total Alkalinity, CaCO ₃	307
Fluoride, F	0.32
Total Phosphorus, P	0.01
Total Iron, Fe	0.02
Manganese, Mn	< 0.01

< - Not Detected / Below Detection Limit

Reviewed By : Nick Ward

2/7/2018

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web site

4007 Cherry Ave., P.O. Box 788
Kearney, Nebraska 68649-0788

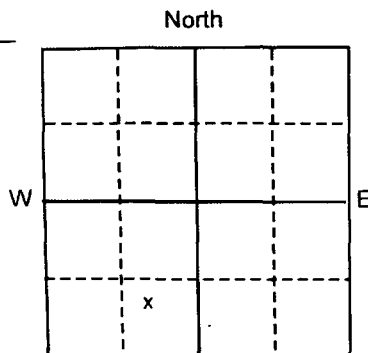
SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53W

County HAMLIN

Please mark well location with an "X"



Well Completion Date

10-17-2018

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:
DIRECT ROTARY

CASING DATA: ☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40.0 LB/FT	10.00 IN	0.0 FT	87.0 FT	16.00 IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWELDF	32	54.0 Lb/gal	0.0 Ft	84.0 Ft
_____	_____	_____ Lb/gal	_____ Ft	_____ Ft

Describe grouting procedure
pressure pull method

SCREEN: ☐ Perforated pipe ☒ Manufactured

Diameter 10.00 Inches Length 20.0 Feet

Material SS

Slot Size .30 Set From 87.0 Feet to 107.0 Feet

Other information _____

WAS A PACKER OR SEAL USED? ☐ Yes ☒ No

If so, what material? _____
Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____
☐ No, Why Not? _____

Lab to which water quality sample sent for analysis _____

Well Owner: CITY OF LAKE NORDEN

Business Name: City well # JL #3

Address: PO BOX 213

City, State, Zip: LAKE NORDEN SD 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
SAND MIXED	2	18
GRAVEL MED-COURSE	18	20
BLUE CLAY	20	40
YELLOW CLAY	40	78
BLUE CLAY	78	87
SAND MED-FINE	87	101

STATIC WATER LEVEL 8 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe: 300 GPM - Sub. Pump
☐ Bailed
☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS JL #3

2nd well East side Pelican Pass

This well was drilled under license # 689 and this report is true and accurate.

Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

Date: _____



Ag Testing - Consulting

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN SD 57248

Invoice No. : 1268594
Date Received : 08/17/2018
Date Reported : 08/20/2018
Lab Number : 14586

Results For : CITY OF LAKE NORDEN

Location :

Sample ID : PELICAN PASS TW#2

(Indicated as WELL No. L3 on Map)

pH	7.6
Total Dissolved Solids (TDS) Est, ppm	1024
Electrical Conductivity, mmho/cm	1.71
Cations / Anions, me/L	22.9 / 21.6

	ppm
Sodium, Na	45
Potassium, K	6
Calcium, Ca	257
Magnesium, Mg	95
Total Hardness, CaCO ₃	1038
Nitrate, NO ₃ -N	< 0.1 (SAFE)
Sulfate, SO ₄ -S	233
Chloride, Cl	5
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	420
Total Alkalinity, CaCO ₃	345
Fluoride, F	0.26
Total Phosphorus, P	0.03
Total Iron, Fe	< 0.01
Manganese, Mn	0.05

"<" - Not Detected / Below Detection Limit

Reviewed By : Raymond Ward

8/21/2018

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web site
www.wardlab.com

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Kearney, Nebraska 68848-0788

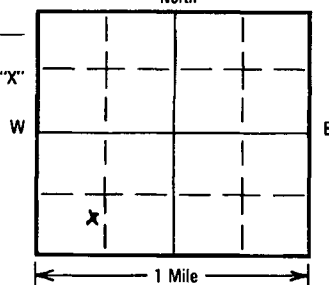
Location SW 1/4 SW 1/4 Sec 15 Twp 53W Rg 119N

County

Hazlin

North

Please mark well location with an "X"

Well Completion Date 7-26-94

LOCATION:

Distance from nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)? 150 ft. from Septic System (identify source).

PROPOSED USE:

☒ Domestic/Stock ☐ Municipal ☐ Business ☐ Test Holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

Mud Rotary

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
<u>SPR2</u> LB/FT	<u>5</u> IN	<u>0</u> FT	<u>99 1/2</u> FT	<u>7 7/8</u> IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA

Grout Type	No. of Sacks	Grout Weight	From	To
<u>Cement</u>	<u>14</u>	_____ lb./gal	<u>7</u> ft	<u>80</u> ft
_____	_____	_____ lb./gal	_____ ft	_____ ft

Describe grouting procedure _____

SCREEN: ☐ Perforated pipe ☒ ManufacturedDiameter 5 IN Length 10 1/2 FEETMaterial PLASTICSlot Size .040 Set From 99 1/2 Feet to 110 Feet

Other information _____

WAS A PACKER OR SEAL USED? ☐ YES ☒ NO

If so, what material? _____

Describe packer(s) and location? _____

DISINFECTION:

Was well disinfected upon completion? ☒ YES, How:

NO, Why Not? Chlorine
circulated before
+ during Gravel
packing

Laboratory sent to for water quality analysis _____

Well Owner: John Larson

Business Name: _____

Address: 4701 Alpine Circle
Sioux Falls, S.D. 57103

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
Top Soil	0	2
Course yellow sand	2	10
Brownish yellow clay	10	19 1/2
yellow + Gray Course sand		
+ Gravel w/ clay lenses	19 1/2	26
Blue Clay (Firm)	26	31 1/2
Course Gray sand + Gravel	31 1/2	36 1/2
Blue Clay Firm	36 1/2	42
Soft Blue Clay (Sediment)	42	47
Blue Clay (Firm)	47	50
yellow Clay (Firm)	50	58
yellow Clay (Sandy)	58	93
Red + Black Course sand		
+ Gravel	93	100
Red + Black sand (med)		
Some Gravel	100	110
Yellow Clay Firm	110	114

STATIC WATER LEVEL 36 Feet

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced Flowrate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☐ PumpedDescribe: Developed w/☐ BailedAir Good☐ Other _____

Pumping Level Below Land Surface

_____ ft. After _____ Hrs. pumped _____ GPM

_____ ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate _____ GPM

REMARKS

This well was drilled under license # 4

And this report is true and accurate.

Drilling firm Bullis Bros

Signature of License Representative:

Se Roy Bullis

Signature of Well Owner or Equitable Property Holder:

John LarsonDate: 7-26-947/8/95

Reference Well Quality:



Ag Testing - Consulting

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN SD 57248

Invoice No. : 1255532
Date Received : 01/29/2018
Date Reported : 01/30/2018

Lab Number : 753

Results For : CITY OF LAKE NORDEN-JON LARSON

Location : EXISTING WELL

Sample ID : 19293 PELICAN PASS DR

pH	7.4	
Total Dissolved Solids (TDS) Est, ppm	1076	
Electrical Conductivity, mmho/cm	1.79	
Cations / Anions, me/L	23.9 / 22.9	
	ppm	lbs / Acr 9 inch
Sodium, Na	47	94
Potassium, K	6	12
Calcium, Ca	272	544
Magnesium, Mg	98	196
Total Hardness, CaCO ₃	1088	2176
Nitrate, NO ₃ -N	< 0.1	< 0.2
Sulfate, SO ₄ -S	253	506
Chloride, Cl	5	10
Carbonate, CO ₃	< 1.0	< 2
Bicarbonate, HCO ₃	422	844
Total Alkalinity, CaCO ₃	347	692
Fluoride, F	0.33	0.6
Total Phosphorus, P	0.07	0.14
Total Iron, Fe	< 0.01	< 0.02
Manganese, Mn	0.19	0.38

< - Not Detected / Below Detection Limit

Reviewed By : Nick Ward

1/31/2018

Copy : 1

Page 1 of 1

Bus: 308-234-2418

web site

4007 Cherry Ave., P.O. Box 788
Kearney, Nebraska 68848-0788

Schlaak, Karen

From: Erin Steever <erins@bannerassociates.com>
Sent: Monday, June 29, 2020 9:10 AM
To: Gronlund, Eric
Cc: Gregg Jorgenson; City of Lake Norden; Schlaak, Karen
Subject: RE: [EXT] Lake Norden Water Permit

Yes, that is correct, Eric.

Erin Steever | Project Manager
Banner Associates, Inc. | Sioux Falls, SD
Toll Free | 1.855.323.6342
www.bannerassociates.com

From: Gronlund, Eric <Eric.Gronlund@state.sd.us>
Sent: Monday, June 29, 2020 9:05 AM
To: Erin Steever <erins@bannerassociates.com>
Cc: Gregg Jorgenson <greggj@bannerassociates.com>; City of Lake Norden <cityln@itctel.com>; Schlaak, Karen <Karen.Schlaak@state.sd.us>
Subject: RE: Lake Norden Water Permit

The application/license filing fee is \$2,050.]

Will an original application signed by the Mayor be sent along with the application filing fee?

Eric

From: Erin Steever <erins@bannerassociates.com>
Sent: Saturday, June 27, 2020 6:07 PM
To: Gronlund, Eric <Eric.Gronlund@state.sd.us>
Cc: Gregg Jorgenson <greggj@bannerassociates.com>; City of Lake Norden <cityln@itctel.com>
Subject: RE: [EXT] Lake Norden Water Permit

Eric,

As advised, I've added well logs and information on the existing wells to the attached applications.

I spoke with John Kaiser, the well driller for the project, and he said that the new wells had yellow clay and were deeper than the existing wells (which had gray clay and were shallower) so he figures they were in the Prairie Coteau and not the Brookings Management of the Big Sioux Aquifer. He suggested that Adam should be able to tell. I downloaded the existing wells' well logs from the DENR website; if we find additional ones I'll forward them on. There are two well logs from other companies in the attached and the rest are from Kaiser.

Please let me know if there is anything else I can provide.

Thank you,
Erin

Erin Steever | Project Manager

Banner Associates, Inc. | Sioux Falls, SD
Toll Free | 1.855.323.6342
www.bannerassociates.com

From: Erin Steever
Sent: Friday, June 26, 2020 3:28 PM
To: Gronlund, Eric <Eric.Gronlund@state.sd.us>
Cc: Gregg Jorgenson <greggi@bannerassociates.com>; City of Lake Norden <cityln@itctel.com>
Subject: Lake Norden Water Permit

Eric,

Per your discussion with Gregg this afternoon, please see two water permit applications attached. The first is for a temporary diversion of water rights from the existing wellfield, the second is for a permanent addition of water rights for the City of Lake Norden.

We will have the City send the application fee as soon as possible along with printed copies.

Your assistance in expediting this process is appreciated. Please let us know if there are any questions.

Thank you,
Erin

Erin Steever, PE | Project Manager



Banner Associates, Inc.
2307 West 57th Street, Suite 102
Sioux Falls, South Dakota 57108
Toll Free | 1.855.323.6342
www.bannerassociates.com



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RECEIPT

WATER RIGHTS PROGRAM South Dakota Department of Environment and Natural Resources

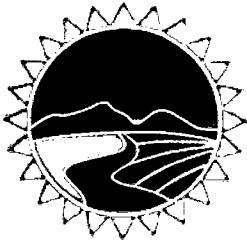
Date June 30, 2020

RECEIVED OF City of Lake Norden PO Box 213 Lake Norden SD 57248

The following amount in fees for services rendered as provided for by law:

Fee for Application for Permit No. <u>8434-3</u> to Appropriate Water, to construct and to put water to beneficial use	\$1850.00
Fee for Application for Permit No. _____ to Appropriate Water for Future use	\$
Fee to retain Future Use Permit No. _____ after period of seven years.	\$
Fee for Inspecting Constructed Works, confirming beneficial use and issuing Water License No. <u>8434-3</u>	\$200.00
Fee for Filing Transfer Form _____	\$
Fee for _____	\$
Fee for Issuing New Well Driller's License No. _____	\$
Fee for Renewal of Well Driller's License No. _____	\$
Fee for Issuing Well Pump Installer's License No. _____	\$
Fee for Renewal of Well Pump Installer's License No. _____	\$
(Any Other Work Provided by Law)	
TOTAL	\$2050.00

By Eric Gronlund
Chief Engineer me



DENR
SOUTH DAKOTA

**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3182
denr.sd.gov

**RECOMMENDATION OF CHIEF ENGINEER FOR WATER PERMIT
APPLICATION NO. 8433-3, City of Lake Norden**

Pursuant to SDCL 46-2A-2, the following is the recommendation of the Chief Engineer, Water Rights Program, Department of Environment and Natural Resources concerning Water Permit Application No. 8433-3, City of Lake Norden, Mayor Jason Aho, PO Box 213, Lake Norden SD 57248.

The Chief Engineer is recommending DEFERRAL of Application No. 8433-3 for further study pursuant to SDCL 46-2A-2 and 46-2A-7. The deferral recommendation is so the city of Lake Norden can provide information to assist with determining if there is unappropriated water available and the potential effect of pumping on existing water users. These criteria need to be addressed as required by SDCL 46-2A-9 to determine whether a water right permit may be issued. The further study needed entails further delineation of either the aquifer boundaries or a 7-day aquifer performance test, or both.

Eric Gronlund

Eric Gronlund, Chief Engineer
July 21, 2020

NOTE: From past experience, it has been useful for the applicant or their consultant to consult with the Water Right Program regarding requirements for a suitable aquifer performance test. To discuss the requirements and recommendations for an aquifer performance test, please contact Adam Mathiowetz at (605) 773-3352.

REPORT TO THE CHIEF ENGINEER
ON
WATER PERMIT APPLICATION NO. 8433-3
CITY OF LAKE NORDEN
NOVEMBER 19, 2020

Water Permit Application No. 8433-3 proposes to appropriate 1,458 acre-feet of water annually (ac-ft/yr) at a maximum instantaneous diversion rate of 2.11 cubic feet of water per second (cfs) from three wells completed into the Prairie Coteau aquifer (97-114 feet deep) located in the SW ¼ Sec.15-T113N-R53W for municipal use. The well locations are approximately one mile east of the City of Lake Norden in Hamlin County.

This application was received by the DENR-Water Rights Program on June 29, 2020. An initial review of the application determined further study was needed to assess the availability of unappropriated water. The Chief Engineer recommended deferral on July 21, 2020 until the October 2020 meeting of the Water Management Board. A constant pump rate aquifer performance test was designed by Banner Associates, Inc. to determine aquifer characteristics using recommendations and requirements provided by the DENR-Water Rights Program. The aquifer performance test was conducted from August 6 to August 21, 2020, with continued monitoring as required in the Temporary Permit To Use Public Waters issued by the Chief Engineer on July 27, 2020. At the October 7, 2020 Water Management Board meeting the application was deferred to the December 2020 meeting so that the analysis of the Banner Associates, Inc. report and application review could be completed by DENR staff.

AQUIFER: Prairie Coteau (PCO)

Aquifer Characteristics:

The Prairie Coteau aquifer consists of many discontinuous and often lenticular bodies of glacial outwash (sand and gravel) that do not typically include surficial (at or very near land surface) or basal (in contact with or very near bedrock) aquifers, such as the Big Sioux and Altamont aquifers, respectively (Kume, 1985). The Prairie Coteau aquifer is the name used by the DENR-Water Rights Program and accepted by the Water Management Board for discontinuous intermediate aquifers located on the Coteau des Prairies in northeastern South Dakota that are not a part of another named aquifer (Water Rights, 2020b, 2020c, and 2020d). These discontinuous outwash deposits can be in lenses separated by layers of glacial till (vertical separation) as well as being geographically separated (SDGS, 2020a; Water Rights, 2020d). In Deuel and Hamlin Counties, the Prairie Coteau aquifer is generally buried by 30 feet or more of glacial till and underlies approximately 1,100 square miles in discontinuous deposits. The aggregate thickness, total thickness of all layered Prairie Coteau aquifer deposits regardless of hydrologic connection, at any geographical location ranges from 4 to 144 feet in Deuel and Hamlin Counties (Kume, 1985).

The wells completed for this application and the subsequent monitoring wells are completed into a portion of the Prairie Coteau aquifer with an approximate elevation range of 1,560 to 1,580 feet above mean sea level (Water Rights, 2020c). The well completion reports indicate aquifer thickness ranging from 14 to 19 feet. The aquifer materials encountered during the drilling of the three pumping wells and two monitoring wells was fine to coarse sand ranging in color from yellow

to grey as labeled by the well driller. While not directly noted on the well completion reports, lithologic logs (SDGS, 2020a), and well completion reports (Water Rights, 2020d) in the area, as well as the drawdown data from the aquifer performance test (Banner Associates, 2020), the available data indicates there is also likely more fine sand or possibly silt intermixed into the sand that comprises the aquifer as labeled on the well completion reports. The aquifer is under confined conditions with a static water level ranging from flowing at well L1 to approximately 8.3 feet below ground surface at monitoring well NMW (see Figure 1) (Water Rights, 2020c).

AQUIFER PERFORMANCE TEST

TECHNIQUE AND METHODOLOGY REVIEW

An aquifer performance test was conducted and analyzed by engineering firm Banner Associates, Inc. (Banner) using wells L1 and L2 as production (pumping) wells and wells L3, NMW and EMW used as monitoring wells for the Prairie Coteau aquifer. These are the well names shown in Figure 1 and used throughout the Banner Associates (2020) report and the remainder of this report. DENR-Water Rights Program observation well HN-76E and a new monitoring well drilled in the nearby city park were initially used to monitor the Big Sioux: Brookings aquifer. During the course of the pumping portion of the aquifer test, it was determined there was no local, highly significant hydrologic interconnection between the Prairie Coteau and Big Sioux: Brookings aquifers in the area of the production wells and measurement of the two Big Sioux: Brookings aquifer monitoring wells ceased.

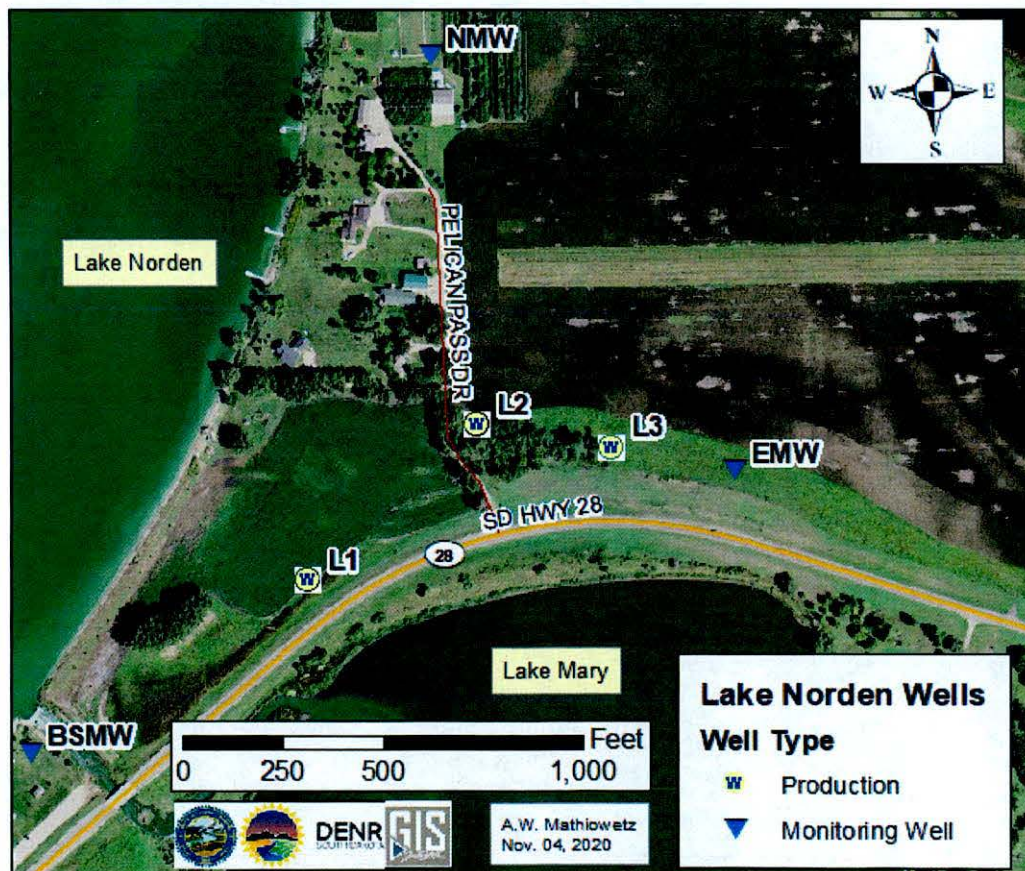


Figure 1-Map of wells used for the City of Lake Norden aquifer performance test

The pumping for the aquifer performance test began at 10:32 am on August 6, 2020 and ceased at 10:00 am on August 17, 2020. The recovery period lasted through 7:00 am on August 21, 2020, when the water level in each of the wells recovered to greater than 95% of the total drawdown measured at the end of the pumping period. All wells recovered to 95% of total drawdown within 69 hours of ceasing pumping. Wells L1 and L2 were pumped at a total combined rate of approximately 640 gallons per minute (gpm) (1.43 cfs). This application is for 2.11 cfs which would be the likely maximum diversion rate if all of the wells, L1, L2 and L3, were pumping simultaneously. Well L3 was used as a monitoring well for this aquifer performance test along with monitoring well EMW, drilled in 2018 as part of the original drilling for the production wells, and well NMW drilled in 2020 specifically for this aquifer performance test.

The production and monitoring wells were manually and electronically measured. The electronic measurements were collected by In-Situ, Inc. Troll 700 data logging pressure transducers every 30 seconds for the duration of the pumping and recovery periods (Banner Associates, 2020). It should be noted that there was an issue with the data logger installed in well NMW and it did not record data until August 11, approximately halfway through the pumping portion of the test. The manual measurements were recorded by staff from Banner Associates, Inc., DENR-Water Rights Program, DENR-Geological Survey Program, and the City of Lake Norden. Manual water level measurements followed the schedule in Table 1 for both the pumping and recovery periods.

Table 1-Manual water level measurement schedule (modified from: Banner Associates, 2020)

Time Since Beginning of Pumping or Cessation of Pumping	Water Level Measurement Interval
0 to 3 minutes	Every 30 seconds
3 to 15 minutes	Every 1 minute
15 to 60 minutes	Every 5 minutes
60 to 120 minutes	Every 10 minutes
120 minutes to 10 hours	Every 30 minutes
10 hours to 48 hours	Every 4 hours
48 hours onward	Every 12 hours

The methodology and equipment used to measure water levels for this aquifer pumping test as well as how the aquifer pumping test was conducted were consistent with standard operating procedures and methods as set forth by the American Water Works Association (AWWA) (1998), United States Environmental Protection Agency (Osborne, 1993), Fetter (1980), and Driscoll (1986) among others. The aquifer pumping test as conducted by Banner Associates, Inc. is acceptable by the DENR-Water Rights Program.

The water level and time data collected during the whole of the aquifer performance test was analyzed using macros in a Microsoft Excel spreadsheet (Halford and Kuniandy, 2002) downloaded from the Nevada District of the U.S. Geological Survey (Odens, 2020). The Cooper-Jacob Solution for Pumping Tests in Confined Aquifers (Cooper and Jacob, 1953) was used to determine aquifer characteristics based on the performance test data (Banner Associates, 2020).

The Cooper-Jacob Solution (Cooper and Jacob, 1953) is used by several software packages for calculating aquifer characteristics and estimating drawdown based on aquifer performance test

data and is commonly used and accepted for analyzing aquifer performance test data. The methods and software used by Banner Associates for analysis of the aquifer pumping test data is acceptable by the DENR-Water Rights Program.

TEST DATA ANALYSIS REVIEW

The primary purposes of this constant-rate aquifer pumping test were to determine the aquifer characteristics and possible aquifer extent of Prairie Coteau aquifer at the well locations. The maximum measured drawdown was 80.46 and 66.05 feet in pumping wells L1 and L2, respectively, and 33.91, 31.13, and 22.25 feet in monitoring wells L3, EMW, and NMW, respectively. Aquifer hydraulic conductivity (K) and transmissivity values (T) were calculated assuming pumping wells L1 or L2 as the pumping well for distance-drawdown calculations and the Cooper-Jacob solution for both the pumping and recovery periods and using all, lower, middle, and upper data were calculated and averaged (Banner Associates, 2020). The calculated T values are shown in Table 2.

Table 2- Local Prairie Coteau aquifer hydraulic conductivity and transmissivity based on aquifer performance test data (Banner Associates, 2020)

		L1 640 gpm		L2 640 gpm	
		K ft/day	T ft ² /day	K ft/day	T ft ² /day
Distance - Drawdown Curve		190	3800	190	3800
Pumping	Cooper- Jacob all data (CS)	110	2200	130	2600
	Cooper- Jacob Lower data (CS)	120	2400	120	2400
	Cooper- Jacob Middle data (CS)	71	1400	80	1600
	Cooper- Jacob Upper data (CS)	210	4100	190	3700
	Average	127.75	2525	130	2575
Recovery	Cooper- Jacob all data (CS)	74	1500	98	2000
	Cooper- Jacob Lower data (CS)	120	2400	130	2500
	Cooper- Jacob Middle data (CS)	65	1300	74	1500
	Cooper- Jacob Upper data (CS)	88	1800	120	2300
	Average	86.75	1750	105.5	2075

The calculated hydraulic conductivity values, 65 to 210 ft/day, are within the general range of fine to medium sand that are listed in Driscoll (1986). This information is consistent with the geologic information provided by the well driller on the well completion reports for each of the wells used for the aquifer performance test. Re-calculation of several of the analyses yielded comparable results when making the same assumptions as the Banner Associates (2020) report. Therefore, the hydraulic conductivity and transmissivity analyses can be assumed to have been done properly when using the same assumptions as the Banner Associates (2020) report.

Banner Associates estimated the well field capacity by multiplying specific capacity, gallons per minute of water pumped per foot of drawdown measured in a well, of each pumping well by the hydraulic head above the top of the aquifer. Well L1 had a specific capacity of 7.995 gpm/ft of drawdown and well L2 had specific capacity of 9.689 gpm/ft of drawdown. These two specific capacity values assumed the total combined pumping rate from each well, 640 gpm, created the

drawdown at each well. This is a reasonable assumption given the length of the aquifer performance test (11 days), the proximity of the two pumping wells to each other (558.97 feet), and the aquifer material consisting of fine to coarse glacial outwash sand. There was 90.65 feet of hydraulic head above the top of the aquifer at well L1 and at well L2 there was 78.57 feet of hydraulic head above the top of the aquifer at the beginning of the aquifer performance test (Banner Associates, 2020).

Using the previously mentioned calculation to determine well capacity, the well field should be able to support a maximum capacity of 721 to 761 gpm of pumping (Banner Associates, 2020). However, it should be noted that the water levels in the pumping and monitoring wells did not reach full stabilization but were approaching it when the pumping ceased. Monitoring of the water level by pressure transducers connected to the SCADA (Supervisory Control And Data Acquisition) system will be required and is planned by the City of Lake Norden (Banner Associates, 2020) to prevent lowering of the water level in any of the pumping wells into the screen area of the well. The lack of full stabilization of the water levels in the pumping and monitoring wells means long-term well field capacity values are likely on the high side. However, there is no way to estimate by how much. Furthermore, the expected long-term capacity of a well field does not represent the availability of unappropriated water in an aquifer.

Banner Associates (2020) concluded the Prairie Coteau aquifer can support a maximum combined capacity range of 721 to 761 gpm from the three wells completed into the aquifer. Because of the artesian head pressure and the more than 95 percent recovery of water level within 4 days of ceasing pumping, Banner Associates (2020) believes that the aquifer receives recharge from the north or higher ground where the confining clay layers may crop out at land surface or transition into the Big Sioux aquifer. The present exploration of the aquifer is not adequate to determine if the recharge occurs at a distance of one or several miles away from the City of Lake Norden's well locations (Banner Associates, 2020). The Banner Associates (2020) report states:

“The aquifer is limited in capacity and may not serve the community in the long term. As the City water demands increase an additional water source will become necessary. We recommend that the City continue to search for a future water supply source.”

The availability of unappropriated water is generally determined by consideration of observation well data and estimated recharge rates multiplied by aquifer area, when those data are available. There are no long-term observation wells constructed into this portion of the Prairie Coteau aquifer. The hydrographs for the two monitoring wells constructed for this aquifer performance test, EMW and NMW, and the three wells the city intends to use for production, L1, L2, and L3, for the time period following the recovery period used for the aquifer performance test are shown in Figure 2. Note that wells L1, L2, and L3 are being actively used during the period shown in Figure 2. This data is collected once per week at approximately the same time by staff from the City of Lake Norden and was obtained from Banner Associates (Beck, 2020). The water level measurements are required as part of the Temporary Permit To Use Public Waters (temporary permit) issued by the Chief Engineer on July 27, 2020. The City of Lake Norden is meeting the requirements of the temporary permit.

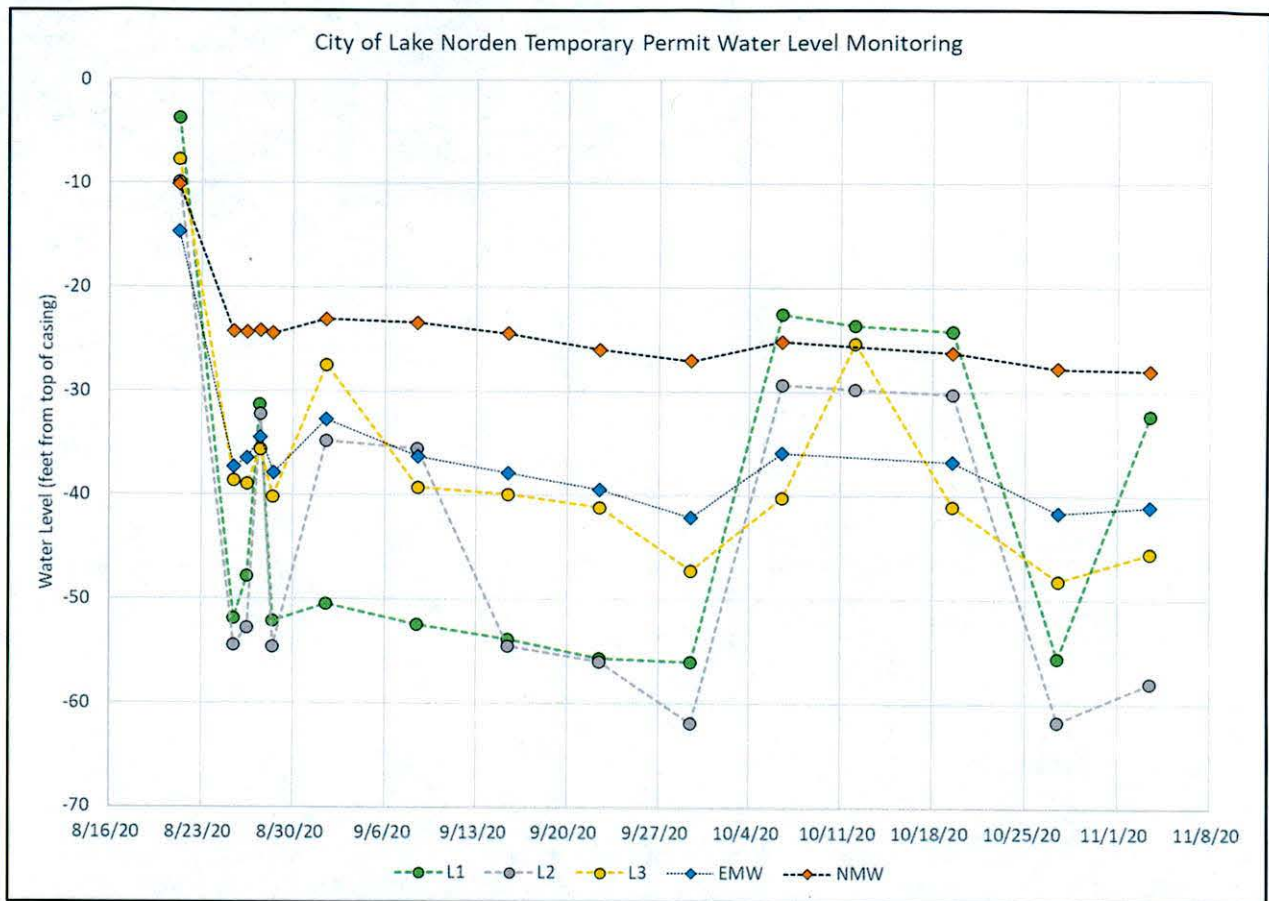


Figure 2- Water level measurements (modified from: Beck, 2020) taken since completion of aquifer performance test for the pumping and monitoring wells

SOUTH DAKOTA CODIFIED LAW (SDCL) 46-2A-9

Pursuant to SDCL 46-2A-9, a permit to appropriate water may be issued only if there is a reasonable probability that there is unappropriated water available for this applicant's proposed use, that the proposed diversion can be developed without unlawful impairment of existing rights and that the proposed use is a beneficial use and in the public interest. This report will address the availability of unappropriated water and effects on existing rights from the aquifer that are pertinent to this application.

WATER AVAILABILITY:

This application proposes to appropriate water from the Prairie Coteau aquifer. The probability of unappropriated water available from the aquifer can be evaluated by considering SDCL 46-6-3.1, which requires:

"No application to appropriate groundwater may be approved if, according to the best information reasonably available, it is probable that the quantity of water withdrawn annually from a groundwater source will exceed the quantity of the average estimated annual recharge of water to the groundwater source. An application may be approved, however, for withdrawals of groundwater from any groundwater formation older than or stratigraphically lower than the greenhorn

formation in excess of the average estimated annual recharge for use by water distribution systems.”

The Prairie Coteau aquifer is not stratigraphically lower/older than the Greenhorn Formation, but the applicant is a water distribution system as defined in SDCL 46-1-6(17). Therefore, a comparison of average annual recharge and average annual withdrawals from the Prairie Coteau aquifer is required for this application.

Hydrologic Budget

Recharge

The Prairie Coteau aquifer receives recharge from infiltration of precipitation and snowmelt where the aquifer is near land surface and permeable layers overlie it, leakage from adjacent aquifers with higher hydraulic head, and hydraulically connected surface water bodies and surficial aquifers (Leap, 1972). However, it is not clear what the specific source of recharge to this portion of the Prairie Coteau aquifer is. The most likely sources of recharge are infiltration of precipitation and snowmelt and a hydraulic connection to the Big Sioux: Brookings aquifer and/or nearby lakes.

There is no estimate of recharge rate to this portion of the Prairie Coteau aquifer. However, Hedges and others (1985) suggested a range of 0.15 to 0.6 inches per year (in/yr) be used for confined aquifers by management and development programs. It was further noted that locally where confined aquifers may encounter unconfined conditions the recharge rates may be within the range calculated for non-buried surficial aquifers (2.0 to 5.6 in/yr) (Hedges et. al, 1985). The nearest non-buried surficial aquifer to this portion of the Prairie Coteau aquifer is the Big Sioux: Brookings aquifer. Hedges and others (1985) calculated a recharge rate of 4.0 in/yr using observation well data analysis. The rate of 4.0 in/yr is likely much greater than the actual recharge rate to this portion of the Prairie Coteau aquifer.

The full extent of this portion of the Prairie Coteau aquifer has not been determined. Attempts to delineate this portion of the Prairie Coteau aquifer when the application was first submitted in June 2020 ranged from approximately 1,320 acres (high confidence) to 2,780 acres (medium to low confidence) using lithologic log data (SDGS, 2020a), well completion report data (Water Rights, 2020d), and water right/permit files (Water Rights, 2020c). Upon further review of available geologic data, the aquifer performance test data (Banner Associates, 2020), and consultation with the DENR-Geological Survey (SDGS, 2020b), a third aquifer delineation was performed. This third delineation has an approximate areal extent 1,690 acres and determined the aquifer most likely extends to the northeast in a manner similar to the low-mid confidence aquifer delineation and potentially to the southeast but not to the west as previously thought in the June 2020 delineation attempts.

The data obtained from the aquifer performance test can be used to estimate a radius of influence, R_0 , for the maximum drawdown created during the performance test. The R_0 value can be used to calculate the extent of the cone of depression for the aquifer performance test. The cone of depression is the absolute minimum aquifer area. As part of the suggested design criteria for this aquifer performance test from the DENR-Water Rights Program, there were to be two wells pumped simultaneously for this aquifer performance test. That led to the issue of where the distance portion of the drawdown-distance part should be measured from. While using the same

drawdown values for each of the monitoring wells, changing the distance from the “pumping well” values lead to different R_0 values and subsequently differing values for the minimum aquifer area. Figure 3 is the distance-drawdown chart using the “pumping well” locations of L1, L2, and halfway in between L1 and L2.

Solving the equation of the logarithmic trendline for the value of x when y is equal to 0 leads to the R_0 value. The table shown in Figure 3 shows the R_0 values using “pumping well” locations of L1, L2, and halfway in between L1 and L2 for the distance portion of the graph, then calculating the area of the circle that R_0 represents and a range of estimated average annual recharge using Hedges and others (1985) suggested range of recharge rates of 0.15 to 0.60 in/yr. A geographic representation of the R_0 values shown in Figure 3 and the initial delineation estimates of this portion of the Prairie Coteau aquifer are shown in Figure 4. The estimated recharge values based on the R_0 calculated minimum aquifer area range from 13.5 to 240.6 ac-ft/yr.

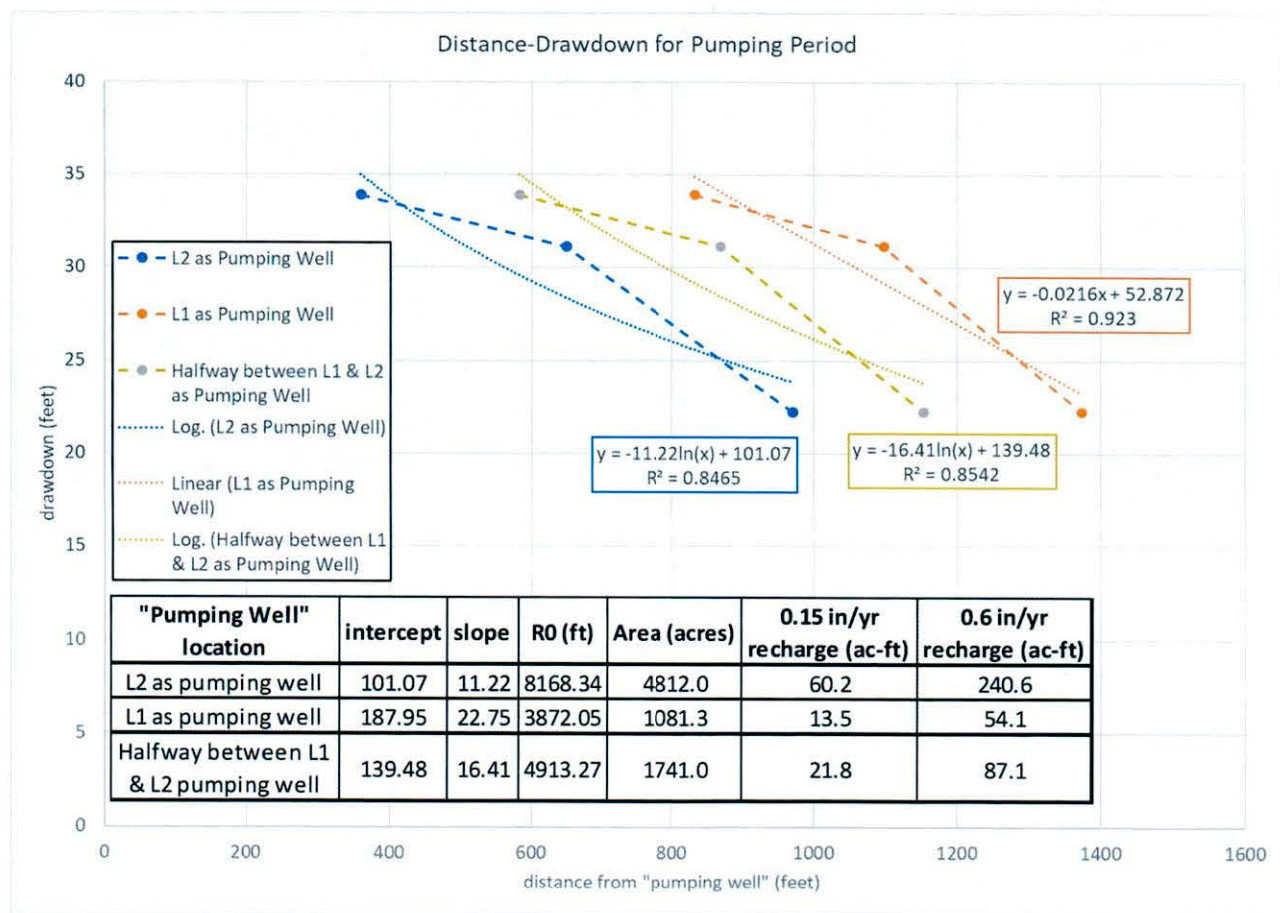


Figure 3- Distance-drawdown chart for the pumping portion of the aquifer performance test

Included in the Banner Associates (2020) report is a potentiometric surface map of the wells at the maximum drawdown elevation during the aquifer performance test (see Figure 6 on page 12 of that report). The potentiometric surface shows a “cone of depression” around the pumping wells, L1 and L2, that is oval in shape with a major axis approximating a straight line between the two wells and the lowest water level at L1. This means that using a simple distance-drawdown chart to estimate minimum aquifer area is not fully representative of the area of influence (cone of

depression) created during the aquifer performance test but is probably a reasonable estimate of the minimum area of influence from the aquifer performance test.

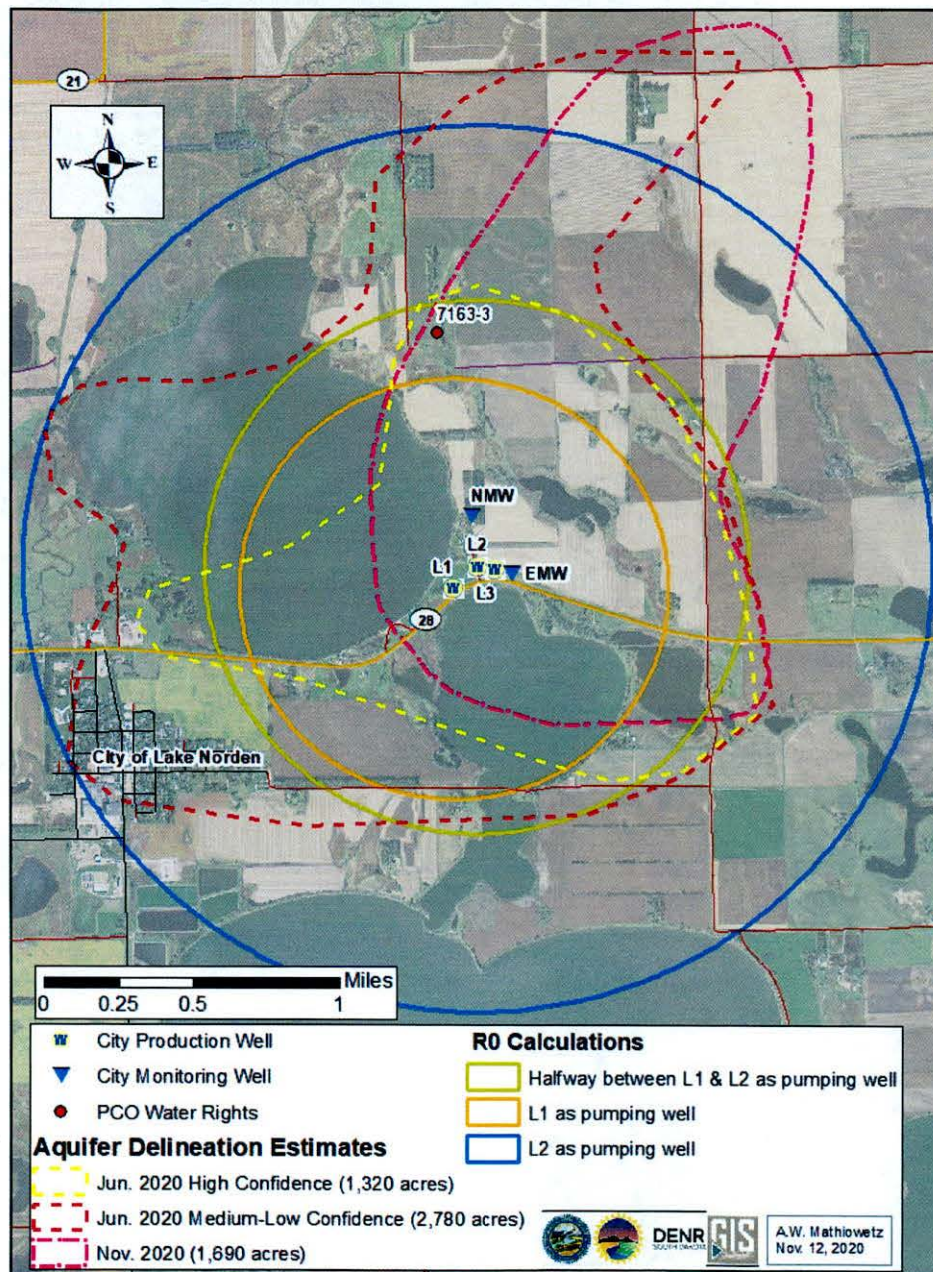


Figure 4- Map of aquifer delineations and R_0 drawdown cone extents with the nearby Prairie Coteau aquifer water permit (Water Rights, 2020c)

The distance-drawdown chart should be used as a sense of scale to estimate likely minimum aquifer area. Considering the original aquifer delineations, especially the high confidence delineation, when compared to the R_0 circles for “cone of depression” for the various distance-drawdown calculations, it is reasonable to assume the **minimum** aquifer extent is likely greater than 1,081.3 acres and is somewhere between the June 2020 high confidence aquifer delineation area, 1,320 acres, and the R_0 calculation with the assumed “pumping well” location halfway

between wells L1 and L2, 1,741 acres. This results in an estimated average annual recharge rate, using Hedges and others' (1985) recharge rate, ranging from 16.5 to 87.1 ac-ft/yr.

It is likely that this portion of the Prairie Coteau receives recharge from the Big Sioux: Brookings aquifer or possibly a nearby surface water source that is also connected to the Big Sioux: Brookings aquifer. The Big Sioux: Brookings aquifer has an estimated recharge rate of 4.0 in/yr (Hedges et. al, 1985). The till separating the Big Sioux: Brookings and the Prairie Coteau aquifer in this area can range from what appears to be non-existent, such as at DENR-Water Rights Program observation well HN-76E located approximately 0.8 miles southeast of production well L3, to between 20 to 70 feet as described by the geology encountered during the drilling of the City of Lake Norden's production wells (Water Rights, 2020b and 2020c). Furthermore, various borings for well completion reports (Water Rights, 2020d) and lithologic logs (SDGS, 2020a) identify sand, gravel, and clay as intermixed, in various quantities and locations, with the glacial till. This means the glacial till locally may have higher permeability than other glacial till. Considering the vertical proximity of the Big Sioux: Brookings aquifer in some areas and the potential for more permeable glacial till, it is reasonable to assume the recharge rate to this portion of the Prairie Coteau aquifer is likely closer to the 0.6 in/yr of the Hedges and others (1985) recharge rate range and may possibly even exceed it.

The actual recharge rate to this portion of the Prairie Coteau aquifer is likely near or possibly somewhat greater than the upper end of Hedges and others (1985) recharge rate estimate, 0.60 in/yr, for confined aquifers. However, it is not possible to determine the actual recharge rate with the currently available information. The minimum estimated average annual recharge to this portion of the Prairie Coteau aquifer is likely around 87.1 ac-ft/yr. Therefore, it is reasonable to assume a **minimum** estimated average annual recharge rate of 87.1 ac-ft/yr to this portion of the Prairie Coteau aquifer when developing a hydrologic budget.

Withdrawals:

Discharge from this portion of the Prairie Coteau aquifer occurs through well withdrawals (Water Rights, 2020c and 2020d) and likely through discharge to adjacent aquifers like the Big Sioux: Brookings and possibly to hydraulically connected surface water bodies. There is one existing water right authorized to withdraw water from the same portion of the Prairie Coteau aquifer the applicant proposes to use (Water Rights, 2020c), Water Permit No. 7163-3 for Travis or Kimberly Hymans. Water Permit No. 7163-3 authorizes the diversion of water at a maximum instantaneous diversion rate of 0.1 cfs for domestic purposes. Historically, the average annual water use by non-irrigation appropriations limited by instantaneous diversion rate has been less than 60 percent of full time pumping at the permitted diversion rate. That is an estimated annual use of 26.9 ac-ft/yr. The water use under 7163-3 is likely much less than 26.9 ac-ft/yr because it is for domestic use and the 60 percent estimate is based off of review of submitted water use numbers and discussions with various large non-irrigation appropriators in the past.

There are several domestic wells on file with the water rights program that appear to be completed into the same portion of the Prairie Coteau aquifer as the applicant's wells (Water Rights, 2020d). Furthermore, there are 12 rural residences that may be served by wells that are within the "Medium-Low Confidence" aquifer delineation shown in Figure 4. Assuming 2.5 people per residence and a per capita daily water use of 72 gallons per day (Carter and Netizert, 2005), it is

estimated the 12 rural residences that may also use water from this portion of the Prairie Coteau aquifer would use at most 2.4 ac-ft/yr.

Balance of Hydrologic Budget

This application proposes to appropriate 1,458 ac-ft/yr from a portion of the Prairie Coteau aquifer. Currently, the estimated average annual appropriative and likely maximum domestic use is probably less than 29.3 ac-ft/yr from this portion of the Prairie Coteau aquifer. The estimates of a minimum recharge rate to this portion of the Prairie Coteau aquifer range from 13.5 to 240.6 ac-ft/yr, with the best available information indicating the most likely **minimum** recharge rate is in the vicinity of 87.1 ac-ft/yr. That would leave at least 57.8 ac-ft/yr unappropriated. That is far less than the requested appropriation. However, there is a reasonable probability that the recharge rate (0.15 to 0.60 in/yr) to this portion of the Prairie Coteau aquifer, as well as the areal extent of the aquifer (1,741 acres), is greater than the best estimates currently available.

Observation Well Data:

Administrative Rule of South Dakota Section 74:02:05:07 requires that the Water Management Board shall rely upon the record of observation well measurements in addition to other data to determine that the quantity of water withdrawn annually from the aquifer does not exceed the estimated average annual recharge of the aquifer.

There are no DENR-Water Rights Program observation wells completed into this portion of the Prairie Coteau aquifer (Water Rights, 2020b). Two monitoring wells, EMW and NMW, were installed and used as part of the aquifer performance test. Once per week measurement of the water levels in these monitoring wells, and the pumping wells (L1, L2 and L3), is required as a qualification of the City of Lake Norden's temporary permit. The hydrographs for EMW and NMW for the time following the end of the recovery period of the aquifer performance test are shown in Figure 5 along with a linear trendline of most of the data. The first measurement taken following the end of the recovery period of the aquifer performance test is much higher for both wells than all of the subsequent measurements, because there had been no pumping from any of the wells for 4 days at that point. Therefore, it is reasonable to not include those readings when looking at the general trend of the monitoring wells.

The hydrographs show that the continued pumping from this portion of the Prairie Coteau aquifer by the City of Lake Norden has consistently lowered the water level in the monitoring wells since the end of the recovery period of the aquifer performance test. The hydrographs in Figure 2 show that even when wells L1, L2, and L3 are not actively pumping or are pumping less, there is not a full recovery of pre-pumping water levels. It should be noted since these readings are taken once per week at a consistent time. Therefore, any changes to water level that may occur between the readings are not shown.

Analysis of observation well data looks at the long-term, generally several years of data, shape and changes of the water level data shown in the hydrograph. Looking at the data over a longer period of time allows for determination of whether a confined aquifer, such as the Prairie Coteau aquifer, is approaching equilibrium with new pumping or whether the aquifer is being depleted (over-appropriated). Currently, there are two months of data that are showing a downward trend. Furthermore, the water levels in the pumping wells and the monitoring wells did not fully stabilize

during the pumping portion of the aquifer performance test. These two factors when considered together can lead to a couple of conclusions. First, the aquifer is very small and the pumping by the City of Lake Norden is too great for the aquifer to actually support (i.e. not enough recharge for the appropriation). Or, the finer sediments that comprise the aquifer have a low transmissivity and the pumping test did not run long enough to allow the aquifer to equilibrate. It is likely that both factors, limited aquifer size and fine sediments, are responsible for the non-stabilization of the water levels during the pumping portion of the aquifer performance test.

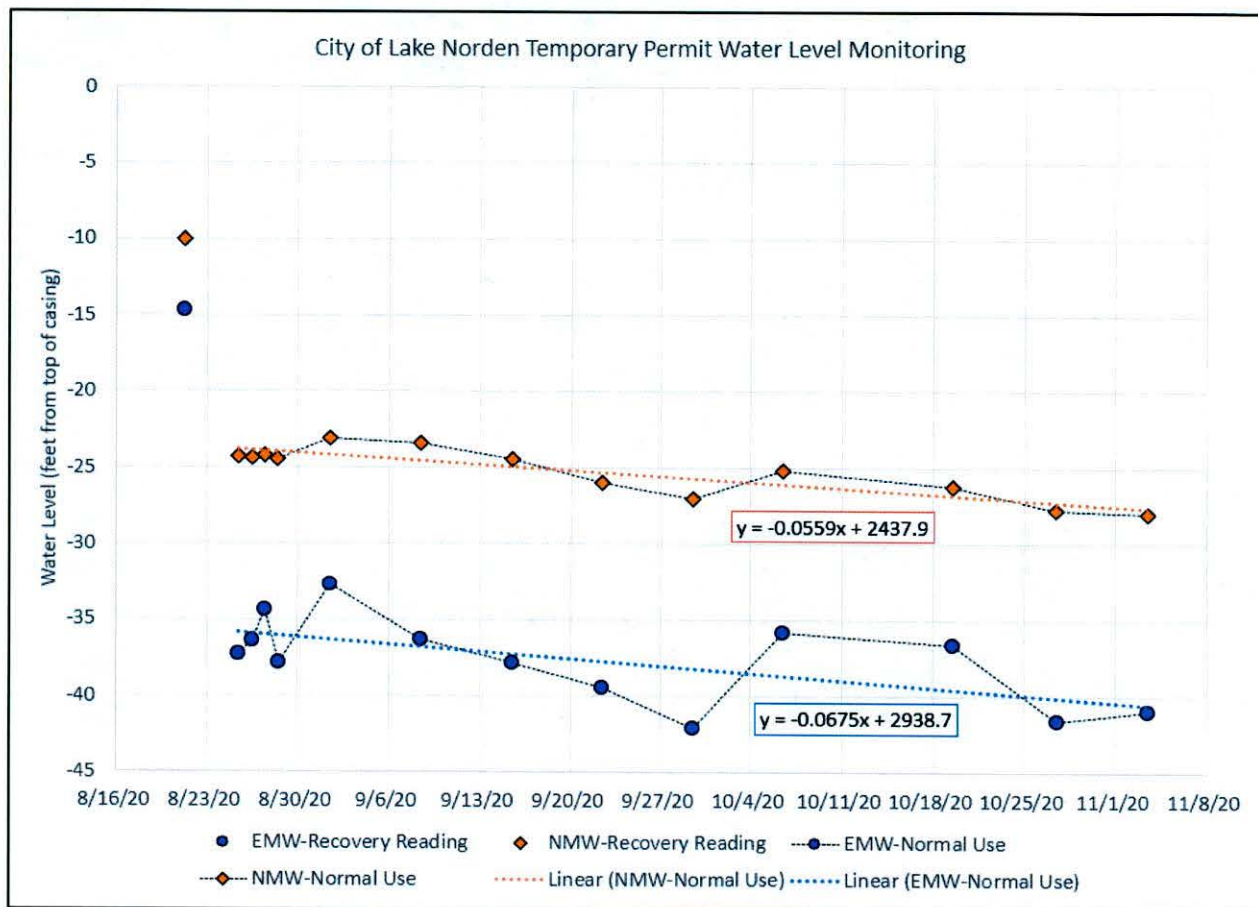


Figure 5- Prairie Coteau aquifer monitoring well hydrographs for period following recovery portion of aquifer performance test (modified form: Beck, 2020)

The hydrographs for the monitoring wells following the end of the aquifer performance test do not explicitly show whether there is or is not unappropriated water available for this proposed application. What they do show is that the water level in the aquifer does draw down during pumping periods and recovers due to recharge events and the cessation/lessening of pumping. Both of these actions are common and the expected behavior of any aquifer. Longer term data, several months to years possibly, is required to determine the availability of unappropriated water using observation well analysis. If this application is approved in any form, a new permanent observation well to monitor this portion of the Prairie Coteau aquifer should be constructed or easements for access and maintenance to one or both of the existing monitoring wells be granted.

Water Availability Conclusion:

Based on the hydrologic budget and monitoring well data currently available, there is not a reasonable probability that unappropriated water is available for the entirety of the proposed appropriation of 1,478 ac-ft/yr. The best currently available estimates show there is likely at least 57.8 ac-ft/yr available for this application. However, there is a reasonable probability that the recharge rate to this aquifer is at least 0.6 in/yr due to probable connections to the Big Sioux: Brookings aquifer and local surface water bodies and might even be greater. However, information is not available to quantify how much greater. Furthermore, there is a reasonable probability that the aquifer areal extent is larger than the likely minimum areal extent (1,741 acres) determined during the aquifer performance test. Therefore, it would be reasonable to approve a portion of this permit for up to 57.8 ac-ft/yr and defer the remainder (1,420.2 ac-ft/yr) for further study. This further study must include, at minimum, continued monitoring of water levels in the Prairie Coteau aquifer. Further drilling to better delineate the extent of this portion of the Prairie Coteau aquifer should be considered. However, an areal extent sufficiently large to support the whole of this application is not likely. Using Hedges and others (1985) recharge rate range (0.15 to 0.6 in/yr), an areal extent ranging from 29,560 to 118,240 acres is needed to support this application as proposed.

POTENTIAL FOR UNLAWFUL IMPAIRMENT OF EXISTING WATER RIGHTS:

As shown in Figure 4, the only water right/permit that appears to withdraw water from the same portion of the Prairie Coteau aquifer the applicant proposes to use is Water Permit No. 7163-3. The well for Water Permit No. 7163-3 is approximately 0.8 miles away from the nearest of the City of Lake Norden's three wells, L2 (Water Rights, 2020c). There are domestic wells on file with the DENR-Water Rights Program within approximately 0.25 miles of the city's wells (Water Rights, 2020d). No complaints regarding well interference were filed with the DENR-Water Rights Program for the duration of the aquifer performance test. Furthermore, there have been no complaints regarding well interference in Hamlin County (Water Rights, 2020a). In other counties, complaints regarding well interference from wells completed into the Prairie Coteau aquifer have been filed with the DENR-Water Rights Program. Most of the complaints have been unsubstantiated and were the result of inadequate pumping depth in the well that had issues (Water Rights, 2020a).

At the well sites for this application, the Prairie Coteau aquifer is under confined conditions. Generally, that means the water level of the aquifer can be subject to significant fluctuations caused by natural conditions and pumping. The drawdown created by pumping a well completed into a confined aquifer may extend a considerable distance from the well as shown by the data from the aquifer performance test. The City of Lake Norden has installed pressure transducers in their production wells (L1, L2 and L3) that are connected to their SCADA system (Beck, 2020) to ensure they do not accidentally pump their own wells dry. By self-limiting their wells, the city protects other nearby adequate domestic wells because there is generally more drawdown at a pumping well than at other locations. The artesian head pressure above the top of the aquifer at the City of Lake Norden's production wells was around 80 feet at the time of completion in late-spring and mid-fall of 2018.

South Dakota Codified Law (SDCL) 46-6-6.1 does not necessarily protect artesian head pressure as a means of delivery, and the Water Management Board has recognized in the past to place water

to maximum beneficial use, a certain amount of drawdown may occur. In order to balance interests between appropriative use and delivery of water by artesian head pressure, the Water Management Board defined an “adversely impacted domestic well” in Administrative Rule of South Dakota (ARSD) 74:02:04:20(7) as:

“a well in which the pump intake was set at least 20 feet below the top of the aquifer at the time of construction or, if the aquifer is less than 20 feet thick, is as near to the bottom of the aquifer as is practical and the water level of the aquifer has declined to a level that the pump will no longer deliver sufficient water for the well owner’s needs”.

The Water Management Board considered the delivery of water by artesian head pressure versus maximum beneficial use of water issue for Water Right No. 2313-2 for Coca-Cola Bottling Company of the Black Hills (Water Rights, 1995). The Water Management Board adopted Findings of Facts and Conclusions of Law that noted reservation of artesian head pressure for delivery of water would be inconsistent with SDCL 46-1-4 which states, “general welfare requires that the water resources of the state be put to beneficial use to the fullest extent of which they are capable...” (Water Rights, 1995). Furthermore, the Water Management Board found if increased cost or decreased production as a result of impacts on artesian head pressure by legitimate users is to be considered an adverse impact it would also be in conflict with SDCL 46-1-4 (Water Rights, 1995). With that in mind, some existing well owners may need to lower their pumps to accommodate for deeper water levels. However, when considering the statute (SDCL 46-6-6.1), rule (ARSD 74:02:04:20(7)), and the artesian head pressure, well interference from this proposed diversion is not expected to unlawfully impair existing appropriative or domestic users with adequate wells. A continued lowering of the water level in the aquifer from pumping would be considered an adverse impact and therefore an unlawful impairment of existing water rights. However, there is not sufficient data available to determine the likelihood of that occurring at this time. Continued monitoring of the water levels in the aquifer is recommended to establish a longer-term trend for the aquifer. The current combined pump rate from wells L1, L2, and L3 was estimated to be 550 to 560 gpm (Beck, 2020).

CONCLUSIONS:

1. Application No. 8433-3 proposes to appropriate up to 1,458 ac-ft/yr at a maximum instantaneous diversion rate of 2.11 cfs from a portion of the Prairie Coteau aquifer.
2. The Prairie Coteau aquifer is found under confined conditions in the area of the well sites.
3. The applicant had a constant-rate aquifer performance test conducted and analyzed by Banner Associates, Inc., an engineering firm.
4. The methodology for completing the aquifer performance test and analyzing the data are sound, within published standard operating procedures for conducting a constant-rate aquifer performance test, and within the guidelines suggested by DENR-Water Rights Program.
5. Based on the observation well data and a hydrologic budget, there is not a reasonable probability unappropriated water is available for the entirety of this proposed appropriation.

6. There is a reasonable probability up to 57.8 ac-ft/yr could be approved for this proposed appropriation based on the hydrologic budget.
7. If the remaining amount of this proposed appropriation (1,420.2 ac-ft/yr) is deferred for further study, the further study should include, at minimum, continued measurements of the water levels in this portion of the Prairie Coteau aquifer. It may be prudent to also complete more drilling to better delineate the extent of the aquifer.
8. If part or all of this application is approved, it would be prudent to have a permanent observation well monitored by the DENR-Water Rights Program completed into this portion of the Prairie Coteau aquifer or easements for access and maintenance of the monitoring wells used for the aquifer performance test granted.
9. There is a reasonable probability the diversion proposed by this application can be made without unlawfully impairing existing appropriative or domestic users with adequate wells.
10. However, general over pumping of the limited areal extent of the aquifer may occur and this would be an unlawful impairment. Continued monitoring of the water levels in the Prairie Coteau aquifer is recommended.

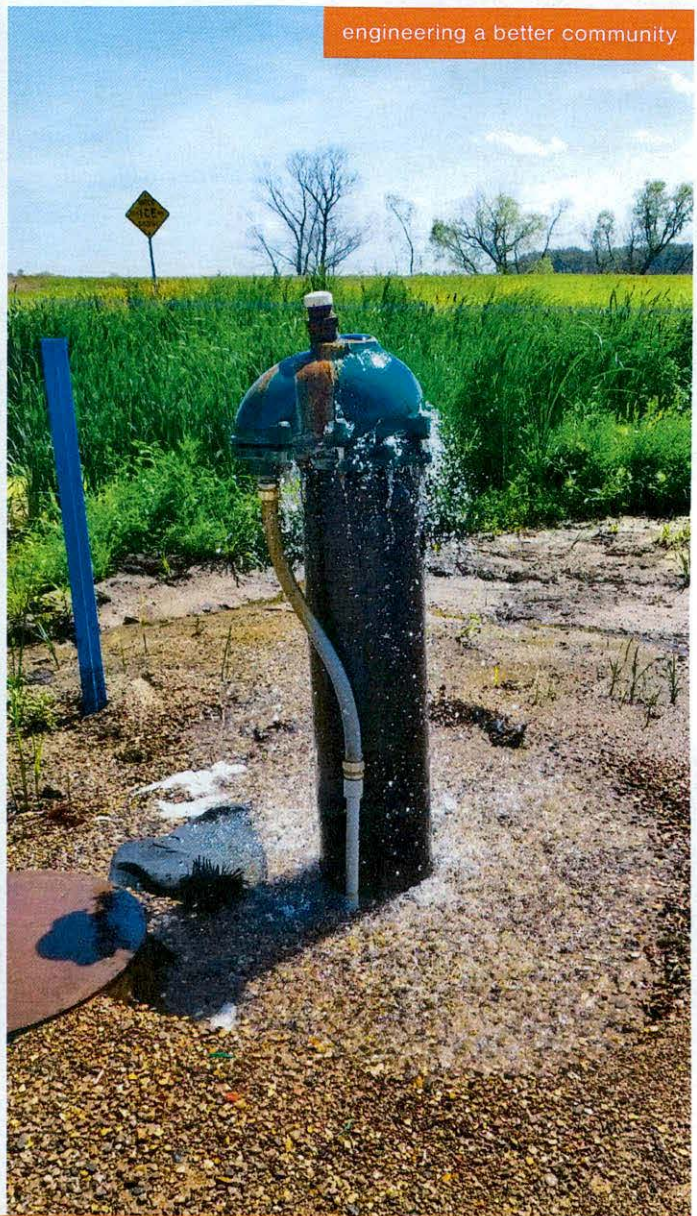


Adam Mathiowetz, PE
SD DENR-Water Rights Program

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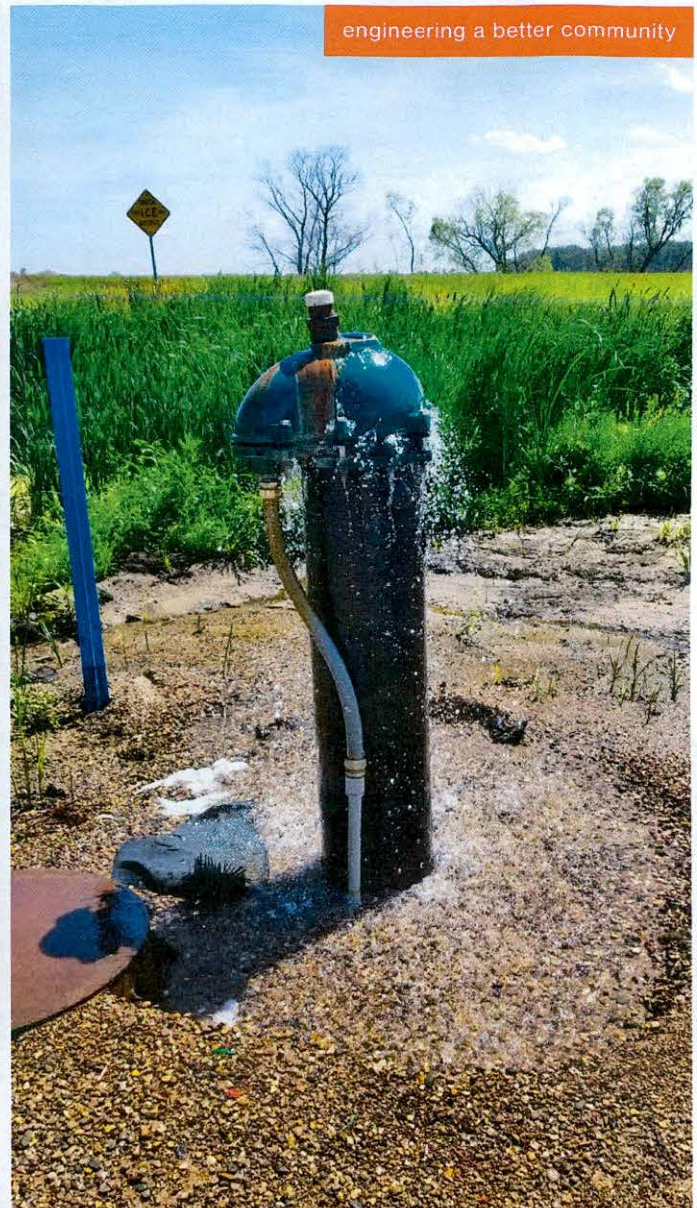


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Lake Norden Prairie Coteau Aquifer Evaluation City of Lake Norden September 2020

Submitted by
Banner Associates, Inc.
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Appendix A – Well Logs
Appendix B – Aquifer Manual Field Test Data
Appendix C – Cooper-Jacob Aquifer Analysis

1. Introduction

The City of Lake Norden contracted with Banner Associates, Inc. to provide engineering services for the installation of 3 well pumps and the associated electrical controls, SCADA system, and raw water service line to the water treatment plant. Lake Norden had previously drilled and installed well screens in 3 new wells with the intention of replacing some of their existing wells with these new wells and transferring the water rights from the old wells to the new wells. When the water rights application was filed, South Dakota Department of Environment & Natural Resources (SD DENR) Water Rights informed the City that they believed the wells were placed in the Prairie Coteau Aquifer and not the Big Sioux Aquifer as they had previous thought. The City of Lake Norden has existing water rights in the Big Sioux Aquifer but not the Prairie Coteau Aquifer.

The purpose of this study is to conduct an aquifer production test, analyze the data and investigate the potential yield of the aquifer in which the wells were placed.

a. Background

The City of Lake Norden has a population of approximately 500 people with an Agropur Cheese Plant that is a large water user. The City has several existing wells in the Big Sioux Aquifer on the southwest side of the lake called Lake Norden. The water from this location of the aquifer is high in iron and the wells plug up and need to be replaced on a 10 to 15-year rotation basis. In 2018, the City of Lake Norden entered into a contract with Kaiser Well Drilling of Lake Norden to find an additional water source for the City of Lake Norden. Exploration began on the northeast side of town between Lake Norden and Lake Mary. Several test wells were drilled in exploration for water and based on well test pumping, Kaiser Well Drilling determined that an adequate water supply had been located. Three of the test wells were converted to production wells with 20 feet of stainless-steel screen placed at the bottom of the aquifer. Each of the three wells are approximately 100 feet deep. When a water right application was filed to transfer water rights to the new wells, the City was informed that the new wells were believed to be in the Prairie Coteau Aquifer and not the Big Sioux Aquifer.

b. Purpose

This report presents the methods used and results obtained from the aquifer investigation performed to date in the Prairie Coteau Aquifer at Lake Norden. Those include:

- Installation of the 2018 wells and observation wells.
- Aquifer testing to determine potential of the aquifer ability to yield water and the potential of an aquifer connection to the Big Sioux Aquifer.
- Estimates of potential yield for the three municipal wells that have been developed in the aquifer.
- Summary and conclusions.

c. Study Area Description

The Lake Norden Prairie Coteau aquifer wells are located northeast of the town of Lake Norden along Highway 28 between Lake Mary and Lake Norden. Two wells are located east of Pelican Pass and one well is located west of Pelican Pass. See Figure 1 – Well Locations.

i. Site Geology/Hydrogeology

The Prairie Coteau aquifer at this location is buried beneath 83 to 87 feet of till. The Prairie Coteau aquifer consists of numerous fine sands to medium sand and medium coarse sand lenses that may or may not be hydraulically connected. The thickness of the sand lens that the Lake Norden Municipal wells were installed ranges from 14 to 19 feet thick and is under artesian conditions.

The ground surface at the five Prairie Coteau test wells/monitoring wells ranged from 1657 to 1675. The lowest ground is near the lake shore of Lake Norden (L1) and the highest ground elevation approximately 1500' north of L1 is at the north monitor well.

The Lake Norden area is part of the Big Sioux River drainage basin. Thus, water flows generally from north to south within this basin. The artesian condition in the Prairie Coteau aquifer is likely also caused by water flowing from the higher elevations north and west of Lake Norden.

Recharge from precipitation on the surrounding area percolates into the groundwater. Generally, the ground water would flow downstream parallel to the Big Sioux River valley. Clay barriers would impede this flow causing the artesian condition noted at the well site.



PAGE 4

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DATE: SEPTEMBER 2000	
DESIGNED BY: DAB	
CHECKED BY: DAB	
DRAWN BY: CML	
SCALE: AS SHOWN	

PROJECT / SHEET TITLE	
NEW WELLFIELD AND RAW WATER TRANSMISSION LINE - 2018	
PRAIRIE COTEAU AQUIFER WELL LOCATIONS	
LAKE NORDEN, SOUTH DAKOTA	
REV.	DATE

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FIGURE 1

2. Site Exploration

a. Test Well Location and Pilot Hole Drilling

The three previously installed 10-inch diameter production wells and three 2 ½ - inch observation wells installed by Kaiser Well drilling were used for this aquifer evaluation. One of these observation wells was drilled in the Big Sioux Aquifer to monitor the water level during the production testing of the wells in the Prairie Coteau Aquifer. The location of these wells is shown on Figure 1 – Well Locations.

The three 10-inch diameter wells were drilled to a depth ranging from 97 to 103 feet below ground surface. Twenty feet of stainless-steel screen was placed at the bottom of each well with a screen slot size of 0.30. The east observation well was drilled to a depth of 101 feet and 10 feet of PVC screen was placed at the bottom of the well with a slot size of 0.30. The north observation well was drilled to a depth of 103 feet and 20 feet of PVC screen with a slot size of 0.25 was placed at the bottom of the well. The Big Sioux Aquifer observation well was drilled to a depth of 82 feet and 20 feet of PVC screen with a slot size of 0.25 was placed at the bottom of the well. The Well logs are attached to this report in Appendix A – Well Logs.

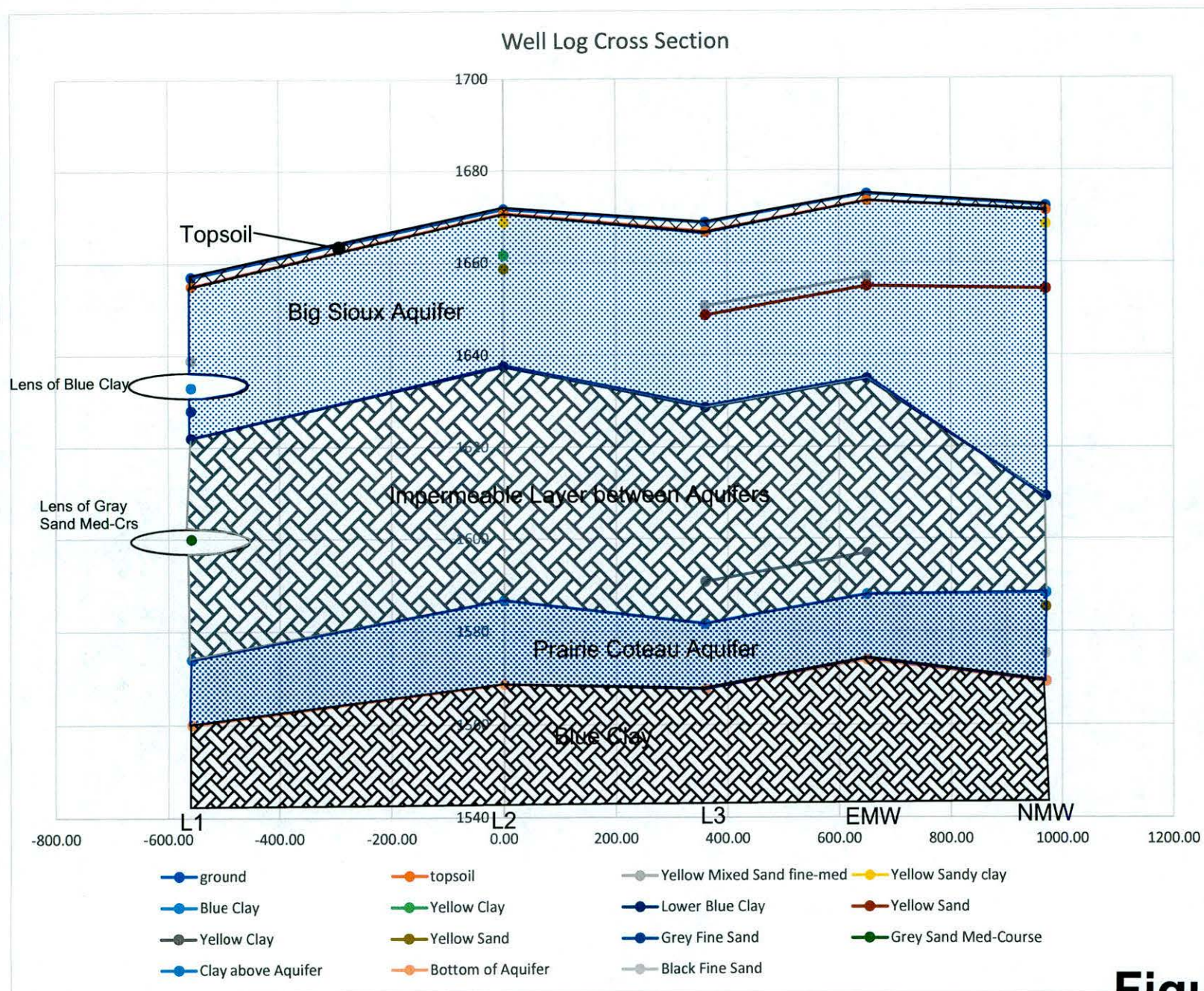
The description of the Prairie Coteau water bearing sands ranged as follows:

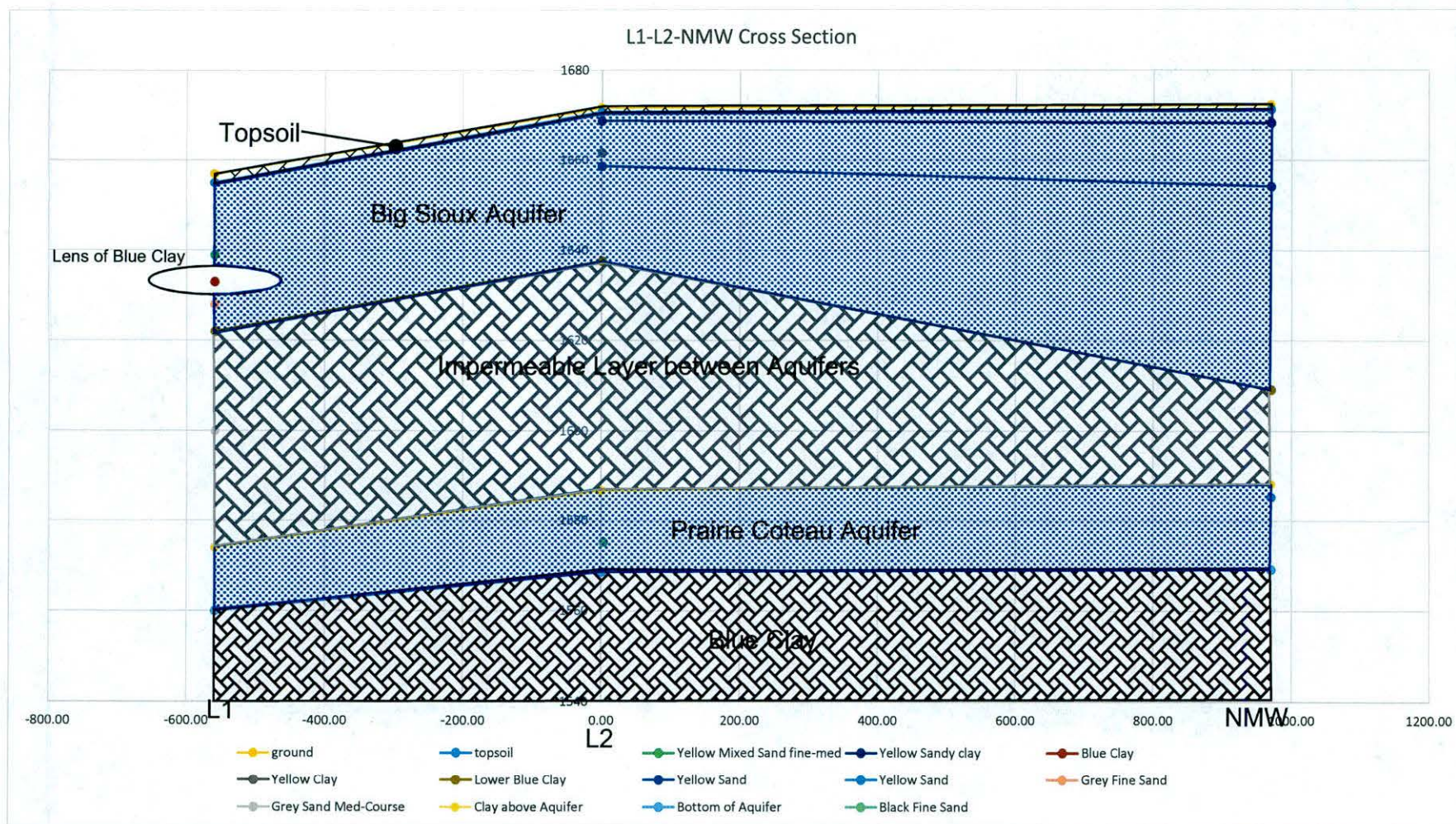
- L1 – yellow medium-course
- L2 - grey sand fine
- L3 and EMW - sand medium-fine
- NMW – yellow fine-medium sand, black fine sand and yellow medium course

It is noted that the bottom of the water bearing sands at L1 are 8.67 feet deeper than the bottom of the water bearing sands at L2 as depicted in Figure 2 - Well Log Cross Sections.

Based on the well logs and the bottom elevations of the Prairie Coteau Aquifer, the water bearing sands tend to be dropping from north to south. Thus, the cross section of the well logs was developed for L1, L2 and NMW to show the north to south aquifer pattern. This is depicted in Figure 3 - L1-L2-NMW Cross Section. There is a drop of 9.25' from north to south.

Wells L2, L3 and the EMW are an east-west cross section of the aquifer. L2 and L3 are nearly flat while the bottom of EMW rises 6.25 feet above the bottom of L3. This is depicted in Figure 4 – L2-L3-EMW Cross Section.

**Figure 2**

**Figure 3**

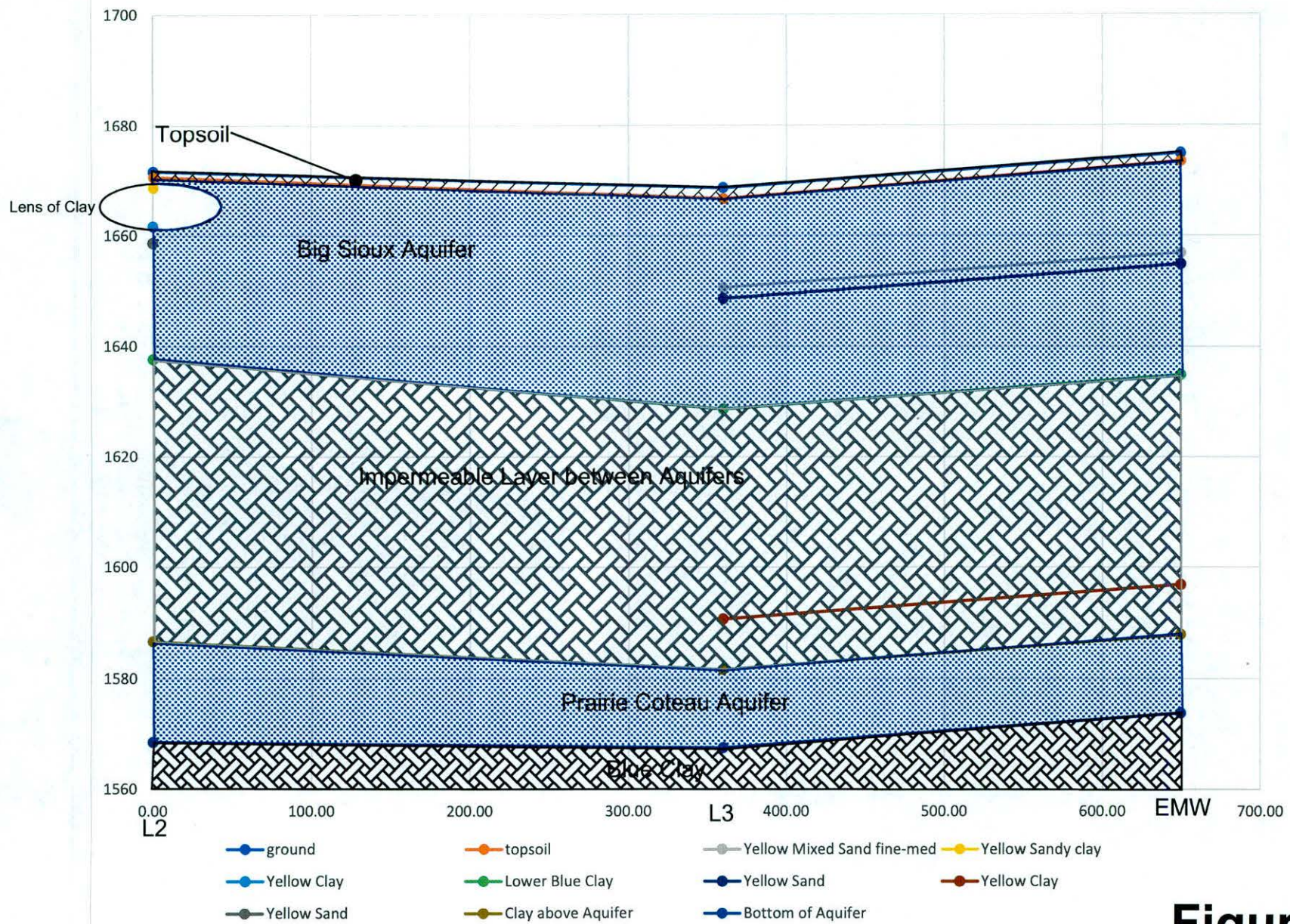


Figure 4

3. Aquifer Testing

a. Water Level Monitoring

In-Situ, Inc. brand Troll 700 datalogging pressure transducers equipped to read both water level and water temperature were installed in both test wells and three monitoring wells during the aquifer testing. Water level drawdown and recovery was also manually monitored using electric water level tapes by Banner staff, SD DENR staff and SD Geological Survey Staff in the 2 test wells and 3 monitoring wells as well as 2 nearby Big Sioux Aquifer observation wells.

Hand measurement were taken at 5 locations with the dataloggers present as a backup to the electronic data. The water levels were tied to mean sea level based on topographic site survey and elevations of the ground at the well as well as the top of casings where the electric water level tapes were measured from. Hand measurements were also taken at periodic intervals at the Big Sioux Aquifer observation wells.

The measurement frequency of the electronic data loggers was set at 30 seconds while the manual measurements followed the reading interval as follows:

0 to 3 minutes	every 30 seconds
3 to 15 minutes	every minute
15 to 60 minutes	every 5 minutes
60 to 120 minutes	every 10 minutes
120 min. to 10 hours	every 30 minutes
10 hours to 48 hours	every 4 hours
48 hours to shut down	every 12 hours

Technical issues with one data logger prevented electronic data at well 1000 N L2 from being electronically recorded until August 11.

b. Constant-Rate Pumping Test Execution

A seven-day constant rate pump test was planned for the aquifer test and initiated at 10:30 a.m. on August 6, 2020. Time clocks were synchronized and the well pumps at L1 and L2 were started at the same. The total flow from these two well measured 640 gpm. The flow was continuously monitored by the SCADA system at the water treatment plant. The aquifer performance test was run by Banner Associates, Inc. and the water level drawdown and recovery data were collected manually and electronically.

At the end of seven days the decision was made to extend the constant rate pump test for 4 more days. Thus, the constant rate pump test ran for a total of 11 days. The pumps were shut off at 10:00 a.m. on August 17, 2020. The recovery data was monitored both manually and electronically by the same staff as the drawdown measurement through 7:00 a.m. on August 21, 2020. The data collected in the field is included in Appendix A – Aquifer Test Data

Table 1 summarizes the details relevant to this study.

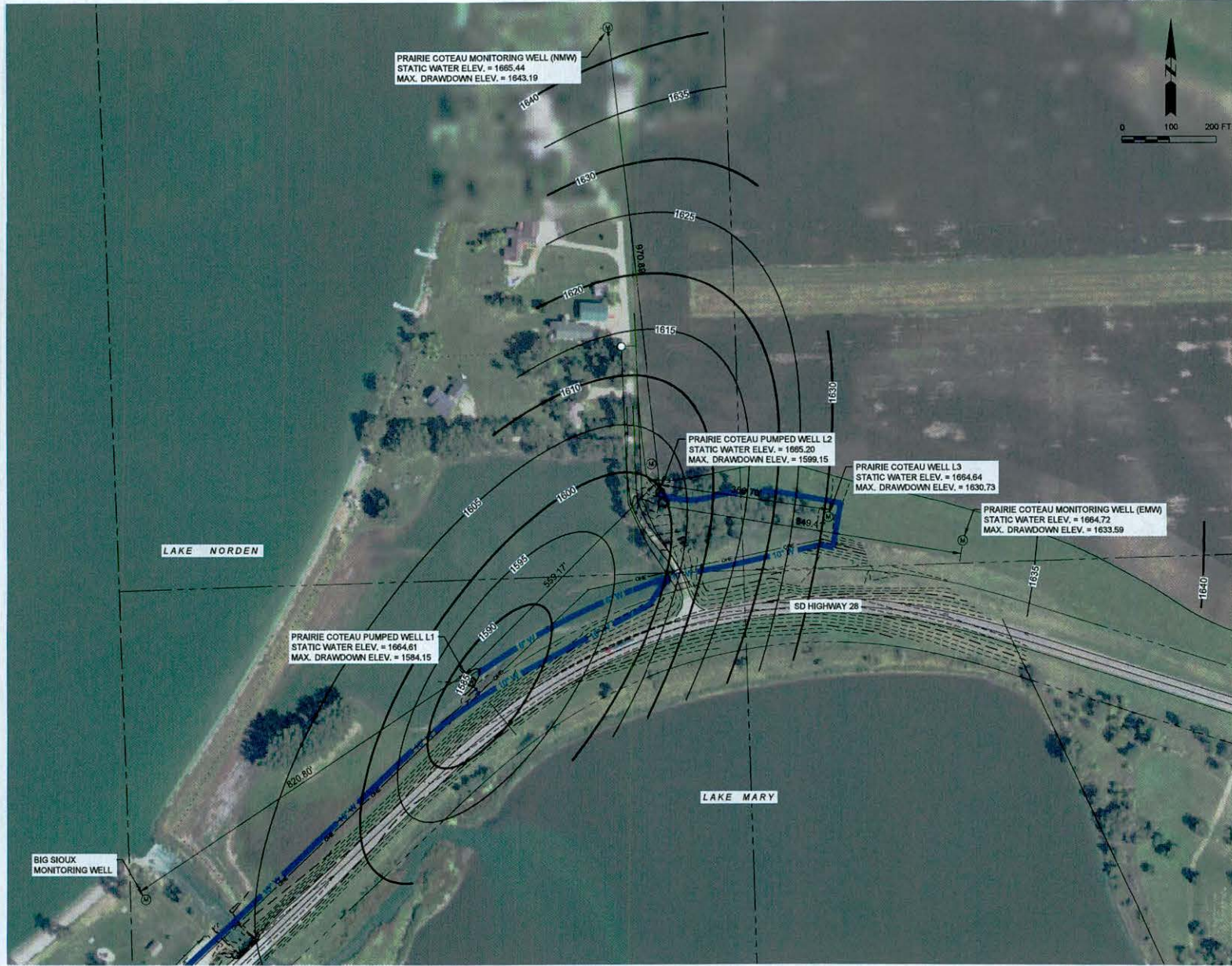
Table 1 - Summary of Aquifer Test Wells

Well Name	Distance from Well L2 (feet)	Ground Elev. (MSL)	Depth Drilled	Aquifer Thickness	Screen Interval	Static Water Elev. (MSL)	Maximum Drawdown Elev. (MSL)	Recovery Elev. (MSL)
L1	-558.97	1656.96	97.00	14'	83-97	1664.61	1584.15	1661.39
L2	0.00	1671.63	103.00	18'	83-103	1665.20	1599.15	1663.75
L3	359.80	1668.62	107.00	14'	87-107	1664.64	1630.73	1663.19
EMW	649.43	1674.87	101.00	14'	91-101	1664.72	1633.59	1663.28
NMW	970.82	1672.21	103.00	19'	93-103	1665.44	1643.19	1663.69

It was noted that the water temperature hovered around 50 degrees Fahrenheit throughout the pump test, then rose to approximately 52 degrees Fahrenheit for 2 hours right after the pump was shut off at well L1. The actual range of temperature during the entire testing period is 49.86 to 52.37 degrees Fahrenheit for a total change in temperature of 2.51 degrees. The temperature at Well L2 was similar with a range of 48.60 to 50.29 degrees Fahrenheit for a total change in temperature of 1.69 degrees. The heat from the pump motor without the constant flow of water is thought to be the reason for the slight upward temperature fluctuation.

Static water level contours were developed and are presented in Figure 5 – Static Water Level Contours. The data and the contours indicate that water is flowing from north to south which is consistent with the flow of ground water in the Big Sioux river valley.

Contours were also developed for the maximum drawdown depths and are presented in Figure 6 – Maximum Drawdown Water Level Contours. These contours appear to be elliptical in shape with the steeper slope in the east-west direction. The well logs indicated fine sands at L3 and EMW. Water will move slower through fine sands which may be the cause of a steeper slope going east of well L2.



PROJECT SHEET TITLE:
NEW WELLFIELD AND RAW WATER TRANSMISSION LINE - 2018
PRAIRIE COTEAU AQUIFER WELL LOCATIONS
LAKE NORDEN, SOUTH DAKOTA

REV	DATE	DESCRIPTION

JOB No.:	22720.00
DATE:	SEPTEMBER 2020
DESIGNED BY:	DLB
CHECKED BY:	DGO
DRAWN BY:	CFM

SCALE: REDUCTION BAR

4. Pumping Test Data Analysis

a. Explanation of Terms and Analytical Methods

Artesian Aquifer - A confined aquifer in which the water level in wells rises above the top of the aquifer.

Hydraulic Conductivity (K) – Constant of proportionality defining the specific discharge of a porous medium under a unit hydraulic gradient, $K=q/i$.

Transmissivity (T) - The product of hydraulic conductivity and saturated thickness, $T=Kb$.

Storativity (S) - Volume of water released from storage by a confined aquifer per unit surface area of aquifer per unit decline in hydraulic head normal to surface equal to product of specific storage and saturated thickness, $S=Ssb$.
[dimensionless]

Specific Storage (Ss) - Volume of water released from storage from a unit volume of aquifer per unit decline in hydraulic head.

Aquifer coefficients of transmissivity and hydraulic conductivity were calculated from the test data using methods appropriate for confined aquifer conditions. Hydraulic conductivity and transmissivity are governed by the size and shape of the pores between the grains of the water bearing aquifer. The properties of water may vary with temperature, and the hydraulic conductivity is defined on the basis of fluid viscosity and density at a particular temperature.

b. Boundary Conditions

Boundary conditions were anticipated by the SDDENR prior to the aquifer performance test. However, during the test, boundary conditions were not readily apparent, therefore, no corrections were made for Boundary Conditions.

c. Aquifer Test Results

i. Aquifer Analysis

A distance-drawdown analysis based on Cooper-Jacob Solution for Pumping Tests in Confined Aquifers was performed on data in all the observation wells at a selected time into pumping. This analysis was completed by plotting drawdown at each observation well versus the log of the distance between the observation well and the pumped well. A solution is derived from a straight-line fit to the points on the graph. When the data was plotted it is apparent that the curve has an "S" shape rather than a straight line. The shape could be caused by a

boundary condition, impact of 2 wells being pumped simultaneously, aquifer media grain size or a combination of these items.

The data indicates that the North Monitoring Well (NMW) was impacted by the pumping within 30 seconds of pump L2 startup. Based on this time frame L1 would have been influencing the drawdown at the East Monitoring Well (EMW) in approximately 33 seconds and the NMW within 43 seconds due to the distance between them, respectively. Thus, for this report and utilizing data at the end of the pumping time frame of 10 days for calculations the total flow of 640 gpm will be used in evaluation of this aquifer.

Utilizing the drawdown data at well L1 the hydraulic conductivity using Cooper-Jacob ranged from 71 to 210 ft/day depending on which portion of the curve was used for the calculation. The average value for hydraulic conductivity of L1 is 127.75 ft/day. The transmissivity using Cooper-Jacob ranged from 1400 to 4100 ft²/day depending on which portion of the curve was used for the calculation. The average value for transitivity of L1 is 2525 ft²/day.

Utilizing the drawdown data at well L2 the hydraulic conductivity using Cooper-Jacob ranged from 80 to 190 ft/day depending on which portion of the curve was used for the calculation. The average value for hydraulic conductivity of L2 is 130 ft/day. The transmissivity using Cooper-Jacob ranged from 1600 to 3700 ft²/day depending on which portion of the curve was used for the calculation. The average value for transmissivity of L2 is 2575 ft²/day.

Utilizing the recovery data at well L1 the hydraulic conductivity using Cooper-Jacob ranged from 71 to 210 ft/day depending on which portion of the curve was used for the calculation. The average value for hydraulic conductivity of L1 is 86.75 ft/day. The transmissivity using Cooper-Jacob ranged from 1300 to 2400 ft²/day depending on which portion of the curve was used for the calculation. The average value for transitivity of L1 is 1750 ft²/day.

Utilizing the recovery data at well L2 the hydraulic conductivity using Cooper-Jacob ranged from 74 to 130 ft/day depending on which portion of the curve was used for the calculation. The average value for hydraulic conductivity of L2 is 105.5 ft/day. The transmissivity using Cooper-Jacob ranged from 1500 to 2500 ft²/day depending on which portion of the curve was used for the calculation. The average value for transmissivity of L2 is 2075 ft²/day.

Another method of computing the hydraulic conductivity and transmissivity is based on the Cooper-Jacobs plot of the Distance-Drawdown curve. This method yields a value of 190 ft/day for hydraulic conductivity and 3800 ft²/day for transmissivity.

Kaiser Well Drilling of Lake Norden to find additional water source for the City of Lake Norden. Exploration began on the northeast side of town between Lake Norden and Lake Mary. Several test wells were drilled in exploration for water and based on well test pumping, Kaiser Well Drilling determined that an adequate water supply had been located.

Three of the test wells were converted to production wells with 20 feet of stainless-steel screen placed at the bottom of the aquifer. Each of the three wells are approximately 100 feet deep.

The three 10-inch diameter wells were drilled to a depth ranging from 97 to 103 feet below ground surface. Twenty feet of stainless-steel screen was placed at the bottom of each well with a screen slot size of 0.30. The east observation well was drilled to a depth of 101 feet and 10 feet of PVC screen was placed at the bottom of the well with a slot size of 0.30. The north observation well was drilled to a depth of 103 feet and 20 feet of PVC screen with a slot size of 0.25 was placed at the bottom of the well. The Big Sioux Aquifer observation well was drilled to a depth of 82 feet and 20 feet of PVC screen with a slot size of 0.25 was placed at the bottom of the well.

The description of the Prairie Coteau water bearing sands ranged as follows:

- L1 – yellow medium-course
- L2 - grey sand fine
- L3 and EMW - sand medium-fine
- NMW – yellow fine-medium sand, black fine sand and yellow medium course

A 11-day constant rate pump test was performed for the aquifer test and initiated at 10:30 a.m. on August 6, 2020. The total flow from these two well measured 640 gpm. The flow was continuous monitored by the SCADA system at the water treatment plant. The aquifer test was run by Banner Associates, Inc. and the water level drawdown and recovery data were collected manually and electronically utilizing Banner Staff, SD DENR personnel, SD Geological Service staff and City staff.

The pumps were shut off at 10:00 a.m. on August 17, 2020. The recovery data was monitored both manually and electronically by the same staff as the drawdown measurement through 7:00 a.m. on August 21, 2020.

The aquifer data analysis is summarized in Table 2- Summary of Well Analysis.

Table 2 - Summary of Well Analysis

Note: The total flow from both wells was 640 gpm.		L1 640 gpm		L2 640 gpm	
		K ft/day	T ft ² /day	K ft/day	T ft ² /day
Distance - Drawdown curve		190	3800	190	3800
Pumping	Cooper -Jacob all data (CS)	110	2200	130	2600
	Cooper -Jacob Lower data (CS)	120	2400	120	2400
	Cooper -Jacob Middle data (CS)	71	1400	80	1600
	Cooper -Jacob Upper data (CS)	210	4100	190	3700
	Average	127.75	2525	130	2575
Recovery	Cooper -Jacob all data (CS)	74	1500	98	2000
	Cooper -Jacob Lower data (CS)	120	2400	130	2500
	Cooper -Jacob Middle data (MS) (CS)	65	1300	74	1500
	Cooper -Jacob Upper data (CS)	88	1800	120	2300
	Average	86.75	1750	105.5	2075

5. Estimates of Well Field Production Potential

a. Estimated Capacity of the Prairie Coteau Aquifer

Based on the above analysis the specific capacity of Well L1 is 7.955 gpm/ft of drawdown and the specific capacity of Well L2 is 9.689 gpm/ft of drawdown.

The distance from the static water level to the top of the aquifer at L1 is 90.65 feet and at L2 is 78.57 feet. The specific capacity times the distance from the static water level to the top of the aquifer will be the maximum expected capacity of each well. Thus, the maximum expected capacity of aquifer ranges from 721 (7.955 x 90.65) gpm to 761 (9.689 x 78.57) gpm. The drawdown will have to be monitored while pumping to observe the water level in each well. The water level/drawdown should not be allowed to enter the screen. The City of Lake Norden plan to install pressure transducers that are connected to the SCADA system to monitor the water levels in the wells.

6. Summary and Conclusions

The City of Lake Norden has a population of approximately 500 people with an Agropur Cheese Plant that is a large water user. The City has several existing wells in the Big Sioux Aquifer on the southwest side of the lake called Lake Norden. The water from this location of the aquifer is high in iron and the wells plug up and need to be replaced on a 10 to 15-year rotation basis. In 2018 the City of Lake Norden entered a contract with

Table 1 - Summary of Aquifer Test Wells

Well Name	Distance from Well L2 (feet)	Ground Elev. (MSL)	Depth Drilled	Aquifer Thickness	Screen Interval	Static Water Elev. (MSL)	Maximum Drawdown Elev. (MSL)	Recovery Elev. (MSL)
L1	-558.97	1656.96	97.00	14'	83-97	1664.61	1584.15	1661.39
L2	0.00	1671.63	103.00	18'	83-103	1665.20	1599.15	1663.75
L3	359.80	1668.62	107.00	14'	87-107	1664.64	1630.73	1663.19
EMW	649.43	1674.87	101.00	14'	91-101	1664.72	1633.59	1663.28
NMW	970.82	1672.21	103.00	19'	93-103	1665.44	1643.19	1663.69

Table 2 - Summary of Well Analysis

		L1 640 gpm		L2 640 gpm	
		K ft/day	T ft ² /day	K ft/day	T ft ² /day
Distance - Drawdown curve		190	3800	190	3800
Pumping	Cooper -Jacob all data (CS)	110	2200	130	2600
	Cooper -Jacob Lower data (CS)	120	2400	120	2400
	Cooper -Jacob Middle data (CS)	71	1400	80	1600
	Cooper -Jacob Upper data (CS)	210	4100	190	3700
	Average	127.75	2525	130	2575
Recovery	Cooper -Jacob all data (CS)	74	1500	98	2000
	Cooper -Jacob Lower data (CS)	120	2400	130	2500
	Cooper -Jacob Middle data (MS) (CS)	65	1300	74	1500
	Cooper -Jacob Upper data (CS)	88	1800	120	2300
	Average	86.75	1750	105.5	2075

The conclusion of this aquifer analysis is that the Prairie Coteau Aquifer in which 3 wells have been installed has a maximum combined expected capacity range of 721 gpm to 761 gpm. The drawdown will have to be monitored while pumping to observe the water level in each well. The water level/drawdown should not be allowed to enter the screen.

Because this aquifer is under artesian pressure and 95% recovery occurred in approximately 4 days it is believed that the aquifer is receiving recharge from the north or higher ground, where the confining clay boundary crops out to the surface or into the Big Sioux Aquifer. Where this occurs may be a mile to several miles away from the three wells installed by the City of Lake Norden. The present exploration into this aquifer is not adequate to determine the actual extents of the aquifer limits.

This aquifer is limited in capacity and may not serve the community in the long term. As the City water demands increase an additional water source will become necessary. We recommend that the City continue to search for a future water supply source.

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

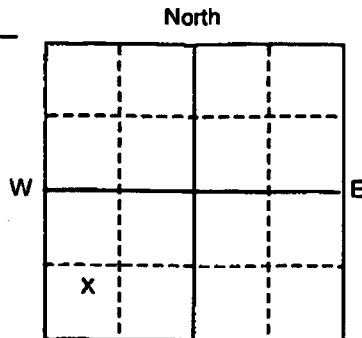
Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WWell Owner: CITY OF LAKE NORDENCounty HAMLIN

Business Name: _____

Address: PO BOX 213City, State, Zip: LAKE NORDEN SD 57248

Ground Elev. = 1656.96

Please mark well location with an "X"



Well Completion Date

10-1-2018

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?

ft. from

(identify source)

PROPOSED USE:

☐ Domestic/Stock Irrigation
 ☒ Municipal Industrial
 ☐ Business Institutional
 ☐ Test holes Monitoring well
METHOD OF DRILLING:
DIRECT ROTARY

CASING DATA:

If other describe

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40.0 LB/FT	10.00 IN	0.0 FT	83.0 FT	16.00 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWELDF	32	54.0 Lb/gal	0.0 Ft	80.0 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

SCREEN:

☐ Perforated pipe
 ☒ Manufactured
 Diameter 10.00 Inches Length 20.0 Feet
 Material SS
 Slot Size .30 Set From 83.0 Feet to 97.0 Feet

Other information

WAS A PACKER OR SEAL USED? ☐ Yes ☒ No

If so, what material?

Describe packer(s) and location

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How?
 ☐ No, Why Not?

Lab to which water quality sample sent for analysis

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
YELLOW MIXED SAND fine-med	2	18
BLUE CLAY	18	24
GREY FINE SAND	24	29
BLUE CLAY soft	29	35
GREY MED-COURSE	35	57
BLUE CLAY SOFT	57	83
YELLOW MED-COURSE	83	97

STATIC WATER LEVEL

FEET

If flowing: closed in pressure

PSI

GPM flow 40 through 10 Inch pipeControlled by ☒ Valve ☐ Reducers ☐ Other

Reduced flow rate _____ GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe:☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

Lake Norden Well L1

Well on west side of Pelican PassThis well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder: **RECEIVED**

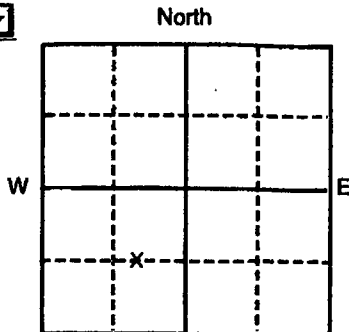
FEB 04 2019

Date:

WATER RIGHTS
PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLIN ☒Please mark well
location with an "X"

Well Completion Date

5-8-2018Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
sch40 LB/FT	10 IN	+2 FT	83 FT	11 3/4 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GrtwelDF	30	54 Lb/gal	0 Ft	80 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure _____

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 10 Inches Length 20 FeetMaterial Stainless SteelSlot Size 30 Set From 83 Feet to 103 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☒ Yes, How? HTH
☐ No, Why Not? _____
Lab to which water
quality sample sent for analysis
SDPHLWell Owner: City of Lake Norden

Business Name: _____

Address: PO Box 213City, State, Zip: Lake Norden ☒ SD ☒ 57248Ground Elev. = 1671.63

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	1
YELLOW SANDYCLAY	1	3
YELLOW SAND	3	8
YELLOW CLAY	8	10
YELLOW SAND	10	13
BLUE CLAY	13	34
YELLOW CLAY	34	85
GREY SAND FINE	85	103
BLUE CLAY	103	

STATIC WATER LEVEL 5 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ Pumped Describe: SUBMERSIBLE☐ Bailed☐ Other

Pumping Level Below Land Surface

51.7 Ft. After 26 Hrs. pumped 500 GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

well #1 east side of Pelican PassLake Norden Well L2This well was drilled under license # 689 and this report is true and accurate.Drilling firm: Kaiser Well Drilling Inc.

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

RECEIVED

FEB 04 2019

Date: _____

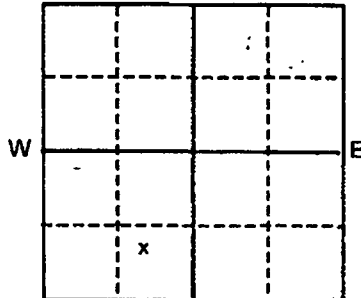
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SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLIN

North

Please mark well
location with an "X"

Well Completion Date

10-17-2018

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well
METHOD OF DRILLING:
DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40.0 LB/FT	10.00 IN	0.0 FT	87.0 FT	16.00 IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWELDF	32	54.0 Lb/gal	0.0 Ft	84.0 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure
pressure pull method

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 10.00 Inches Length 20.0 FeetMaterial SSSlot Size .30 Set From 87.0 Feet to 107.0 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____

☐ No, Why Not? _____
Lab to which water
quality sample sent for analysis _____Well Owner: CITY OF LAKE NORDEN

Business Name: _____

Address: PO BOX 213City, State, Zip: LAKE NORDEN SD 57248Ground Elev. = 1668.62

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
SAND MIXED	2	18
GRAVEL MED-COURSE	18	20
BLUE CLAY	20	40
YELLOW CLAY	40	78
BLUE CLAY	78	87
SAND MED-FINE	87	101

STATIC WATER LEVEL

8 FEET

If flowing: closed in pressure _____

PSI

GPM flow _____ through _____

Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe: 300 GPM - Sub. Pump
☐ Bailed
☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

Lake Norden Well L3

2nd Well East side Pelican PassThis well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

RECEIVED

FEB 04 2019

WATER RIGHTS
PROGRAM

Date: _____

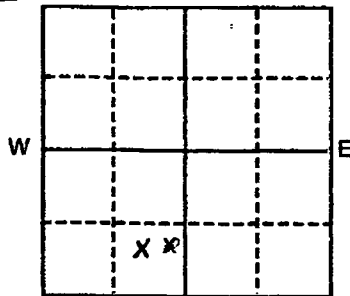
SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLIN ☒

North

Please mark well location with an "X"



Well Completion Date

8-3-2018

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
sch40 LB/FT	2.5 IN	+2 FT	91 FT	6 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
grtweldf	6	54 Lb/gal	0 Ft	90 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure _____

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 2.5 Inches Length 10 FeetMaterial SCH40Slot Size 30 Set From 91 Feet to 101 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____
☐ No, Why Not? _____
 Lab to which water quality sample sent for analysis _____
Well Owner: CITY OF LAKE NORDEN

Business Name: _____

Address: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

Ground Elev. = 1674.87

WELL LOG:

DEPTH

FORMATION	FROM	TO
TOP SOIL	0	1.5
SAND MIXED	1.5	18
GRAVEL MED- COURSE	18	20
BLUE CLAY	20	40
YELLOW CLAY	40	78
BLUE CLAY	78	87
SAND MED-FINE	87	101

STATIC WATER LEVEL

8 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT 100+☐ Bailed☐ Other _____

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

John Larson Observation well
located east of Lake Norden Well L3

This well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INCSignature of License Representative: TH for well-EastSignature of Well Owner or Equitable Property Holder: Side of Pelican Pass

RECEIVED

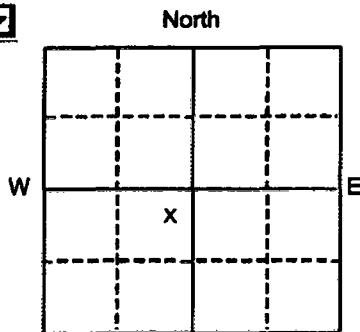
FEB 04 2019

Date: _____

WATER RIGHTS PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location NE 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLINPlease mark well
location with an "X"

Well Completion Date

07/28/2020

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (Identify source) _____

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40 LB/FT	3 IN	+2 FT	93 FT	6 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
grtweldf	5	54 Lb/gal	0 Ft	93 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured

Diameter 2.5 Inches Length 20 Feet

Material SCH 40 PVC

Slot Size 25 Set From 93 Feet to 103 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____☒ No, Why Not? _____Lab to which water
quality sample sent for analysis _____OBSERVATION WELL
NO PUMP INSTALLED

Well Owner: _____

Business Name: CITY OF LAKE NORDENAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

Ground Elev. = 1672.21

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	1
SANDY YELLOW CLAY	1	4
YELLOW GRAVEL MED- COURSE	4	18
BLUE CLAY	18	63
YELLOW CLAY	63	84
YELLOW FINE-MED	84	87
BLACK FINE SAND	87	97
YELLOW MED-COURSE	97	103

STATIC WATER LEVEL 8.3 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ Pumped Describe: PUMPED WITH AIR 60gpm☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

JOHN LARSON OBSERVATION WELL

This well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

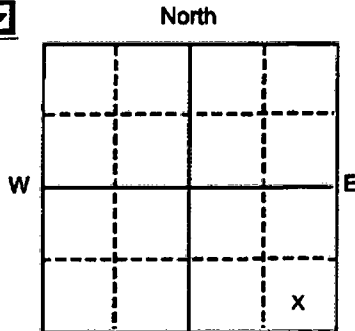
RECEIVED

AUG 24 2020

Date 8/19/2020WATER RIGHTS
PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location SE ¼ SE ¼ Sec 16 Twp 113N Rg 53WCounty HAMLIN ☒Please mark well
location with an "X"

Well Completion Date

07/29/2020

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (Identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40 LB/FT	2.5 IN	+2 FT	62 FT	6 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
grtweldf	4	54 Lb/gal	0 Ft	62 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ ManufacturedDiameter 2.5 Inches Length 20 FeetMaterial SCH 40 PVCSlot Size 25 Set From 62 Feet to 82 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____☒ No, Why Not? _____Lab to which water
quality sample sent for analysisOBSERVATION WELL
NO PUMP INSTALLED

Well Owner:

Business Name: CITY OF LAKE NORDENAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

Ground Elev. = 1660

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	1.5
YELLOW CLAY	1.5	8
FINE SAND GREY	8	20
FINE-MED	20	30
BLUE CLAY	30	32
FINE SAND	32	38
BLACK DIRT	38	48
FINE-MED	48	60
MEDIUM	60	70

STATIC WATER LEVEL

4.5 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe: PUMPED WITH AIR 75gpm☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

MED- COURSE 70-82

BLUE CLAY 82-104

YELLOW CLAY 104-160

Big Sioux Aquifer

LAKE NORDEN PARK OBSERVATION WELL

This well was drilled under license # 689 and this
report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

Date: 8/19/2020

RECEIVED

AUG 24 2020

WATER RIGHTS
PROGRAM

DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

No. 71-49

OTHER NOS.

HN-76 E

WELL LOG

State South Dakota County Hamlin Subarea HN-76 E

Owner USGS

Location 113N-53W-22aand

Lake Mary (east)

Drilled by Denver Auger Address _____

Date Aug. 12, 1971 Casing diam. 1.25 in Land-surf. alt. 1660 (T)

Source of data Clee Heaney

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Sand, buff, fine to medium, silty, wet	5	0- 5
	Sand, as above, slightly gravelly, clayey, wet	3	5- 8
	Clay, buff, gravelly, coarse	4	8-12
	Sand, buff, gravelly, clayey	5	12-17
	Sand and gravel, brown, dirty	30	17-47
	Sand and gravel, gray, dirty	15	47-62
	Sand, gravelly, dirty	5	62-67
	Sand and gravel	5	67-72
	Clay, gray, silty, pebbly, (till)	5	72-77
	observation well		
	34ft plastic pipe (21 ft slotted)		
	MP= +1.51 ft		
Aug. 12	W/L= 13.69 ft		

RECORD BY Jack Kume DATE 8-12-71

SHEET _____ OF _____



DENR
SOUTH DAKOTA

**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3182
denr.sd.gov

August 03, 2020

Gregg Jorgenson
Banner Associates, Inc.
409 22nd Ave South
Brookings, SD 57006

Dear Mr. Jorgenson:

This letter serves as official permission to access and measure observation well HN-76E for the duration of the aquifer performance test being conducted on behalf of the City of Lake Norden. There are just a few items when measuring observation well HN-76E.

1. If the observation well has a lock, please keep the observation well locked when it is not being measured or surveyed.
2. Keep the observation well covered when it is not being measured or surveyed.
3. Do not modify the observation well in any manner without written or in person permission from SDDENR Water Rights Program staff engineers Adam Mathiowetz or Whitney Kilts.
4. If any damage to the observation well is observed or if the lock or cap is missing, please notify the SDDENR Water Rights Program immediately so staff can be sent to repair the well.
5. Please do not leave anything foreign in the well. If a piece of measuring equipment falls down the well, please notify the SDDENR Water Rights Program immediately.
6. When the project is completed, please return the observation well and its immediate vicinity to as close as possible to pre-performance test condition (e.g. well cover, fence posts, labels, etc.).
7. Please notify us of any changes to the measurement schedule that has been established during the design of the city's aquifer performance test.
8. Please notify us once monitoring of the observation well for the aquifer performance test has been completed.

If you have any questions or to notify the SDDENR Water Rights Program of an issue with the observation wells, please contact Adam Mathiowetz at 605-773-3352.

Sincerely,

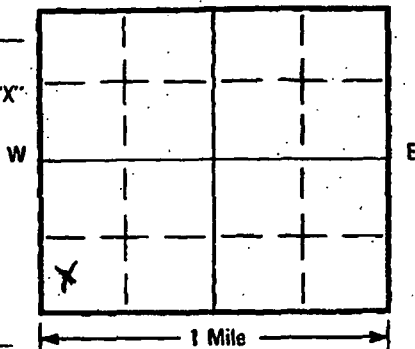
Adam Mathiowetz
South Dakota DENR-Water Rights Program

SOUTH DAKOTA WATER WELL COMPLETION REPORT

07-92

Location SW 1/4 SW 1/4 Sec 10 Twp 113N Rg 53W
 County Hamlin

Please mark well location with an "X"



Well Completion Date

8-18-09

LOCATION:

Distance from nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)? 1000 ft. from old well (identify source)

PROPOSED USE:

☒ Domestic/Stock ☐ Municipal ☐ Business ☐ Test Holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

Direct Rotary

CASING DATA: ☐ Steel ☒ Plastic ☐ Other

If other describe

PIPEWEIGHT DIAMETER FROM TO HOLE DIAMETER
Sch 40 LB/FT 5 IN 264 FT 92 FT 8 1/2 IN
 LB/FT IN FT FT IN
 LB/FT IN FT FT IN

GROUTING DATA

Grout Type Grout Wash No. of Sacks 8 Grout Weight 5-1 lb./gal From 0 ft To 80 ft
DF lb./gal ft

Describe grouting procedure pressure grout method

SCREEN: ☐ Perforated pipe ☒ Manufactured

Diameter 5 IN Length 10 FEET

Material plastic
 Slot Size 2035 Set From 92 Feet to 102 Feet

Other information

WAS A PACKER OR SEAL USED? ☐ YES ☐ NO

If so, what material?

Describe packer(s) and location?

DISINFECTION: Was well disinfected upon completion?

☒ YES, How: 12.14 Table

☐ NO, Why Not?

Laboratory sent to for water quality analysis

None
no pump installed

Well Owner: Travis and Kim Hymans
 Business Name:
 Address: PO Box 395
Hayti, SD 57241

WELL LOG: Ground Elev. = 1671

FORMATION	DEPTH	
	FROM	TO
Top Soil	0	1
yellow clay	1	10
yellow sand	10	18
Blue clay	18	87
yellow clay	87	92
yellow mixed gravel	92	102

STATIC WATER LEVEL 21 Feet

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

Reduced Flowrate _____ GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe: air lift

☐ Bailed

☐ Other

Pumping Level Below Land Surface

25 ft. After 2 Hrs. pumped 100 GPM

ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate _____ GPM

REMARKS

RECEIVED

SEP 17 2009

WATER RIGHTS PROGRAM

This well was drilled under license # 689

And this report is true and accurate.

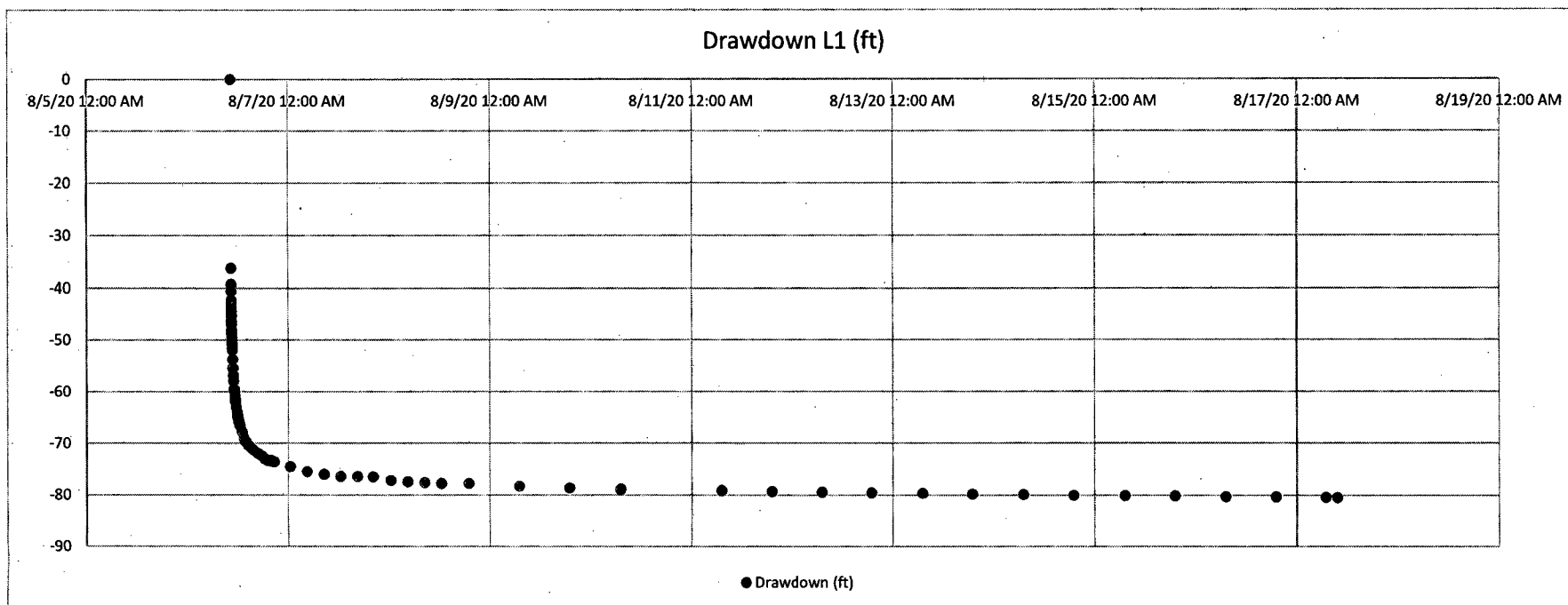
Drilling firm Kaiser Well Drilling

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder:

Date: 9-11-09

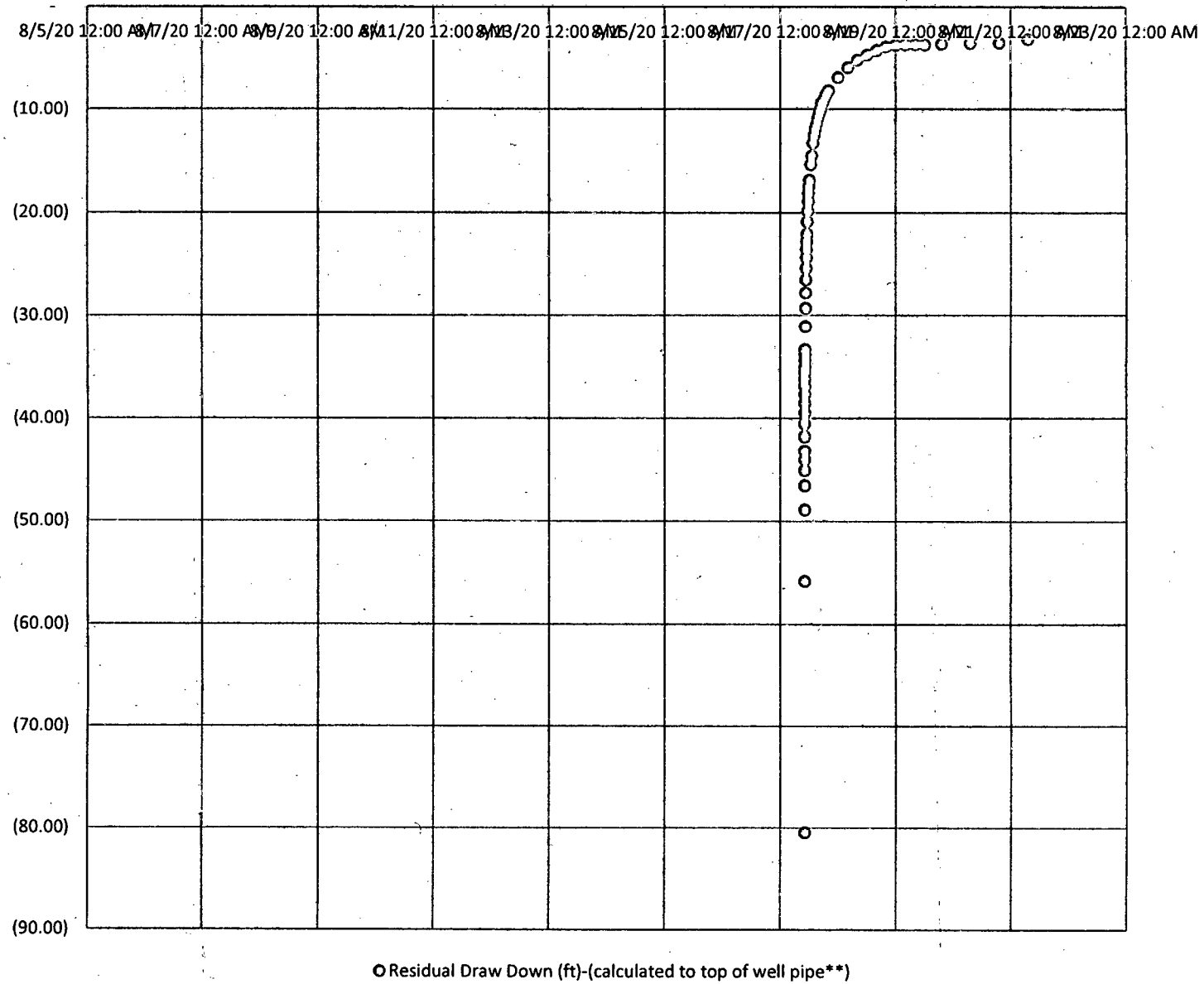
Type of Test	Drawdown	Well ID:	L1	Well Elev.	1665.063	1661.063	Ground
Static Water Level	1664.605	Date:	6-Aug-20	Ground Elev.	1656.96	1575	Screen
Distance of Observation well from pumped well (r):							
Time	Time since Pumping began (min)	Depth to Water Level (ft)	Drawdown (ft)	t/r^2	Pumping Rate (Q) (gpm)	Comments	Water Elev. *Screen from 83' to 97'
8/6/20 10:32 AM	0	0.458	0				1664.605
8/6/20 10:32 AM	0.50	36.65	-36.192				1628.413
8/6/20 10:33 AM	1.00	39.75	-39.292				1625.313
8/6/20 10:33 AM	1.50	40.95	-40.492				1624.113
8/6/20 10:34 AM	2.00	42.65	-42.192				1622.413
8/6/20 10:34 AM	2.50	43.35	-42.892				1621.713
8/6/20 10:35 AM	3.00	44.25	-43.792				1620.813
8/6/20 10:36 AM	4.00	44.85	-44.392				1620.213
8/6/20 10:37 AM	5.00	45.8	-45.342				1619.263
8/6/20 10:38 AM	6.00	46.85	-46.392				1618.213
8/6/20 10:39 AM	7.00	47.45	-46.992				1617.613
8/6/20 10:40 AM	8.00	48.55	-48.092				1616.513
8/6/20 10:41 AM	9.00	49.2	-48.742				1615.863
8/6/20 10:42 AM	10.00	49.85	-49.392				1615.213
8/6/20 10:43 AM	11.00	50.45	-49.992				1614.613
8/6/20 10:44 AM	12.00	51	-50.542				1614.063
8/6/20 10:45 AM	13.00	51.53	-51.072				1613.533
8/6/20 10:46 AM	14.00	52	-51.542				1613.063
8/6/20 10:47 AM	15.00	52.47	-52.012				1612.593
8/6/20 10:52 AM	20.00	54.25	-53.792				1610.813
8/6/20 10:57 AM	25.00	55.92	-55.462				1609.143
8/6/20 11:02 AM	30.00	57.35	-56.892				1607.713
8/6/20 11:07 AM	35.00	58.4	-57.942				1606.663
8/6/20 11:12 AM	40.00	59.95	-59.492				1605.113
8/6/20 11:17 AM	45.00	60.29	-59.832				1604.773
8/6/20 11:22 AM	50.00	61.06	-60.602				1604.003
8/6/20 11:27 AM	55.00	61.78	-61.322				1603.283
8/6/20 11:32 AM	60.00	62.38	-61.922				1602.683
8/6/20 11:42 AM	70.00	63.46	-63.002				1601.603
8/6/20 11:52 AM	80.00	64.38	-63.922				1600.683
8/6/20 12:02 PM	90.00	65.16	-64.702				1599.903
8/6/20 12:12 PM	100.00	65.84	-65.382				1599.223
8/6/20 12:22 PM	110.00	66.44	-65.982				1598.623
8/6/20 12:32 PM	120.00	66.97	-66.512				1598.093
8/6/20 1:02 PM	150.00	68.24	-67.782				1596.823
8/6/20 1:32 PM	180.00	69.44	-68.982				1595.623
8/6/20 2:02 PM	210.00	70.19	-69.732				1594.873
8/6/20 2:32 PM	240.00	70.84	-70.382				1594.223
8/6/20 3:02 PM	270.00	71.18	-70.722				1593.883
8/6/20 3:32 PM	300.00	71.57	-71.112				1593.493
8/6/20 4:02 PM	330.00	71.91	-71.452				1593.153
8/6/20 4:32 PM	360.00	72.22	-71.762				1592.843
8/6/20 5:06 PM	394.00	72.54	-72.082				1592.523
8/6/20 5:39 PM	427.00	72.85	-72.392				1592.213
8/6/20 6:24 PM	472.00	73.45	-72.992				1591.613
8/6/20 7:00 PM	508.00	73.73	-73.272				1591.333
8/6/20 7:22 PM	530.00	73.85	-73.392				1591.213
8/6/20 7:49 PM	557.00	73.79	-73.332				1591.273
8/6/20 8:12 PM	580.00	73.91	-73.452				1591.153
8/6/20 8:41 PM	609.00	74.06	-73.602				1591.003
8/7/20 12:32 AM	840.00	74.96	-74.502				1590.103
8/7/20 4:32 AM	1,080.00	75.92	-75.462				1589.143
8/7/20 8:34 AM	1,322.00	76.46	-76.002				1588.603
8/7/20 12:29 PM	1,557.00	76.85	-76.392				1588.213
8/7/20 4:31 PM	1,799.00	76.88	-76.422				1588.183
8/7/20 8:16 PM	2,024.00	76.92	-76.462				1588.143
8/8/20 12:30 AM	2,278.00	77.65	-77.192				1587.413
8/8/20 4:32 AM	2,520.00	77.87	-77.412				1587.193
8/8/20 8:35 AM	2,763.00	78.08	-77.622				1586.983
8/8/20 12:34 PM	3,002.00	78.22	-77.762				1586.843
8/8/20 7:04 PM	3,392.00	78.23	-77.772				1586.833
8/9/20 7:04 AM	4,112.00	78.75	-78.292				1586.313
8/9/20 6:57 PM	4,825.00	79.05	-78.592				1586.013
8/10/20 7:04 AM	5,552.00	79.29	-78.832				1585.773
8/10/20 7:02 AM	5,550.00	79.45	-78.992				1585.613
8/11/20 7:07 AM	6,995.00	79.6	-79.142				1585.463
8/11/20 7:07 PM	7,715.00	79.75	-79.292				1585.313
8/12/20 7:10 AM	8,438.00	79.89	-79.432				1585.173
8/12/20 6:57 PM	9,145.00	80	-79.542				1585.063
8/13/20 7:03 AM	9,871.00	80.12	-79.662				1584.943
8/13/20 6:52 PM	10,580.00	80.25	-79.792				1584.813
8/14/20 7:01 AM	11,309.00	80.33	-79.872				1584.733
8/14/20 6:56 PM	12,024.00	80.44	-79.982				1584.623
8/15/20 7:05 AM	12,753.00	80.5	-80.042				1584.563
8/15/20 7:02 PM	13,470.00	80.61	-80.152				1584.453
8/16/20 7:07 AM	14,195.00	80.71	-80.252				1584.353
8/16/20 7:03 PM	14,911.00	80.77	-80.312				1584.293
8/17/20 6:54 AM	15,622.00	80.86	-80.402				1584.203
8/17/20 9:35 AM	15,783.00	80.91	-80.452				1584.153



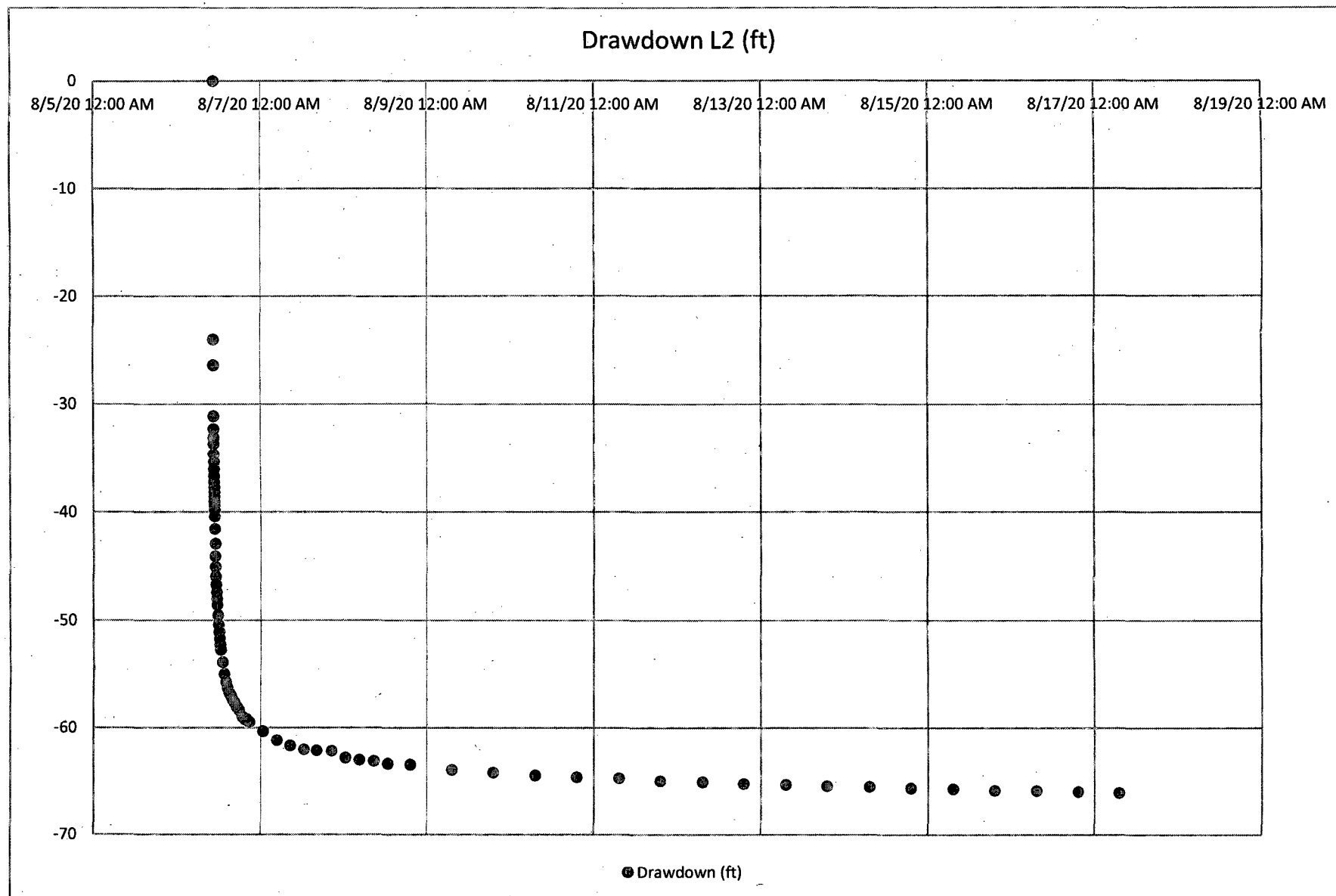
Type of Test		Recovery	Well ID:	L1	Well Elev.	1665.063	Top of PVC extension
Static Water Level		1664.605	Date:	17-Aug-20	Ground Elev.	1656.96	Static water level = 1666.355-1.75
Distance of Observation well from pumped well (r):							
Time	Time since Pumping began (min)	Time (t') since Pumping stopped (min)	Depth to Water Level (ft)	Residual Draw Down (ft)-(calculated to top of well pipe**)	t/t'	Comments	Water Elevation *Screen from 83' to 97'
8/6/20 10:32 AM	0		0.458			Pumping Started	1664.605
8/17/20 10:00 AM	15,808.00		80.91	-80.45		Pumping Stopped	1584.15
8/17/20 10:00 AM	15,808.50	0.50	56.25	-55.79	31616.9999		1608.81
8/17/20 10:01 AM	15,809.00	1.00	49.35	-48.89	15808.99995		1615.71
8/17/20 10:01 AM	15,809.50	1.50	47.00	-46.54	10540.25217		1618.06
8/17/20 10:02 AM	15,810.00	2.00	45.55	-45.09	7905.329336		1619.51
8/17/20 10:02 AM	15,810.50	2.50	44.45	-43.99	6324.410769		1620.61
8/17/20 10:03 AM	15,811.00	3.00	43.55	-43.09	5270.626086		1621.51
8/17/20 10:04 AM	15,812.00	4.00	42.20	-41.74	3952.999997		1622.86
8/17/20 10:05 AM	15,813.00	5.00	41.00	-40.54	3162.547308		1624.06
8/17/20 10:06 AM	15,814.00	6.00	39.95	-39.49	2635.556894		1625.11
8/17/20 10:07 AM	15,815.00	7.00	39.00	-38.54	2259.151301		1626.06
8/17/20 10:08 AM	15,816.00	8.00	38.15	-37.69	1976.855927		1626.91
8/17/20 10:09 AM	15,817.00	9.00	37.38	-36.92	1757.298086		1627.68
8/17/20 10:10 AM	15,818.00	10.00	36.68	-36.22	1581.655107		1628.38
8/17/20 10:11 AM	15,819.00	11.00	36.02	-35.56	1437.960275		1629.04
8/17/20 10:12 AM	15,820.00	12.00	35.43	-34.97	1318.205271		1629.63
8/17/20 10:13 AM	15,821.00	13.00	34.82	-34.36	1216.875294		1630.24
8/17/20 10:14 AM	15,822.00	14.00	34.26	-33.80	1130.02189		1630.80
8/17/20 10:15 AM	15,823.00	15.00	33.76	-33.30	1054.749583		1631.30
8/17/20 10:20 AM	15,828.00	20.00	31.55	-31.09	791.3999999		1633.51
8/17/20 10:25 AM	15,833.00	25.00	29.77	-29.31	633.3663736		1635.29
8/17/20 10:30 AM	15,838.00	30.00	28.28	-27.82	527.9962801		1636.78
8/17/20 10:35 AM	15,842.99	34.99	27.01	-26.55	452.7259773		1638.05
8/17/20 10:40 AM	15,847.99	39.99	25.89	-25.43	396.2699957		1639.17
8/17/20 10:45 AM	15,853.00	45.00	24.86	-24.40	352.2888889		1640.20
8/17/20 10:50 AM	15,858.00	50.00	24.04	-23.58	317.16		1641.02
8/17/20 10:55 AM	15,863.00	55.00	23.26	-22.80	288.4181818		1641.80
8/17/20 11:00 AM	15,868.00	60.00	22.56	-22.10	264.4666666		1642.50
8/17/20 11:10 AM	15,878.00	70.00	21.35	-20.89	226.8285714		1643.71
8/17/20 11:20 AM	15,888.00	80.00	20.30	-19.84	198.6		1644.76
8/17/20 11:30 AM	15,898.00	90.00	19.40	-18.94	176.6444444		1645.66
8/17/20 11:40 AM	15,908.00	100.00	18.63	-18.17	159.08		1646.43
8/17/20 11:50 AM	15,918.00	110.00	17.94	-17.48	144.7090909		1647.12
8/17/20 12:00 PM	15,928.00	120.00	17.32	-16.86	132.7333333		1647.74
8/17/20 12:30 PM	15,958.00	150.00	15.81	-15.35	106.3866667		1649.25
8/17/20 1:00 PM	15,988.00	180.00	14.97	-14.51	88.82222222		1650.09
8/17/20 1:30 PM	16,018.00	210.00	13.73	-13.27	76.27619047		1651.33
8/17/20 2:00 PM	16,048.00	240.00	12.96	-12.50	66.86666666		1652.10
8/17/20 2:30 PM	16,078.00	270.00	12.35	-11.89	59.54814815		1652.71
8/17/20 3:00 PM	16,108.00	300.00	11.82	-11.36	53.69333333		1653.24
8/17/20 3:30 PM	16,138.00	330.00	11.32	-10.86	48.9030303		1653.74
8/17/20 4:00 PM	16,168.00	360.00	10.89	-10.43	44.91111111		1654.17
8/17/20 4:28 PM	16,196.00	388.00	10.53	-10.07	41.74226804		1654.53
8/17/20 4:58 PM	16,226.00	418.00	9.87	-9.41	38.81818182		1655.19
8/17/20 5:28 PM	16,256.00	448.00	9.85	-9.39	36.28571429		1655.21
8/17/20 5:56 PM	16,284.00	476.00	9.58	-9.12	34.21008403		1655.48
8/17/20 6:28 PM	16,316.00	508.00	9.29	-8.83	32.11811024		1655.77
8/17/20 6:56 PM	16,344.00	536.00	9.07	-8.61	30.49253731		1655.99
8/17/20 7:29 PM	16,377.00	569.00	8.83	-8.37	28.78207381		1656.23
8/17/20 7:57 PM	16,405.00	597.00	8.63	-8.17	27.47906198		1656.43
8/17/20 11:53 PM	16,641.00	833.00	7.35	-6.89	19.97719088		1657.71
8/18/20 3:58 AM	16,886.00	1,078.00	6.42	-5.96	15.66419295	Difference	1658.64
8/18/20 7:57 AM	17,125.00	1,317.00	5.67	-5.21	13.00303721		1659.39
8/18/20 11:58 AM	17,366.00	1,558.00	5.18	-4.72	11.14634146		1659.88
8/18/20 3:56 PM	17,604.00	1,796.00	4.76	-4.30	9.801781737		1660.30
8/18/20 7:51 PM	17,839.00	2,031.00	4.38	-3.92	8.783357952		1660.68
8/18/20 11:50 PM	18,078.00	2,270.00	4.23	-3.77	7.963876652		1660.83
8/19/20 4:00 AM	18,328.00	2,520.00	4.22	-3.76	7.273015873		1660.84
8/19/20 8:05 AM	18,573.00	2,765.00	4.18	-3.72	6.717179024		1660.88
8/19/20 12:06 PM	18,814.00	3,006.00	4.20	-3.74	6.258815702		1660.86
8/19/20 6:59 PM	19,227.00	3,419.00	4.13	-3.67	5.623574144		1660.93
8/20/20 6:58 AM	19,946.00	4,138.00	4.05	-3.59	4.820202997		1661.01
8/20/20 7:01 PM	20,669.00	4,861.00	4.00	-3.54	4.25200576		1661.06
8/21/20 6:58 AM	21,386.00	5,578.00	3.67	-3.21	3.833990678		1661.39

Ground = 1656.96
top of casing = 1661.42
Top of PVC extension = 1665.673

Residual Recovery L1 (ft)-(calculated to top of well pipe**)



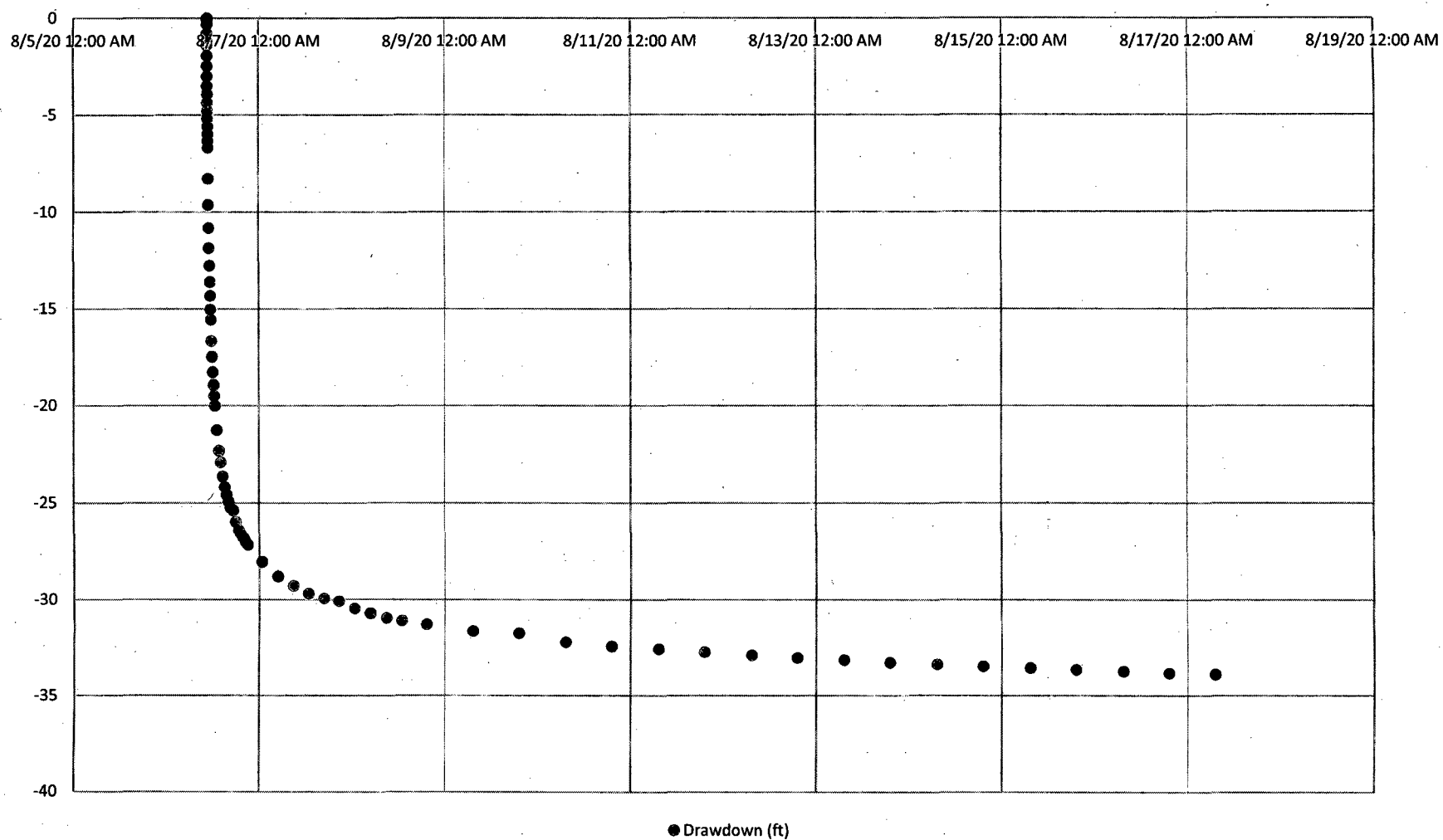
Type of Test	Drawdown	Well ID:	Well L2	Well Elev.	1673.594	1671.594 ground		
Static Water Level	1665.204	Date:	6-Aug-20	Ground Elev	1671.63	1588.594 screen		
Distance of Observation well from pumped well (r):								
Time	Time since Pumping began (min)	Depth to Water Level (ft)	Drawdown (ft)	t/r^2	Pumping Rate (Q) (gpm)	Comments	Water Elevation	*Screen from 83' to 103'
8/6/20 10:32 AM	#####	8.39	0				1665.204	
8/6/20 10:32 AM	0.50	32.4	-24.01				1641.194	
8/6/20 10:33 AM	1.00	34.81	-26.42				1638.784	
8/6/20 10:33 AM	1.50	39.5	-31.11				1634.094	
8/6/20 10:34 AM	2.00	40.71	-32.32				1632.884	
8/6/20 10:34 AM	2.50	41.45	-33.06				1632.144	
8/6/20 10:35 AM	3.00	42.03	-33.64				1631.564	
8/6/20 10:36 AM	4.00	43.01	-34.62				1630.584	
8/6/20 10:37 AM	5.00	43.75	-35.36				1629.844	
8/6/20 10:38 AM	6.00	44.42	-36.03				1629.174	
8/6/20 10:39 AM	7.00	45.05	-36.66				1628.544	
8/6/20 10:40 AM	8.00	45.57	-37.18				1628.024	
8/6/20 10:41 AM	9.00	46.09	-37.70				1627.504	
8/6/20 10:42 AM	10.00	46.56	-38.17				1627.034	
8/6/20 10:43 AM	11.00	46.99	-38.60				1626.604	
8/6/20 10:44 AM	12.00	47.42	-39.03				1626.174	
8/6/20 10:45 AM	13.00	47.81	-39.42				1625.784	
8/6/20 10:46 AM	14.00	48.18	-39.79				1625.414	
8/6/20 10:47 AM	15.00	48.81	-40.42				1624.784	
8/6/20 10:52 AM	20.00	49.96	-41.57				1623.634	
8/6/20 10:57 AM	25.00	51.33	-42.94				1622.264	
8/6/20 11:02 AM	30.00	52.48	-44.09				1621.114	
8/6/20 11:07 AM	35.00	53.47	-45.08				1620.124	
8/6/20 11:12 AM	40.00	54.34	-45.95				1619.254	
8/6/20 11:17 AM	45.00	55.11	-46.72				1618.484	
8/6/20 11:22 AM	50.00	55.82	-47.43				1617.774	
8/6/20 11:27 AM	55.00	56.42	-48.03				1617.174	
8/6/20 11:32 AM	60.00	56.97	-48.58				1616.624	
8/6/20 11:42 AM	70.00	57.93	-49.54				1615.664	
8/6/20 11:52 AM	80.00	58.78	-50.39				1614.814	
8/6/20 12:02 PM	90.00	59.48	-51.09				1614.114	
8/6/20 12:12 PM	100.00	60.09	-51.70				1613.504	
8/6/20 12:22 PM	110.00	60.64	-52.25				1612.954	
8/6/20 12:32 PM	120.00	61.13	-52.74				1612.464	
8/6/20 1:02 PM	150.00	62.29	-53.90				1611.304	
8/6/20 1:32 PM	180.00	63.37	-54.98				1610.224	
8/6/20 2:02 PM	210.00	64.11	-55.72				1609.484	
8/6/20 2:32 PM	240.00	64.69	-56.30				1608.904	
8/6/20 3:02 PM	270.00	65.18	-56.79				1608.414	
8/6/20 3:32 PM	300.00	65.43	-57.04				1608.164	
8/6/20 4:02 PM	330.00	65.77	-57.38				1607.824	
8/6/20 4:32 PM	360.00	66.05	-57.66				1607.544	
8/6/20 5:15 PM	403.00	66.43	-58.04				1607.164	
8/6/20 5:51 PM	439.00	66.73	-58.34				1606.864	
8/6/20 6:49 PM	497.00	67.34	-58.95				1606.254	
8/6/20 7:07 PM	515.00	67.47	-59.08				1606.124	
8/6/20 7:32 PM	540.00	67.63	-59.24				1605.964	
8/6/20 7:57 PM	565.00	67.57	-59.18				1606.024	
8/6/20 8:23 PM	591.00	67.7	-59.31				1605.894	
8/6/20 8:52 PM	620.00	67.87	-59.48				1605.724	
8/7/20 12:46 AM	854.00	68.72	-60.33				1604.874	
8/7/20 4:44 AM	1,092.00	69.56	-61.17				1604.034	
8/7/20 8:42 AM	1,330.00	70.06	-61.67				1603.534	
8/7/20 12:39 PM	1,567.00	70.44	-62.05				1603.154	
8/7/20 4:17 PM	1,785.00	70.52	-62.13				1603.074	
8/7/20 8:36 PM	2,044.00	70.56	-62.17				1603.034	
8/8/20 12:38 AM	2,286.00	71.21	-62.82				1602.384	
8/8/20 4:40 AM	2,528.00	71.41	-63.02				1602.184	
8/8/20 8:49 AM	2,777.00	71.53	-63.14				1602.064	
8/8/20 12:47 PM	3,015.00	71.77	-63.38				1601.824	
8/8/20 7:16 PM	3,404.00	71.85	-63.46				1601.744	
8/9/20 7:16 AM	4,124.00	72.33	-63.94				1601.264	
8/9/20 7:09 PM	4,837.00	72.59	-64.20				1601.004	
8/10/20 7:15 AM	5,563.00	72.84	-64.45				1600.754	
8/10/20 7:11 PM	6,279.00	73.03	-64.64				1600.564	
8/11/20 7:17 AM	7,005.00	73.11	-64.72				1600.484	
8/11/20 7:08 PM	7,716.00	73.35	-64.96				1600.244	
8/12/20 7:19 AM	8,447.00	73.48	-65.09				1600.114	
8/12/20 7:05 PM	9,153.00	73.62	-65.23				1599.974	
8/13/20 7:11 AM	9,879.00	73.72	-65.33				1599.874	
8/13/20 7:01 PM	10,589.00	73.85	-65.46				1599.744	
8/14/20 7:12 AM	11,320.00	73.92	-65.53				1599.674	
8/14/20 7:03 PM	12,031.00	74.03	-65.64				1599.564	
8/15/20 7:15 AM	12,763.00	74.12	-65.73				1599.474	
8/15/20 7:10 PM	13,478.00	74.25	-65.86				1599.344	
8/16/20 7:14 AM	14,202.00	74.28	-65.89				1599.314	
8/16/20 7:10 PM	14,918.00	74.36	-65.97				1599.234	
8/17/20 7:02 AM	15,630.00	74.44	-66.05				1599.154	



Type of Test		Recovery	Well ID:	Well L2	Well Elev.	1673.594		
Static Water Level		1665.204	Date:	6-Aug-20	Ground Elev	1671.63		
Distance of Observation well from pumped well (r):								
Time	Time since Pumping began (min)	Time (t') since Pumping stopped (min.)	Depth to Water Level (ft)	Residual Drawdown (ft)	t/t'	Comments	Water Elev.	*Screen from 83' to 103'
8/6/20 10:32 AM	0		8.39			Pumping Started	1665.204	
8/17/20 10:00 AM	15,808.00	-	74.44			Pumping Stopped		
8/17/20 10:00 AM	15,808.50	0.50	51.73	-43.34	31616.9999		1621.864	
8/17/20 10:01 AM	15,809.00	1.00	47.46	-39.07	15808.9999		1626.134	
8/17/20 10:01 AM	15,809.50	1.50	46.13	-37.74	10540.2522		1627.464	
8/17/20 10:02 AM	15,810.00	2.00	45.18	-36.79	7905.32934		1628.414	
8/17/20 10:02 AM	15,810.50	2.50	44.52	-36.13	6324.41077		1629.074	
8/17/20 10:03 AM	15,811.00	3.00	43.87	-35.48	5270.62609		1629.724	
8/17/20 10:04 AM	15,812.00	4.00	42.94	-34.55	3953		1630.654	
8/17/20 10:05 AM	15,813.00	5.00	42.15	-33.76	3162.54731		1631.444	
8/17/20 10:06 AM	15,814.00	6.00	41.42	-33.03	2635.55689		1632.174	
8/17/20 10:07 AM	15,815.00	7.00	40.83	-32.44	2259.1513		1632.764	
8/17/20 10:08 AM	15,816.00	8.00	40.23	-31.84	1976.85593		1633.364	
8/17/20 10:09 AM	15,817.00	9.00	39.69	-31.3	1757.29809		1633.904	
8/17/20 10:10 AM	15,818.00	10.00	39.19	-30.8	1581.65511		1634.404	
8/17/20 10:11 AM	15,819.00	11.00	38.65	-30.26	1437.96028		1634.944	
8/17/20 10:12 AM	15,820.00	12.00	38.27	-29.88	1318.20527		1635.324	
8/17/20 10:13 AM	15,821.00	13.00	37.85	-29.46	1216.87529		1635.744	
8/17/20 10:14 AM	15,822.00	14.00	37.44	-29.05	1130.02189		1636.154	
8/17/20 10:15 AM	15,823.00	15.00	37.05	-28.66	1054.74958		1636.544	
8/17/20 10:20 AM	15,828.00	20.00	35.36	-26.97	791.4		1638.234	
8/17/20 10:25 AM	15,833.00	25.00	33.95	-25.56	633.366374		1639.644	
8/17/20 10:30 AM	15,838.00	30.00	32.74	-24.35	527.99628		1640.854	
8/17/20 10:35 AM	15,842.99	34.99	31.68	-23.29	452.725977		1641.914	
8/17/20 10:40 AM	15,847.99	39.99	30.75	-22.36	396.269996		1642.844	
8/17/20 10:45 AM	15,853.00	45.00	29.92	-21.53	352.288889		1643.674	
8/17/20 10:50 AM	15,858.00	50.00	29.18	-20.79	317.16		1644.414	
8/17/20 10:55 AM	15,863.00	55.00	29.54	-21.15	288.418182		1644.054	
8/17/20 11:00 AM	15,868.00	60.00	27.93	-19.54	264.466667		1645.664	
8/17/20 11:10 AM	15,878.00	70.00	26.86	-18.47	226.828571		1646.734	
8/17/20 11:20 AM	15,888.00	80.00	25.96	-17.57	198.6		1647.634	
8/17/20 11:30 AM	15,898.00	90.00	25.18	-16.79	176.644444		1648.414	
8/17/20 11:40 AM	15,908.00	100.00	24.5	-16.11	159.08		1649.094	
8/17/20 11:50 AM	15,918.00	110.00	23.88	-15.49	144.709091		1649.714	
8/17/20 12:00 PM	15,928.00	120.00	23.35	-14.96	132.733333		1650.244	
8/17/20 12:30 PM	15,958.00	150.00	21.98	-13.59	106.386667		1651.614	
8/17/20 1:00 PM	15,988.00	180.00	21.3	-12.91	88.822222		1652.294	
8/17/20 1:30 PM	16,018.00	210.00	20.18	-11.79	76.2761905		1653.414	
8/17/20 2:00 PM	16,048.00	240.00	19.49	-11.1	66.8666667		1654.104	
8/17/20 2:30 PM	16,078.00	270.00	18.93	-10.54	59.5481481		1654.664	
8/17/20 3:00 PM	16,108.00	300.00	18.41	-10.02	53.6933333		1655.184	
8/17/20 3:30 PM	16,138.00	330.00	17.97	-9.58	48.9030303		1655.624	
8/17/20 4:00 PM	16,168.00	360.00	17.59	-9.2	44.9111111		1656.004	
8/17/20 4:36 PM	16,204.00	396.00	17.13	-8.74	40.9191919		1656.464	
8/17/20 5:04 PM	16,232.00	424.00	16.83	-8.44	38.2830189		1656.764	
8/17/20 5:36 PM	16,264.00	456.00	16.32	-7.93	35.6666667		1657.274	
8/17/20 6:02 PM	16,290.00	482.00	16.3	-7.91	33.7966805		1657.294	
8/17/20 6:35 PM	16,323.00	515.00	16.05	-7.66	31.6951456		1657.544	
8/17/20 7:02 PM	16,350.00	542.00	15.84	-7.45	30.1660517		1657.754	
8/17/20 7:35 PM	16,383.00	575.00	15.62	-7.23	28.4921739		1657.974	
8/17/20 8:03 PM	16,411.00	603.00	15.44	-7.05	27.2155887		1658.154	
8/18/20 12:00 AM	16,648.00	840.00	14.23	-5.84	19.8190476		1659.364	
8/18/20 4:08 AM	16,896.00	1,088.00	13.38	-4.99	15.5294118		1660.214	
8/18/20 8:07 AM	17,135.00	1,327.00	12.74	-4.35	12.9125848		1660.854	
8/18/20 12:04 PM	17,372.00	1,564.00	12.23	-3.84	11.1074169		1661.364	
8/18/20 4:03 PM	17,611.00	1,803.00	11.84	-3.45	9.76760954		1661.754	
8/18/20 7:57 PM	17,845.00	2,037.00	11.52	-3.13	8.76043201		1662.074	
8/18/20 11:57 PM	18,085.00	2,277.00	11.24	-2.85	7.94246816		1662.354	
8/19/20 4:11 AM	18,339.00	2,531.00	11.05	-2.66	7.24575267		1662.544	
8/19/20 8:13 AM	18,581.00	2,773.00	10.88	-2.49	6.70068518	10.557 <- 95% recove	1662.714	
8/19/20 12:14 PM	18,822.00	3,014.00	10.72	-2.33	6.24485733		1662.874	
8/20/20 7:05 AM	19,953.00	4,145.00	10.48	-2.09	4.81375151		1663.114	
8/20/20 7:04 PM	20,672.00	4,864.00	10.17	-1.78	4.25		97.3% 1663.424	
8/21/20 7:07 AM	21,395.00	5,587.00	10	-1.61	3.82942545		97.6% 1663.594	
8/21/20 7:05 PM	22,113.00	6,305.00	9.84	-1.45	3.50721649		97.8% 1663.754	

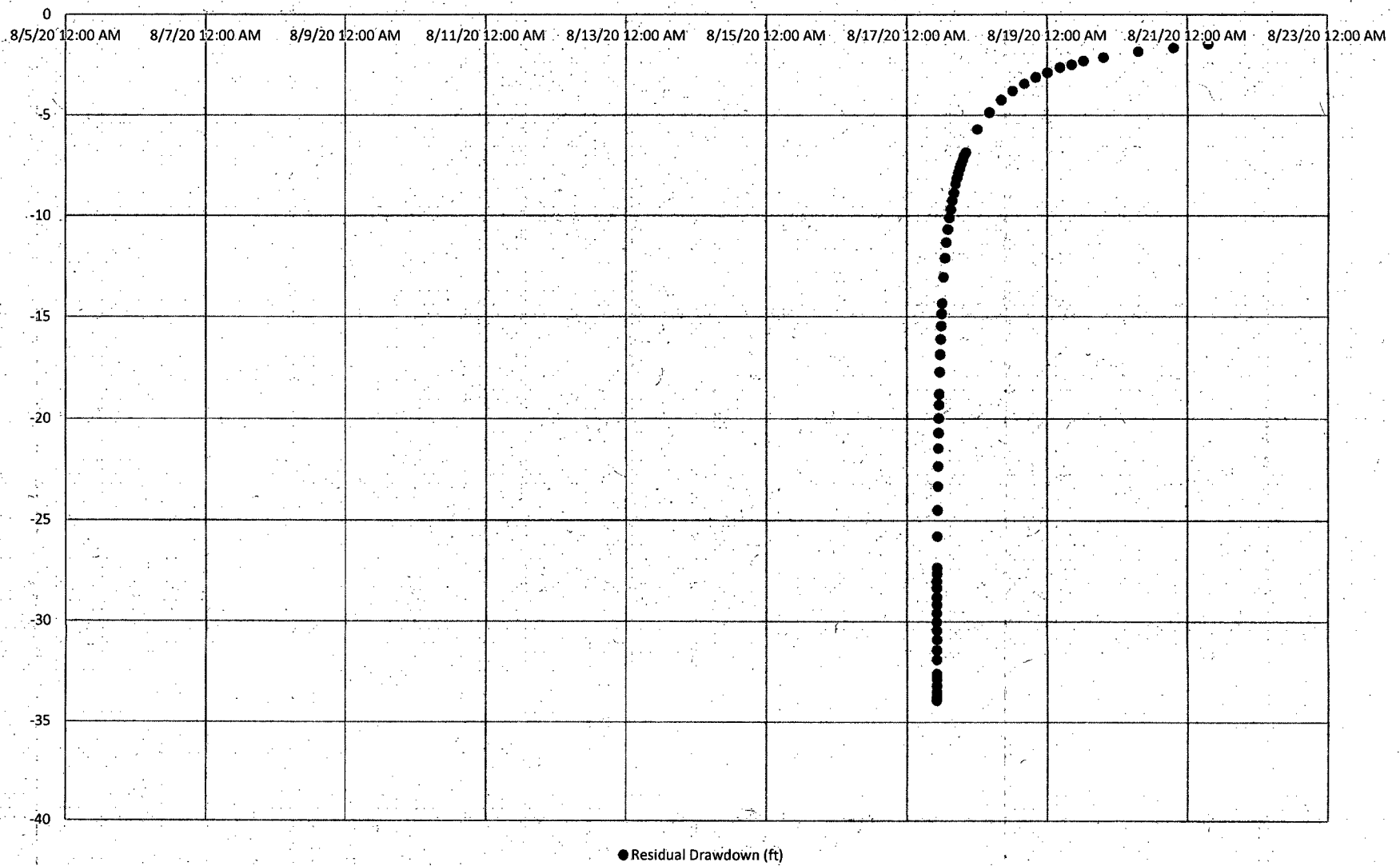
Type of Test	Drawdown	Well ID:	L3	Well Elev.	1670.912		
Static Water Level	1664.642	Date:	6-Aug-20	Gr. Elev.	1668.62		
Distance of Observation well from pumped well (r):	359.8						
Time	Time since Pumping began (min)	Depth to Water Level (ft)	Drawdown (ft)	t/r^2	Pumping Rate (Q) (gpm)	Comments	Water Elevation
8/6/20 10:32 AM	#####	6.27	0				1664.642
8/6/20 10:32 AM	0.50	6.27	0				1664.642
8/6/20 10:33 AM	1.00	6.36	-0.09				1664.552
8/6/20 10:33 AM	1.50	6.59	-0.32				1664.322
8/6/20 10:34 AM	2.00	7.08	-0.81				1663.832
8/6/20 10:34 AM	2.50	7.46	-1.19				1663.452
8/6/20 10:35 AM	3.00	7.68	-1.41				1663.232
8/6/20 10:36 AM	4.00	8.23	-1.96				1662.682
8/6/20 10:37 AM	5.00	8.75	-2.48				1662.162
8/6/20 10:38 AM	6.00	9.3	-3.03				1661.612
8/6/20 10:39 AM	7.00	9.78	-3.51				1661.132
8/6/20 10:40 AM	8.00	10.2	-3.93				1660.712
8/6/20 10:41 AM	9.00	10.65	-4.38				1660.262
8/6/20 10:42 AM	10.00	11.07	-4.8				1659.842
8/6/20 10:43 AM	11.00	11.45	-5.18				1659.462
8/6/20 10:44 AM	12.00	11.86	-5.59				1659.052
8/6/20 10:45 AM	13.00	12.24	-5.97				1658.672
8/6/20 10:46 AM	14.00	12.61	-6.34				1658.302
8/6/20 10:47 AM	15.00	12.95	-6.68				1657.962
8/6/20 10:52 AM	20.00	14.55	-8.28				1656.362
8/6/20 10:57 AM	25.00	15.9	-9.63				1655.012
8/6/20 11:02 AM	30.00	17.1	-10.83				1653.812
8/6/20 11:07 AM	35.00	18.14	-11.87				1652.772
8/6/20 11:12 AM	40.00	19.06	-12.79				1651.852
8/6/20 11:17 AM	45.00	19.89	-13.62				1651.022
8/6/20 11:22 AM	50.00	20.6	-14.33				1650.312
8/6/20 11:27 AM	55.00	21.32	-15.05				1649.592
8/6/20 11:32 AM	60.00	21.84	-15.57				1649.072
8/6/20 11:42 AM	70.00	22.95	-16.68				1647.962
8/6/20 11:52 AM	80.00	23.77	-17.5				1647.142
8/6/20 12:02 PM	90.00	24.56	-18.29				1646.352
8/6/20 12:12 PM	100.00	25.2	-18.93				1645.712
8/6/20 12:22 PM	110.00	25.77	-19.5				1645.142
8/6/20 12:32 PM	120.00	26.28	-20.01				1644.632
8/6/20 1:02 PM	150.00	27.54	-21.27				1643.372
8/6/20 1:36 PM	184.00	28.6	-22.33				1642.312
8/6/20 1:59 PM	207.00	29.2	-22.93				1641.712
8/6/20 2:34 PM	242.00	29.92	-23.65				1640.992
8/6/20 3:04 PM	272.00	30.45	-24.18				1640.462
8/6/20 3:34 PM	302.00	30.85	-24.58				1640.062
8/6/20 4:04 PM	332.00	31.2	-24.93				1639.712
8/6/20 4:34 PM	362.00	31.52	-25.25				1639.392
8/6/20 5:18 PM	406.00	31.65	-25.38				1639.262
8/6/20 5:57 PM	445.00	32.25	-25.98				1638.662
8/6/20 6:44 PM	492.00	32.7	-26.43				1638.212
8/6/20 7:10 PM	518.00	32.84	-26.57				1638.072
8/6/20 7:36 PM	544.00	33.01	-26.74				1637.902
8/6/20 8:01 PM	569.00	33.11	-26.84				1637.802
8/6/20 8:26 PM	594.00	33.28	-27.01				1637.632
8/6/20 8:58 PM	626.00	33.42	-27.15				1637.492
8/7/20 12:41 AM	849.00	34.29	-28.02				1636.622
8/7/20 4:48 AM	1,096.00	35.05	-28.78				1635.862
8/7/20 8:46 AM	1,334.00	35.53	-29.26				1635.382
8/7/20 12:43 PM	1,571.00	35.95	-29.68				1634.962
8/7/20 4:42 PM	1,810.00	36.19	-29.92				1634.722
8/7/20 8:38 PM	2,046.00	36.34	-30.07				1634.572
8/8/20 12:42 AM	2,290.00	36.72	-30.45				1634.192
8/8/20 4:43 AM	2,531.00	36.97	-30.7				1633.942
8/8/20 8:54 AM	2,782.00	37.21	-30.94				1633.702
8/8/20 12:55 PM	3,023.00	37.37	-31.1				1633.542
8/8/20 7:20 PM	3,408.00	37.55	-31.28				1633.362
8/9/20 7:20 AM	4,128.00	37.92	-31.65				1632.992
8/9/20 7:12 PM	4,840.00	38.02	-31.75				1632.892
8/10/20 7:19 AM	5,567.00	38.48	-32.21				1632.432
8/10/20 7:14 PM	6,282.00	38.7	-32.43				1632.212
8/11/20 7:20 AM	7,008.00	38.84	-32.57				1632.072
8/11/20 7:11 PM	7,719.00	39.01	-32.74				1631.902
8/12/20 7:22 AM	8,450.00	39.17	-32.9				1631.742
8/12/20 7:07 PM	9,155.00	39.3	-33.03				1631.612
8/13/20 7:14 AM	9,882.00	39.41	-33.14				1631.502
8/13/20 7:05 PM	10,593.00	39.55	-33.28				1631.362
8/14/20 7:15 AM	11,323.00	39.63	-33.36				1631.282
8/14/20 7:06 PM	12,034.00	39.75	-33.48				1631.162
8/15/20 7:19 AM	12,767.00	39.84	-33.57				1631.072
8/15/20 7:13 PM	13,481.00	39.93	-33.66				1630.982
8/16/20 7:22 AM	14,210.00	40.02	-33.75				1630.892
8/16/20 7:12 PM	14,920.00	40.11	-33.84				1630.802
8/17/20 7:04 AM	15,632.00	40.18	-33.91				1630.732

Drawdown L3 (ft)

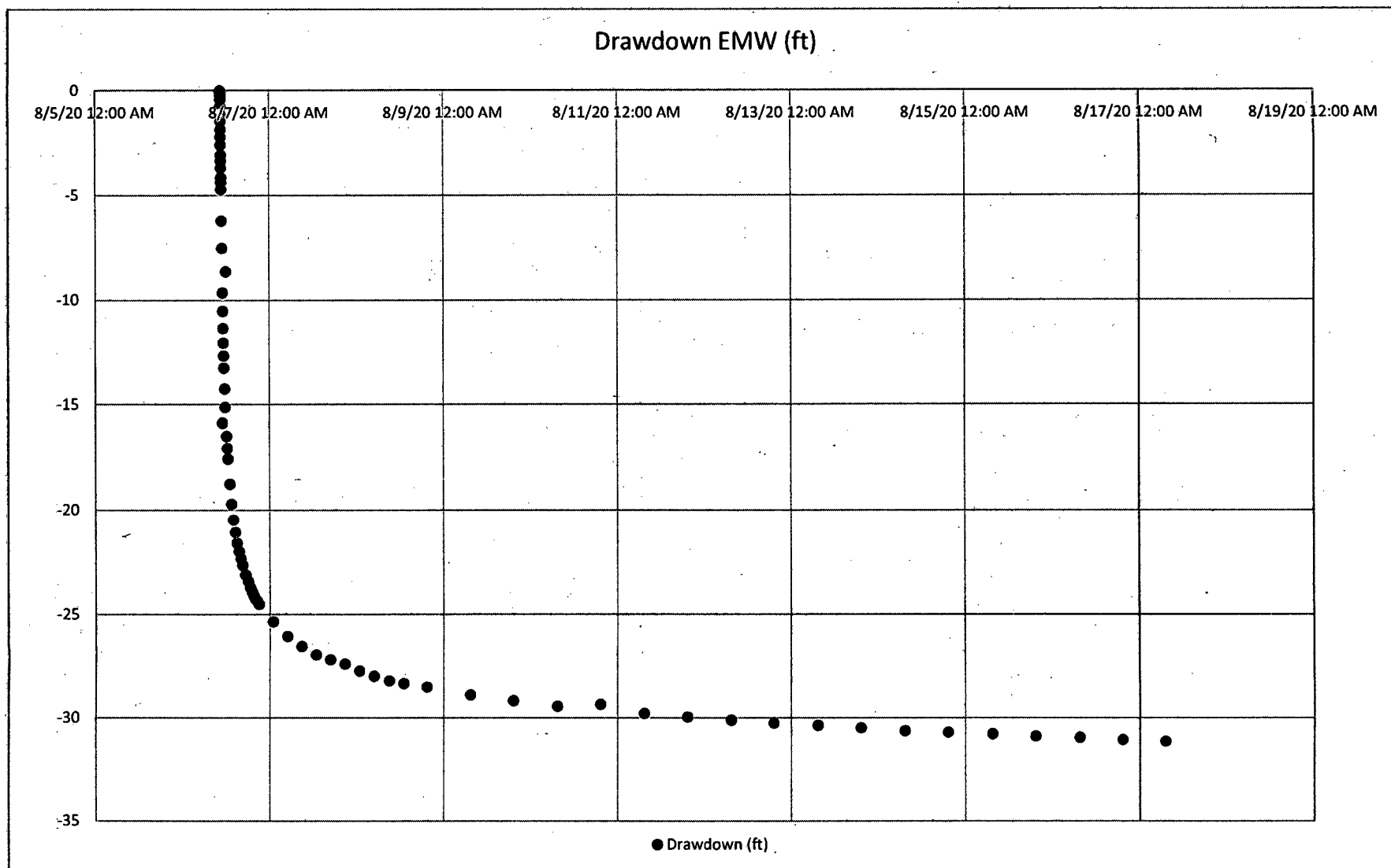


Type of Test		Recovery	Well ID:	L3	Well Elev.	1670.912	
Static Water Level		1664.642	Date:	6-Aug-20 Gr. Elev. 1668.62			
Distance of Observation well from pumped well (r):							
Time	Time since Pumping began (min)	Time (t') since Pumping stopped (min.)	Depth to Water Level (ft)	Residual Drawdown (ft)	t/t'	Comments	Water Elevation
8/6/20 10:32 AM	0		6.27			Pumping Started	1664.642
8/17/20 10:00 AM			40.2	-33.93		Pumping Stopped	1630.712
8/17/20 10:00 AM	0.50	0.50	40.19	-33.92	1		1630.722
8/17/20 10:01 AM	1.00	1.00	40.02	-33.75	1		1630.892
8/17/20 10:01 AM	1.50	1.50	39.77	-33.5	1		1631.142
8/17/20 10:02 AM	2.00	2.00	39.45	-33.18	1		1631.462
8/17/20 10:02 AM	2.50	2.50	39.12	-32.85	1		1631.792
8/17/20 10:03 AM	3.00	3.00	38.87	-32.6	1		1632.042
8/17/20 10:04 AM	4.00	4.00	38.16	-31.89	1		1632.752
8/17/20 10:05 AM	5.00	5.00	37.68	-31.41	1		1633.232
8/17/20 10:06 AM	6.00	6.00	37.16	-30.89	1		1633.752
8/17/20 10:07 AM	7.00	7.00	36.71	-30.44	1		1634.202
8/17/20 10:08 AM	8.00	8.00	36.29	-30.02	1		1634.622
8/17/20 10:09 AM	9.00	9.00	35.84	-29.57	1		1635.072
8/17/20 10:10 AM	10.00	10.00	35.43	-29.16	1		1635.482
8/17/20 10:11 AM	11.00	11.00	35.06	-28.79	1		1635.852
8/17/20 10:12 AM	12.00	12.00	34.6	-28.33	1		1636.312
8/17/20 10:13 AM	13.00	13.00	34.27	-28	1		1636.642
8/17/20 10:14 AM	14.00	14.00	33.9	-27.63	1		1637.012
8/17/20 10:15 AM	15.00	15.00	33.6	-27.33	1		1637.312
8/17/20 10:20 AM	20.00	20.00	32.05	-25.78	1		1638.862
8/17/20 10:25 AM	25.00	25.00	30.77	-24.5	1		1640.142
8/17/20 10:30 AM	30.00	30.00	29.6	-23.33	1		1641.312
8/17/20 10:35 AM	34.99	34.99	28.62	-22.35	1		1642.292
8/17/20 10:40 AM	39.99	39.99	27.73	-21.46	1		1643.182
8/17/20 10:45 AM	45.00	45.00	26.97	-20.7	1		1643.942
8/17/20 10:50 AM	50.00	50.00	26.26	-19.99	1		1644.652
8/17/20 10:55 AM	55.00	55.00	25.6	-19.33	1		1645.312
8/17/20 11:00 AM	60.00	60.00	25.06	-18.79	1		1645.852
8/17/20 11:10 AM	70.00	70.00	24	-17.73	1		1646.912
8/17/20 11:20 AM	80.00	80.00	23.14	-16.87	1		1647.772
8/17/20 11:30 AM	90.00	90.00	22.38	-16.11	1		1648.532
8/17/20 11:40 AM	100.00	100.00	21.72	-15.45	1		1649.192
8/17/20 11:50 AM	110.00	110.00	21.14	-14.87	1		1649.772
8/17/20 12:00 PM	120.00	120.00	20.61	-14.34	1		1650.302
8/17/20 12:30 PM	150.00	150.00	19.33	-13.06	1		1651.582
8/17/20 1:00 PM	180.00	180.00	18.38	-12.11	1		1652.532
8/17/20 1:30 PM	210.00	210.00	17.6	-11.33	1		1653.312
8/17/20 2:00 PM	240.00	240.00	16.95	-10.68	1		1653.962
8/17/20 2:30 PM	270.00	270.00	16.38	-10.11	1		1654.532
8/17/20 3:00 PM	300.00	300.00	15.97	-9.7	1		1654.942
8/17/20 3:30 PM	330.00	330.00	15.53	-9.26	1		1655.382
8/17/20 4:00 PM	360.00	360.00	15.14	-8.87	1		1655.772
8/17/20 4:38 PM	398.00	398.00	14.69	-8.42	1		1656.222
8/17/20 5:06 PM	426.00	426.00	14.42	-8.15	1		1656.492
8/17/20 5:38 PM	458.00	458.00	14.14	-7.87	1		1656.772
8/17/20 6:04 PM	484.00	484.00	13.94	-7.67	1		1656.972
8/17/20 6:37 PM	517.00	517.00	13.69	-7.42	1		1657.222
8/17/20 7:04 PM	544.00	544.00	13.51	-7.24	1		1657.402
8/17/20 7:36 PM	576.00	576.00	13.28	-7.01	1		1657.632
8/17/20 8:05 PM	605.00	605.00	13.13	-6.86	1		1657.782
8/18/20 12:03 AM	843.00	843.00	11.98	-5.71	1		1658.932
8/18/20 4:14 AM	1,094.00	1,094.00	11.15	-4.88	1		1659.762
8/18/20 8:10 AM	1,330.00	1,330.00	10.54	-4.27	1		1660.372
8/18/20 12:06 PM	1,566.00	1,566.00	10.09	-3.82	1		1660.822
8/18/20 4:05 PM	1,805.00	1,805.00	9.72	-3.45	1		1661.192
8/18/20 8:02 PM	2,042.00	2,042.00	9.39	-3.12	1		1661.522
8/18/20 11:59 PM	2,279.00	2,279.00	9.15	-2.88	1		1661.762
8/19/20 4:13 AM	2,533.00	2,533.00	8.9	-2.63	1		1662.012
8/19/20 8:14 AM	2,774.00	2,774.00	8.76	-2.49	1		1662.152
8/19/20 12:17 PM	3,017.00	3,017.00	8.58	-2.31	1		1662.332
8/19/20 7:06 PM	3,426.00	3,426.00	8.4	-2.13	1		1662.512
8/20/20 7:06 AM	4,146.00	4,146.00	8.1	-1.83	1		1662.812
8/20/20 7:09 PM	4,869.00	4,869.00	7.91	-1.64	1	7.9665 <- 95% recovery	1663.002
8/21/20 7:08 AM	5,588.00	5,588.00	7.72	-1.45	1		1663.192

Residual Recovery L3 (ft)

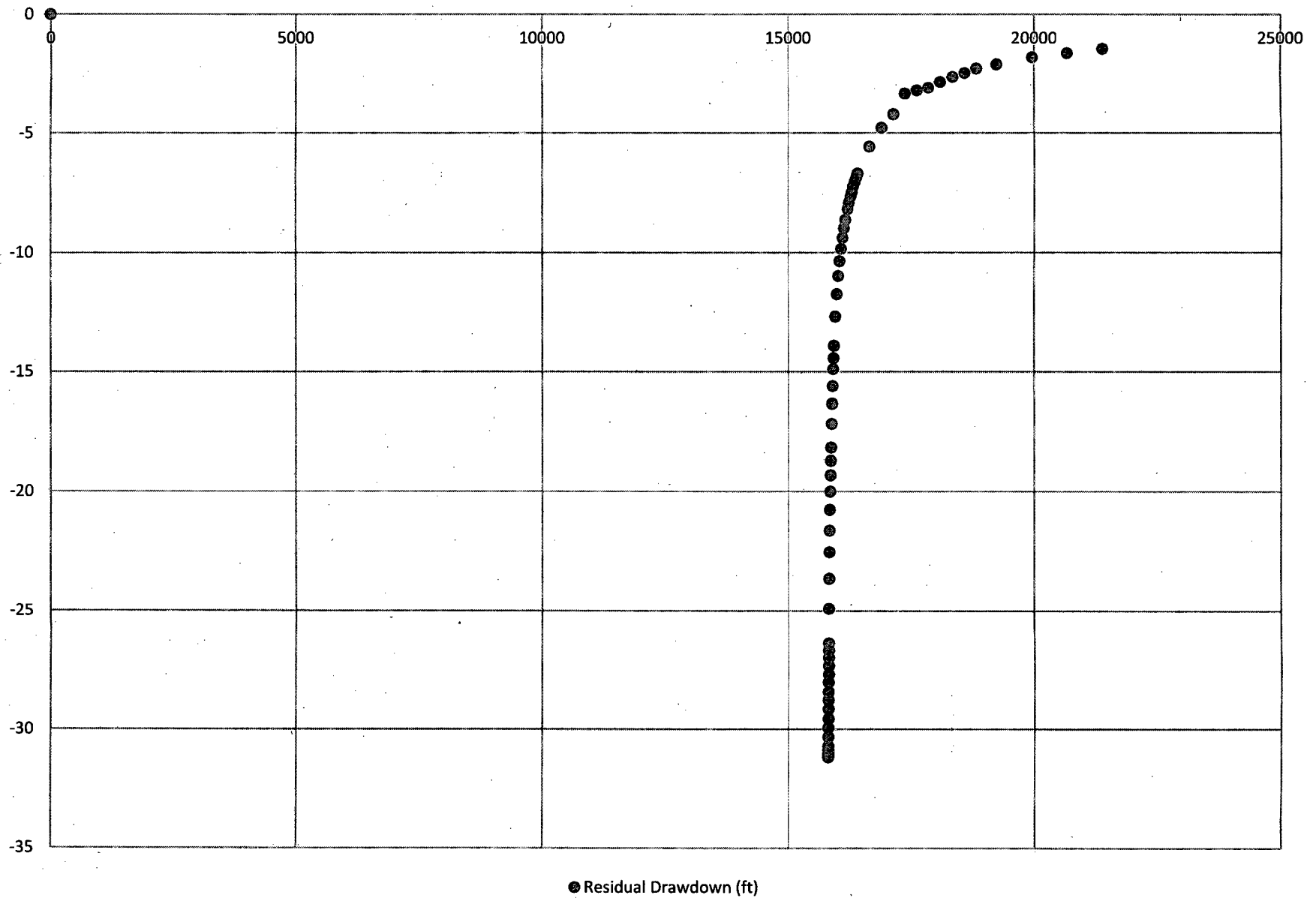


Type of Test	Drawdown	Well ID:	650 E L2	Well Elev.	1677.952		
Static Water Level	1664.722	Date:	6-Aug-20	Gr Elev.	1674.87		
Distance of Observation well from pumped well (r):	650						
Time	Time since Pumping began (min)	Depth to Water Level (ft)	Drawdown (ft)	t/r^2	Pumping Rate (Q) (gpm)	Comments	Water Elevation
8/6/20 10:32 AM	#####	13.23	0				1664.722
8/6/20 10:32 AM	0.50	13.23	0				1664.722
8/6/20 10:33 AM	1.00	13.23	0				1664.722
8/6/20 10:33 AM	1.50	13.28	-0.05				1664.672
8/6/20 10:34 AM	2.00	13.33	-0.1				1664.622
8/6/20 10:34 AM	2.50	13.48	-0.25				1664.472
8/6/20 10:35 AM	3.00	13.65	-0.42				1664.302
8/6/20 10:36 AM	4.00	14	-0.77				1663.952
8/6/20 10:37 AM	5.00	14.35	-1.12				1663.602
8/6/20 10:38 AM	6.00	14.71	-1.48				1663.242
8/6/20 10:39 AM	7.00	15.11	-1.88				1662.842
8/6/20 10:40 AM	8.00	15.46	-2.23				1662.492
8/6/20 10:41 AM	9.00	15.84	-2.61				1662.112
8/6/20 10:42 AM	10.00	16.32	-3.09				1661.632
8/6/20 10:43 AM	11.00	16.59	-3.36				1661.362
8/6/20 10:44 AM	12.00	16.93	-3.7				1661.022
8/6/20 10:45 AM	13.00	17.39	-4.16				1660.562
8/6/20 10:46 AM	14.00	17.61	-4.38				1660.342
8/6/20 10:47 AM	15.00	17.96	-4.73				1659.992
8/6/20 10:52 AM	20.00	19.45	-6.22				1658.502
8/6/20 10:57 AM	25.00	20.75	-7.52				1657.202
8/6/20 12:02 PM	90.00	21.88	-8.65				1656.072
8/6/20 11:07 AM	35.00	22.9	-9.67				1655.052
8/6/20 11:12 AM	40.00	23.78	-10.55				1654.172
8/6/20 11:17 AM	45.00	24.59	-11.36				1653.362
8/6/20 11:22 AM	50.00	25.29	-12.06				1652.662
8/6/20 11:27 AM	55.00	25.91	-12.68				1652.042
8/6/20 11:32 AM	60.00	26.49	-13.26				1651.462
8/6/20 11:42 AM	70.00	27.49	-14.26				1650.462
8/6/20 11:52 AM	80.00	28.36	-15.13				1649.592
8/6/20 11:02 AM	30.00	29.1	-15.87				1648.852
8/6/20 12:12 PM	100.00	29.72	-16.49				1648.232
8/6/20 12:22 PM	110.00	30.29	-17.06				1647.662
8/6/20 12:32 PM	120.00	30.79	-17.56				1647.162
8/6/20 1:02 PM	150.00	31.99	-18.76				1645.962
8/6/20 1:32 PM	180.00	32.95	-19.72				1645.002
8/6/20 2:02 PM	210.00	33.71	-20.48				1644.242
8/6/20 2:32 PM	240.00	34.3	-21.07				1643.652
8/6/20 3:02 PM	270.00	34.82	-21.59				1643.132
8/6/20 3:32 PM	300.00	35.21	-21.98				1642.742
8/6/20 4:02 PM	330.00	35.56	-22.33				1642.392
8/6/20 4:32 PM	360.00	35.88	-22.65				1642.072
8/6/20 5:23 PM	411.00	36.35	-23.12				1641.602
8/6/20 6:02 PM	450.00	36.66	-23.43				1641.292
8/6/20 6:42 PM	490.00	36.97	-23.74				1640.982
8/6/20 7:13 PM	521.00	37.19	-23.96				1640.762
8/6/20 7:39 PM	547.00	37.37	-24.14				1640.582
8/6/20 8:03 PM	571.00	37.49	-24.26				1640.462
8/6/20 8:29 PM	597.00	37.6	-24.37				1640.352
8/6/20 9:02 PM	630.00	37.74	-24.51				1640.212
8/7/20 12:55 AM	863.00	38.59	-25.36				1639.362
8/7/20 4:54 AM	1,102.00	39.31	-26.08				1638.642
8/7/20 8:46 AM	1,334.00	39.78	-26.55				1638.172
8/7/20 12:46 PM	1,574.00	40.19	-26.96				1637.762
8/7/20 4:45 PM	1,813.00	40.43	-27.2				1637.522
8/7/20 8:46 PM	2,054.00	40.63	-27.4				1637.322
8/8/20 12:45 AM	2,293.00	40.97	-27.74				1636.982
8/8/20 4:47 AM	2,535.00	41.22	-27.99				1636.732
8/8/20 8:59 AM	2,787.00	41.44	-28.21				1636.512
8/8/20 12:57 PM	3,025.00	41.58	-28.35				1636.372
8/8/20 7:23 PM	3,411.00	41.76	-28.53				1636.192
8/9/20 7:23 AM	4,131.00	42.13	-28.9				1635.822
8/9/20 7:15 PM	4,843.00	42.41	-29.18				1635.542
8/10/20 7:22 AM	5,570.00	42.67	-29.44				1635.282
8/10/20 7:16 PM	6,284.00	42.59	-29.36				1635.362
8/11/20 7:22 AM	7,010.00	43.02	-29.79				1634.932
8/11/20 7:14 PM	7,722.00	43.2	-29.97				1634.752
8/12/20 7:25 AM	8,453.00	43.35	-30.12				1634.602
8/12/20 7:09 PM	9,157.00	43.49	-30.26				1634.462
8/13/20 7:19 AM	9,887.00	43.59	-30.36				1634.362
8/13/20 7:08 PM	10,596.00	43.72	-30.49				1634.232
8/14/20 7:17 AM	11,325.00	43.86	-30.63				1634.092
8/14/20 7:08 PM	12,036.00	43.93	-30.7				1634.022
8/15/20 7:22 AM	12,770.00	44.01	-30.78				1633.942
8/15/20 7:15 PM	13,483.00	44.12	-30.89				1633.832
8/16/20 7:25 AM	14,213.00	44.18	-30.95				1633.772
8/16/20 7:15 PM	14,923.00	44.28	-31.05				1633.672
8/17/20 7:07 AM	15,635.00	44.36	-31.13				1633.592



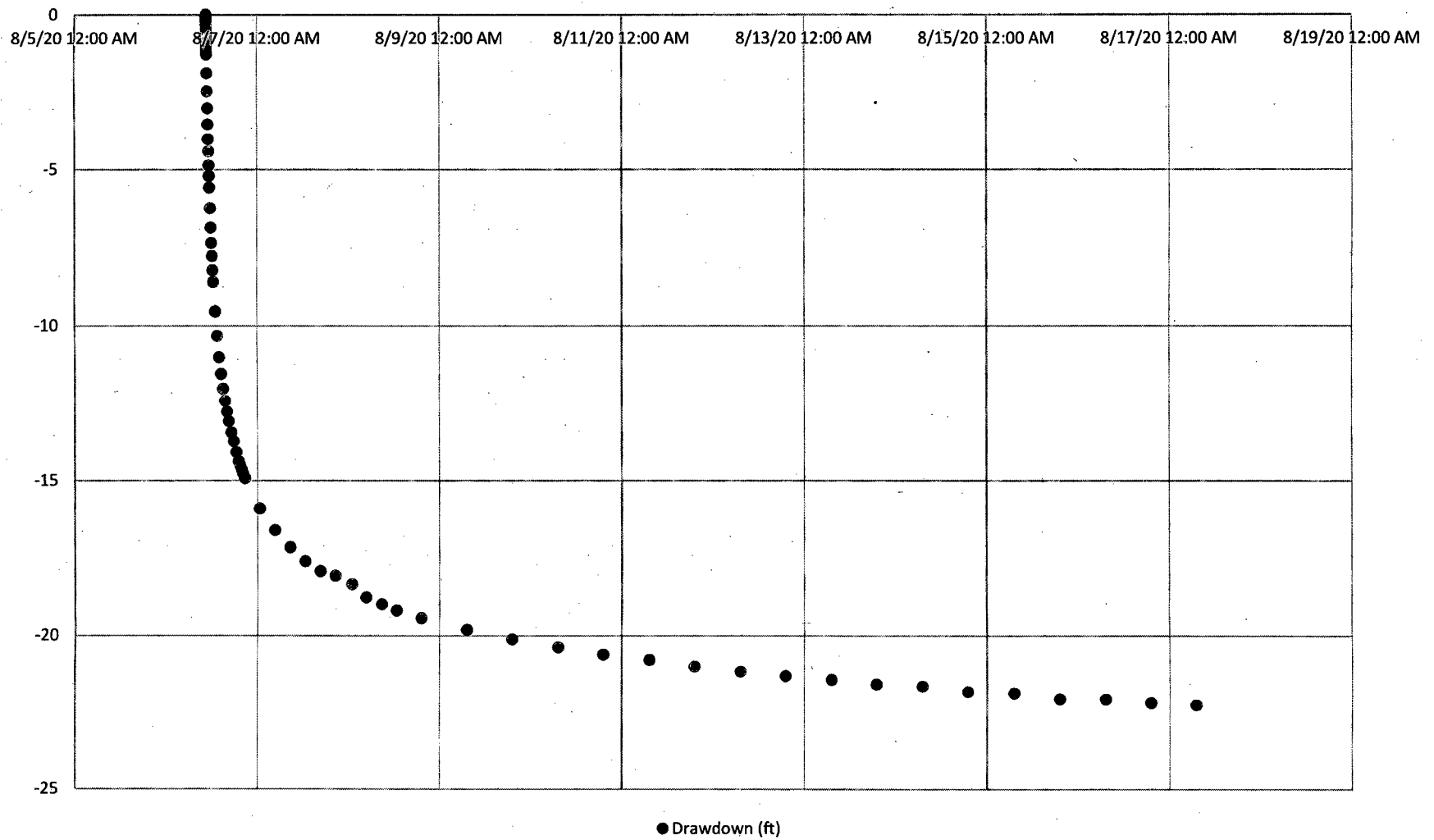
Type of Test		Recovery	Well ID:	650 E L2	Well Elev.	1677.952
Static Water Level		1664.722	Date:	6-Aug-20	Gr Elev.	1674.87
Distance of Observation well from pumped well (r):		650				
Time	Time since Pumping began (min)	Time (t') since Pumping stopped (min.)	Depth to Water Level (ft)	Residual Drawdown (ft)	t/t'	Comments
8/6/20 10:32 AM	0	13:23	0			Pumping Began
8/17/20 10:00 AM	15,808.00	-	44.38	-31.15		Pumping Stopped
8/17/20 10:00 AM	15,808.50	0.50	44.39	-31.16	31616.9999	
8/17/20 10:01 AM	15,809.00	1.00	44.38	-31.15	15808.9999	
8/17/20 10:01 AM	15,809.50	1.50	44.33	-31.1	10540.2522	
8/17/20 10:02 AM	15,810.00	2.00	44.22	-30.99	7905.32934	
8/17/20 10:02 AM	15,810.50	2.50	44.09	-30.86	6324.41077	
8/17/20 10:03 AM	15,811.00	3.00	43.92	-30.69	5270.62609	
8/17/20 10:04 AM	15,812.00	4.00	43.54	-30.31	3953	
8/17/20 10:05 AM	15,813.00	5.00	43.15	-29.92	3162.54731	
8/17/20 10:06 AM	15,814.00	6.00	42.78	-29.55	2635.55689	
8/17/20 10:07 AM	15,815.00	7.00	42.36	-29.13	2259.1513	
8/17/20 10:08 AM	15,816.00	8.00	41.99	-28.76	1976.85593	
8/17/20 10:09 AM	15,817.00	9.00	41.64	-28.41	1757.29809	
8/17/20 10:10 AM	15,818.00	10.00	41.24	-28.01	1581.65511	
8/17/20 10:11 AM	15,819.00	11.00	40.9	-27.67	1437.96028	
8/17/20 10:12 AM	15,820.00	12.00	40.54	-27.31	1318.20527	
8/17/20 10:13 AM	15,821.00	13.00	40.2	-26.97	1216.87529	
8/17/20 10:14 AM	15,822.00	14.00	39.89	-26.66	1130.02189	
8/17/20 10:15 AM	15,823.00	15.00	39.58	-26.35	1054.74958	
8/17/20 10:20 AM	15,828.00	20.00	38.12	-24.89	791.4	
8/17/20 10:25 AM	15,833.00	25.00	36.86	-23.63	633.366374	
8/17/20 10:30 AM	15,838.00	30.00	35.76	-22.53	527.99628	
8/17/20 10:35 AM	15,842.99	34.99	34.85	-21.62	452.725977	
8/17/20 10:40 AM	15,847.99	39.99	33.99	-20.76	396.269996	
8/17/20 10:45 AM	15,853.00	45.00	33.23	-20	352.288889	
8/17/20 10:50 AM	15,858.00	50.00	32.55	-19.32	317.16	
8/17/20 10:55 AM	15,863.00	55.00	31.94	-18.71	288.418182	
8/17/20 11:00 AM	15,868.00	60.00	31.39	-18.16	264.466667	
8/17/20 11:10 AM	15,878.00	70.00	30.4	-17.17	226.828571	
8/17/20 11:20 AM	15,888.00	80.00	29.56	-16.33	198.6	
8/17/20 11:30 AM	15,898.00	90.00	28.83	-15.6	176.644444	
8/17/20 11:40 AM	15,908.00	100.00	28.12	-14.89	159.08	
8/17/20 11:50 AM	15,918.00	110.00	27.66	-14.43	144.709091	
8/17/20 12:00 PM	15,928.00	120.00	27.14	-13.91	132.733333	
8/17/20 12:30 PM	15,958.00	150.00	25.92	-12.69	106.386667	
8/17/20 1:00 PM	15,988.00	180.00	24.98	-11.75	88.8222222	
8/17/20 1:30 PM	16,018.00	210.00	24.22	-10.99	76.2761905	
8/17/20 2:00 PM	16,048.00	240.00	23.59	-10.36	66.8666667	
8/17/20 2:30 PM	16,078.00	270.00	23.07	-9.84	59.5481481	
8/17/20 3:00 PM	16,108.00	300.00	22.61	-9.38	53.6933333	
8/17/20 3:30 PM	16,138.00	330.00	22.21	-8.98	48.9030303	
8/17/20 4:00 PM	16,168.00	360.00	21.86	-8.63	44.9111111	
8/17/20 4:41 PM	16,209.00	401.00	21.4	-8.17	40.4214464	
8/17/20 5:08 PM	16,236.00	428.00	21.15	-7.92	37.9345794	
8/17/20 5:42 PM	16,270.00	462.00	20.88	-7.65	35.2164502	
8/17/20 6:06 PM	16,294.00	486.00	20.69	-7.46	33.526749	
8/17/20 6:38 PM	16,326.00	518.00	20.45	-7.22	31.5173745	
8/17/20 7:06 PM	16,354.00	546.00	20.27	-7.04	29.952381	
8/17/20 7:38 PM	16,386.00	578.00	20.07	-6.84	28.349481	
8/17/20 8:07 PM	16,415.00	607.00	19.91	-6.68	27.0428336	
8/18/20 12:05 AM	16,653.00	845.00	18.79	-5.56	19.7076923	
8/18/20 4:15 AM	16,903.00	1,095.00	18	-4.77	15.4365297	
8/18/20 8:13 AM	17,141.00	1,333.00	17.42	-4.19	12.8589647	
8/18/20 12:00 PM	17,368.00	1,560.00	16.56	-3.33	11.1333333	
8/18/20 4:08 PM	17,616.00	1,808.00	16.42	-3.19	9.74336283	
8/18/20 8:04 PM	17,852.00	2,044.00	16.31	-3.08	8.73385519	
8/19/20 12:02 AM	18,090.00	2,282.00	16.07	-2.84	7.92725679	
8/19/20 4:17 AM	18,345.00	2,537.00	15.85	-2.62	7.23098147	
8/19/20 8:18 AM	18,586.00	2,778.00	15.69	-2.46	6.69042477	
8/19/20 12:20 PM	18,828.00	3,020.00	15.5	-2.27	6.23443709	
8/19/20 7:09 PM	19,237.00	3,429.00	15.33	-2.1	5.61009041	14.7875 <-95% recover
8/20/20 7:08 AM	19,956.00	4,148.00	15.03	-1.8	4.81099325	
8/20/20 7:11 PM	20,679.00	4,871.00	14.85	-1.62	4.2453295	
8/21/20 7:10 AM	21,398.00	5,590.00	14.67	-1.44	3.82790698	

Residual Recovery EMW (ft)



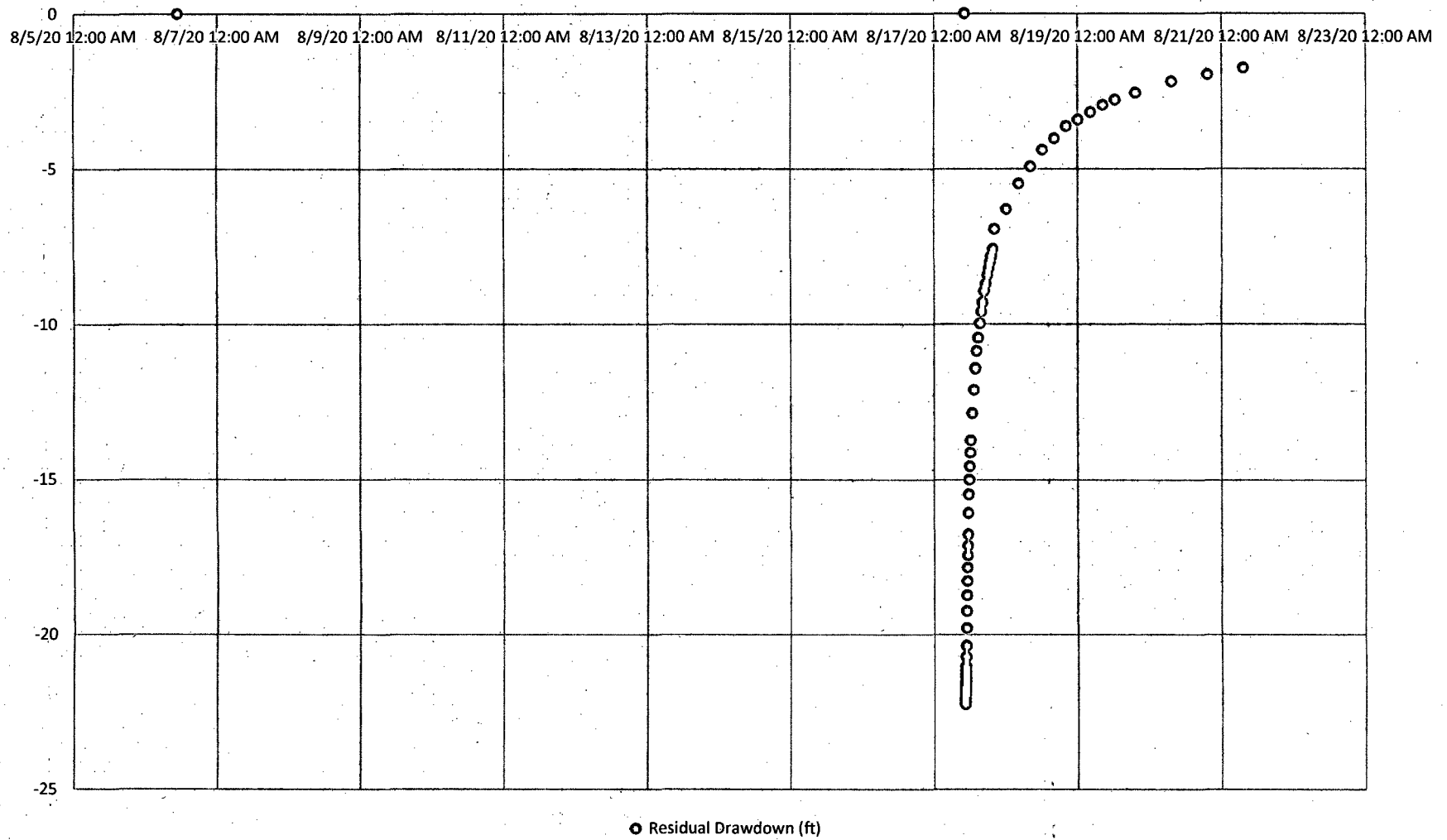
Type of Test	Drawdown	Well ID:	1000 N L2	Well Elev.	1673.74		
Static Water Level	1665.44	Date:	6-Aug-20	Gr. Elev.	1672.21		
Distance of Observation well from pumped well (r):	970.82						
Time	Time since Pumping began (min)	Depth to Water Level (ft)	Drawdown (ft)	t/r^2	Pumping Rate (Q) (gpm)	Comments	Water Elevation
8/6/20 10:32 AM	#####	8.3	0				
8/6/20 10:32 AM	0.50	8.34	-0.04				1665.4
8/6/20 10:33 AM	1.00	8.38	-0.08				1665.36
8/6/20 10:33 AM	1.50	8.39	-0.09				1665.35
8/6/20 10:34 AM	2.00	8.37	-0.07				1665.37
8/6/20 10:34 AM	2.50	8.39	-0.09				1665.35
8/6/20 10:35 AM	3.00	8.42	-0.12				1665.32
8/6/20 10:36 AM	4.00	8.44	-0.14				1665.3
8/6/20 10:37 AM	5.00	8.51	-0.21				1665.23
8/6/20 10:38 AM	6.00	8.62	-0.32				1665.12
8/6/20 10:39 AM	7.00	8.74	-0.44				1665
8/6/20 10:40 AM	8.00	8.82	-0.52				1664.92
8/6/20 10:41 AM	9.00	8.91	-0.61				1664.83
8/6/20 10:42 AM	10.00	9.01	-0.71				1664.73
8/6/20 10:43 AM	11.00	9.15	-0.85				1664.59
8/6/20 10:44 AM	12.00	9.28	-0.98				1664.46
8/6/20 10:45 AM	13.00	9.39	-1.09				1664.35
8/6/20 10:46 AM	14.00	9.5	-1.2				1664.24
8/6/20 10:47 AM	15.00	9.59	-1.29				1664.15
8/6/20 10:52 AM	20.00	10.19	-1.89				1663.55
8/6/20 10:57 AM	25.00	10.77	-2.47				1662.97
8/6/20 11:02 AM	30.00	11.32	-3.02				1662.42
8/6/20 11:07 AM	35.00	11.84	-3.54				1661.9
8/6/20 11:12 AM	40.00	12.31	-4.01				1661.43
8/6/20 11:17 AM	45.00	12.7	-4.4				1661.04
8/6/20 11:22 AM	50.00	13.16	-4.86				1660.58
8/6/20 11:27 AM	55.00	13.5	-5.2				1660.24
8/6/20 11:32 AM	60.00	13.87	-5.57				1659.87
8/6/20 11:42 AM	70.00	14.53	-6.23				1659.21
8/6/20 11:52 AM	80.00	15.16	-6.86				1658.58
8/6/20 12:02 PM	90.00	15.65	-7.35				1658.09
8/6/20 12:12 PM	100.00	16.07	-7.77				1657.67
8/6/20 12:22 PM	110.00	16.53	-8.23				1657.21
8/6/20 12:32 PM	120.00	16.9	-8.6				1656.84
8/6/20 1:02 PM	150.00	17.84	-9.54				1655.9
8/6/20 1:32 PM	180.00	18.62	-10.32				1655.12
8/6/20 2:02 PM	210.00	19.3	-11				1654.44
8/6/20 2:32 PM	240.00	19.84	-11.54				1653.9
8/6/20 3:02 PM	270.00	20.32	-12.02				1653.42
8/6/20 3:32 PM	300.00	20.72	-12.42				1653.02
8/6/20 4:02 PM	330.00	21.07	-12.77				1652.67
8/6/20 4:32 PM	360.00	21.38	-13.08				1652.36
8/6/20 5:10 PM	398.00	21.74	-13.44				1652
8/6/20 5:47 PM	435.00	22.03	-13.73				1651.71
8/6/20 6:29 PM	477.00	22.39	-14.09				1651.35
8/6/20 7:03 PM	511.00	22.67	-14.37				1651.07
8/6/20 7:28 PM	536.00	22.79	-14.49				1650.95
8/6/20 7:54 PM	562.00	22.94	-14.64				1650.8
8/6/20 8:18 PM	586.00	23.09	-14.79				1650.65
8/6/20 8:46 PM	614.00	23.23	-14.93				1650.51
8/7/20 12:41 AM	849.00	24.21	-15.91				1649.53
8/7/20 4:38 AM	1,086.00	24.9	-16.6				1648.84
8/7/20 8:38 AM	1,326.00	25.45	-17.15				1648.29
8/7/20 12:35 PM	1,563.00	25.9	-17.6				1647.84
8/7/20 4:34 PM	1,802.00	26.22	-17.92				1647.52
8/7/20 8:32 PM	2,040.00	26.36	-18.06				1647.38
8/8/20 12:55 AM	2,303.00	26.63	-18.33				1647.11
8/8/20 4:36 AM	2,524.00	27.06	-18.76				1646.68
8/8/20 8:43 AM	2,771.00	27.28	-18.98				1646.46
8/8/20 12:40 PM	3,008.00	27.49	-19.19				1646.25
8/8/20 7:09 PM	3,397.00	27.74	-19.44				1646
8/9/20 7:10 AM	4,118.00	28.12	-19.82				1645.62
8/9/20 7:03 PM	4,831.00	28.42	-20.12				1645.32
8/10/20 7:10 AM	5,558.00	28.68	-20.38				1645.06
8/10/20 7:06 PM	6,274.00	28.91	-20.61				1644.83
8/11/20 7:12 AM	7,000.00	29.09	-20.79				1644.65
8/11/20 7:04 PM	7,712.00	29.3	-21				1644.44
8/12/20 7:13 AM	8,441.00	29.47	-21.17				1644.27
8/12/20 7:00 PM	9,148.00	29.61	-21.31				1644.13
8/13/20 7:07 AM	9,875.00	29.73	-21.43				1644.01
8/13/20 6:56 PM	10,584.00	29.88	-21.58				1643.86
8/14/20 7:05 AM	11,313.00	29.95	-21.65				1643.79
8/14/20 6:59 PM	12,027.00	30.12	-21.82				1643.62
8/15/20 7:09 AM	12,757.00	30.17	-21.87				1643.57
8/15/20 7:06 PM	13,474.00	30.36	-22.06				1643.38
8/16/20 7:11 AM	14,199.00	30.37	-22.07				1643.37
8/16/20 7:06 PM	14,914.00	30.48	-22.18				1643.26
8/17/20 6:58 AM	15,626.00	30.55	-22.25				1643.19

Drawdown NMW (ft)

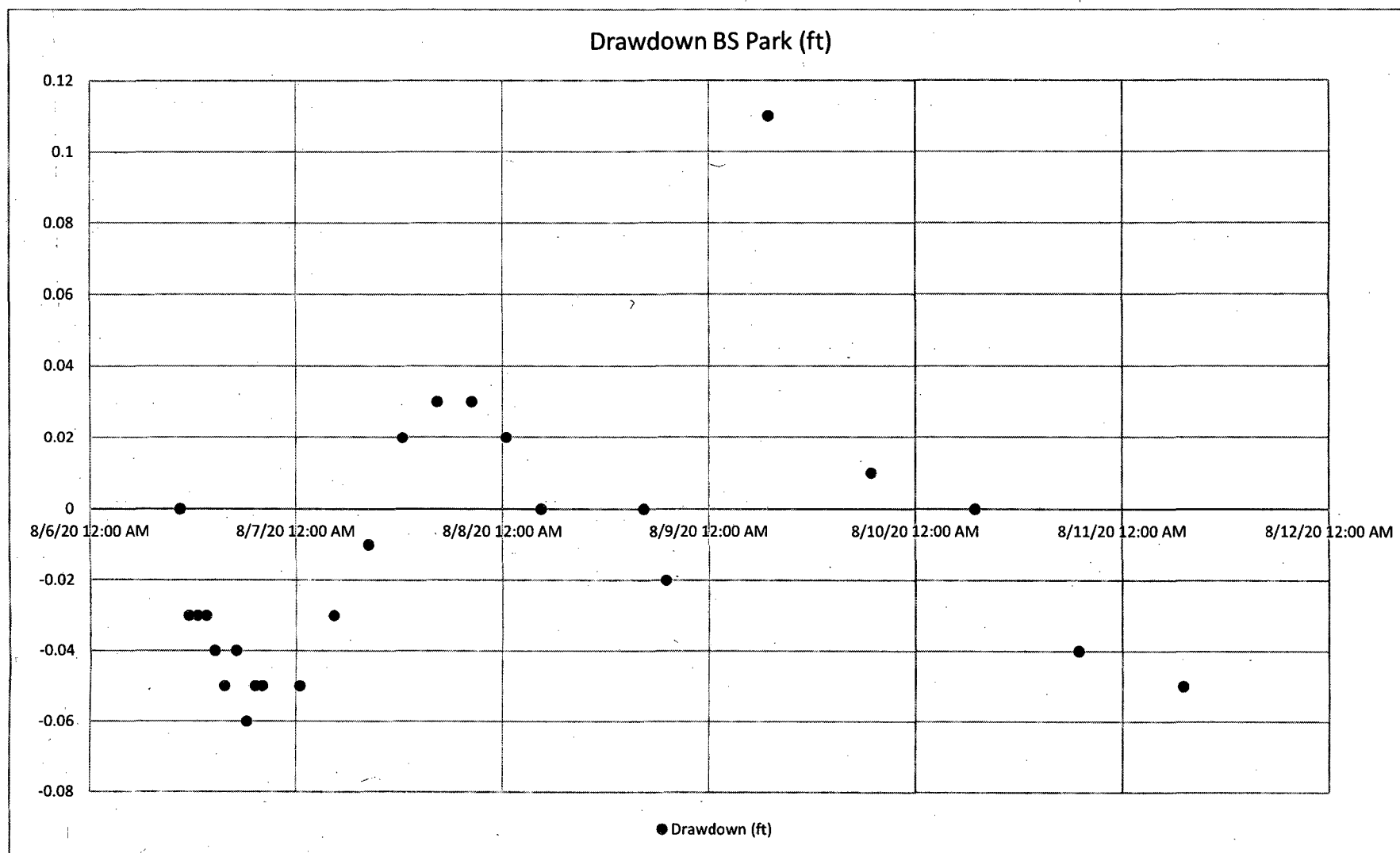


Type of Test		Recovery		Well ID:	1000 N L2	Well Elev.	1673.74
Static Water Level		1665.44	8.3	Date:	6-Aug-20	Gr. Elev.	1672.21
Distance of Observation well from pumped well (r):		970.823693					
Time	Time since Pumping began (min)	Time Since Pumping Stopped (min)	Depth to Water Level (ft)	Residual Drawdown (ft)	t/t'	Comments	Water Elevation
8/6/20 10:32 AM	0		8.3	0		Pumping Began	1665.44
8/17/20 10:00 AM	15,808.00	-	30.55	0		Pumping Stopped	1643.19
8/17/20 10:00 AM	15,808.50	0.50	30.55	-22.25	31616.9999		1643.19
8/17/20 10:01 AM	15,809.00	1.00	30.54	-22.24	15808.9999		1643.2
8/17/20 10:01 AM	15,809.50	1.50	30.54	-22.24	10540.2522		1643.2
8/17/20 10:02 AM	15,810.00	2.00	30.52	-22.22	7905.32934		1643.22
8/17/20 10:02 AM	15,810.50	2.50	30.51	-22.21	6324.41077		1643.23
8/17/20 10:03 AM	15,811.00	3.00	30.48	-22.18	5270.62609		1643.26
8/17/20 10:04 AM	15,812.00	4.00	30.42	-22.12	3953		1643.32
8/17/20 10:05 AM	15,813.00	5.00	30.34	-22.04	3162.54731		1643.4
8/17/20 10:06 AM	15,814.00	6.00	30.24	-21.94	2635.55689		1643.5
8/17/20 10:07 AM	15,815.00	7.00	30.14	-21.84	2259.1513		1643.6
8/17/20 10:08 AM	15,816.00	8.00	30.04	-21.74	1976.85593		1643.7
8/17/20 10:09 AM	15,817.00	9.00	29.92	-21.62	1757.29809		1643.82
8/17/20 10:10 AM	15,818.00	10.00	29.8	-21.5	1581.65511		1643.94
8/17/20 10:11 AM	15,819.00	11.00	29.68	-21.38	1437.96028		1644.06
8/17/20 10:12 AM	15,820.00	12.00	29.57	-21.27	1318.20527		1644.17
8/17/20 10:13 AM	15,821.00	13.00	29.45	-21.15	1216.87529		1644.29
8/17/20 10:14 AM	15,822.00	14.00	29.32	-21.02	1130.02189		1644.42
8/17/20 10:15 AM	15,823.00	15.00	29.02	-20.72	1054.74958		1644.72
8/17/20 10:20 AM	15,828.00	20.00	28.66	-20.36	791.4		1645.08
8/17/20 10:25 AM	15,833.00	25.00	28.09	-19.79	633.366374		1645.65
8/17/20 10:30 AM	15,838.00	30.00	27.53	-19.23	527.99628		1646.21
8/17/20 10:35 AM	15,842.99	34.99	27.02	-18.72	452.725977		1646.72
8/17/20 10:40 AM	15,847.99	39.99	26.56	-18.26	396.269996		1647.18
8/17/20 10:45 AM	15,853.00	45.00	26.13	-17.83	352.288889		1647.61
8/17/20 10:50 AM	15,858.00	50.00	25.73	-17.43	317.16		1648.01
8/17/20 10:55 AM	15,863.00	55.00	25.42	-17.12	288.418182		1648.32
8/17/20 11:00 AM	15,868.00	60.00	25.06	-16.76	264.466667		1648.68
8/17/20 11:10 AM	15,878.00	70.00	24.37	-16.07	226.828571		1649.37
8/17/20 11:20 AM	15,888.00	80.00	23.77	-15.47	198.6		1649.97
8/17/20 11:30 AM	15,898.00	90.00	23.3	-15	176.644444		1650.44
8/17/20 11:40 AM	15,908.00	100.00	22.87	-14.57	159.08		1650.87
8/17/20 11:50 AM	15,918.00	110.00	22.43	-14.13	144.709091		1651.31
8/17/20 12:00 PM	15,928.00	120.00	22.04	-13.74	132.733333		1651.7
8/17/20 12:30 PM	15,958.00	150.00	21.15	-12.85	106.386667		1652.59
8/17/20 1:00 PM	15,988.00	180.00	20.39	-12.09	88.8222222		1653.35
8/17/20 1:30 PM	16,018.00	210.00	19.71	-11.41	76.2761905		1654.03
8/17/20 2:00 PM	16,048.00	240.00	19.16	-10.86	66.8666667		1654.58
8/17/20 2:30 PM	16,078.00	270.00	18.74	-10.44	59.5481481		1655
8/17/20 3:00 PM	16,108.00	300.00	18.28	-9.98	53.6933333		1655.46
8/17/20 3:30 PM	16,138.00	330.00	17.9	-9.6	48.9030303		1655.84
8/17/20 4:00 PM	16,168.00	360.00	17.61	-9.31	44.9111111		1656.13
8/17/20 4:31 PM	16,199.00	391.00	17.25	-8.95	41.4296675		1656.49
8/17/20 5:02 PM	16,230.00	422.00	17.01	-8.71	38.4597156		1656.73
8/17/20 5:33 PM	16,261.00	453.00	16.73	-8.43	35.8962472		1657.01
8/17/20 6:00 PM	16,288.00	480.00	16.51	-8.21	33.9333333		1657.23
8/17/20 6:32 PM	16,320.00	512.00	16.31	-8.01	31.875		1657.43
8/17/20 7:00 PM	16,348.00	540.00	16.13	-7.83	30.2740741		1657.61
8/17/20 7:32 PM	16,380.00	572.00	15.89	-7.59	28.6363636		1657.85
8/17/20 8:00 PM	16,408.00	600.00	15.25	-6.95	27.3466667		1658.49
8/17/20 11:57 PM	16,645.00	837.00	14.61	-6.31	19.8864994		1659.13
8/18/20 4:03 AM	16,891.00	1,083.00	13.78	-5.48	15.5964912		1659.96
8/18/20 8:02 AM	17,130.00	1,322.00	13.22	-4.92	12.9576399		1660.52
8/18/20 12:01 PM	17,369.00	1,561.00	12.69	-4.39	11.1268418		1661.05
8/18/20 4:00 PM	17,608.00	1,800.00	12.32	-4.02	9.78222222		1661.42
8/18/20 7:59 PM	17,847.00	2,039.00	11.92	-3.62	8.75282001		1661.82
8/18/20 11:54 PM	18,082.00	2,274.00	11.72	-3.42	7.95162709		1662.02
8/19/20 4:05 AM	18,333.00	2,525.00	11.48	-3.18	7.26059406		1662.26
8/19/20 8:10 AM	18,578.00	2,770.00	11.24	-2.94	6.70685921		1662.5
8/19/20 12:11 PM	18,819.00	3,011.00	11.07	-2.77	6.25008303		1662.67
8/19/20 7:02 PM	19,230.00	3,422.00	10.85	-2.55	5.61952075	9.4125 <-95% recove	1662.89
8/20/20 7:01 AM	19,949.00	4,141.00	10.48	-2.18	4.8174354		1663.26
8/20/20 7:05 PM	20,673.00	4,865.00	10.26	-1.96	4.24933196		1663.48
8/21/20 7:01 AM	21,389.00	5,581.00	10.05	-1.75	3.8324673		1663.69

Residual Recovery NMW (ft)

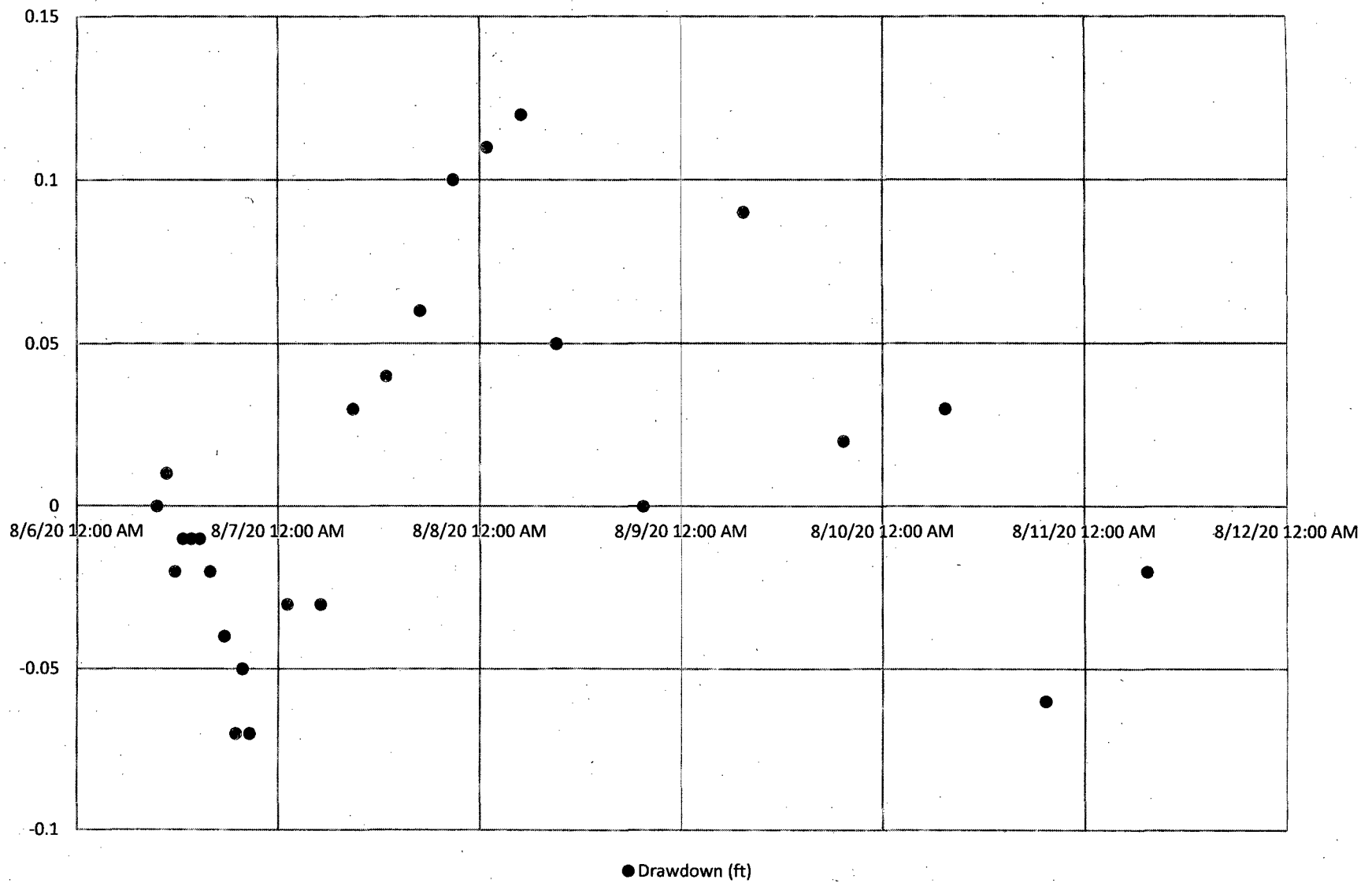


Type of Test	Drawdown	Well ID:	BS-Park	Well Elev.	1671.718	
Static Water Level	1665.448	Date:	6-Aug-20			
Distance of Observation well from pumped well (r):						
Time	Time since Pumping began (min)	Depth to Water Level (ft)	Drawdown (ft)	t/r^2	Pumping Rate (Q) (gpm)	Comments
8/6/20 10:31 AM		4.53	0			
8/6/20 10:32 AM	1.00	4.53	0			
8/6/20 11:32 AM	61.00	4.56	-0.03			
8/6/20 12:32 PM	121.00	4.56	-0.03			
8/6/20 1:32 PM	181.00	4.56	-0.03			
8/6/20 2:32 PM	241.00	4.57	-0.04			
8/6/20 3:42 PM	311.00	4.58	-0.05			
8/6/20 5:01 PM	390.00	4.57	-0.04			
8/6/20 6:18 PM	467.00	4.59	-0.06			
8/6/20 7:17 PM	526.00	4.58	-0.05			
8/6/20 8:07 PM	576.00	4.58	-0.05			
8/7/20 12:28 AM	837.00	4.58	-0.05			
8/7/20 4:25 AM	1,074.00	4.56	-0.03			
8/7/20 8:29 AM	1,318.00	4.54	-0.01			
8/7/20 12:24 PM	1,553.00	4.51	0.02			
8/7/20 4:25 PM	1,794.00	4.5	0.03			
8/7/20 8:26 PM	2,035.00	4.5	0.03			
8/8/20 12:26 AM	2,275.00	4.51	0.02			
8/8/20 4:28 AM	2,517.00	4.53	0			
8/8/20 4:25 PM	3,234.00	4.53	0			
8/8/20 6:58 PM	3,387.00	4.55	-0.02			
8/9/20 6:57 AM	4,106.00	4.42	0.11			
8/9/20 6:51 PM	4,820.00	4.52	0.01			
8/10/20 6:57 AM	5,546.00	4.53	0			
8/10/20 6:56 PM	6,265.00	4.57	-0.04			
8/11/20 7:01 AM	6,990.00	4.58	-0.05			



Type of Test	Drawdown	Well ID:	BSHN76E	Well Elev.	1661.014	
Static Water Level	1654.604	Date:	6-Aug-20			
Distance of Observation well from pumped well (r):						
Time	Time since Pumping began (min)	Depth to Water Level (ft)	Drawdown (ft)	t/r^2	Pumping Rate (Q) (gpm)	Comments
8/6/20 9:32 AM		6.41	0			
8/6/20 10:39 AM	67.00	6.4	0.01			
8/6/20 11:39 AM	127.00	6.43	-0.02			
8/6/20 12:39 PM	187.00	6.42	-0.01			
8/6/20 1:39 PM	247.00	6.42	-0.01			
8/6/20 2:39 PM	307.00	6.42	-0.01			
8/6/20 3:49 PM	377.00	6.43	-0.02			
8/6/20 5:31 PM	479.00	6.45	-0.04			
8/6/20 6:55 PM	563.00	6.48	-0.07			
8/6/20 7:44 PM	612.00	6.46	-0.05			
8/6/20 8:34 PM	662.00	6.48	-0.07			
8/7/20 1:01 AM	929.00	6.44	-0.03			
8/7/20 4:59 AM	1,167.00	6.44	-0.03			
8/7/20 8:54 AM	1,402.00	6.38	0.03			
8/7/20 12:52 PM	1,640.00	6.37	0.04			
8/7/20 4:51 PM	1,879.00	6.35	0.06			
8/7/20 8:51 PM	2,119.00	6.31	0.1			
8/8/20 12:52 AM	2,360.00	6.3	0.11			
8/8/20 4:55 AM	2,603.00	6.29	0.12			
8/8/20 9:05 AM	2,853.00	6.36	0.05			
8/8/20 7:26 PM	3,474.00	6.41	0			
8/9/20 7:28 AM	4,196.00	6.32	0.09			
8/9/20 7:20 PM	4,908.00	6.39	0.02			
8/10/20 7:27 AM	5,635.00	6.38	0.03			
8/10/20 7:21 PM	6,349.00	6.47	-0.06			
8/11/20 7:27 AM	7,075.00	6.43	-0.02			

Drawdown BS HN76E (ft)



Appendix C – Cooper Jacob Aquifer Analysis

WELL ID: Lake Norden L1

Local ID: Prairie Cotaeu

Date: 8/10/2020

Time: 10:32

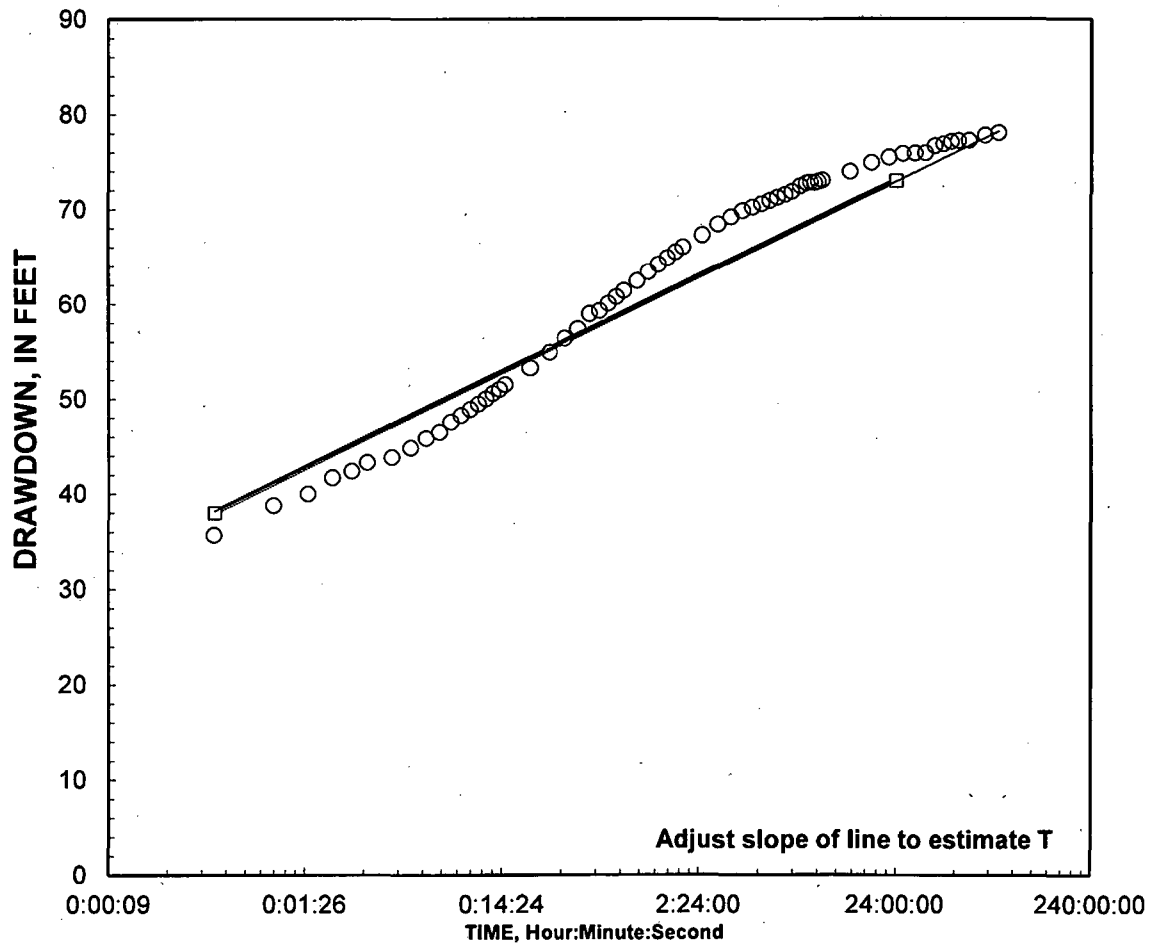
INPUT

Construction:	
Casing dia. (d_c)	10 Inch
Annulus dia. (d_w)	16 Inch
Screen Length (L)	20 Feet
Depths to:	
water level (DTW)	0 Feet
Top of Aquifer	88 Feet
Base of Aquifer	108 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Cement
Aquifer Material --	Coarse Sand
FLOW RATE	640 GPM

COMPUTED

Aquifer thickness = 20 Feet

Slope = 10.1174 Feet/log10

Input is consistent.**K = 110 Feet/Day****T = 2200 Feet²/Day****REMARKS:**

Cooper-Jacob analysis of single-well aquifer test

WELL ID: Lake Norden L2

Local ID: Prairie Coteau

Date: 8/10/2020

Time: 10:32

INPUT

Construction:	
Casing dia. (d_c)	10 Inch
Annulus dia. (d_w)	16 Inch
Screen Length (L)	20 Feet
Depths to:	
water level (DTW)	0 Feet
Top of Aquifer	85 Feet
Base of Aquifer	105 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Cement
Aquifer Material -- Coarse Sand	
FLOW RATE	640 GPM

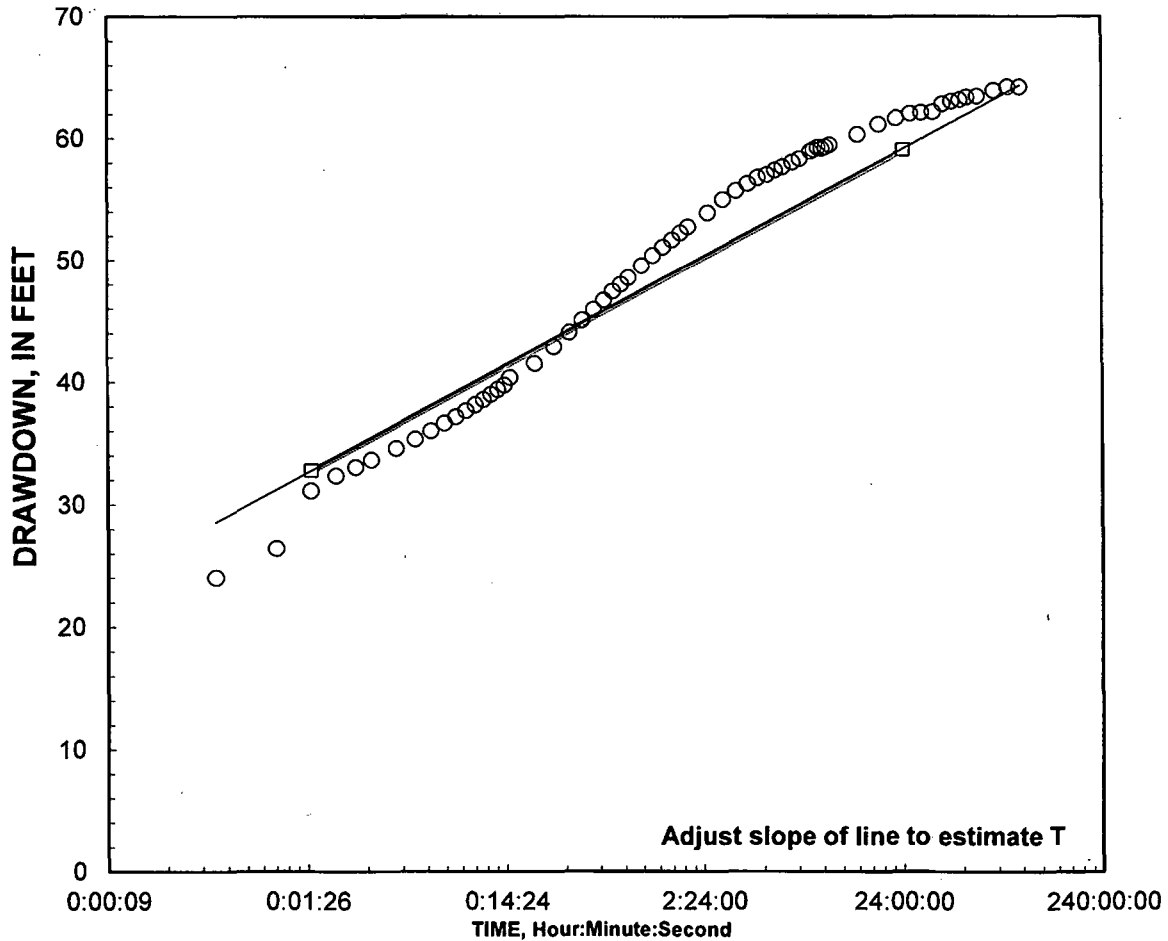
COMPUTED

Aquifer thickness = 20 Feet

Slope = 8.818797 Feet/log10

Input is consistent.

K = 130 Feet/Day

T = 2600 Feet²/Day

REMARKS:

Cooper-Jacob analysis of single-well aquifer test

PUMPING WELL ID: L1

Local ID: Lake Norden L2

Date: 8/18/2020

Time: 16:00

INPUT

Construction:	
Casing dia. (d_c)	10 Inch
Annulus dia. (d_w)	16 Inch
Screen Length (L)	20 Feet
Depths to:	
Initial Depth to Water	8.39 Feet
Top of Aquifer	83 Feet
Base of Aquifer	103 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Cement
Aquifer Material --	Coarse Sand
FLOW RATE	640 GPM

COMPUTED

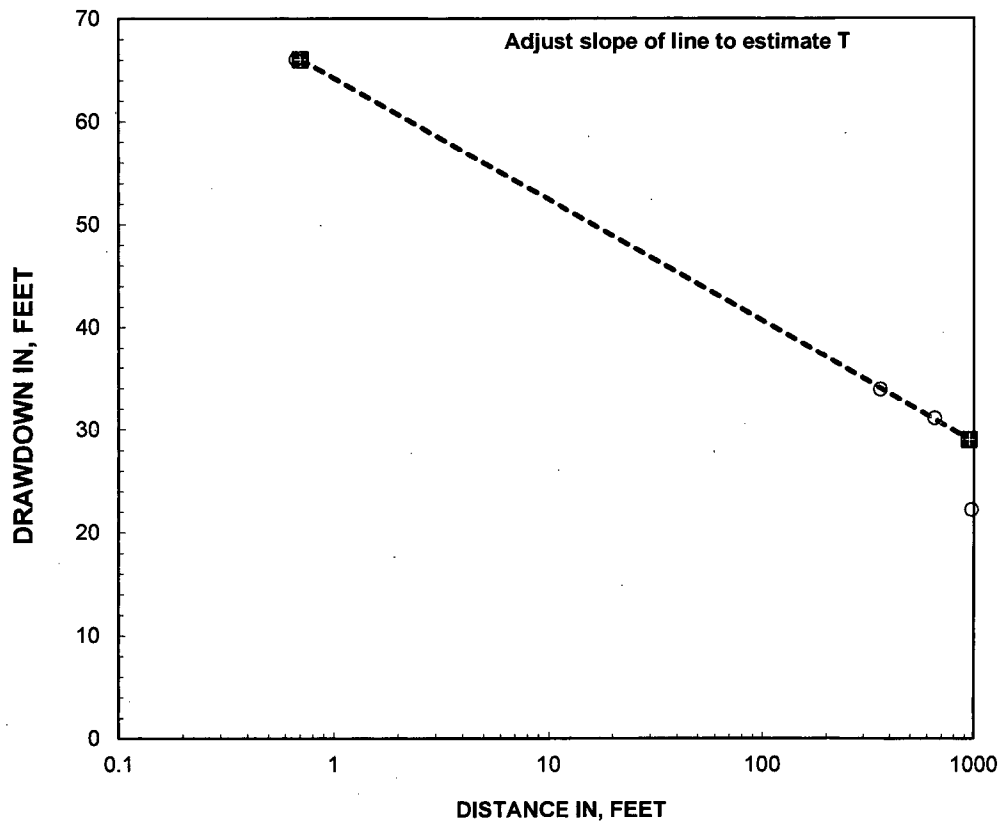
Aquifer thickness = 20 Feet

Aquifer is: **CONFINED**

Slope = -11.81118 Feet/log10

Input is consistent.

K = 190 Feet/Day

T = 3800 Feet²/Day**REMARKS:**

Drawdown-Distance analysis of multi-well aquifer test

Aquifer Test Lake Norden
Data from end of 11 days of pumping

PUMPING WELL ID: L2

Local ID: Lake Norden L2

Date: 8/18/2020

Time: 16:00

INPUT

Construction:	
Casing dia. (d_c)	10 Inch
Annulus dia. (d_w)	16 Inch
Screen Length (L)	20 Feet
Depths to:	
Initial Depth to Water	8.39 Feet
Top of Aquifer	83 Feet
Base of Aquifer	103 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Cement
Aquifer Material -- Coarse Sand	
FLOW RATE	640 GPM

COMPUTED

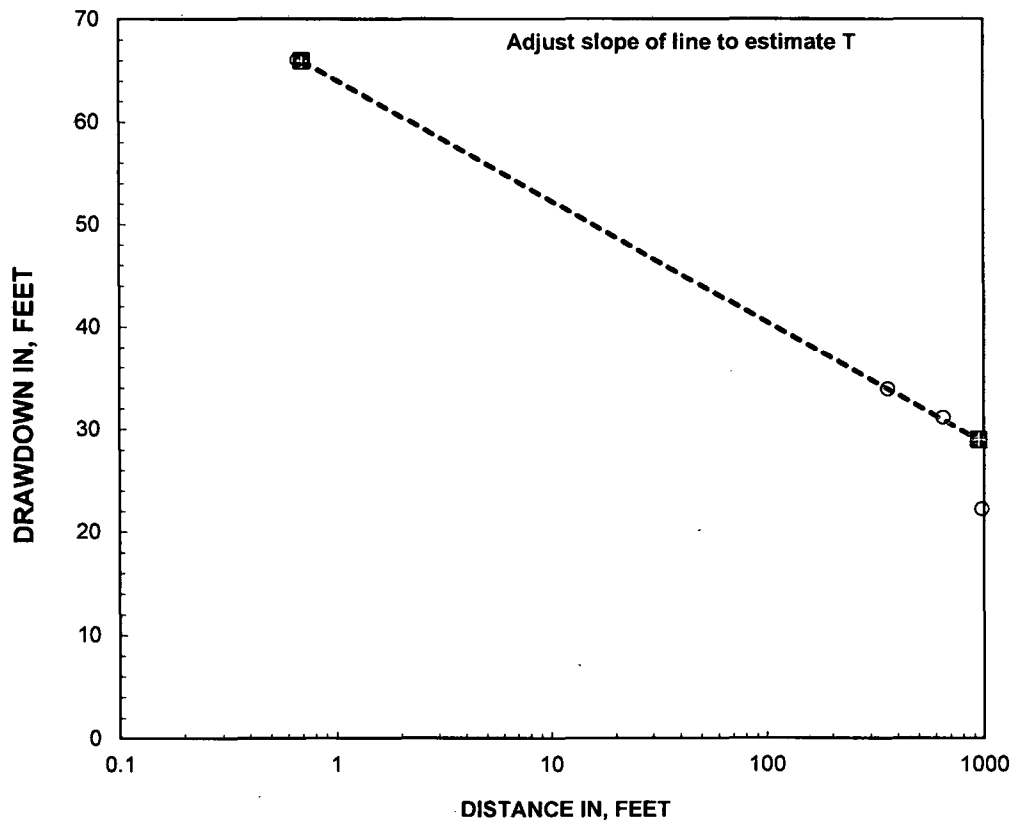
Aquifer thickness = 20 Feet

Aquifer is: **CONFINED**

Slope = -11.81118 Feet/log10

Input is consistent.

K =	190 Feet/Day
T =	3800 Feet ² /Day

**REMARKS:**

Drawdown-Distance analysis of multi-well aquifer test

Aquifer Test Lake Norden
Data from end of 11 days of pumping

WELL ID: L1

Local ID: Prairie Coteau

Date: 8/20/2020

Time: 10:32

INPUT

Construction:	
Casing dia. (d_c)	10 Inch
Annulus dia. (d_w)	16 Inch
Screen Length (L)	20 Feet
Depths to:	
water level (DTW)	0.458 Feet
Top of Aquifer	83 Feet
Base of Aquifer	103 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Cement
Aquifer Material --	Coarse Sand
FLOW RATE	640 GPM

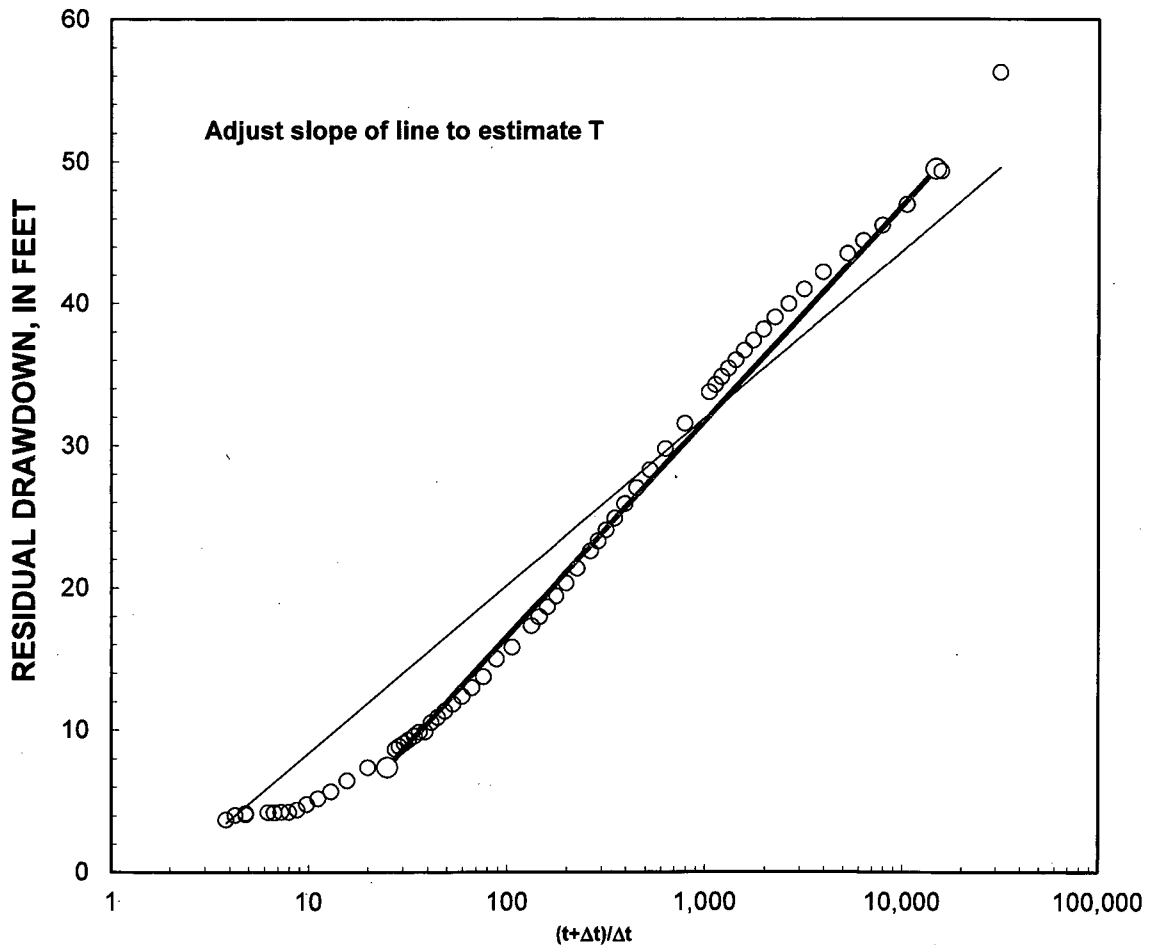
COMPUTED

Aquifer thickness = 20 Feet

Slope = 15.19737 Feet/log10

Input is consistent.

K = 74 Feet/Day

T = 1500 Feet²/Day**REMARKS:**

Cooper-Jacob recovery analysis of single-well aquifer test

Hypothetical recovery test

WELL ID: L2

Local ID: Prairie Coteau

Date: 8/20/2020

Time: 10:32

INPUT

Construction:	
Casing dia. (d_c)	10 Inch
Annulus dia. (d_w)	16 Inch
Screen Length (L)	20 Feet
Depths to:	
water level (DTW)	0.458 Feet
Top of Aquifer	83 Feet
Base of Aquifer	103 Feet
Annular Fill:	
across screen --	Medium Sand
above screen --	Cement
Aquifer Material -- Coarse Sand	
FLOW RATE	640 GPM

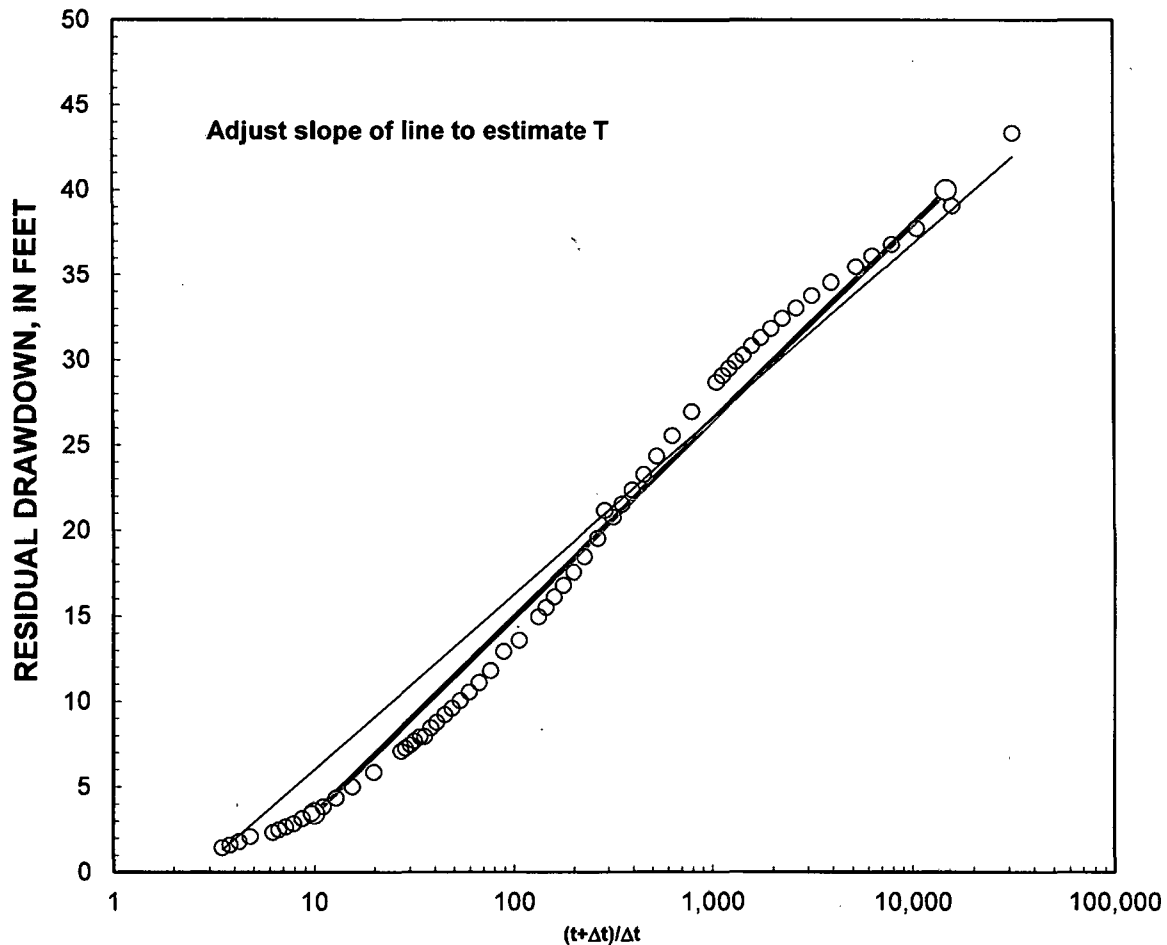
COMPUTED

Aquifer thickness = 20 Feet

Slope = 11.52471 Feet/log10

Input is consistent.

K = 98 Feet/Day

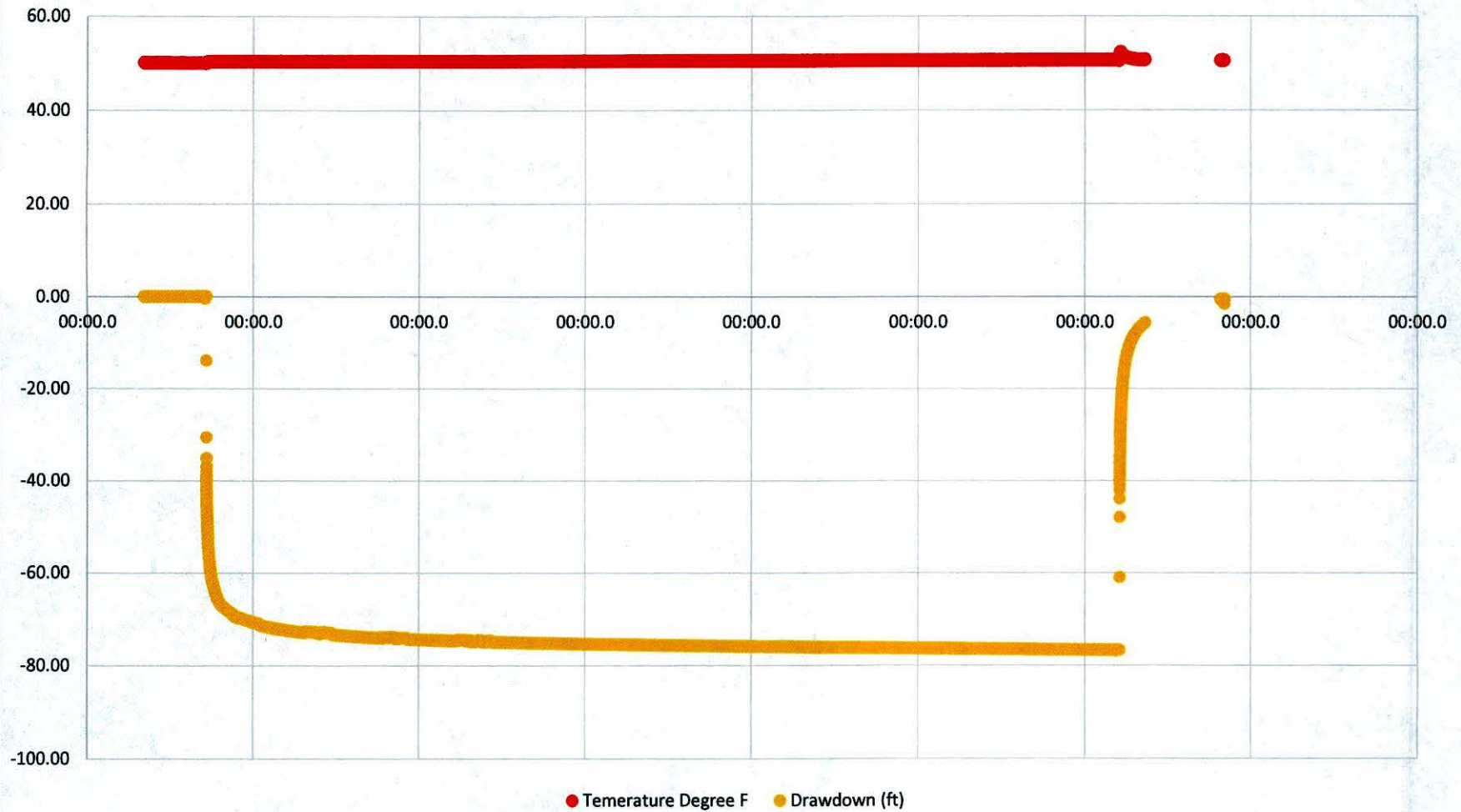
T = 2000 Feet²/Day

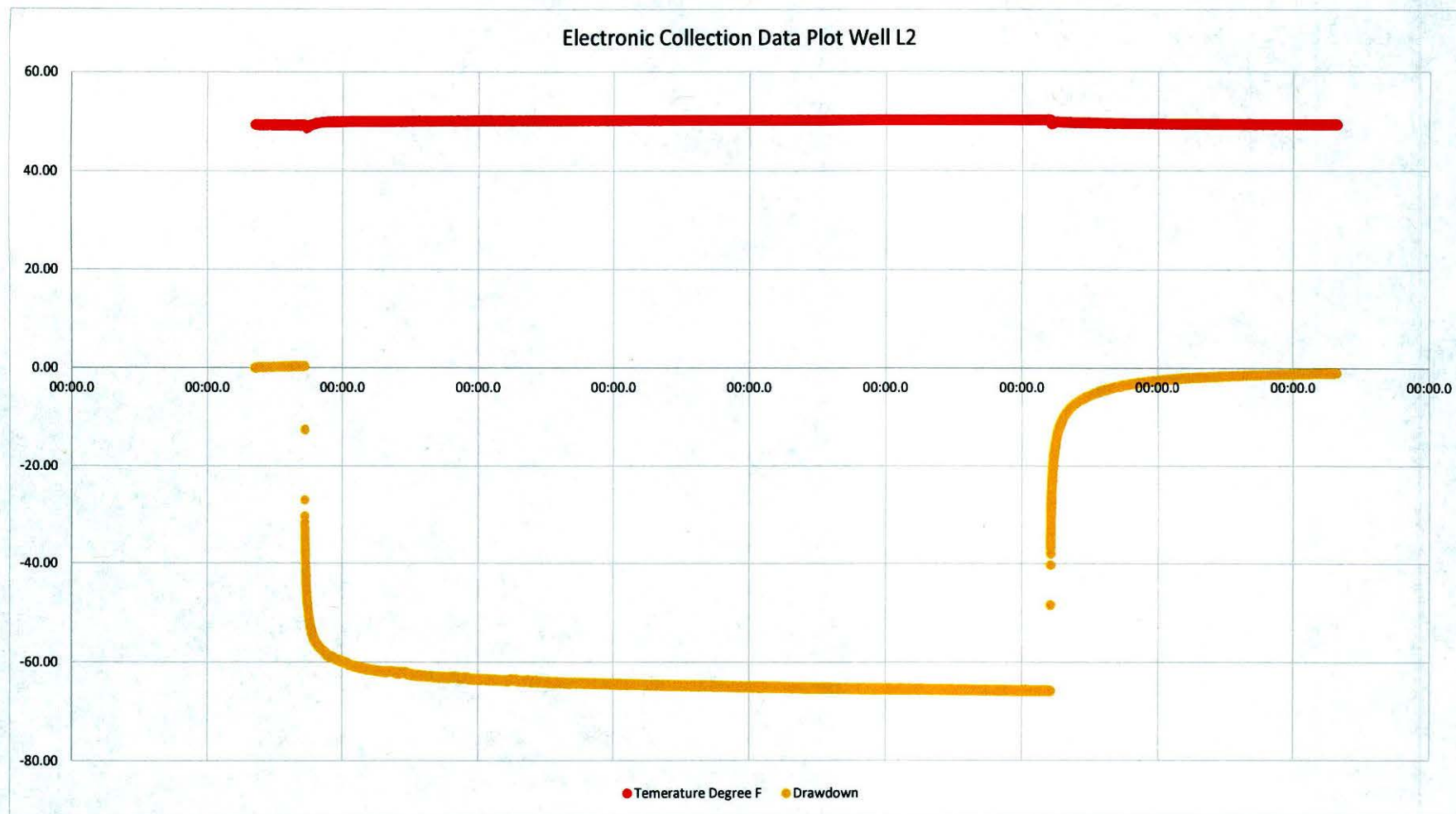
REMARKS:

Cooper-Jacob recovery analysis of single-well aquifer test

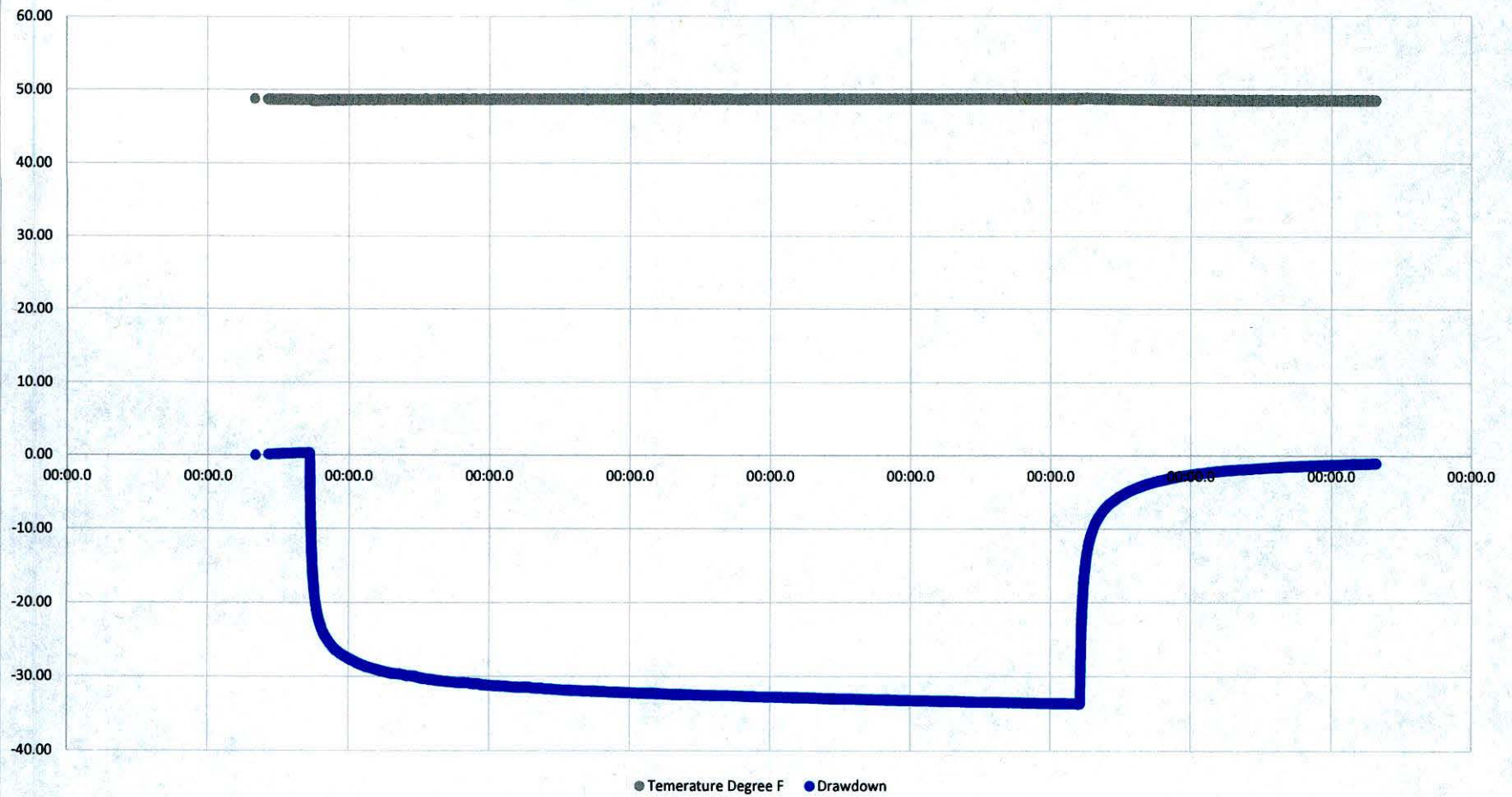
Hypothetical recovery test

Electronic Collection Data Plot Well L1

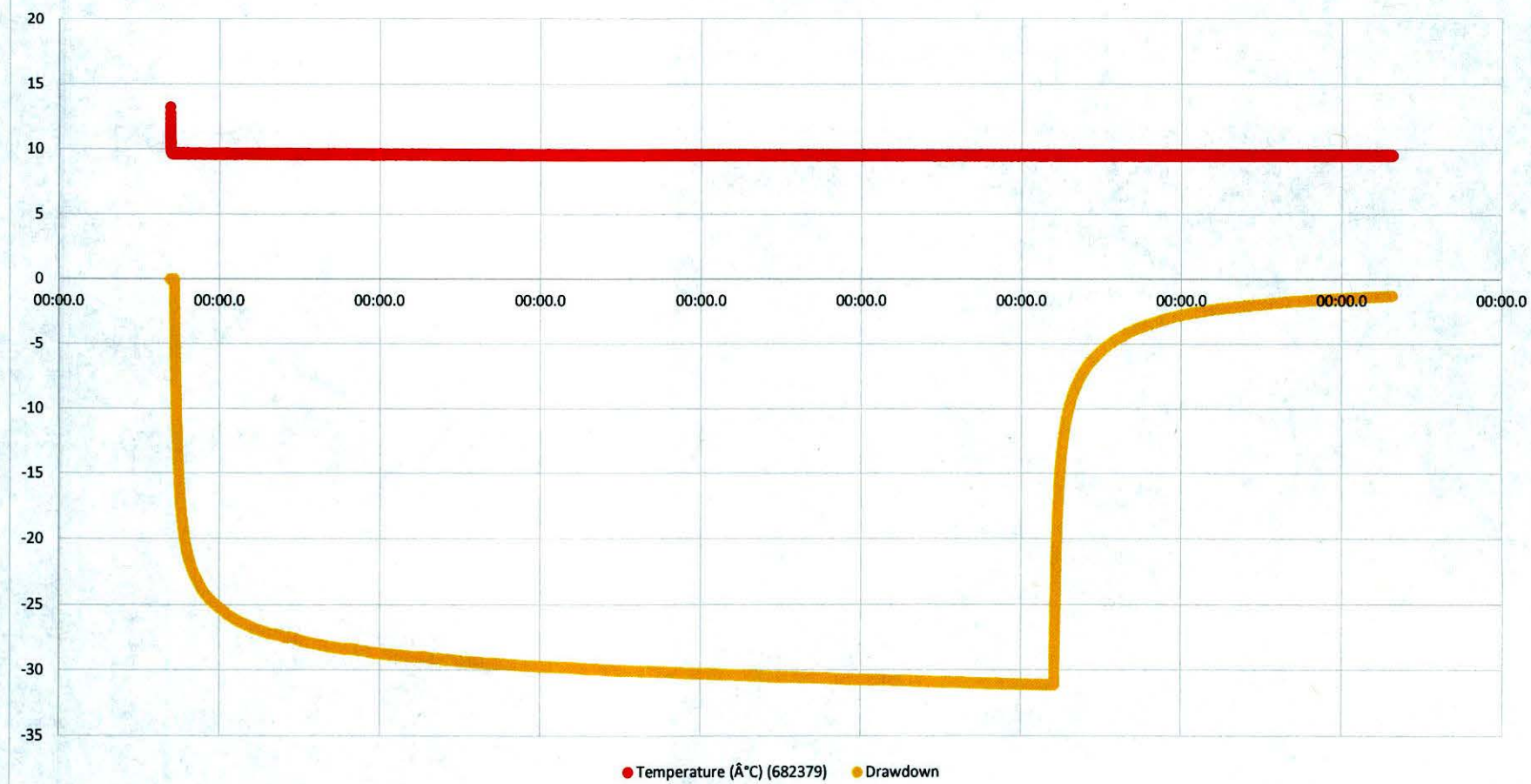




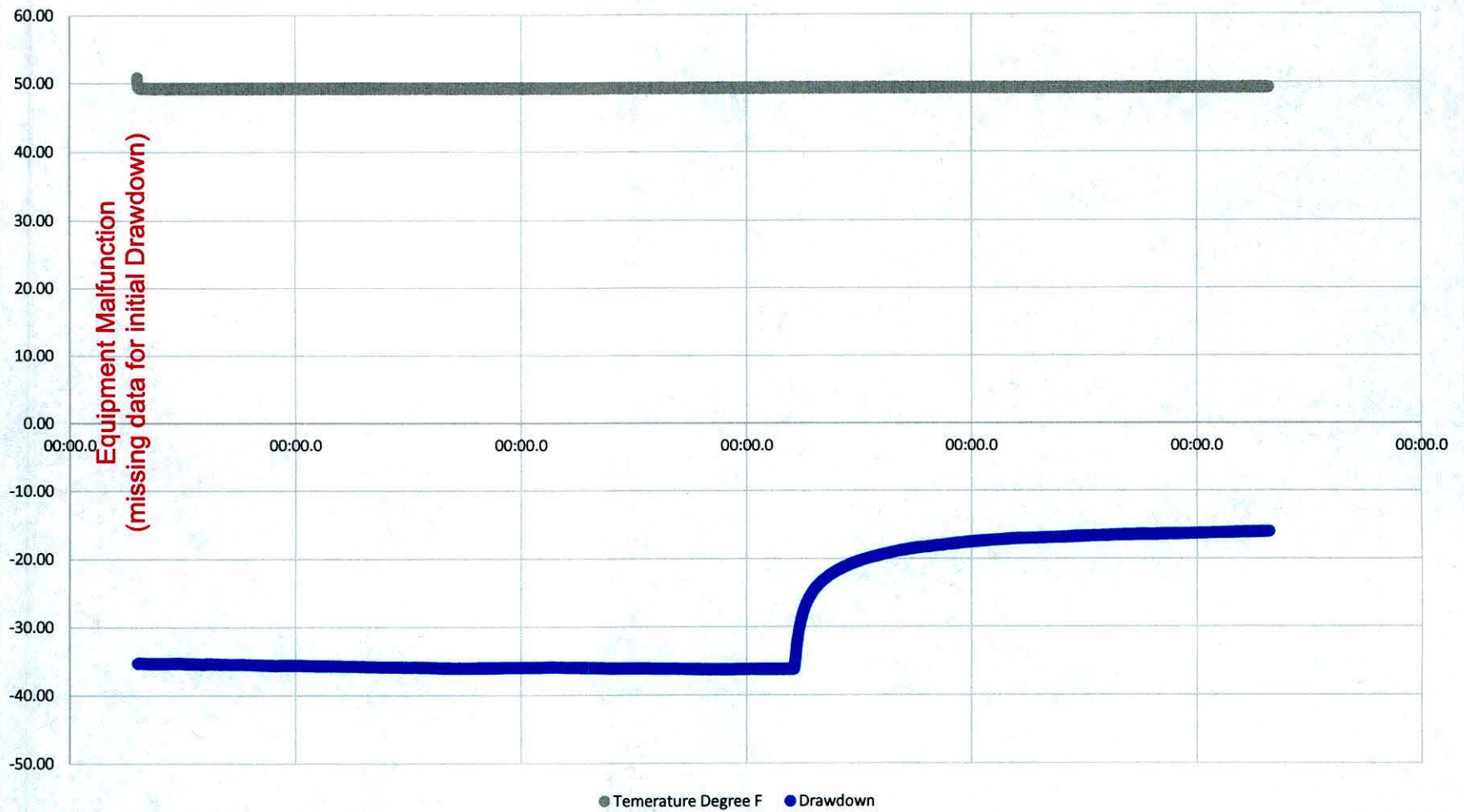
Electronic Collection Data Plot Well L3



Electronic Collection Data Plot EMW



Electronic Collection Data Plot NMW





DENR
SOUTH DAKOTA

**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3182
denr.sd.gov

October 13, 2020

NOTICE

TO: Jason Aho, Mayor
City of Lake Norden
PO Box 213
Lake Norden SD 57248

FROM: Eric Gronlund, Chief Engineer
Water Rights Program

SUBJECT: Deferral of Water Permit Application No. 8433-3, City of Lake Norden

Notice is hereby given that on the 7th day of October 2020, the South Dakota Water Management Board deferred Water Permit Application No. 8433-3 for further study so the city can provide information to assist with determining if there is unappropriated water available and the potential effect of pumping on existing water users.

Last week DENR received the Lake Norden Prairie Coteau Aquifer Evaluation from Banner Associates. DENR is reviewing the submitted evaluation with the desire to be able to make a recommendation and schedule Application No. 8433-3 for Board consideration at their December 2, 2020 meeting. Future notice scheduling the application before the Board will be provided to the city.

c: Gregg Jorgenson, Banner Associates

CERTIFICATION

I hereby certify that on October 13, 2020, I have personally deposited with the United States mail at Pierre, South Dakota, first class postage, prepaid envelopes containing a Notice dated October 13, 2020, regarding deferral of Water Right Permit Application No. 8433-3, as addressed below:

Jason Aho, Mayor
City of Lake Norden
PO Box 213
Lake Norden SD 57248

Gregg Jorgenson
Banner Associates
PO Box 298
Brookings SD 57006



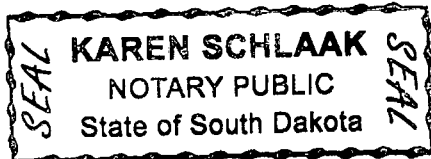
Eric Gronlund
Water Rights Program, DENR

STATE OF SOUTH DAKOTA)
) SS
COUNTY OF HUGHES)

Sworn to, before me, this 13th day of October, 2020.

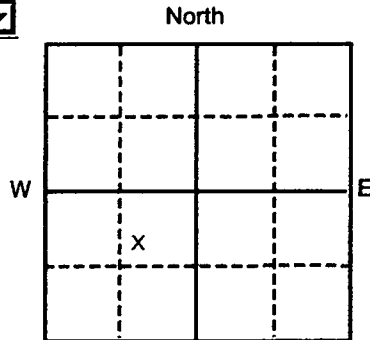


Karen Schlaak
Notary Public
My Commission expires April 1, 2025



SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location NE 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLINPlease mark well
location with an "X"

Well Completion Date

3-5-2021

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (Identify source)

PROPOSED USE:

☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☐ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
Sch40 LB/FT	5 IN	+2 FT	50 FT	8.75 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
ENVRPLG	18	54 Lb/gal	0 Ft	47 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

TREMIE LINE- PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 5 Inches Length 5 FeetMaterial SCH 40Slot Size 25 Set From 50 Feet to 55 Feet

Other Information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How?

☒ No, Why Not?
Lab to which water
quality sample sent for analysis

NONE

MONITORING WELL-
NO PUMPWell Owner: CITY OF LAKE NORDENBusiness Name: AQUIFER STUDYAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
SAND YELLOW	2	18
ROCK	18	19
CLAY WITH GRAVEL	19	21
BLUE CLAY	21	39
YELLOW CLAY	39	56

STATIC WATER LEVEL 48 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? YES

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

WELL ID L2MW-1 L2 WELL SITENO SAMPLEThis well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

RECEIVED

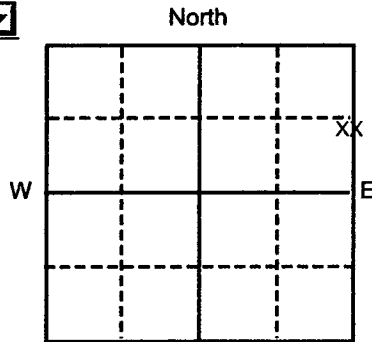
Signature of Well Owner or Equitable Property Holder: _____

APR 06 2021

WATER RIGHTS
PROGRAMDate: 3/22/2021

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location SE 1/4 NE 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLINPlease mark well
location with an "X"

Well Completion Date

3-13-2021

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
Sch40 LB/FT	2.5 IN	+2 FT	101 FT	6 IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWLDF	7	54 Lb/gal	0 Ft	91 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

TREMIE LINE- PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured
 Diameter 2.5 Inches Length 10 Feet
 Material SCH 40
 Slot Size 25 Set From 101 Feet to 111 Feet
 Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____☒ No, Why Not? _____Lab to which water
quality sample sent for analysis

WARD LABS

MONITORING WELL-
NO PUMPWell Owner: CITY OF LAKE NORDENBusiness Name: AQUIFER STUDYAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	3
YELLOW CLAY	3	6
YELLOW GRAVEL	6	16
YELLOW CLAY	16	22
BLUE CLAY	22	41
YELLOW CLAY	41	48
BLUE CLAY	48	56
YELLOW CLAY	56	67
YELLOW GRAVEL	67	68

STATIC WATER LEVEL 19 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? YES

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT 25+☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

YELLOW CLAY 68-96
 YELLOW GRAVEL FINE-MED 96-108
 BLUE CLAY 108

WELL ID NEMW 452ND AVE

This well was drilled under license # 689 and this
report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

RECEIVED

APR 06 2021

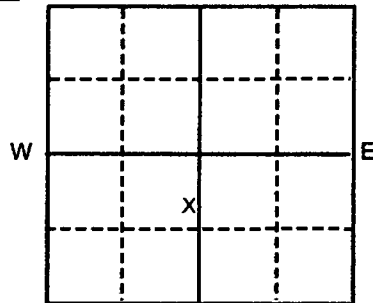
Date: 3/22/2021WATER RIGHTS
PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location NE 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLIN

North

Please mark well
location with an "X"

Well Completion Date

3-9-2021

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

If other describe _____

☐ Steel ☐ Plastic ☐ Other

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
<u>sch40</u> LB/FT	<u>2.5</u> IN	<u>+2</u> FT	<u>93</u> FT	<u>6</u> IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
<u>GRTWLDF</u>	<u>4</u>	<u>54</u> Lb/gal	<u>0</u> Ft	<u>88</u> Ft
		_____ Lb/gal	_____ Ft	_____ Ft

Describe grouting procedure

TREMIE LINE- PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 2.5 Inches Length 10 FeetMaterial SCH 40Slot Size 25 Set From 93 Feet to 103 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION:

Was well disinfected upon completion?

☐ Yes, How? _____

☒ No, Why Not? _____
Lab to which water
quality sample sent for analysis

WARD LABS

MONITORING WELL-
NO PUMPWell Owner: CITY OF LAKE NORDENBusiness Name: AQUIFER STUDYAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
SANDY YELLOW CLAY	2	17
BLUE CLAY	17	38
YELLOW CLAY	38	62
ROCK	62	62.5
YELLOW CLAY	62.5	79
BLUE CLAY	79	88
YELLOW GRAVEL FINE-MED MIX	88	103
BLUE CLAY	103	105

STATIC WATER LEVEL 11 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? YES

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT 50+☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

WELL ID EMW2 L3 WELL SITE

This well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

Date: 3/22/2021

RECEIVED

APR 06 2021

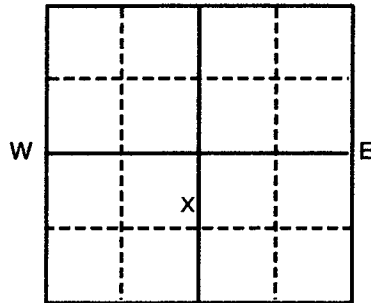
WATER RIGHTS
PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location NE 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLIN

North

Please mark well
location with an "X"

Well Completion Date

3-5-2021

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (Identify source)

PROPOSED USE:

☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☐ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
Sch40 LB/FT	5 IN	+2 FT	11 FT	8.75 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWLDF	4	54 Lb/gal	0 Ft	8 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

TREMIE LINE- PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 5 Inches Length 10 FeetMaterial SCH 40Slot Size 25 Set From 11 Feet to 21 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How?☒ No, Why Not?Lab to which water
quality sample sent for analysis

WARD LABS

MONITORING WELL-
NO PUMPWell Owner: CITY OF LAKE NORDENBusiness Name: AQUIFER STUDYAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	3.5
YELLOW CLAY	3.5	5
YELLOW SAND FINE-MED	5	17
YELLOW MED-COARSE	17	21
BLUE CLAY	21	25

STATIC WATER LEVEL 14 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? YES

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

WELL ID L3MW-S L3 WELL SITE

This well was drilled under license # 689 and this
report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

Date: 3/20/2021

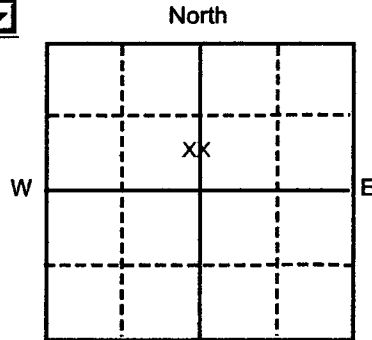
RECEIVED

APR 06 2021

WATER RIGHTS
PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location SE ¼ NW ¼ Sec 21 Twp 113N Rg 53WCounty HAMLIN ☒Please mark well
location with an "X"

Well Completion Date

3-11-2021

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock Irrigation ☐ Municipal Industrial ☐ Business Institutional ☐ Test holes ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☐ Plastic ☐ Other

If other describe

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
Sch40 LB/FT	2.5 IN	+2 FT	147 FT	6 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWLDF	10	54 Lb/gal	0 Ft	142 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

TREMIE LINE- PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 2.5 Inches Length 10 FeetMaterial SCH 40Slot Size 25 Set From 147 Feet to 157 Feet

Other information

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material?

Describe packer(s) and location

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How?

☒ No, Why Not?
Lab to which water
quality sample sent for analysis

WARD LABS

MONITORING WELL-
NO PUMPWell Owner: CITY OF LAKE NORDENBusiness Name: AQUIFER STUDYAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
YELLOW CLAY	2	17
BLUE CLAY	17	22
QUARTZ	22	23
BLUE CLAY	23	40
GREY SAND	40	45
BLUE CLAY	45	142
YELLOW GRAVEL MED-COARSE	142	150
BLUE CLAY	150	151

STATIC WATER LEVEL 17 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? YES

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT 25+☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

YELLOW GRAVEL MIXED 151-154

BLUE CLAY 154-159

WELL ID SWMW-D LAKER

This well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder:

RECEIVED

APR 06 2021

Date: 3/22/2021WATER RIGHTS
PROGRAM

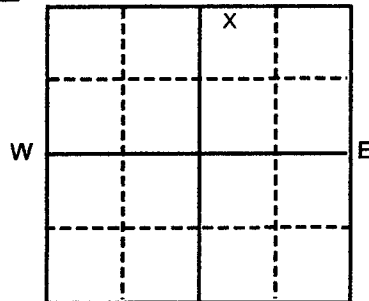
SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location NW ¼ NE ¼ Sec 15 Twp 113N Rg 53W

County HAMLIN

North

Please mark well
location with an "X"

Well Completion Date

3-13-2021

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from (identify source)

PROPOSED USE:

☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☐ Plastic ☐ Other

If other describe

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
sch40 LB/FT	2.5 IN	+2 FT	96 FT	6 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWLDF	4.5	54 Lb/gal	0 Ft	89 Ft
ENVIROPLG	3	Lb/gal	0 Ft	1 Ft

Describe grouting procedure

TREMIE LINE- PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured

Diameter 2.5 Inches Length 10 Feet

Material SCH 40

Slot Size 25 Set From 96 Feet to 106 Feet

Other information

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material?

Describe packer(s) and location

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How?

☒ No, Why Not?
Lab to which water
quality sample sent for analysis

WARD LABS

MONITORING WELL-
NO PUMP

Well Owner: CITY OF LAKE NORDEN

Business Name: AQUIFER STUDY

Address: PO BOX 213

City, State, Zip: LAKE NORDEN SD 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	4
YELLOW CLAY	4	9
YELLOW GRAVEL	9	17
BLUE CLAY	17	26
ROCK	26	27
BLUE CLAY	27	55
YELLOW CLAY	55	62
BLUE CLAY	62	74
ROCK	74	74.5

STATIC WATER LEVEL 14 FEET

If flowing: closed in pressure PSI

GPM flow through Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

Reduced flow rate GPM

Can well be completely shut in? YES

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT 25+

☐ Bailed

☐ Other

Pumping Level Below Land Surface

Ft. After Hrs. pumped GPM

Ft. After Hrs. pumped GPM

If pump installed, pump rate: GPM

REMARKS

BLUE CLAY 74.5-88

MED- COARSE YELLOW GRAVEL 88-106

WELL ID: NNMW

192ND ST

This well was drilled under license # 689 and this report is true and accurate.

Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder:

RECEIVED

APR 06 2021

WATER RIGHTS
PROGRAM

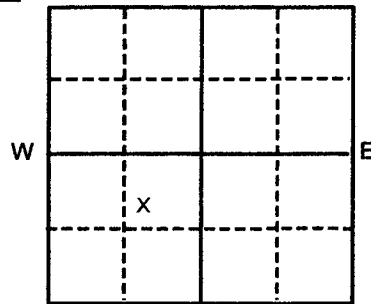
Date: 3/20/2021

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location NE 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLIN ☒

North

Please mark well
location with an "X"

Well Completion Date

3-3-2021

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☐ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
<u>sch40</u> LB/FT	<u>5</u> IN	<u>+2</u> FT	<u>110</u> FT	<u>8.75</u> IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
<u>GRTWLDF</u>	<u>11</u>	<u>54</u> Lb/gal	<u>0</u> Ft	<u>98</u> Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

TREMIE LINE- PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured
 Diameter 5 Inches Length 10 Feet
Material SCH 40Slot Size 25 Set From 100 Feet to 110 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____☒ No, Why Not? _____Lab to which water
quality sample sent for analysis

WARD LABS

MONITORING WELL-
NO PUMPWell Owner: CITY OF LAKE NORDENBusiness Name: AQUIFER STUDYAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
YELLOW CLAY	2	7
YELLOW GRAVEL	7	10
YELLOW CLAY	10	16
YELLOW GRAVEL	16	17
BLUE CLAY	17	41
YELLOW CLAY	41	45
YELLOW FINE SAND	45	46
YELLOW CLAY	46	89

STATIC WATER LEVEL 14 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? YES

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT 100+☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

YELLOW GRAVEL FINE-MED 89-110
YELLOW CLAY 110

WELL ID L2MW-D L2 WELL SITE

This well was drilled under license # 689 and this
report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

RECEIVED

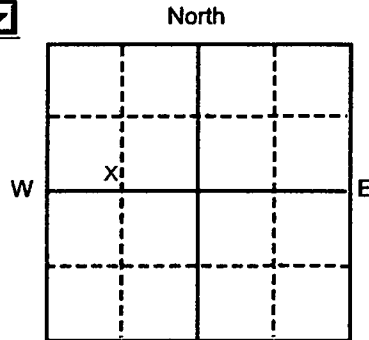
Signature of Well Owner or Equitable Property Holder: _____

APR 06 2021

WATER RIGHTS
PROGRAMDate: 3/22/2021

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location SE 1/4 NW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLINPlease mark well
location with an "X"

Well Completion Date

3-3-2021Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (Identify source)

PROPOSED USE:

☐ Domestic/Stock Irrigation ☐ Municipal Industrial ☐ Business Institutional ☒ Test holes Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☐ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
Sch40 LB/FT	5 IN	+2 FT	26 FT	8.75 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
ENVRPLG	6	54 Lb/gal	0 Ft	25 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure _____

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 5 Inches Length 5 FeetMaterial SCH 40Slot Size 25 Set From 26 Feet to 31 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____

☒ No, Why Not? _____
Lab to which water
quality sample sent for analysis

WARD LABS

MONITORING WELL-
NO PUMPWell Owner: CITY OF LAKE NORDENBusiness Name: AQUIFER STUDYAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	3
GREY SAND	3	14
SILT	14	18
FINE SAND	18	23
COARSE GRAVEL	23	26
FINE SAND	26	31

STATIC WATER LEVEL _____ 4 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? YES

WELL TEST DATA:

☒ Pumped Describe: AIR LIFT 50+☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

WELL ID SWMW-~~15~~ PARKThis well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

RECEIVED

Signature of Well Owner or Equitable Property Holder: _____

APR 06 2021

WATER RIGHTS
PROGRAMDate: 3/22/2021



CONNECTING WATER TO LIFE

30-DAY AQUIFER PUMPING TEST

Analysis and Results – Prairie Coteau Well Field

Lake Norden, MN

Prepared for:

Banner Associates, Inc.

May 21, 2021

5509BAN02

I hereby certify that this plan, document, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of South Dakota.

A handwritten signature in black ink, appearing to read "MK S", positioned above a horizontal line.

Mitch Kannenberg, PE #7489

The following members of the LRE Water staff contributed to the preparation of this report.

Senior Project Manager – Mitch Kannenberg, PE

Lead Hydrogeologist – Mike Plante, GISP

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SECTION 1: INTRODUCTION, PURPOSE AND BACKGROUND INFORMATION

In late 2018, Kaiser Well Drilling, Inc. (KWD) constructed three municipal wells (L1, L2, and L3) on behalf of the City of Lake Norden, SD (City). The three wells were completed in the Prairie Coteau aquifer. In 2019 and 2020, Banner Associates, Inc. (Banner) designed and oversaw the construction of the control systems and raw water transmission pipeline associated with bringing the water pumped from these three wells to the City's water treatment plant. As part of this process, it became apparent that the City did not have a water right authorizing withdrawals from the Prairie Coteau aquifer.

In June 2020, the City submitted a water permit application (WPA #8433-3) requesting an annual appropriation of groundwater from the Prairie Coteau aquifer of 1,458 acre-feet per year at a maximum instantaneous diversion rate of 2.11 cubic feet per second (cfs). The annual volume and maximum diversion rate are equivalent to continuous pumping rates of approximately 904 gallons per minute (gpm) and 947 gpm, respectively. In the Summer of 2020, Banner, working with personnel from the Water Rights Program (WRP) and the Geological Survey Program (SDGS) of the South Dakota Department of Environment and Natural Resources (DENR), conducted an aquifer pumping test (2020 Aquifer Test). The 2020 Aquifer Test was conducted utilizing two wells (L1 and L2) pumping at a combined rate of 640 gpm. The results of the 2020 Aquifer Test (Banner, 2020) are briefly summarized in Section 1.3.

In late 2020, Banner hired LRE Water (LRE) to provide hydrogeologic consulting services associated with the evaluation of WPA #8433-3. Those services have included an independent review and analysis of the 2020 Aquifer Test data and various field and office services related to the completion of a 30-day aquifer pumping test.

1.1 PURPOSE

The purpose of the 30-day aquifer pumping test (30-day Test) is to provide hydrogeologic information with which to evaluate the long-term yield potential of the City's Prairie Coteau aquifer well field and to assess the potential for municipal pumping from the well field to adversely impact nearby domestic wells. A copy of this report, as well as the raw water-level displacement data collected during the 30-day Test, will be provided to the WRP of the South Dakota Department of Agriculture & Natural Resources (DANR) for use in evaluating WPA #8433-3.

1.2 PROJECT AREA LOCATION

The City's Prairie Coteau aquifer well field (Site) is located approximately ½-mile east of town, in the southwest quarter of Section 15, Township 113 North, Range 53 West, Hamlin County, South Dakota. The Project Area is defined as the area shown in Figure 1, which includes the area within an approximate one-mile radius of City Well L2.

1.3 SUMMARY OF PREVIOUS WORK

The 2020 Aquifer Test conducted by Banner consisted of pumping City wells L1 and L2 at a combined rate of 640 gpm. Banner, utilizing the confined Cooper-Jacob analytical solution, calculated an average transmissivity value of 1,750 feet squared per day (ft^2/day) to 2,525 ft^2/day for L1 and 2,075 ft^2/day to 2,575 ft^2/day for L2 (Table 2, Banner, 2020). There were no boundary conditions apparent in the data. Banner concluded that the Prairie Coteau was limited in capacity and recommended that the City continue to search for additional water supplies.

At Banner's request, LRE conducted a detailed review and analysis of the 2020 Aquifer Test data. LRE calculated numerous different values of transmissivity (T) and storativity (S) utilizing three different analytical solutions applied to both the early and late time portions of the drawdown data. Using only those T & S values deemed valid based on the solution assumptions, the geometric mean of the T values was 1,002 ft^2/day and the geometric mean of the S values was 2.22×10^{-5} . LRE provided the results of LRE's review and analysis to Banner in a Memorandum dated December 23, 2020 (LRE, 2020). Banner submitted a copy of the LRE Memorandum to the WRP, who responded with a recommendation for a single well pumping test along with recommendations for observation well locations.

LRE developed an Aquifer Pumping Test Workplan for the City of Lake Norden Prairie Coteau Well Field (Workplan) that incorporated the WRP recommendations. The WRP approved the Test Workplan in a February 2, 2021 email. LRE provided three Workplan updates, and Banner provided these updates to the City and the WRP. The Workplan updates were primarily associated with drilling progress updates and schedule revisions. The 30-day Test was conducted in general accordance with Update #3 of the Workplan, dated February 22, 2021 (LRE, 2021).

1.4 TEMPORARY USE PERMITS

The City obtained a *Temporary Permit to Use Public Waters for Testing Purposes* (Temporary Use Permit) from the WRP on July 7, 2020. The 2020 Aquifer Test was conducted under the July 7, 2020 Temporary Use Permit. Banner and the City conducted weekly water-level monitoring under the July 7, 2020 Temporary Use Permit for the remainder of 2020.

On January 1, 2021, the WRP issued a new Temporary Use Permit allowing pumping from City Wells L1, L2 and L3 at a combined rate of 550 gpm for the period from January 1, 2021 through May 6, 2021. The purpose of the January 1, 2021 Temporary Use Permit was to allow continued testing of the Prairie Coteau aquifer. Due to unanticipated project delays associated with the installation of new Prairie Coteau aquifer observation wells (primarily related to weather and equipment problems), it became apparent that the aquifer testing would not be completed prior to the Temporary Use Permit expiration date of May 6, 2021. Consequently, on March 25, 2021, LRE submitted an application for another Temporary Use Permit to authorize continued pumping, at a combined rate not to exceed 550 gpm, from the City's Prairie Coteau aquifer well field. On April 12, 2021, the WRP issued a temporary permit authorizing pumping of up to 550 gpm from the Prairie Coteau well field from May 7, 2021 to July 9, 2021. The Temporary Use Permits require monthly reporting of the amount of water pumped from the City's Prairie Coteau aquifer well field

to the WRP, and the City has been complying with this reporting requirement, as well as other provisions of the Temporary Use Permits.

SECTION 2: HYDROGEOLOGIC CONCEPTUAL MODEL

A hydrogeologic conceptual model (HCM) is a description of the geologic and hydrogeologic elements that control the occurrence, flow and quality of groundwater in a defined area or unit. An HCM includes a description of the sediments, groundwater occurrence, groundwater quality, and recharge and discharge conditions.

2.1 HYDROGEOLOGIC SETTING

Lake Norden is located in northeastern South Dakota, near the center of the Coteau des Prairies. The Coteau des Prairies is a major topographic feature in South Dakota consisting of a flatiron-shaped highland that is approximately 200 miles in length (Beissel & Gilbertson, 1987). The Coteau des Prairies was shaped by various advances and retreats of continental glaciers during the Pleistocene Epoch (Pleistocene).

A map showing the geologic formations exposed at the surface is shown in Figure 2 (Beissel and Gilbertson, 1987). All of the sediments shown in the geologic map are glacial drift. Drift is a general term for all rock materials deposited either directly from glacial ice or from glacial meltwaters. The drift in the Project Area is approximately 450 to 500 feet thick, and overlies bedrock comprised of the Cretaceous Pierre Shale.

In the Project Area, there are three main forms of glacial drift. Till is a heterogenous material consisting primarily of clay, with varying amounts of silt, sand, gravel and boulders. The clay-rich till is not suitable for municipal water supply wells. Outwash is comprised primarily of sand and gravel deposited by glacial meltwaters, and is often suitable for municipal water supply wells. The third type of drift in the Project Area is lacustrine sediments. The lacustrine sediments consist of fine-grained silts and clays that were deposited in lakes (either directly associated with the continental glaciers or present during the inter-glacial periods of the Pleistocene). The fine-grained lacustrine sediments are typically not suitable for municipal water supply wells.

The surficial deposits at the City's Prairie Coteau aquifer well field are mapped in Figure 2 as collapsed outwash (Qwloc). The areas mapped as moraine in Figure 2 (either Stagnation or James Lobe Altamont) are comprised primarily of till. The City overlies lacustrine sediments.

The three main aquifers in the Project Area are the Brookings management unit of the Big Sioux (Big Sioux:Brookings) aquifer, the Prairie Coteau aquifer, and the Altamont aquifer. These three aquifers are comprised of outwash. Kume (1985) defines the Big Sioux aquifer as surficial outwash, mostly associated with valleys of either the Big Sioux River or its tributaries, that is often overlain by 1 to 4 feet of alluvium. The surficial outwash in the Project Area is not associated with either the Big Sioux River or one of its tributaries.

The Altamont aquifer is an outwash aquifer that either directly overlies the Pierre Shale bedrock or a thin layer of till overlying the bedrock. The average depth to the top of the Altamont aquifer in Deuel and Hamlin counties is 475 feet (Kume, 1985). Based on a review of well logs available online at the SDGS Oil & Gas Initiative, Map-Based Data Source (<https://usd.maps.arcgis.com/apps/webappviewer/index.html?id=9888ec2e3ee844998385265dfa22e449¢er=-100.33,%2044.36>), the depth to the Altamont aquifer in the Project Area is in the range of 400 to 450 feet.

Kume (1985) describes the Prairie Coteau aquifer as lenticular bodies of outwash buried beneath till within the thick layer of glacial drift. The outwash bodies occur as separate bodies at differing elevations in the till, and Kume (1985) states that "The beds of outwash at a given site probably are not connected hydraulically."

Within the Project Area, the Prairie Coteau aquifer is defined as outwash encapsulated in till that occurs at an elevation below the surficial outwash that has been classified as the Big Sioux:Brookings aquifer by Hedges (1982) and Kume (1985) and above the basal outwash Altamont aquifer. This is shown schematically in cross-section C-C' from Beissel & Gilbertson (1987), which is provided in Appendix A. Outwash of the Altamont aquifer is labeled as Qpwo₂, surficial outwash of the Big Sioux:Brookings aquifer is labeled as Qwlo, and the intermediate and Prairie Coteau outwash is labeled as Qoa.

In an oft-cited report of the groundwater resources of eastern South Dakota and the Big Sioux River watershed (Hedges, et. al., 1982), the aquifers located in unconsolidated glacial and non-glacial deposits of Pleistocene and Recent age are divided roughly by their elevation into four general systems: 1. Deep James System and Fairmount Aquifer; 2. Basal System, 3. Intermediate System, and 4. Surface System. Hedges, et. al. (1982) recommended that all aquifers in the Intermediate System be considered the Prairie Coteau aquifer. The aquifers in the Intermediate System, while mostly artesian, do include water-table aquifers, or artesian aquifers that are hydraulically connected to water-table aquifers.

2.2 SITE STRATIGRAPHY AND 2021 OBSERVATION WELL INSTALLATION

Fourteen wells (3 production wells and 11 observation wells) have been constructed during the assessment of the City's Prairie Coteau aquifer well field. As indicated previously, municipal wells L1, L2 and L3 were constructed by KWD in 2018. Observation wells NMW (1000N), EMW (650E), and BS Park MW were constructed by KWD for use in the 2020 Aquifer Test. In March 2021, KWD constructed an additional 8 observation wells. Five of the eight are completed in the Prairie Coteau aquifer (EMW2, L2MW-D, NEMW, NNMW, and SWMW-D), two of the eight are completed in surficial outwash (L3MW-S and SWMW-S), and one of the eight is completed in the till confining layer overlying the Prairie Coteau aquifer at L2 (L2MW-I). Some of the observation wells are 5-inch in diameter and some are 2.5 inch in diameter (the diameter was determined by the timing of the availability of PVC casing and screen).

LRE observed the installation of the March 2021 observation wells, and a detailed geologic description of the materials encountered during the drilling of the wells is provided in the LRE well construction logs (well logs) provided in Appendix B. LRE utilized the Unified Soil Classification System (USCS) to describe the texture and grain size of the samples.

Four principal materials were encountered and sampled during the installation of the observation wells: 1) topsoil; 2) outwash; 3) unoxidized till; and 4) oxidized till. The topsoil is comprised primarily of dark brown silty clay. The till, both the oxidized and unoxidized till, is predominantly clay, that contains a variable amount of other materials, including silt, fine to coarse sand, fine to coarse gravel, cobbles and boulders. A boulder with an estimated 1-foot diameter of Milbank Granite was encountered at 22 feet below ground surface (ft bgs) in SWMW-D. The till, particularly the un-oxidized till, was sometimes quite dense. The unoxidized till is referred to as "blue clay" by KWD and other drillers.

The oxidized till is comprised of the same materials as the un-oxidized till. The oxidized till is typically yellowish-brown in color. The color is generally a thin coating of yellow-brown material on the otherwise mostly gray-colored clay.

The outwash generally consists of medium to coarse sand, with varying amounts of gravel, often with minor amounts of silt and clay. However, it was not uncommon to encounter clay-rich lenses or clay layers within the outwash.

The larger grain sizes in the outwash are typically angular to sub-angular, and the finer-grained materials are rounded to subrounded. The rocks and minerals observed in the outwash include granite, limestone, quartz, quartzite, chert, shale and possibly very fine lignite particles. The fine to very fine sand is comprised of primarily clear quartz. The outwash is poorly sorted. The poor sorting and variable degree of particle rounding is characteristic of outwash.

There are three outwash bodies (surficial, intermediate, and Prairie Coteau aquifer) located in the first 150 feet of till in the Project Area (Table 1). The thickness, lateral location, and elevation of the three units are variable, and the averages are reported here (refer to Table 1 for more detail). The surficial outwash extends from near the surface to approximately 21 ft bgs. The intermediate outwash, that, with the exception of the BS Park MW, is from 1 to 22 feet thick, is present at approximately 50 ft bgs. Technically speaking, if the definitions of Hedges (1982) and Kume (1985) are applied, the intermediate outwash in the Project Area should be considered the Prairie Coteau aquifer.

Outwash bodies that are on average 16 feet thick and meet the definition of the Prairie Coteau aquifer are present at approximately 83 to 108 ft bgs (and deeper at SWMW-D). The color of the Prairie Coteau aquifer outwash is nearly always yellowish brown, indicating a degree of oxidation.

2.3 SURFACE WATER

Lake Norden is located in an area referred to by South Dakota Game Fish and Parks as the glacial lakes region, and there are literally hundreds of lakes scattered throughout the Coteau des Prairies. The well field is located between Lake Norden and Lake Mary, and other lakes in the vicinity are shown in Figure 2. Lakes Norden, Mary, St. John and Albert are interconnected, and water flows from north to south. These four lakes and Lake Marsh to the north are shallow lakes, ranging in depth from 2 to 10 feet (Table 2, Kume, 1985). Lake Poinsett is deeper, with a reported average depth of 10 to 12 feet (Kume, 1985). It should be noted that the depths reported by Kume (1985) are data from 1977, and it is likely that, due to relatively wet conditions experienced by the region over the last two decades, the current depths of these lakes are likely 25% or more greater than the depths reported by Kume (1985).

The lakes in Figure 2 are likely in hydraulic connection with the surficial outwash (symbols Qwlo and Qwloc in Figure 2) and the lacustrine sediments (symbols Qwllc and Qwll in Figure 2). During wet periods, with significant amounts of recharge, groundwater from the outwash and lacustrine sediments likely discharges to the lakes. During drought conditions, it is possible that water from the lakes may discharge to groundwater.

The streams in the Project Area are not located within the Big Sioux River watershed. Surface water drainage in the Project Area is classified as "internal drainage only" in Beissel and Gilbertson (1987).

2.4 GROUNDWATER QUALITY

The observation wells installed by KWD in March 2021 were developed by the air-lift method. Each well was developed for at least an hour until the sediment content of the groundwater being discharged was largely removed. The water discharged from SWMW-S during development had a strong odor, similar to hydrogen sulfide. KWD sampled the BS Park MW in March 2021, and purged the well by air-lift development while drilling the SWMW-S. The water discharged from BS Park MW also exhibited a strong odor, similar to that noted in the SWMW-S discharge.

Personnel from the City measured the pH and temperature of the well discharge in the field. The pH values generally range from 7.16 to 8.43, and the temperature values range from 51.2 degrees Fahrenheit (°F) to 58.2 °F (Table 2).

Following well development, KWD collected water quality samples and shipped them to Ward Laboratories, Inc. of Kearny, NE. KWD also collected a sample from L2 on April 14, 2021, approximately 2 days before the end of the pumping period of the 30-Day Test. The samples were analyzed for 18 different water quality parameters jointly selected by Banner and LRE, including total iron, total manganese, sulfate, total hardness, nitrate, and total dissolved solids (TDS). The results are shown in Table 2, and copies of the laboratory reports are included in Appendix C. Also shown in Table 2 are the elevations of the well screened intervals, the maximum contaminant levels (MCLs), and the secondary MCLs.

The water in all the samples is very hard, which is common for groundwater sources in eastern South Dakota. In those wells completed in the Prairie Coteau aquifer, the TDS concentrations ranged from a low of 845 milligrams per liter (mg/L) in NNMW to a high of 1,154 mg/L in SWMW-D. These hardness and TDS data are consistent with Kume (1985), who reported that water from the Prairie Coteau aquifer is very hard, with TDS concentrations averaging approximately 1,200 mg/L. The only samples in the Deuel and Hamlin county study (Kume 1985) with TDS concentrations less than 1,000 mg/L were obtained from wells that were less than 250 feet deep.

The water quality of the Prairie Coteau aquifer wells located in or adjacent to the City's Prairie Coteau well field is significantly better than the quality of the wells located some distance from the well field. For example, the total iron concentrations in L2, L2MW-D, EMW2, and NNMW are significantly less than the iron concentrations measured in the other Prairie Coteau aquifer wells, and are below the secondary MCL for iron of 0.3 mg/L. The manganese concentrations in these same 4 wells, while exceeding the manganese secondary MCL of 0.05 mg/L, are lower than the manganese concentrations in the other 5 wells.

In the Prairie Coteau aquifer samples, calcium and magnesium are the dominant cations and bicarbonate and sulfate are the dominant anions, which is consistent with Kume (1985). The sulfate concentrations, with the exception of SWMW-D, are below the secondary MCL for sulfate of 250 mg/L. The superior water quality of the City's Prairie Coteau aquifer well field suggests a source of recharge that has had relatively little residence time in the aquifer.

Concentrations of nitrate measured at levels above the laboratory reporting limit of 0.1 mg/l were only measured in L3MW-S (10.1 mg/L), SWMW-D (0.1 mg/L), L2 (0.2 mg/L) and NEMW (0.1 mg/L). The concentration in L3MW-S exceeds the MCL of 10 mg/L and is likely elevated due to fertilizer application (the well is shallow, and located on the edge of a field that in 2020 was planted with corn). Kume (1985) states that, for the Prairie Coteau aquifer, "Of the wells sampled, many were high in nitrate, but the elevated nitrate levels probably are due to inadequate sealing of the casing or well bore to surface or near-surface drainage rather than to naturally high nitrate in the aquifer or to large-scale areal infiltration of nitrate." Well seal integrity is not in doubt with the 30-day Test wells, and it is therefore likely that the relatively low nitrate concentrations in the Prairie Coteau aquifer wells are due to infiltration of groundwater originating from shallow sediments containing groundwater with relatively higher nitrate concentrations.

2.5 GROUNDWATER ELEVATIONS

The static (pre-pumping) groundwater elevations in the surficial aquifer wells, (L3MW-S – 1,654.94 feet, SWMW-S - 1,654.96 feet, and the BS Park MW-1, 654.48 feet), measured in the background monitoring period of the Test, are all within ½-foot of each other. The groundwater elevations in L3MW-S and SWMW-S indicate water-table conditions. The static groundwater elevation in BS Park MW appears to be confined, with the static water level approximately 4 feet above the top of the shallow outwash. The static groundwater elevations are provided in Table 3.

The average of the three static level elevations is 1,654.80 feet. The most recent surface water elevation data, for the nearby lakes, from September 29, 2020, were obtained online from the DNR (<https://apps.sd.gov/NR65LakeInfo/public.aspx>). The elevations are as follows: Lake Norden - 1655.24 feet, Lake Mary - 1652.47 feet, and Lake St. John - 1,652.29 feet. While these elevation data are not time coincident, the data indicate that static water levels in the surficial outwash are likely a few feet above the lake levels, which would be expected in this hydrogeologic environment.

With the exception of SWMW-D, the groundwater elevations in the Prairie Coteau aquifer wells are from 72 feet to 87 feet above the top of the aquifer (Table 3). The static level in SWMW-D is 124.61 feet above the top of the aquifer. A groundwater elevation contour map for the Prairie Coteau aquifer is provided in Figure 3. The elevations do not contour very well, due to the geometry of the well locations, but in general suggest a hydraulic gradient generally from northeast to southwest.

2.6 GROUNDWATER BUDGET AND AQUIFER DISCHARGE AND RECHARGE

There is an estimated 5,000,000 acre-feet of groundwater in storage in the Prairie Coteau aquifer in Deuel and Hamlin counties (Kume, 1985). Due to the discontinuous nature of the buried outwash bodies that comprise the Prairie Coteau aquifer, it is unlikely that all of the outwash bodies are directly hydraulically connected. Recharge to the aquifer occurs via infiltrating precipitation and lateral inflow from till adjacent to the aquifer (Buhler and Goodman, 2008). It is also likely that recharge occurs from adjacent surficial outwash bodies, as described by Hedges, et. al. (1982), as well as infiltration of precipitation to the unconfined portions of the confined aquifer, as described by Hedges, et. al. (1985).

The Hedges, et. al. (1985) report on groundwater recharge rates for unconfined and confined, buried and non-buried aquifers in eastern South Dakota is an important reference from which recharge rates are often cited. The report states that "...for management and development programs the minimum recharge rate to confined aquifers is estimated to be 0.15 inches per year (in/yr) and the maximum rate is 0.50 in/yr. Locally, where the confined aquifers encountered unconfined conditions, the recharge rates may be within the range calculated for non-buried surficial aquifers." Hedges, et. al. (1985) calculated a recharge rate of 4.0 in/yr for the Big Sioux:Brookings aquifer, and a recharge rate of 4.9 in/yr for the unconfined portion of the Prairie Coteau buried confined aquifer.

The relatively good water quality near the City's Prairie Coteau aquifer well field suggests a nearby source of recharge, with the relatively lower degree of mineralization suggesting less residence time. There is a great deal of surface water in the Project Area, and outwash deposits are fairly ubiquitous.

There are no industrial use or irrigation permits authorizing withdrawals from the Prairie Coteau aquifer in the Project Area. Consequently, discharge is limited to withdrawals by domestic wells and to overlying or adjacent sediments (mostly till).

Nearby domestic wells are shown in Figure 1. The Korpen-Kaskie well has been abandoned and the home at that property is connected to the municipal water supply (City of Lake Norden, personal communication, 2021), and the Bentley well is 25 feet deep (Banner, personal communication, 2021) and is therefore completed in surficial outwash. The volume of groundwater used by the remaining 6 domestic wells (Figure 1) is insignificant compared to the groundwater in storage in the Prairie Coteau aquifer. Withdrawals from the City will lower the head in the nearby domestic wells, particularly the two wells labeled as Larson DW-00488 and Larson DW-26216. Based on the well logs for these two wells (Appendix B), there is from 51 to 63 feet or more of head above the top of the aquifer at these two locations. The owner of these two wells (John Larson) is known to the City, and to date, no complaints indicating a reduced ability to pump from either of the wells have been received by the City. Further information regarding potential impacts to domestic wells is provided in Section 4.3.2 of this report.

SECTION 3: 30-DAY TEST PROCEDURES

As indicated previously, the 30-day Test was conducted in general accordance with the February 22, 2021 Workplan. The 30-day Test was conducted by the City and by Banner.

City water demand during the 30-day Test was met by the water pumped from L2 during the Test, supplemented occasionally with water pumped primarily from City Well #9 with minor contributions from Wells #1, #2, and #3. City Wells #1, #2, #3 and #9 are located in the City's Big Sioux:Brookings aquifer well field located west of the lake (Lake Norden). The City did not pump from Prairie Coteau aquifer wells L1 and L3 during the 30-day Test.

3.1 TEST SCHEDULE

The 30-day Test was divided into three periods: the background monitoring period, the pumping period, and the recovery period. The background monitoring period was from February 22, 2021 to March 17, 2021. The City's Prairie Coteau aquifer well field was shut down for the background period to allow water levels to return to static conditions before conducting the 30-day Test. The pumping period of the 30-day Test began at 11:00 AM on March 17, 2021 and was completed 30 days later at 11:16 AM on April 16, 2021. L2 was the pumping well, and pumping from L2 was continuous, with no interruptions, throughout the 30-day Test. Start and stop times, pumping duration, pumping rate, and recovery period information are provided in the Aquifer Test Summary Sheet in Appendix D. The recovery period was from 11:16 AM on April 16, 2021 to 3:20 PM on April 30, 2021.

3.2 PUMPING AND OBSERVATION WELL NETWORK

Wells monitored during the 30-day Test included the following, listed below by aquifer or formation. The well locations are shown in Figure 1.

- Prairie Coteau aquifer: L1, L2, L3, L2MW-D, EMW2, NMW, NNMW, NEMW, SWMW-D
- Till Confining Layer: L2MW-I
- Big Sioux:Brookings aquifer: L3MW-S, BS Park MW, SWMW-S

Well logs are provided in Appendix B and well details are summarized in the Aquifer Test Summary Data Sheet in Appendix D.

3.3 MONITORING EQUIPMENT

Water levels were monitored during the 30-day Test using dedicated In-Situ LevelTroll pressure transducers with integrated data loggers installed by Banner in L2MW-D, EMW2, NMW, NNMW, NEMW, SWMW-D, L2MW-I, L3MW-S, BS Park MW, and SWMW-S. Dedicated and existing TE Connectivity KPSI 320 transducers with integrated SCADA communication are installed and in routine use in the three City wells L1, L2, and L3. Transducer specifications are provided in the Aquifer Test Summary Data Sheet in Appendix D. In addition, manual water-level measurements were collected periodically in the wells equipped with a transducer using an electronic water-level meter.

Data were downloaded from the transducers and manual water level measurements were collected weekly throughout the 30-day Test. The water-level displacement versus time data were plotted to illustrate the progress during the 30-day Test, and to evaluate if the transducers were functioning properly. The manual measurements confirmed that the transducers recorded the water level fluctuations correctly.

An existing flow-rate meter, located at the water treatment plant and connected to the SCADA system, was used to record the flow rates during the 30-day Test. The flow-rate meter is located downstream from the raw-water manifold that connects all of the municipal wells from the Prairie Coteau and Big Sioux well fields. The City wells are not individually metered.

3.4 FLOW RATES AND DISCHARGE WATER

Flow rate data was available with each weekly SCADA download. Flow rates specific to L2 were only available when City Wells #1, #2, #3, and #9 were not in use. However, utilizing data from a calibrated raw water pipeline hydraulic model, pre-testing conducted by the City pumping L2 and Well #9 individually and together and recording the flow rates, and the pump drive frequency information recorded by the SCADA system, an accurate flow rate for L2 was determined. The uniform drawdown curve of L2 is also a manifestation of the constant pumping rate.

L2 was pumped at an average rate of 353 gpm for the duration of the 30-day Test. Flow-rate readings and specific capacity versus elapsed time are graphed on Figure 4. The L2 pumping

rate was held nearly perfectly constant during the entire 30-day Test which allowed the collection of high-quality water-level displacement versus time data for the pumping and recovery periods. Flow rate data recorded during the pumping period of the 30-day Test are provided in the Aquifer Test Summary Data Sheet in Appendix D.

Pumped groundwater was conveyed from L2 using the existing raw-water pipeline from the Prairie Coteau well field to the water treatment plant. There were no discharges to the ground surface during the Test and no receiving surface water bodies.

3.5 PRECIPITATION AND BAROMETRIC PRESSURE

Precipitation and barometric pressure data were downloaded from Weather Underground for the KSDHAYTI5 weather station located in Hayti, SD. There were several small precipitation events during the 30-day Test that did not influence water levels; however, three larger precipitation events on April 6, 7, and 8, 2021 resulted in a rise in water levels in all wells, with the possible exception of L2MW-I. The water level in L2MW-I was on a continual rise since the installation of the transducer, and it is not possible to distinguish if the precipitation influenced the water level in the well.

Approximately 17,500 minutes into the pumping period, a steep drop in barometric pressure produced a slight decrease in the water levels in L1, L2, and L3 (Appendix E). The pressure decrease did not influence the water levels in the other observation wells; therefore, barometric pressure likely is not influencing water levels in the Prairie Coteau aquifer. This decrease in water level with a decrease in barometric pressure is opposite of what is normally observed, and is believed to be an artifact associated with the construction methods associated with the TE Connectivity KPSI 320 transducers utilized in L1, L2 and L3. In any case, the apparent barometric-induced change in the water-levels in these three wells was insignificant relative to the entire data set. There were no significant influences from barometric pressure on water levels in any of the wells during the 30-day Test. The precipitation and barometric pressure data are provided on the qualitative plots in Appendix E.

3.6 SITE SURVEY

Top-of-casing measuring point elevations, average grade elevations, and horizontal coordinates were determined by surveys conducted by Banner in August 2020 and March 2021. The horizontal coordinates are referenced to NAD 83 South Dakota State Plane in feet and the elevations are referenced to NAVD 88 in feet.

SECTION 4: RESULTS AND DISCUSSION

The data obtained from the 30-day Test are of very high quality, thereby facilitating qualitative and quantitative analysis. These high-quality data were made possible by the City's excellent efforts in keeping the L2 flow rate constant and un-interrupted and by Banner's competent execution of field procedures (programming and installing transducers followed by weekly data

downloads). This section of the report provides the results of the qualitative and quantitative analysis, drawdown projections, and a discussion of potential impacts associated with the long-term pumping from the City's Prairie Coteau aquifer well field.

4.1 QUALITATIVE ANALYSIS

The static groundwater elevations prior to the pumping period of the 30-day Test are provided in Table 3 and on Figure 3. Groundwater elevation and drawdown versus time data for the wells are shown in Figure 5, and on well hydrographs provided in Appendix E. Also shown in Figure 5 is the precipitation amounts received during the 30-day Test.

The purpose of monitoring water levels in L2MW-I was to determine if pumping could induce infiltration of groundwater through the till. However, no influence from pumping was observed in L2MW-I; consequently, no further analysis of the data was conducted. The analysis is limited to the data from those wells completed in the Prairie Coteau and Big Sioux:Brookings aquifers.

4.1.1 PRAIRIE COTEAU AQUIFER

Influence from pumping is apparent in the drawdown versus time data from L1, L2, L3, L2MW-D, EMW2, NMW (1000N), NNMW, and SWMW-D. No drawdown attributable to pumping from L2 was observed in NEMW. The water level response observed in the Prairie Coteau aquifer wells shows the following:

- 1) The Prairie Coteau aquifer behaves like a confined to leaky confined system with no observed negative or no-flow boundaries.
- 2) The Prairie Coteau aquifer receives recharge from precipitation within hours of the rainfall event. This influence was observed in the 30-day Test data after about 30,000 minutes of elapsed time (Figure 5).
- 3) The precipitation recharge response in the Prairie Coteau aquifer was nearly identical to the precipitation recharge response observed in the Big Sioux:Brookings aquifer. This similar and rapid response of the two aquifers to precipitation suggests that, although not directly hydraulically connected at the Site, the two aquifers are likely hydraulically connected elsewhere.

The Prairie Coteau aquifer groundwater elevations at the end of the pumping period are contoured in Figure 6. Because no negative boundary conditions were observed in the data, it was inferred that drawdown is radial around the pumping well, and the inferred drawdown contours are shown in Figure 7. Additional Test information for each well and observed drawdown is provided in Appendix D and E.

The drawdown at the end of the pumping period of the 30-day Test is provided in the Aquifer Test Summary Data Sheet in Appendix D and ranged from 53.01 feet in L2 to 1.46 feet in SWMW-D. Using an average pumping rate of 353 gpm, L2 had a specific capacity of 6.66 gallons per minute per foot (gpm/ft) of drawdown at the end of the 30-day Test.

It is an industry standard to, at a minimum, monitor water-level recovery after shutdown for the same duration as the pumping period, or until the observation wells have recovered to at least 90 percent of their pre-pumping (static) water levels. However, water levels in the Prairie Coteau aquifer wells recovered to 99- to 100-percent of the static levels within approximately 14 days. Based on the observed amount of recovery, and to assist the City with meeting growing seasonal water demand, the recovery period of the 30-day Test was terminated at 3:20 PM on April 30, 2021. Representatives of the WRP, SDGS, and the City approved the termination of recovery monitoring during a conference call on April 29, 2021.

A distance-drawdown plot is provided on Figure 8 (and in Appendix E). The distance-drawdown plot indicates that there is good correlation in drawdown versus distance from L2 in the Prairie Coteau aquifer. The distance-drawdown plot was used to estimate the several different radii of influence from pumping in L2 (Figure 9), as discussed further in Section 4.2.4.

4.1.2 BIG SIOUX:BROOKINGS AQUIFER

The water level response observed in the Big Sioux:Brookings aquifer, as monitored in L3MW-S, BS Park MW, and SWMW-S, during the 30-day Test shows the following:

- 1) Water-levels in the Big Sioux:Brookings aquifer observation wells were not influenced by pumping from L2.
- 2) Water-levels in the Big Sioux:Brookings aquifer observation wells rose within hours of a rainfall event (Figure 5), confirming that the surficial outwash of the Big Sioux:Brookings aquifer is recharged by the infiltration of precipitation.
- 3) The precipitation recharge response in the Big Sioux:Brookings aquifer was nearly identical to the response observed in the Prairie Coteau aquifer. This similar and rapid response of the two aquifers to precipitation suggests that, though not directly hydraulically connected at the Site, the two aquifers are likely hydraulically connected elsewhere.

4.2 QUANTITATIVE ANALYSIS

The quantitative analysis consists primarily of calculating the T and S based on the water-level displacement versus time data. Diagnostic plots of the data were also constructed and analyzed to provide further information about the possible presence of boundary conditions and insight into the aquifer extent.

4.2.1 Boundary Conditions

There were no negative boundary conditions observed during the 30-day Test. This indicates that the Prairie Coteau aquifer is laterally extensive or is sufficiently hydraulically connected with other buried and surficial aquifers, and potentially surface waters. A positive or recharge boundary condition was observed during the 30-day Test. The positive boundary was due to a prolonged precipitation event from April 6, 2020 to April 8, 2021 and resulted in a rise in water levels during the pumping period of the Test. The location of the hydraulic connection between the Prairie

Coteau aquifer and the ground surface (to receive recent precipitation recharge) is unknown; however, the 30-day Test data indicate a nearly identical recharge response in both the Prairie Coteau aquifer and Big Sioux:Brookings aquifer observation wells.

4.2.2 *Diagnostic Evaluation and Recharge Trend Water-Level Corrections*

Prior to conducting the quantitative analysis, several diagnostic evaluations were completed for each observation well. This included: 1) review of the input data to determine how much data or which dataset to analyze; 2) review of the drawdown curves on semi-log graphs to determine if the slopes doubled or halved and, if so, evaluate if that was indicative of a boundary condition; 3) review of the linear and bilinear diagnostic plots in AQTESOLV, which indicate the occurrence of channel aquifer or lateral leakage from channel sidewalls, respectively; and, 4) consideration of the conceptual hydrogeologic model when evaluating the appropriateness of applying boundary conditions, if necessary, and how those conditions may affect the data.

The results of the diagnostic plot analysis indicate that the aquifer is not a channel aquifer and that drawdown during the pumping period had largely stabilized prior to the recharge that occurred during the precipitation received approximately 3 weeks into the pumping period. Additional details regarding the diagnostic plot evaluation are provided in Table 4.

A general increasing background trend was observed in the recovery data, resulting in water levels recovering to above their pre-pumping static levels. This increasing background or regional water-level recovery trend is likely due to a combination of seasonal (spring) conditions and the precipitation-based recharge event that occurred between April 6 and 8, 2021.

A water-level correction factor was estimated based on the recharge trend observed in all of the wells. This water-level correction factor was applied to the data for the purpose of removing the effect of the recharge associated with this increasing background water-level trend. The purpose of the water-level correction was to create a dataset uninfluenced by the precipitation and background recharge trend. The background trend was estimated and applied, as an adjustment, to the water-level elevation and drawdown data. The magnitude of the trend adjustment is observed by comparing the unadjusted water elevation data in Figure 10 to the adjusted data in Figure 11. As illustrated in Figures 10 and 11, applying the trend adjustment resulted in more drawdown relative to the unadjusted data, allowing for more conservative approach when projecting drawdown into the future.

4.2.3 *Aquifer Parameters*

Values for T and S were calculated for a confined aquifer and leaky confined aquifer using AQTESOLV (ver.4.5) and data from L1, L2, L3, L2MW-D, EMW2, NMW, NNMW, and SWMW-D. Well construction information was not included in the analysis because partial penetration affects are negligible due to the limited aquifer thickness (less than 21 feet) and comparatively large distance between the wells. The aquifer thickness varied per well and ranged from 12 feet at SWMW-D to 21 feet at L2MW-D. Also, since the L2 screen is fully penetrating (e.g. the screen

crosses the entire aquifer thickness), partial penetration effects are negligible and laminar flow is assumed in the Prairie Coteau aquifer.

The confined Theis (1935), confined Cooper-Jacob (1946), leaky-confined Hantush-Jacob (1955), and leaky-confined Neuman-Witherspoon (1969) solutions were used to estimate T and S. Additionally, the Theis (1935) recovery method was used to analyze the recovery data. The leaky-confined solutions were applied to all wells except for SWMW-D, which did not show a leaky-confined response. The T values ranged from 1,441 to 4,729 ft²/day with a geometric mean of 2,721 ft²/day, and S ranged from 2.98×10^{-7} to 1.02×10^{-3} with a geometric mean of 1.48×10^{-5} . Hydraulic conductivity, calculated by dividing T by the aquifer thickness at each well, ranged from 69 to 394 feet per day (ft/day) with a geometric mean of 165 ft/day. This range in hydraulic conductivity is consistent with what would be expected in an aquifer comprised of sand and gravel outwash deposits.

Interestingly, SWMW-D had the highest T and S values and fell farthest from the straight line on the distance drawdown plot (Figure 8). This indicates that the drawdown in SWMW-D may be the result of an indirect groundwater flow path that may be longer than the Euclidean distance to L2. The fact that the distance to SWMW-D from L2 may be artificially low, since the Euclidean distance was utilized in the AQTESOLV solutions, could explain the resulting high T and S values relative to those determined from the other wells.

The Theis (1935) recovery solution was used to evaluate the ratio of storativity during pumping (S) to the storativity after pumping (S'). In general, S/S' ratios greater than 1 indicate a positive boundary and ratios <1 indicate a negative boundary. The S/S' ratios ranged from approximately 2.3 to 3.3 with a geometric mean of approximately 2.8, indicating that there are positive boundary conditions present. The quantitative analyses are provided in Appendix F and the results are summarized in Table 5.

4.2.4 Distance-Drawdown Analysis

Distance-drawdown analysis was completed to estimate the theoretical radius of influence (r_0) for the 30-day Test's cone of depression in the Prairie Coteau aquifer. Four radii were calculated, and are shown in Figure 9. The radii were calculated using the following data:

1) $r_0 = 15,804$ ft: used all Prairie Coteau aquifer wells that had pumping-induced drawdown (L2, L2MW-D, L3, EMW2, L1, NMW, NNMW, and SWMW-D), and the drawdown measured at the end of the pumping period of the 30-day Test (drawdown influenced by the recharge associated with the April 6th and 8th precipitation events);

2) $r_0 = 18,455$ ft: used only select Prairie Coteau aquifer wells that had pumping-induced drawdowns that exhibited a generally linear trend relative to each other (L2MW-D, L3, EMW2, NMW, and NNMW), and the drawdown measured at the end of the pumping period of the 30-day Test (drawdown influenced by the recharge associated with the April 6th and 8th precipitation events);

3) $r_0 = 19,804$ ft: used only select Prairie Coteau aquifer wells that had pumping-induced drawdowns that exhibited a generally linear trend relative to each other (L2MW-D, L3, EMW2, NMW, and NNMW) and drawdown data from before the precipitation and recharge event (21 days); and,

4) $r_0 = 23,099$ ft: used only select Prairie Coteau aquifer wells that had pumping-induced drawdowns that exhibited a generally linear trend relative to each other (L2MW-D, L3, EMW2, NMW, and NNMW) and adjusted drawdown data (adjusted for the background trend previously discussed) from before the precipitation and recharge event (21 days).

As shown in Figure 8, drawdown generally increased in all wells with increased time during the 30-day Test. However, the recharge associated with the precipitation events decreased the drawdown, thereby decreasing the calculated radius of influence. This is why two radii were calculated utilizing the data from day 21 prior to the recharge event. Although the four calculated radii are similar, and within the same order of magnitude, their differences illustrate the impact of time and recharge on the radius of influence calculations.

4.2.5 Groundwater Recharge Estimation

Several small precipitation events occurred during the 30-day Test with no perceived influence on water levels. However, a prolonged precipitation event occurred on April 6 (1.7 inches), April 7 (1.46 inches), and April 8 (1.05 inches), for a three-day total of 4.21 inches (0.351 ft). This precipitation resulted in rising water levels in all 30-day Test observation wells (with the possible exception L2MW-I, which was already on a rising trend).

The hydrographs for all observation wells (except L2MW-I) were reviewed to estimate the amount of water-level rise due to the precipitation event. The water-table fluctuation (WTF) method was used to estimate the percentage of precipitation that entered the aquifer as recharge. The WTF method is generally only considered applicable to unconfined aquifers. However, the response to this precipitation was nearly identical in the observation wells completed in both the Prairie Coteau aquifer and Big Sioux:Brookings aquifer. This similarity in response suggests that the Prairie Coteau aquifer likely receives recharge from an unconfined source, in direct connection with the ground surface and infiltrating precipitation.

An example hydrograph measuring the rise in water level due to the precipitation event at L2MW D is provided in Appendix G. The corresponding water-level rise in each observation well was multiplied by a porosity of 0.25 to estimate an equivalent height of water (without the aquifer matrix) and resulted in a range in heights from 0.1 ft (SWMW-D) to 0.325 ft (L2 and L3MW-S). The equivalent heights were divided by the precipitation event total to estimate the percentage of precipitation that contributed to the groundwater level increases and aquifer recharge. The percentage of total precipitation entering the aquifers ranged from 28 percent (SWMW-D) to 93 percent (L2 and L3MW-S), with a geometric mean of 65 percent.

Annual average precipitation data for seven cities surrounding the Site, including Lake Norden, were queried from www.usa.com and www.usclimatedata.com/climate. The precipitation amounts ranged from 21.85 inches per year (in/yr) at Watertown, SD to 26.87 in/yr at Clear Lake, SD. Lake Norden has an annual average precipitation of 24.12 in/yr. The annual average precipitation for Lake Norden was multiplied by the following percentages to approximate a groundwater recharge rate:

- 1) the geometric mean of 65 percent (15.67 in/yr of recharge);
- 2) the low value of 28 percent (6.87 in/yr of recharge); and,
- 3) a value of 10 percent which is commonly used in groundwater modeling applications (2.41 in/yr of recharge).

Five additional groundwater recharge rates, available from Hedges et.al. (1985), were reviewed and included in the groundwater recharge evaluation. They include 5.6 in/yr, 4.0 in/yr, 2.0 in/yr, 0.6 in/yr, and 0.15 in/yr.

Each of the eight recharge rates presented above were applied to the four radii of influence (Figure 9) to estimate an annual recharge volume. The following three pumping rates were used to calculate an annual withdrawal volume: 1) 353 gpm (the 30-day Test rate), 2) 500 gpm (a withdrawal similar to current City usage of the Prairie Coteau aquifer well field), and 3) 904 gpm (the annual appropriation of groundwater per WPA #8433-3).

These assumed annual withdrawal volumes are compared to the estimated annual recharge volumes to calculate an approximate percentage of withdrawal relative to recharge. With three potential pumping rates, four potential radii of influence, and eight potential recharge rates, a total of 96 withdrawal/recharge percentages were estimated and are provided in Appendix G. The bar charts in Appendix G are color coded by pumping rate and radii of influence. The bars are also labeled with their corresponding recharge percentage in black (the annual withdrawal volume is less than 100 percent of the estimated annual recharge from precipitation) or red (the annual withdrawal volume is greater than 100 percent of the estimated annual recharge from precipitation). Of the 96 withdrawal/recharge scenarios, 81 scenarios have annual withdrawals that are less than the estimated annual recharge. The 15 scenarios that have annual withdrawals exceeding the estimated annual recharge occur at the lower assumed recharge rates of 0.15 in/yr or 0.6 in/yr.

As indicated in Section 2.6, locally, where buried confined aquifers encounter unconfined conditions, the recharge rates may be within the range calculated for non-buried surficial aquifers. The estimated recharge rate for the Big Sioux:Brookings aquifer is 4.0 in/yr and the estimated recharge rate for the unconfined portions of the Prairie Coteau aquifer is of 4.9 in/yr (Hedges, et. al., 1985). These two calculated values are approximately midway between the 2.41 in/yr calculated based on 10% of the average annual recharge and the lower value calculated by LRE based on the precipitation received during the 30-day Test (6.87 in/yr). Although some solutions

in Appendix G indicate that there may be sufficient recharge to support withdrawals as high as approximately 900 gpm, the Prairie Coteau aquifer likely cannot support withdrawals of that magnitude due to the limitations associated with the Site-specific T and S values.

4.3 DRAWDOWN PROJECTIONS

One method for estimating future water levels is to project drawdown or groundwater elevation versus elapsed time trends using semi-log plots. This method is based on the assumptions of the Cooper-Jacob (1946) straight-line solution. Three future drawdown projections were created using 1) the 30-day Test data, 2) the long-term monitoring data collected by Banner from the Prairie Coteau aquifer well field under normal operations between October 2020 and December 2020, and 3) the long-term monitoring data collected by Banner from the Prairie Coteau aquifer well field under normal operations between December 2020 and February 2021.

4.3.1 *Projections Based on the 30-day Test*

Figures 10 and 11 illustrate the Prairie Coteau aquifer observation wells' water elevation versus elapsed time using the data for which no background recharge correction was applied (unadjusted data) and the data with the background recharge trend removed (adjusted data), respectively (the water level adjustments are described in Section 4.2.2). Water-levels were projected into the future using the data between 10,000 minutes and 28,622 minutes, prior to the observed recharge from the precipitation event. The rise in water levels due to the precipitation event were excluded from the projections in order to estimate future water levels assuming recharge did not occur; a conservative approach. The straight-line projections were extended to 19 years. Both Figures 10 and 11 illustrate that the projected water-levels at L1, L2, and L3 do not fall below the top of screen or top of aquifer. This indicates that the Prairie Coteau aquifer is likely a viable long-term groundwater source at the 30-day Test rate (353 gpm) for the Site based on the straight-line projection and assumptions inherent to the Cooper-Jacob (1946) straight-line solution.

4.3.2 *Projections Based on Long-Term Monitoring Data*

Long-term monitoring data from the Prairie Coteau aquifer well field are provided in Figure 12 and represent three distinct pumping periods: 1) Operational Period #1 pumping L1, L2 and L3 at an approximate combined rate of 534 gpm between October 2020 and December 2020, 2) Operational Period #2 pumping L1, L2 and L2 at an approximate combined rate of 418 gpm between December 2020 and February 2021, and 3) Aquifer Testing Period pumping L2 only at an average rate of 353 gpm during the 30-day Test. Figure 12 also illustrates the total system pumping rate and the on/off cycling of wells L1, L2 and L3.

Water levels during Operational Period #1 decreased slightly with time, and it is unknown if the well field would eventually stabilize after longer pumping durations. Water levels during Operational Period #2 appeared to stabilize.

Water level data during the two operational periods were analyzed to identify the lowest pumping elevation for each day and plotted (as blue, red, or green circles (Operational Period #1) or squares (Operational Period #2) on Figure 12. These data were converted to elapsed time from

the start of each operational period in order to view the water level data on a semi-log plot (water elevation versus elapsed time) and estimate a linear forward projection of the water level data (Figure 13). As illustrated on Figure 13, projected water levels continue to decline slowly out to 19 years. The water levels projected from Operational Period #1 (pumping at 534 gpm) decline an additional 5 feet. The water levels projected from Operational Period #2 (pumping at 418 gpm) decline an additional 1 to 2 feet. In both cases, the water levels remain above the well screens in L1, L2, and L3.

4.4 POTENTIAL IMPACTS

The DANR cannot recommend approval of a water permit application if the WRP determines that groundwater withdrawals under the proposed new appropriation will adversely impact senior water rights or nearby domestic wells. Consequently, potential impacts associated with withdrawals from the City's Prairie Coteau aquifer well field were evaluated.

4.4.1 AQUIFERS

The 30-day Test illustrated that pumping from L2 (and inferred from L1 and L3) influenced water levels in only the Prairie Coteau aquifer. Water levels in the Big Sioux:Brookings aquifer or in the intermediate till were not influenced from pumping L2 during the 30-day Test. These results are consistent with the results of the 2020 Aquifer Test. However, data from the 30-day Test indicate that the Prairie Coteau and Big Sioux:Brookings aquifers both reacted similarly to the precipitation and recharge event in April 2021. This recharge response indicates that the two aquifers are likely hydraulically connected, allowing relatively rapid recharge from infiltration of precipitation.

4.4.2 GROUNDWATER USERS & WELL INTERFERENCE

Eight domestic wells are located near the Prairie Coteau aquifer well field as shown on Figure 1. Two of the eight wells (Bentley DW-depth_25-ft and Isaacson DW-26217) are completed in shallow or intermediate sand and gravel not associated with that portion of the Prairie Coteau aquifer from which the City is pumping (although technically the Isaacson well is completed in the Prairie Coteau aquifer). Pumping L2 for 30 days produced no measurable drawdown in any of the three Big Sioux:Brookings aquifer observation wells, and the Bentley well, with a reported depth of 25 feet, is completed in the Big Sioux:Brookings aquifer.

No influence from pumping was observed in the NEMW located near the Isaacson well. Both of these wells are by definition completed in the Prairie Coteau aquifer, although the Isaacson well is screened at an elevation (1632 to 1652 feet) that is approximately 46 feet higher than the Prairie Coteau aquifer at L2. Additionally, the residence at the location of the Isaacson domestic well is served by Kingsbrook Rural Water (KWD, personal communication, 2021). The well labeled on Figure 1 as the Isaacson domestic well is actually located in a pasture west of the residence, and is rarely used.

The potential for well interference between the City's Prairie Coteau aquifer well field and the six remaining Prairie Coteau aquifer domestic wells was evaluated using an analytical Excel-based tool and the confined Cooper-Jacob (1946) solution using the 30-day Test geometric mean values

of T and S. The evaluation assumed a pumping duration of 1 year and a pumping rate of 595 gpm (that is continuous, round-the-clock pumping at 595 gpm for 365 days). The amount of drawdown at each of the domestic wells that could potentially be induced by pumping from L1, L2, and L3 at a combined rate of 595 gpm was calculated. This is a conservative approach because the Cooper-Jacob (1946) solution does not include recharge, and there are multiple lines of evidence from the 30-day Test indicating recharge is occurring (S/S' values greater than 1, rapid rises in water-levels following precipitation, even during pumping). The recharge reduces the overall amount of drawdown.

The results of this evaluation indicate that the drawdown at the two closest domestic wells (Larson DW-00488 and Larson DW-26216, Figure 1) could be approximately 40 to 45 feet, respectively. The amount of available head at these two wells, based on the well logs (Appendix B), is from 51 to 63 feet. As indicated previously, the owner of these wells, who is known to the City, has not indicated there have been any adverse impacts associated with the City's past and current pumping of L1, L2 and L3, particularly during the period from August to December 2020.

The drawdown induced by pumping at 595 gpm calculated at the more distant wells (Antonen, Hauschildt, and Hymans) utilizing the analytical Excel-based tool ranged from 28 to 33 feet. These three wells have available heads ranging from 88 feet to 139 feet, consequently no adverse impacts are likely. In addition, while drilling NNMW, a Kingsbrook Rural Water valve was observed near the entrance to the Hyman's residence. A member of the Hyman's household informed KWD that the connection between the valve and the home had not yet been completed, but was planned for 2021 (KWD, personal communication, 2021).

No well interference between the City's Prairie Coteau well field and the City's Big Sioux:Brookings aquifer well field, which is located approximately 1.5 miles west of L2, is likely. There are no other known high-capacity wells located near the Site.

4.5 POTENTIAL YIELD

The Cooper-Jacob (1946) analytical well interference approach discussed above was also used to estimate the potential maximum yield of the City's Prairie Coteau aquifer well field. Two well efficiency values were used for L1, L2, and L3; 85 percent (the value achieved during manual calibration of the analytical well interference tool to 30-day Test data) and 99 percent (the L2 efficiency estimated from distance-drawdown analysis on Figure 8). Geometric mean values of T and S determined from the 30-day Test and a pumping duration of 1 year were used in the evaluation. Longer durations were not simulated because 30-day Test results showed the aquifer receives recharge rapidly from precipitation and the Cooper-Jacob (1946) solution does not include recharge. Therefore, simulating longer durations with the well interference tool may overestimate the amount of drawdown.

The results of this evaluation indicated that a long-term yield of approximately 550 to 600 gpm from the Prairie Coteau aquifer well field, while maintaining at least 10 feet of water above the top of the well screens in L1, L2, and L3 and nearby domestic wells, is likely possible. The effects of

adding a fourth production well, located near SWMW-D, were evaluated with the analytical solutions. The results indicated that the total well field yield may only increase to approximately 650 gpm (again maintaining at least 10 feet of water above the top of the well screens). The results of this evaluation indicate that the limiting factors relative to yield are the aquifer thickness and aquifer T and S, rather than the amount of recharge.

SECTION 5: CONCLUSIONS

The lack of negative boundary conditions observed in the 30-day Test confirm the conclusions relative to boundary conditions drawn from the 2020 Aquifer Test. The geometric mean of T values determined from the 30-day Test is 2,721 ft²/day, and the geometric mean of the S values is 1.48×10^{-5} . The geometric mean of the hydraulic conductivity (K) is 165 ft/day. These values of T, S and K are consistent with what would be expected in a confined aquifer comprised of sand and gravel outwash deposits.

The 30-day Test results confirm the HCM presented in Section 2 of this report. The Prairie Coteau aquifer, while lenticular and discontinuous in nature, appears to receive recharge directly from the infiltration of precipitation. The exact location and mechanism of recharge is unknown, but the most likely possibility is that the Prairie Coteau aquifer at some location directly underlies surficial outwash (the Big Sioux:Brookings aquifer), or an unconfined portion of the aquifer is near the ground surface. Multiple lines of evidence for the recharge include the observed water-level rise following a precipitation event, the lack of any observed negative boundary conditions (in either the 2020 Aquifer Test or the 30-Day Test), the S/S' values of 2.3 to 3.3 (greater than 1), and the superior water quality in the Prairie Coteau aquifer wells located near the City's Prairie Coteau well field.

The rate of recharge to the City's Prairie Coteau aquifer well field, based on the recharge analysis conducted by LRE and compared with the Hedges, et. al. (1985) reported recharge rates (4.0 in/yr Big Sioux:Brookings aquifer and 4.9 in/yr unconfined portion of Prairie Coteau aquifer), is estimated to be from 2 in/yr to 6 in/yr. At this recharge rate, average annual withdrawals at a continuous pumping rate of 550 to 600 gpm would not exceed the annual recharge rate. At the higher end of the recharge rate range (6 in/yr), it is possible that annual withdrawals at a continuous pumping rate of 904 gpm (the amount requested by WPA #8433-3) would not exceed the average annual recharge. However, based on the available data, the aquifer cannot likely sustain withdrawals from the City's Prairie Coteau well field at continuous pumping rates greater than 550 to 600 gpm (887 to 967 ac-ft/yr) without producing drawdown that would lower the water-levels to below the top of the aquifer.

SECTION 6: RECOMMENDATIONS

LRE recommends that withdrawals from the City's Prairie Coteau well field be limited to 967 ac-ft/yr at a maximum instantaneous diversion rate of 1.34 cfs. It is further recommended that long-

term monitoring of the water levels in the Prairie Coteau aquifer be conducted utilizing at a minimum observation wells NNMW and EMW2, as well as the SCADA data from L1, L2 and L3. The minimum frequency of the monitoring for the observation wells would be once per month. However, if dedicated transducers are installed in the observation wells, they should be programmed to record water levels hourly. LRE recommends that the results of the monitoring of the observation wells and pumping wells be evaluated on at least an annual basis. Adjustments to the data collection frequency should be determined based on the annual data review.

The performance of L1, L2, and L3 should be monitored and routinely evaluated and compared with performance benchmarks specific to each well. Those performance benchmarks could include specific capacity, average monthly pump drive frequency, or other factors.

It is also recommended that additional water supply options be investigated to provide redundancy and to support the continued population growth of the City.

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Table 1

Outwash Body Elevations and Prairie Coteau Aquifer Thickness

30-Day Aquifer Pumping Test
Banner Associates, Inc.
Prairie Coteau Well Field
Lake Norden, SD

Well	Ground Surface Elevation (feet)	Surficial Outwash Depth (ft bgs)		Surficial Outwash Elevation (feet)		Intermediate Outwash Depth (ft bgs)		Intermediate Outwash Elevation (feet)		Prairie Coteau Aquifer Outwash Depth (ft bgs)		Prairie Coteau Aquifer Outwash Elevation (feet)		Prairie Coteau Aquifer Thickness (feet)
BS Park MW	1658.75	8	38	1651	1621	48	82	1611	1577					
EMW (650E)	1674.87	1.5	20	1673	1655					87	101	1588	1574	14
EMW2	1669.52	2	18	1668	1652					88	103	1582	1567	15
L1	1656.96	2	29	1655	1628	35	57	1622	1600	83	97	1574	1560	14
L2	1671.63	3	13	1669	1659					85	103	1587	1569	18
L2MW-D	1671.54	2	17	1670	1655	45	46	1627	1626	89	110	1583	1562	21
L2MW-I	1672.11	2	19	1670	1653									
L3	1668.62	2	20	1667	1649					87	101	1582	1568	14
L3MW-S	1669.33	3.5	21	1666	1648									
NEMW	1694.48	6	16	1688	1678	67	68	1627	1626	96	108	1598	1586	12
NMW (1000N)	1672.21	4	18	1668	1654					84	103	1588	1569	19
NNMW	1672.67	9	17	1664	1656					88	106	1585	1567	18
SWMW-S	1658.38	3	32	1655	1626									
SWMW-D	1674.05					40	45	1634	1629	142	154	1532	1520	12
Averages	1670.37	3.7	21.4	1666.4	1648.7	47.0	59.6	1624.2	1611.6	92.9	108.6	1579.8	1564.1	15.7
Prairie Coteau Aquifer Averages Excluding SWMW-D										87.4	103.6	1585.1	1568.9	16.1

Notes:

Utilizing the Prairie Coteau aquifer definition in the text, the intermediate outwash could technically be considered part of the Prairie Coteau aquifer.

ft bgs = feet below ground surface

Table 2
Water Quality Data

30-Day Aquifer Pumping Test
Banner Associates, Inc.
Prairie Coteau Well Field
Lake Norden, SD

Well Name	SWMW-D	SWMW-S	BS Park MW	L2	L2MW-D	EMW2	L3MW-S	NNMW	NEMW	Units	MCL	Secondary MCL
Well Depth (feet)	157	31	82	103	110.7	103.7	21.1	106.6	111.2			
Ground Surface Elevation (feet)	1674.1	1658.4	1660.0	1671.6	1671.5	1669.5	1669.33	1672.7	1694.5			
Top of Screen Elevation (feet)	1527.1	1632.4	1598.0	1588.6	1570.8	1575.8	1657.73	1576.1	1593.4			
Bottom of Screen Elevation (feet)	1517.1	1627.4	1578.0	1568.6	1560.8	1565.8	1648.2	1566.1	1583.3			
Sample Date	3/1/21	3/1/21	3/1/21	4/14/21	3/3/21	3/1/21	3/1/21	3/1/21	3/1/21			
PHYSICAL PROPERTIES												
Electrical Conductivity	1,920	2,010	2,080	1,660	1,560	1,550	1,010	1,410	1,420	umhos/cm		
Total Hardness (CaCO ₃)	1,089	1,020	1,079	876	833	902	452	758	838	mg/L		
Total Dissolved Solids	1,154	1,206	1,246	994	936	931	608	845	851	mg/L		500
pH (measured by laboratory)	7.8	7.8	7.8	7.5	7.7	7.7	7.8	7.7	7.7	mg/L		6.5 - 8.5
pH (field)	7.68	7.92	7.80	7.16	7.58	7.91	8.43	7.59	7.87			
Temperature	52.2	54.2	54.3	52.5	51.2	58.2	54.7	53.5	51.6	° Fahrenheit		
NON-METALLICS												
Total Alkalinity (as CaCO ₃)	387	452	405	305	364	359	394	378	443	mg/L		
Bicarbonate (HCO ₃)	470	548	490	371	442	436	478	458	538	mg/L		
Carbonate (CO ₃)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	mg/L		
Chloride	9	18	16	4	4	5	15	5	4	mg/L		250
Fluoride	0.23	0.12	0.14	0.35	0.30	0.30	0.25	0.28	0.32	mg/L	4	2
Nitrate as N	0.1	<0.1	<0.1	0.2	<0.1	<0.1	10.9	<0.1	0.1	mg/L	10	
Sulfate	278	265	286	211	194	208	47	157	154	mg/L		250
METALS, TOTAL												
Iron	1.10	0.06	4.42	<0.01	0.02	0.01	3.45	0.15	2.32	mg/L		0.3
Manganese	4.15	2.66	2.71	0.09	0.43	0.14	0.25	0.73	0.76	mg/L		0.05
Calcium	289.2	183.4	195.4	222.2	213.3	234.3	98.7	192.8	196.7	mg/L		
Magnesium	88	135	142	77	72	76	49	66	83	mg/L		
Potassium	22	19	23	7	6	18	5	19	17	mg/L		
Sodium	75	87	92	41	43	45	68	39	39	mg/L		
CATIONS/ANIONS BALANCE												
Cations	25.6	24.7	26.2	19.5	18.7	20.5	12.1	17.3	18.8	me/L		
Anions	25.3	26.1	26.4	19.4	19.5	20.3	12.0	17.4	18.5	me/L		

NOTES:

mg/L = milligrams per liter
umhos/cm = micro Mhos per centimeter
me/L = milliequivalents per liter
CaCO₃ = calcium carbonate
N = nitrogen

MCL = maximum contaminant limit

Denotes concentration that exceeds MCL or Secondary MCL

Table 3

Static Elevations and Available Head

30-Day Aquifer Pumping Test
Banner Associates, Inc.
Prairie Coteau Well Field
Lake Norden, SD

Well	Material	Static Elevation (feet)	Date	Top of Aquifer Elevation (feet)	Available Head above Top of Aquifer * (feet)
L3MW-S	Surficial Outwash / Big Sioux	1654.95	3/17/2021	1665.83	-10.88
SWMW-S	Surficial Outwash / Big Sioux	1654.96	3/17/2021	1655.38	-0.42
BS Park MW	Surficial Outwash / Big Sioux	1654.48	3/17/2021	1650.75	3.73
L2MW-I	Confining Till	1644.19	3/17/2021	NA	NA
L1	Prairie Coteau Outwash	1661.42	3/17/2021	1573.96	87.46
L2	Prairie Coteau Outwash	1661.54	3/17/2021	1586.63	74.91
L3	Prairie Coteau Outwash	1661.12	3/17/2021	1581.62	79.50
NEMW	Prairie Coteau Outwash	1675.81	3/17/2021	1598.48	77.33
NNMW	Prairie Coteau Outwash	1661.90	3/17/2021	1584.67	77.23
EMW2	Prairie Coteau Outwash	1659.29	3/17/2021	1581.52	77.77
NMW	Prairie Coteau Outwash	1660.45	3/17/2021	1588.21	72.24
L2MW-D	Prairie Coteau Outwash	1659.99	3/17/2021	1582.54	77.45
SWMW-D	Prairie Coteau Outwash	1656.66	3/17/2021	1532.05	124.61

Notes:

* Positive values indicate aquifer is confined, and represents head in feet above the top of the aquifer. Negative values indicate aquifer is unconfined.

NA: Not Applicable

Table 4

Summary of Diagnostic Plots

30-Day Aquifer Pumping Test
Banner Associates, Inc.
Prairie Coteau Well Field
Lake Norden, SD

Wells	Discussion
L2, L2MW-D, L3, L1, EMW2, NMW, SWMW-D, NNMW	Input Data: Transducers data quantity and quality is good. Transducers were programmed to a 2-minute linear sample rate. Manual water-level data indicated transducers worked properly.
	Slope of Drawdown Curve: The slope of the drawdown curves generally stabilizes after approximately 500 minutes in to the Test, with the exception of SWMW-D which stabilizes after approximately 10,000 minutes in to the Test due to its distance from L2.
	Linear Diagnostic Plot: Data does not indicate a channel aquifer as there is not a 1:1 straight line section of the drawdown curve in late time on the time ^{1/2} plot.
	Bilinear Diagnostic Plot: Data does not indicate lateral leakage as there is not a 1:1 straight-line section of the drawdown curve in late time on the time ^{1/4} plot, with the exception of NNMW drawdown data which appears to approximate the 1:1 straight-line. Although the Linear and Bilinear Diagnostic plots do not indicate a channel aquifer, the conceptual model and SDGS cross section (Appendix A) indicate that the aquifer is laterally complex, may thin in areas, and may be hydraulically connected to other buried and surficial aquifer systems.
	Derivative Plot: Drawdown derivative data, shown on the quantitative plots as similarly colored crosses (transducer drawdown derivative), illustrate a relatively stable profile in mid- to late-time, indicating aquifer response to pumping had stabilized. However, the late-time recharge event influenced the resulting derivative. The derivative response indicates the aquifer responds as a non-leaky confined aquifer to a leaky confined aquifer.
	Boundary Condition: There are no apparent negative boundary conditions as seen in the drawdown response even though the conceptual model and SDGS cross section (Appendix A) indicate that the aquifer is laterally complex and may thin in areas. The SDGS cross section also indicated that the aquifers (buried and surficial) may be hydraulically connected. Additionally, there is potential for leakage from the overlying clay and interconnected aquifer systems; however, this was not identified in data from L2MW-I or L3MW-S, and other shallow observation wells.
	Comment: Precipitation events on 4/6/2021, 4/7/2021, and 4/8/2021 resulted in groundwater recharge observed in all Test observation wells.

Table 5

Summary of Aquifer Parameters

30-Day Aquifer Pumping Test
Banner Associates, Inc.
Prairie Coteau Well Field
Lake Norden, SD

Well	Distance to L2 (feet)	Screen Interval (ft bg)	Aquifer Thickness (feet)	Transmissivity (ft ² /day)	Transmissivity (gpd/ft)	Hydraulic Conductivity (ft/day)	Storativity	S/S'	Method of Analysis
L2	0	83-103	18	3,651	27,307	203	NA	NA	Confined Theis
				3,399	25,422	189	NA	NA	Confined Cooper-Jacob
				2,256	16,874	125	NA	NA	Leaky Confined Hantush-Jacob
				1,561	11,674	87	NA	NA	Leaky Confined Neuman-Witherspoon
				2,682	20,064	149	NA	NA	Confined Theis (Agarwal Recovery)
				2,827	21,145	157	NA	NA	Confined Cooper-Jacob (Agarwal Recovery)
				2,827	21,145	157	NA	2.624	Confined Theis Recovery
L2MW-D	49	100.7-110.7	21	4,245	31,752	202	1.24E-08	NA	Confined Theis
				3,573	26,728	170	2.98E-07	NA	Confined Cooper-Jacob
				1,441	10,779	69	3.20E-05	NA	Leaky Confined Hantush-Jacob
				1,441	10,778	69	4.02E-05	NA	Leaky Confined Neuman-Witherspoon
				2,550	19,077	121	5.86E-05	NA	Confined Theis (Agarwal Recovery)
				2,671	19,976	127	3.37E-05	NA	Confined Cooper-Jacob (Agarwal Recovery)
				2,679	20,038	128	NA	2.818	Confined Theis Recovery
L3	360	87-107	14+	3,250	24,309	232	1.38E-06	NA	Confined Theis
				3,343	25,006	239	1.24E-06	NA	Confined Cooper-Jacob
				2,464	18,432	176	1.50E-05	NA	Leaky Confined Hantush-Jacob
				2,721	20,351	194	3.44E-06	NA	Leaky Confined Neuman-Witherspoon
				2,677	20,024	191	8.27E-06	NA	Confined Theis (Agarwal Recovery)
				2,935	21,955	210	3.46E-06	NA	Confined Cooper-Jacob (Agarwal Recovery)
				2,960	22,142	211	NA	2.338	Confined Theis Recovery
EMW2	396	93.7-103.7	15	4,297	32,143	286	4.70E-08	NA	Confined Theis
				3,625	27,113	242	5.23E-07	NA	Confined Cooper-Jacob
				2,516	18,820	168	1.28E-05	NA	Leaky Confined Hantush-Jacob
				2,844	21,271	190	2.38E-06	NA	Leaky Confined Neuman-Witherspoon
				2,615	19,559	174	9.97E-06	NA	Confined Theis (Agarwal Recovery)
				2,362	17,664	157	2.43E-05	NA	Confined Cooper-Jacob (Agarwal Recovery)
				2,351	17,588	157	NA	2.944	Confined Theis Recovery
L1	559	83-97	14+	3,000	22,443	214	1.64E-06	NA	Confined Theis
				3,222	24,103	230	5.06E-07	NA	Confined Cooper-Jacob
				2,300	17,206	164	7.67E-06	NA	Leaky Confined Hantush-Jacob
				2,278	17,039	163	9.10E-06	NA	Leaky Confined Neuman-Witherspoon
				2,578	19,286	184	3.37E-06	NA	Confined Theis (Agarwal Recovery)
				2,807	20,993	200	1.53E-06	NA	Confined Cooper-Jacob (Agarwal Recovery)
				2,750	20,570	196	NA	2.72	Confined Theis Recovery

Table 5

Summary of Aquifer Parameters

30-Day Aquifer Pumping Test
Banner Associates, Inc.
Prairie Coteau Well Field
Lake Norden, SD

Well	Distance to L2 (feet)	Screen Interval (ft bg)	Aquifer Thickness (feet)	Transmissivity (ft ² /day)	Transmissivity (gpd/ft)	Hydraulic Conductivity (ft/day)	Storativity	S/S'	Method of Analysis
NMW	971	93-103	19+	3,262	24,400	172	2.32E-05	NA	Confined Theis
				3,577	26,754	188	1.14E-05	NA	Confined Cooper-Jacob
				2,577	19,275	136	5.51E-05	NA	Leaky Confined Hantush-Jacob
				1,851	13,847	97	6.18E-05	NA	Leaky Confined Neuman-Witherspoon
				2,841	21,251	150	3.73E-05	NA	Confined Theis (Agarwal Recovery)
				2,713	20,295	143	4.37E-05	NA	Confined Cooper-Jacob (Agarwal Recovery)
				2,685	20,082	141	NA	2.773	Confined Theis Recovery
NNMW	3,674	96.6-106.6	18	3,289	24,602	183	8.12E-05	NA	Confined Theis
				3,444	25,762	191	6.41E-05	NA	Confined Cooper-Jacob
				2,279	17,049	127	1.07E-04	NA	Leaky Confined Hantush-Jacob
				2,284	17,085	127	1.07E-04	NA	Leaky Confined Neuman-Witherspoon
				2,511	18,781	139	9.57E-05	NA	Confined Theis (Agarwal Recovery)
				2,383	17,823	132	1.03E-04	NA	Confined Cooper-Jacob (Agarwal Recovery)
				2,495	18,663	139	NA	2.92	Confined Theis Recovery
SWMW-D	5,271	147-157	12	11,340	84,823	945	6.34E-04	NA	Confined Theis
				5,686	42,528	474	1.19E-03	NA	Confined Cooper-Jacob
				3,757	28,099	313	1.02E-03	NA	Confined Theis (Agarwal Recovery)
				4,729	35,374	394	7.42E-04	NA	Confined Cooper-Jacob (Agarwal Recovery)
				3,727	27,875	311	NA	3.303	Confined Theis Recovery
			min =	1,441	10,778	69	2.98E-07	2.3380	
			max =	4,729	35,374	394	1.02E-03	3.3030	
			geometric mean =	2,721	20,355	165	1.48E-05	2.7929	

Notes:

ft: feet

gpd: gallons per day

ft bgs: feet below ground surface

NA: not applicable

ft/day: feet per day

NV: not valid

ft²/day: feet squared per day

Italicized values in grey cells not used in the statistics due to either poor curve matching, misalignment with other solutions, or results inconsistent with the conceptual model.

S/S': the ratio of storativity during pumping to storativity during recovery. Values > 1 indicate a positive boundary. Values < 1 indicate a negative boundary.

30-Day Aquifer Pumping Test
Prairie Coteau Well Field
Lake Norden, SD

FIGURES

D:\GIS\GIS\Banner Lake Norden SD\map5509BAN01_011_Test_config.mxd, 5/19/2021, 9:40:03 AM, NAD 1983 StatePlane South Dakota North FIPS 4001 Feet

-  Pumping Well
-  Observation Well
-  Domestic Well
-  Observation Well
(to be abandoned and not monitored during L2 test)

(103 ft) Depth of Well (ft bgs)

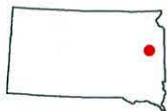
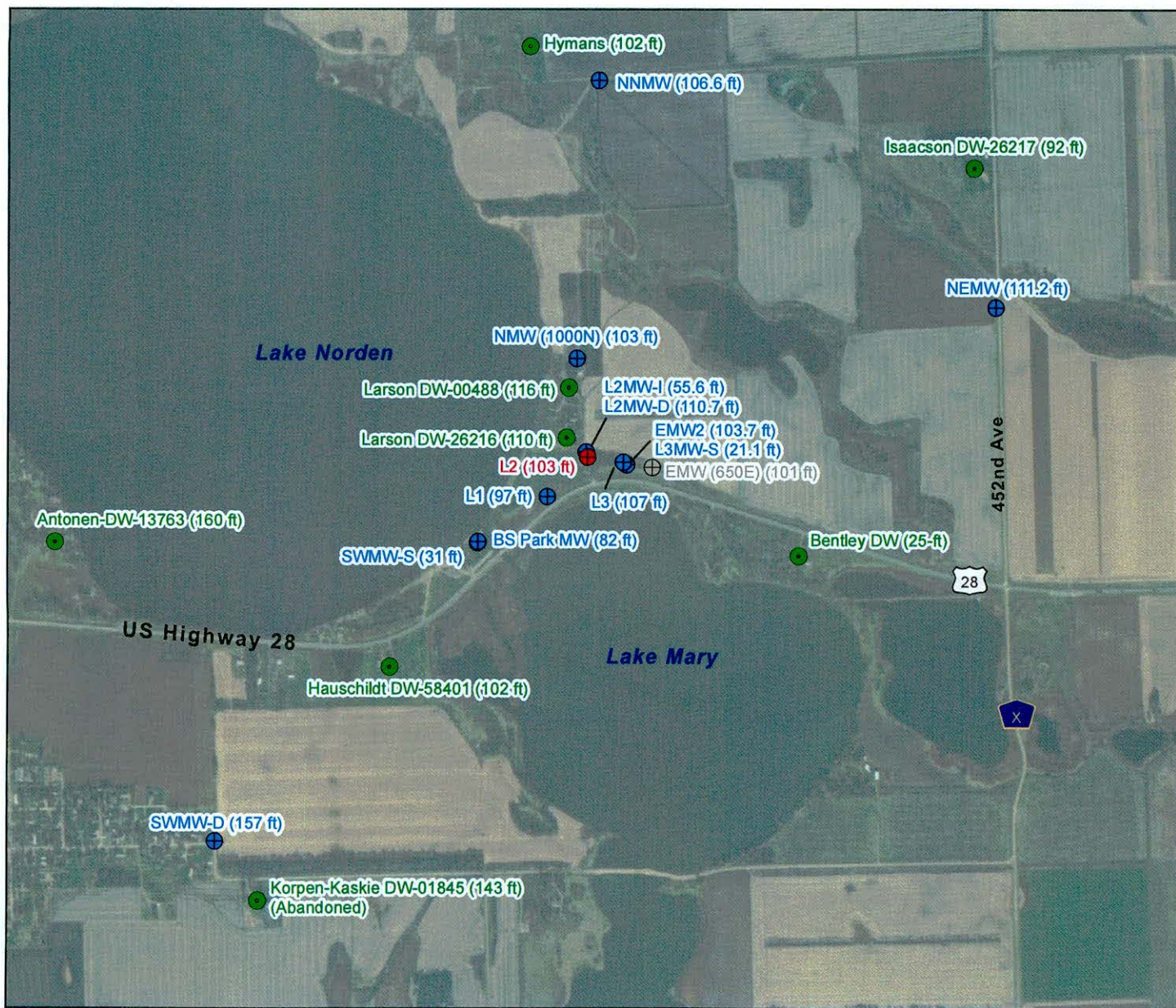


0 1,500
Feet

Notes:

Sources:

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Prepared By:
LRE Water
Innovative Water Resource Solutions
South Dakota Office
Sioux Falls, South Dakota
(605) 310-1721

BANNER ASSOCIATES, INC.
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SOUTH DAKOTA

30-DAY AQUIFER TEST CONFIGURATION

FILE: 5509BAN01_011_Test_config.MXD

DATE: 5/19/2021

FIGURE: 1

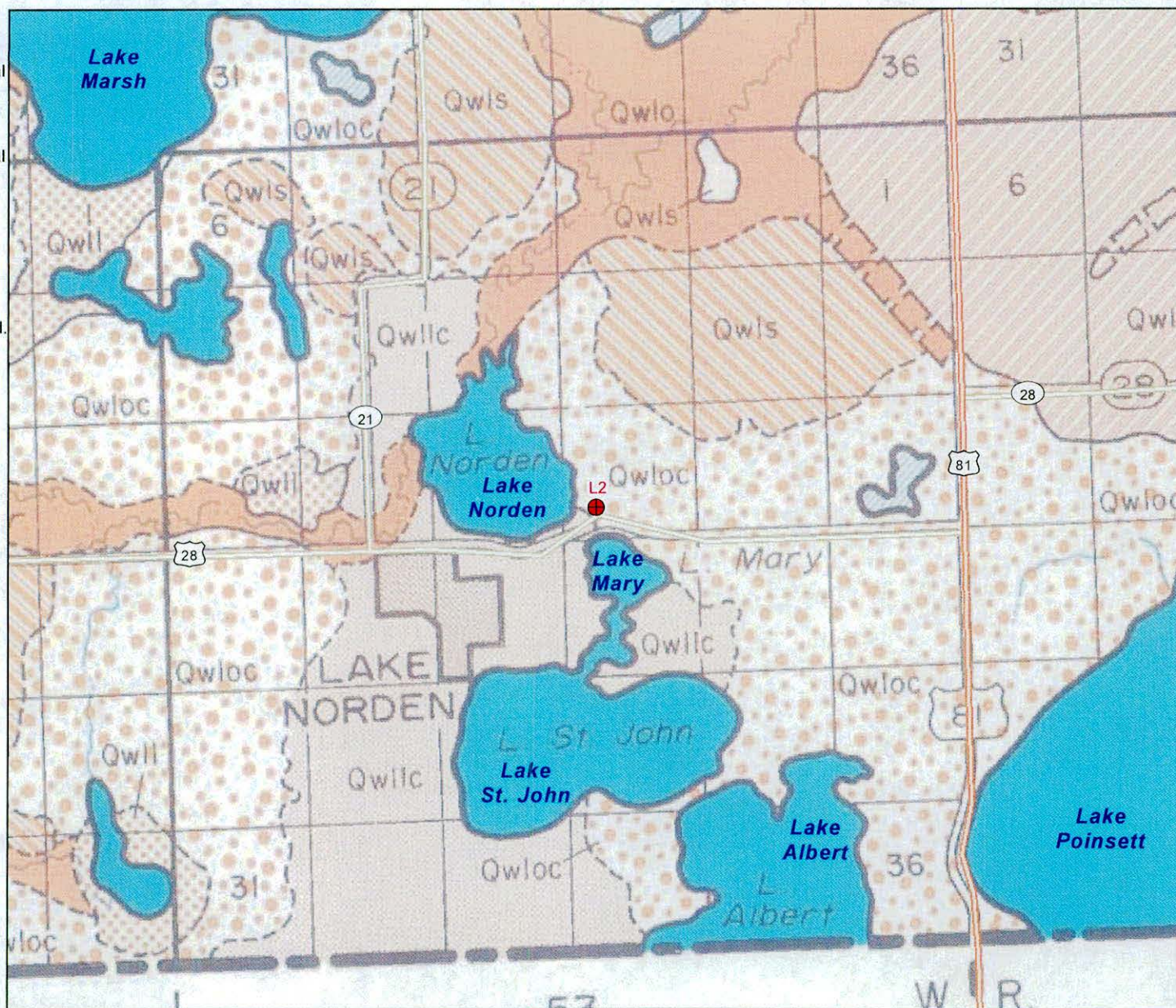
-  Pumping Well
-  Outwash, undifferentiated
Sand and gravel of glaciofluvial origin; minor amounts of silt and clay.
-  Outwash, collapsed
Sand and gravel of glaciofluvial origin; minor amounts of till; irregular topography.
-  Lacustrine sediment, undifferentiated.
Silt and clay with minor amounts of sand and fine gravel; flat to smoothly sloping surface.
-  Lacustrine sediment, collapsed.
Silt and clay with minor amounts of sand and fine gravel; irregular topography.
-  Stagnation moraine
Heterogeneous mixture of boulders, sand, silt, and clay; isolated deposits of sand and gravel; rugged, hummocky topography; contains many sloughs.
-  James Lobe Altamont moraine
Heterogeneous mixture of boulders, sand, silt, and clay; isolated deposits of sand and gravel; composed of one or more high ridges or linear masses.



0 6,000
Feet

Sources:

Plate I, Geologic Map of Deuel and Hamlin Counties, SD. D.R. Beissel and J.P. Gilbertson, 1987. South Dakota Geological Survey Bulletin 27.



CONNECTING WATER TO LIFE

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BANNER ASSOCIATES, INC.
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SOUTH DAKOTA

GEOLOGIC MAP

FILE: 5509BAN01_01m_Geologic_Map.MXD

DATE: 5/3/2021

FIGURE: 2

D:\GIS\GISBanner Lake Norden SD\maps\5509BAN01_01h_static.mxd, 5/19/2021, 9:45:14 AM, NAD 1983 StatePlane South Dakota North FIPS 4001 Feet

- Pumping Well
 - ⊕ Observation Well
 - Domestic Well
 - ⊕ Observation Well (to be abandoned and not monitored during L2 test)
- 1661.54 Static Water Elevation (feet)
- Approximate Groundwater Elevation Contour (feet)
- ➔ Approximate Groundwater Flow Direction (feet)

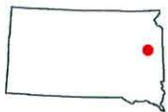
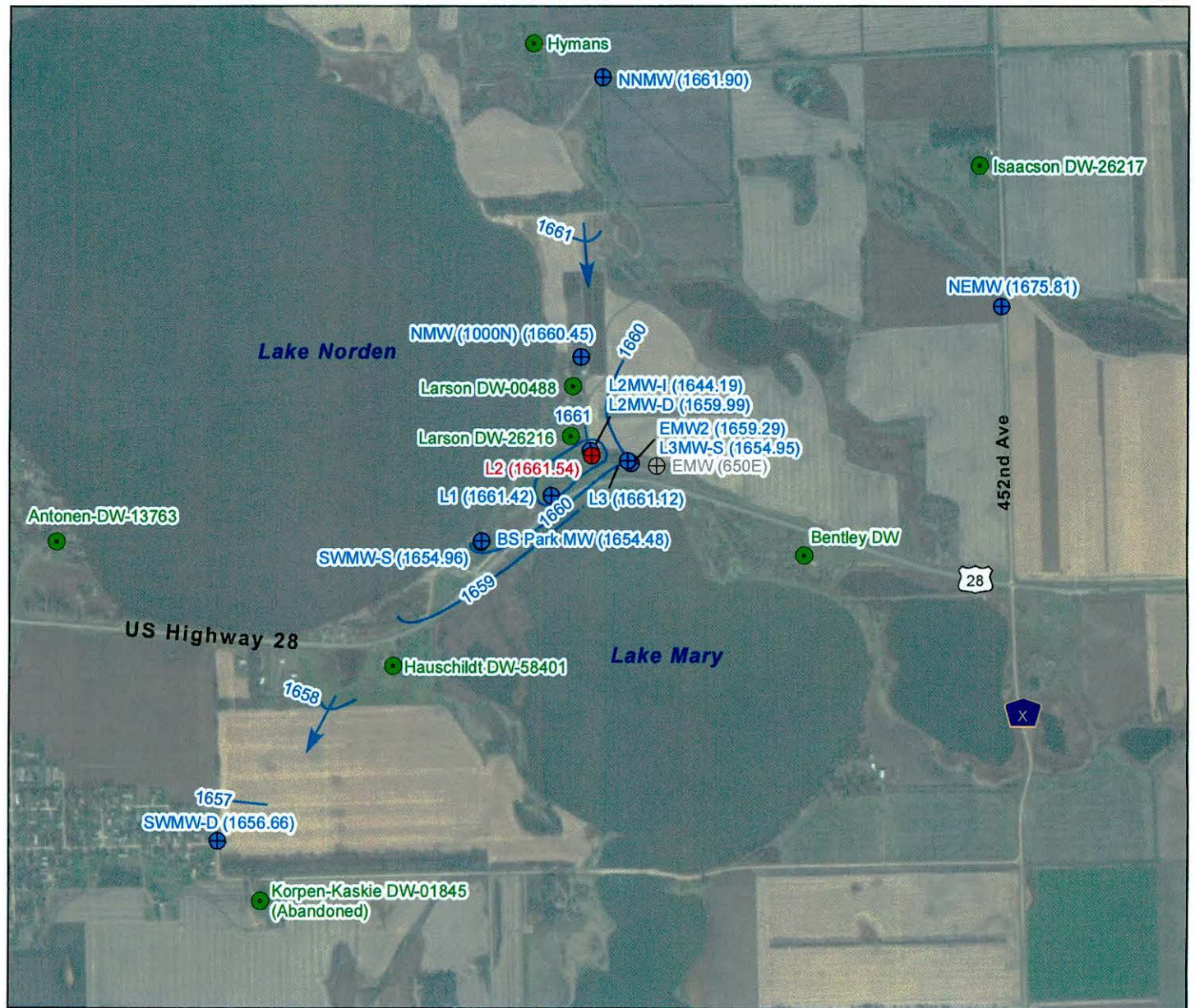


0 1,500
Feet

Notes:

Sources:

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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BANNER ASSOCIATES, INC.
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SOUTH DAKOTA

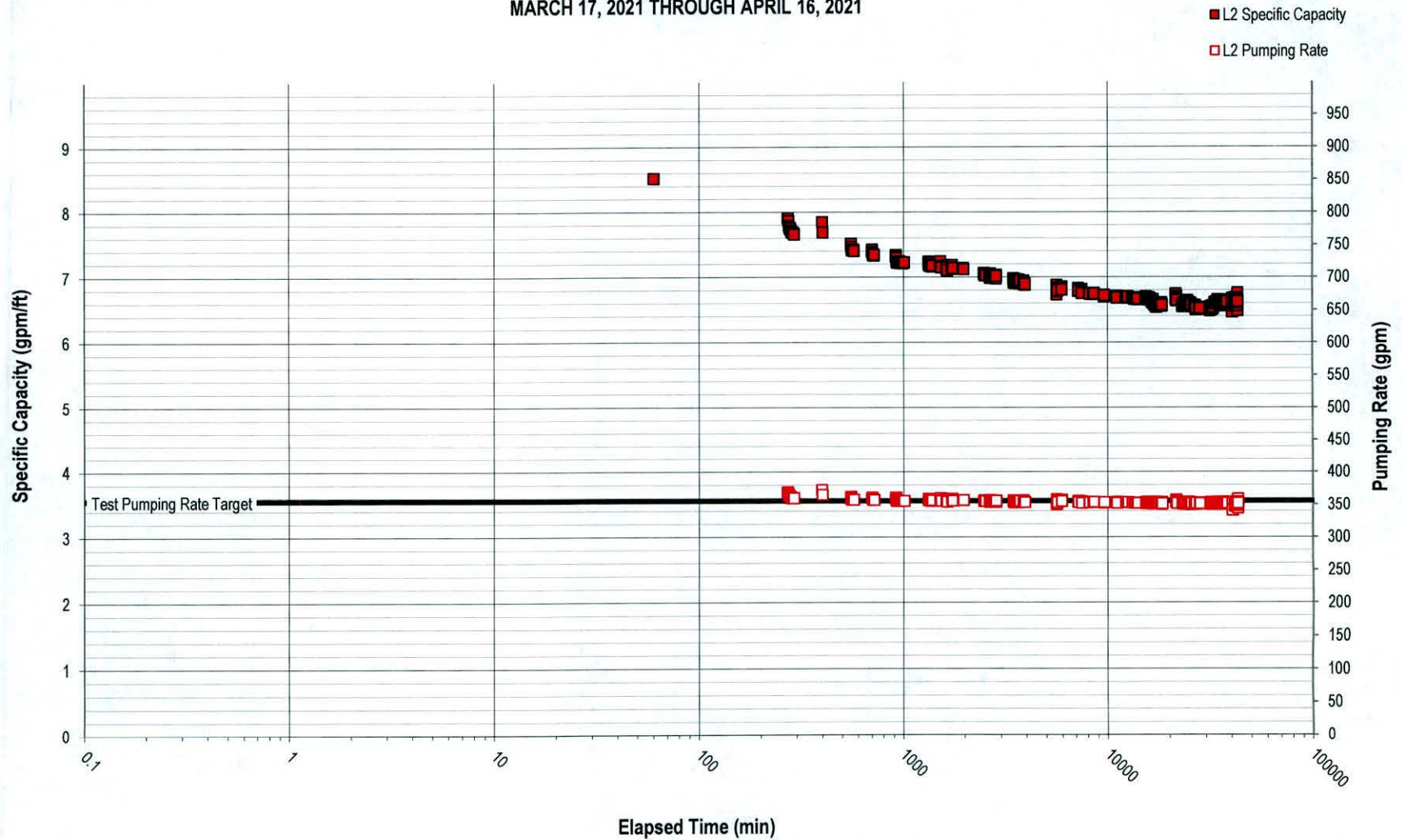
STATIC WATER ELEVATION PRIOR TO TEST

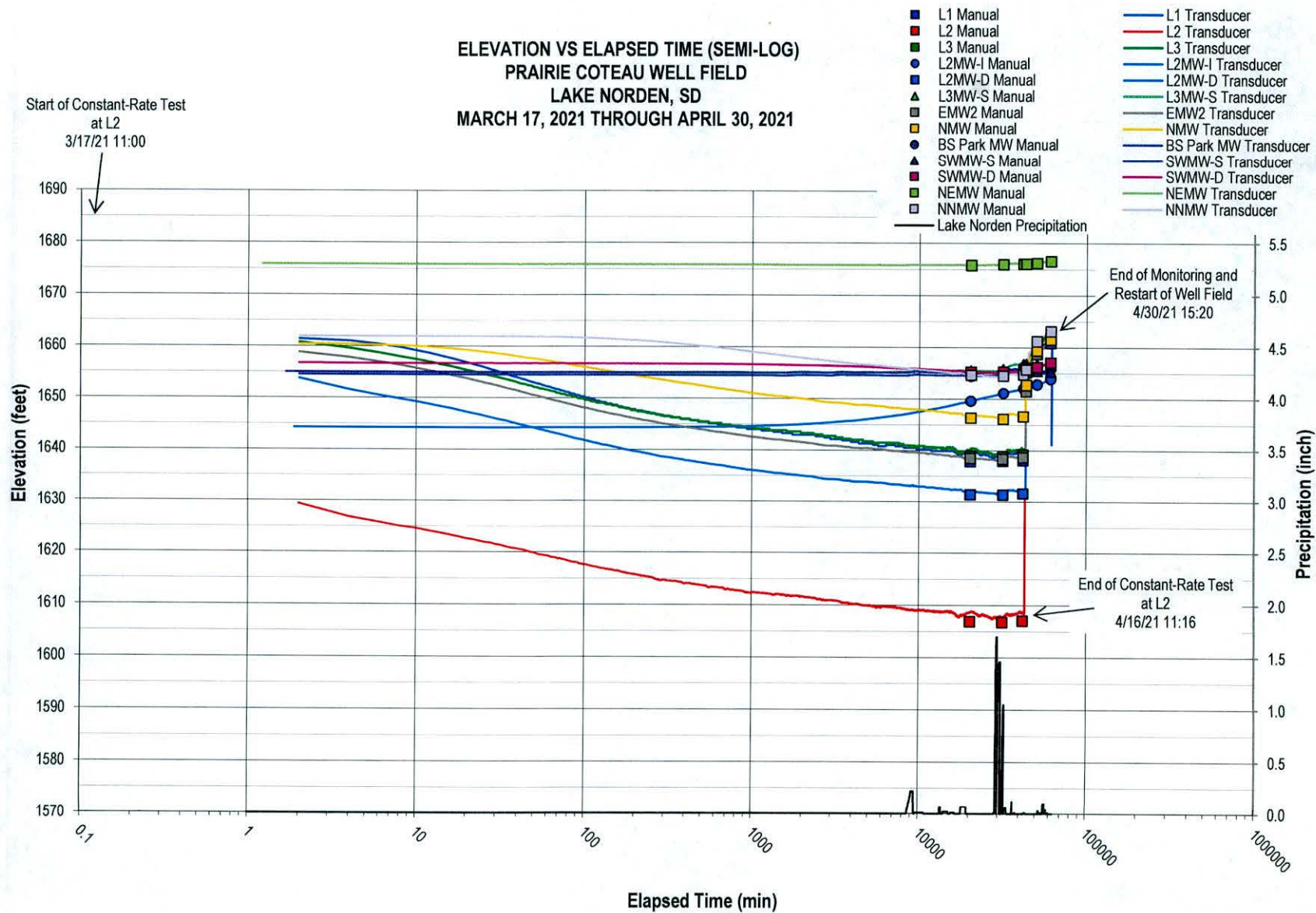
FILE: 5509BAN01_01h_static.MXD

DATE: 5/19/2021

FIGURE: 3

SPECIFIC CAPACITY AND PUMPING RATE VS ELAPSED TIME (SEMI-LOG)
 PRAIRIE COTEAU WELL FIELD
 LAKE NORDEN, SD
 MARCH 17, 2021 THROUGH APRIL 16, 2021





D:\GIS\Banner Lake Norden S:\maps\5509BAN01_01_end_test_elev.mxd, 5/19/2021, 2:01:28 PM, NAD 1983 StatePlane South Dakota North FIPS 4001 Feet

- Pumping Well
- ⊕ Observation Well
- Domestic Well
- ⊕ Observation Well (to be abandoned and not monitored during L2 test)

1608.53 Pumping Water Elevation (feet)

— Approximate Groundwater Elevation Contour (feet)

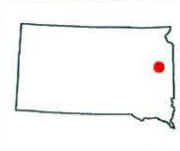
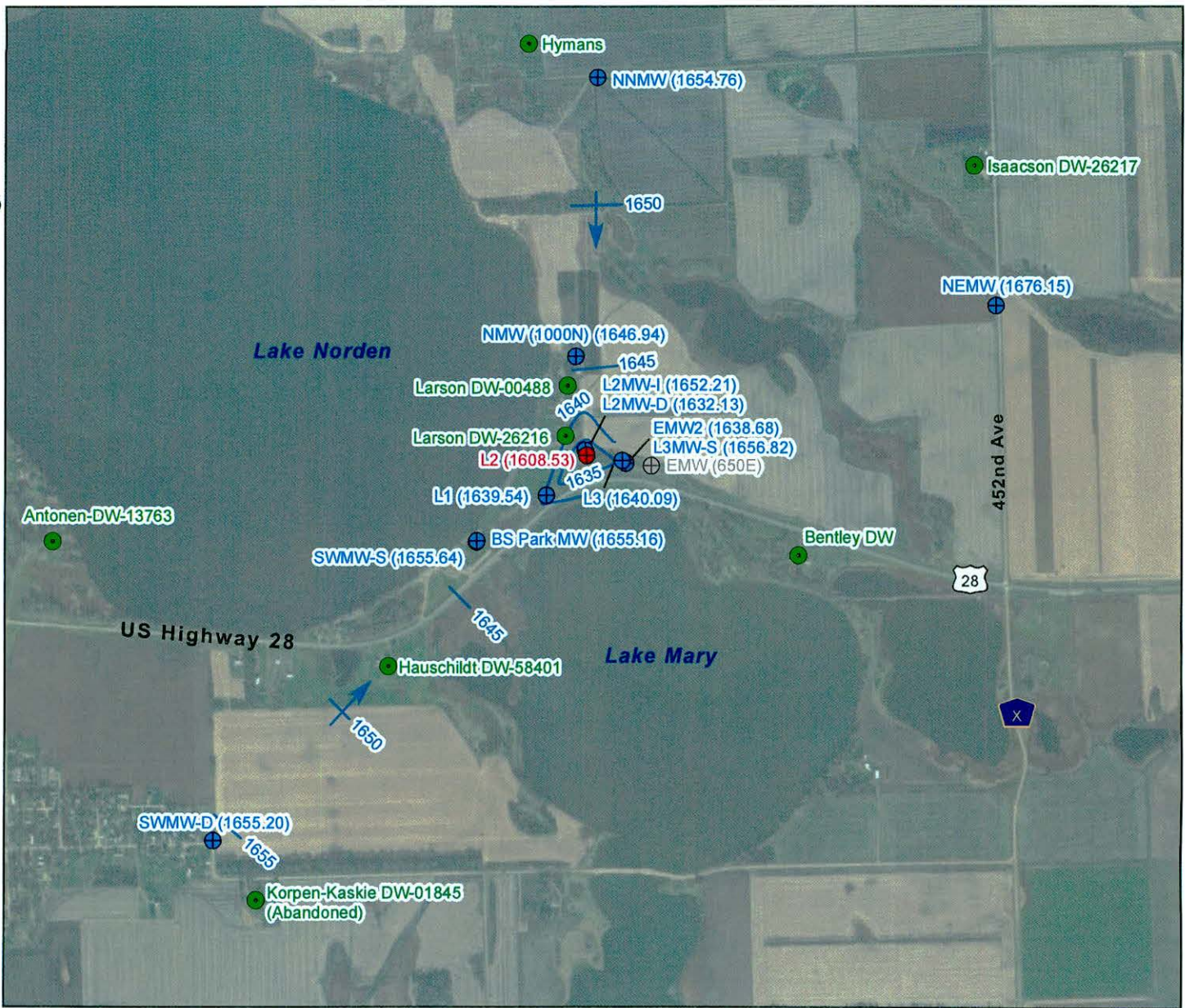
➔ Approximate Groundwater Flow Direction (feet)



Notes:

Sources:

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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BANNER ASSOCIATES, INC.
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SOUTH DAKOTA

PUMPING WATER ELEVATION AT END OF TEST

D:\GIS\Banner Lake Norden_SDMaps\5509BAN01_01j_drawdown.mxd, 5/19/2021, 2:03:03 PM, NAD 1983 StatePlane South Dakota North FIPS 4001 Feet

-  Pumping Well
-  Observation Well
-  Domestic Well
-  Observation Well (to be abandoned and not monitored during L2 test)
- 53.01 Drawdown (feet)
-  Inferred Groundwater Drawdown Contour (feet)
-  Inferred Groundwater Flow Direction (feet)



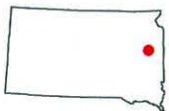
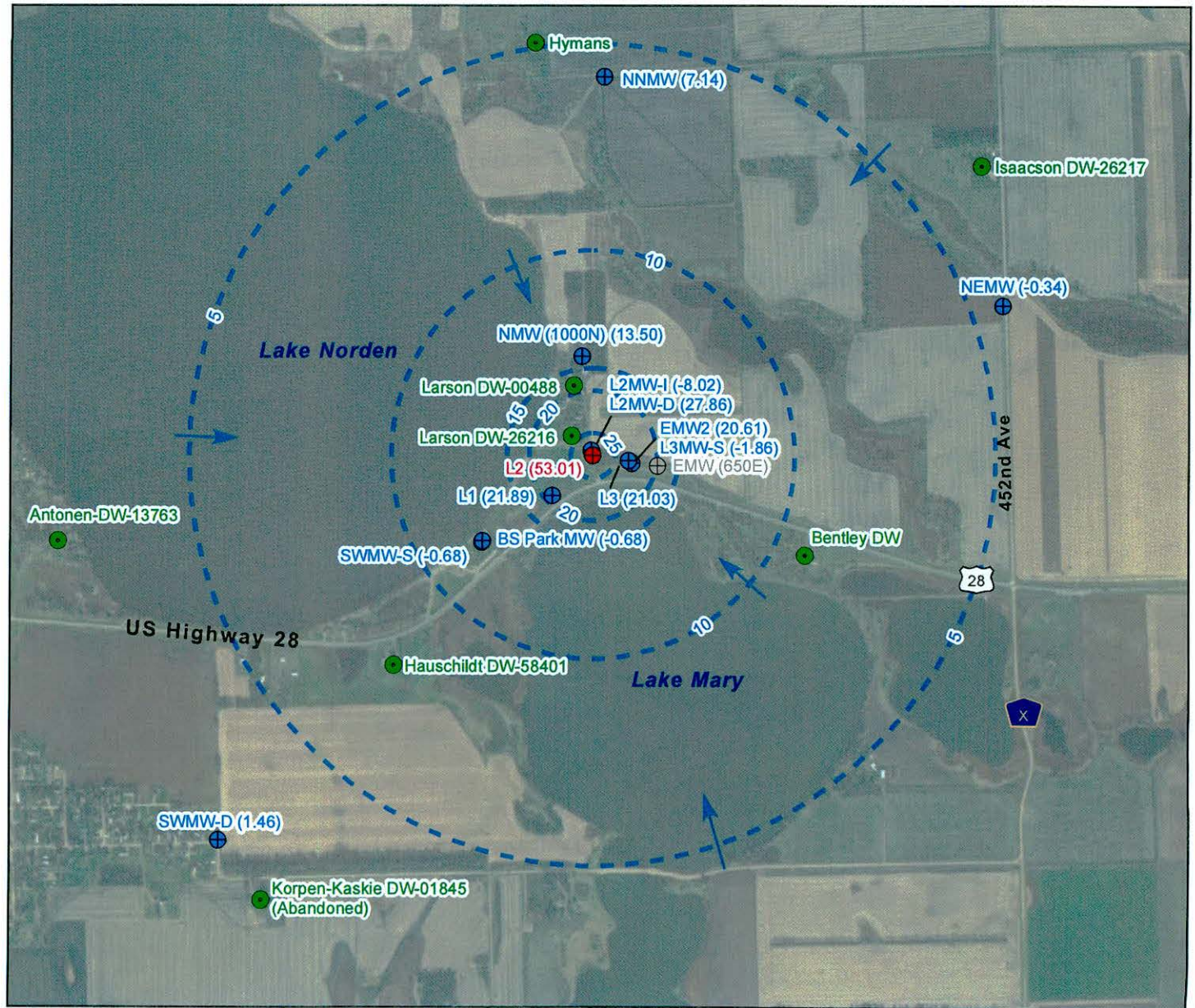
0 1,500
Feet

Notes:

Negative drawdown values indicate that water levels rose during the Test and were not influenced by pumping in L2.

Sources:

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SOUTH DAKOTA

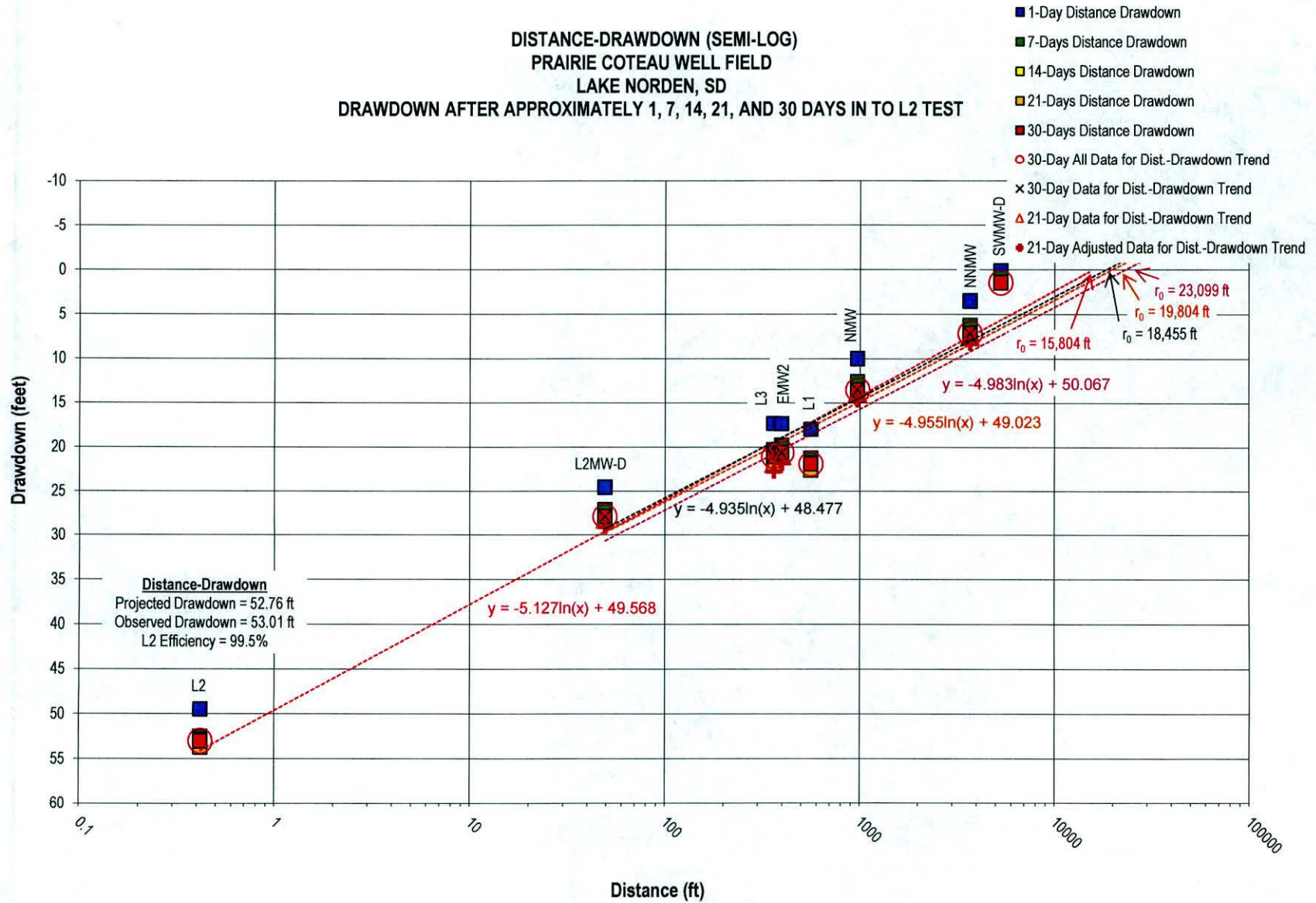
DRAWDOWN AT END OF TEST

FILE: 5509BAN01_01j_drawdown.MXD

DATE: 5/19/2021

FIGURE: 7

DISTANCE-DRAWDOWN (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
DRAWDOWN AFTER APPROXIMATELY 1, 7, 14, 21, AND 30 DAYS IN TO L2 TEST



D:\GIS\GIS\Banner Lake Norden_SDMaps\5509BAN01_01k_r0.mxd 5/20/2021 11:08:08 AM NAD 1983 StatePlane South Dakota North FIPS 4001 Feet

-  Pumping Well
-  Observation Well
-  Domestic Well
-  Observation Well (to be abandoned and not monitored during L2 test)
-  Radius of Influence* (r_0) Using Distance-Drawdown Data from L1, L2, L3, L2MW-D, EMW2, NMW, NNMW, and SWMW-D
-  Radius of Influence* (r_0) Using Distance-Drawdown Data from L3, L2MW-D, EMW2, NMW, and NNMW
-  Radius of Influence** (r_0) Using Distance-Drawdown Data from L3, L2MW-D, EMW2, NMW, and NNMW
-  Radius of Influence** (r_0) Using Distance-Drawdown Data from L3, L2MW-D, EMW2, NMW, and NNMW with Adjusted Drawdown Data

0 6,000 Feet



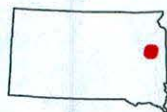
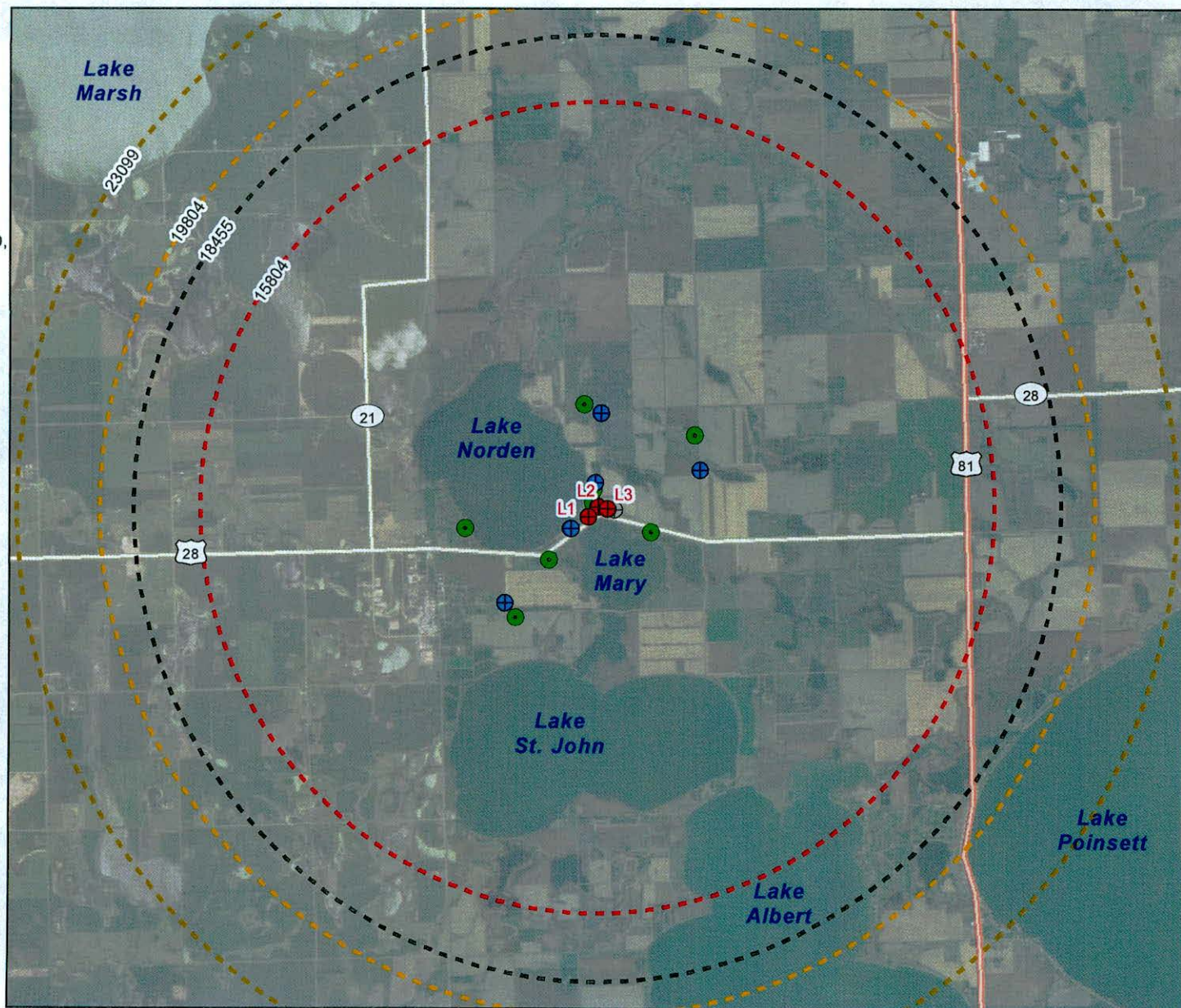
Notes:

* Radii of influence (r_0) calculated based on distance-drawdown data at the end of the Test (43,200 minutes).

** Radii of influence (r_0) calculated based on distance-drawdown data at 21-days (30,240 minutes).

Sources:

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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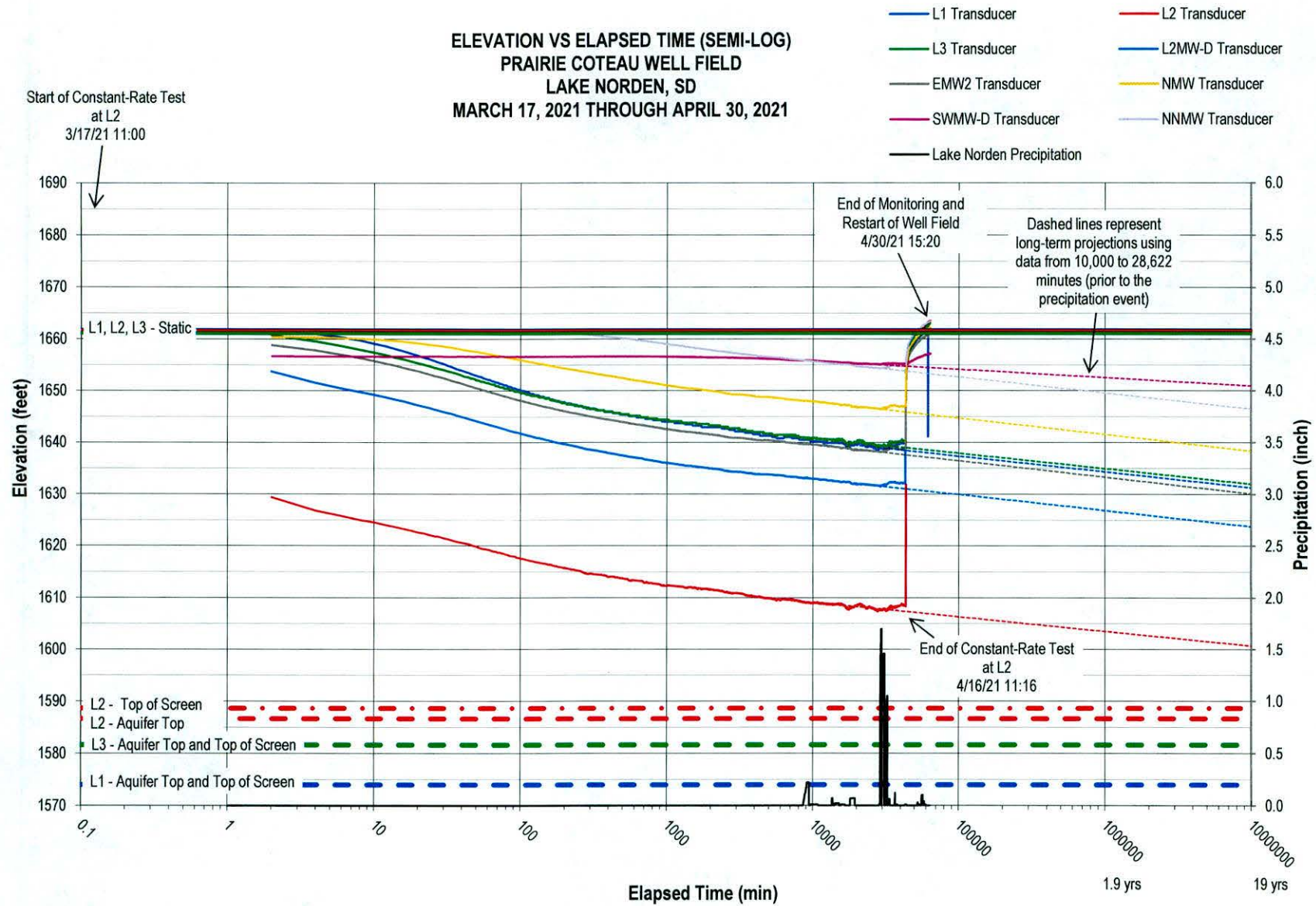
BANNER ASSOCIATES, INC.
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SOUTH DAKOTA

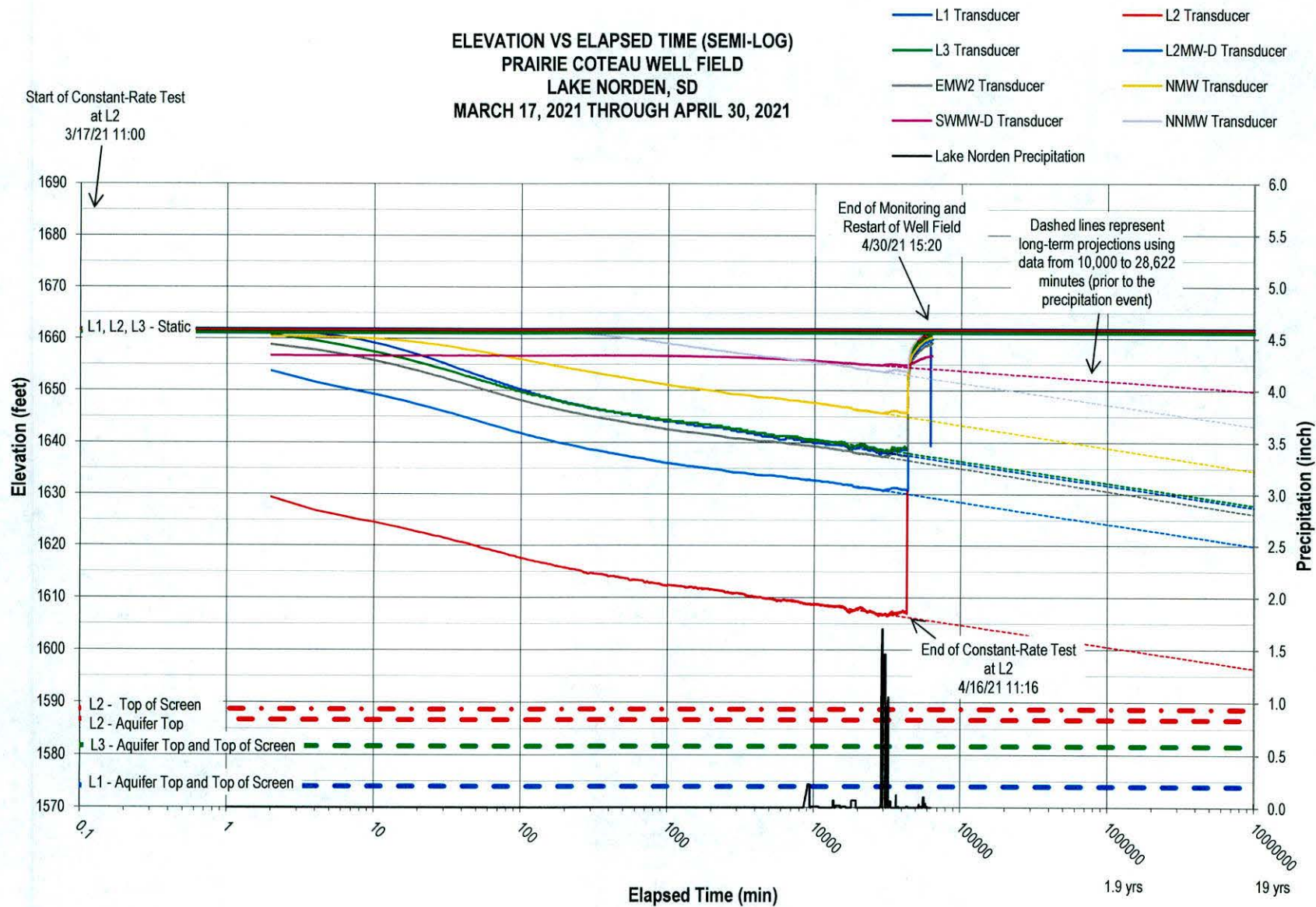
RADIi OF INFLUENCE

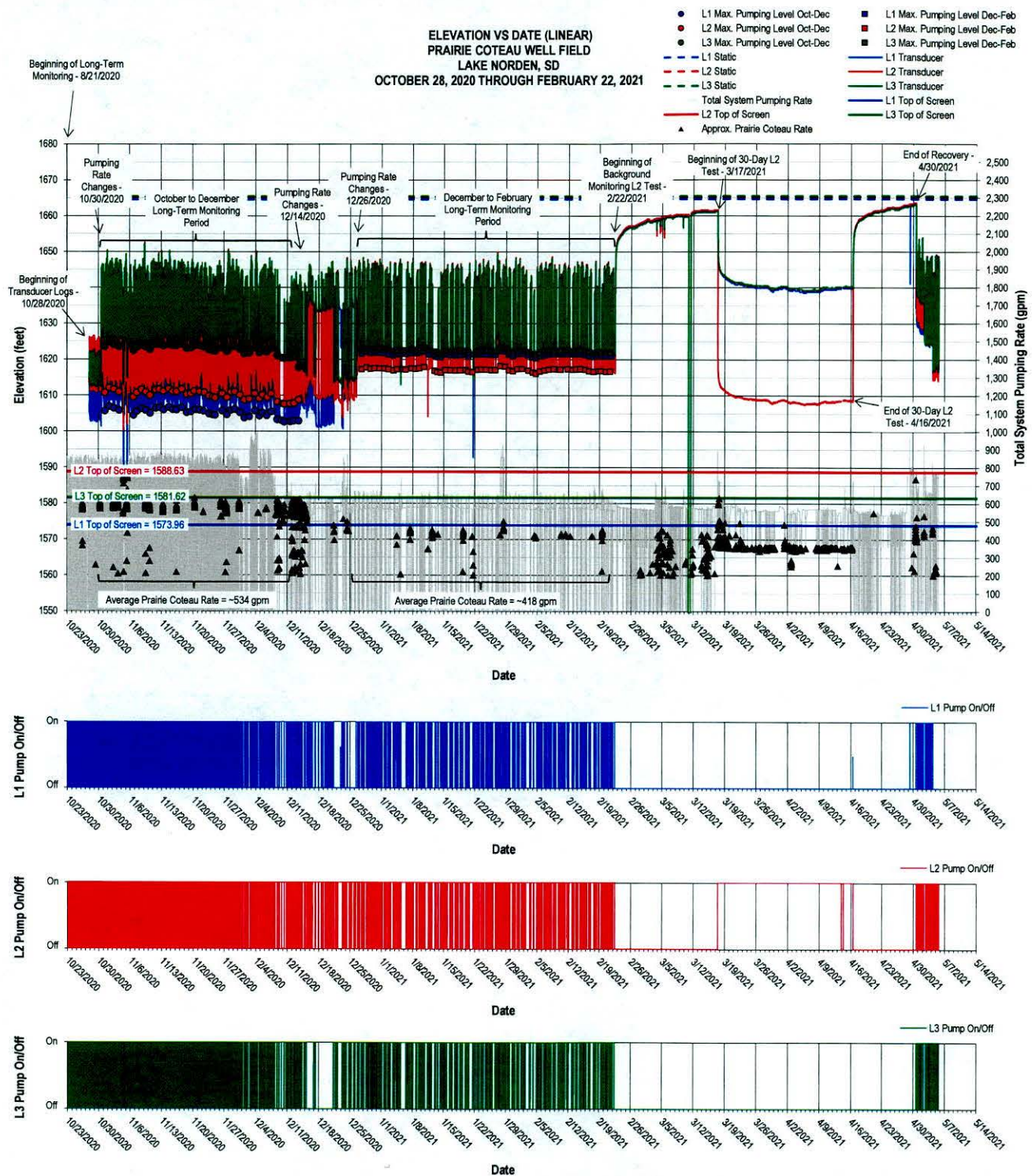
FILE: 5509BAN01_01k_r0.MXD

DATE: 5/20/2021

FIGURE: 9

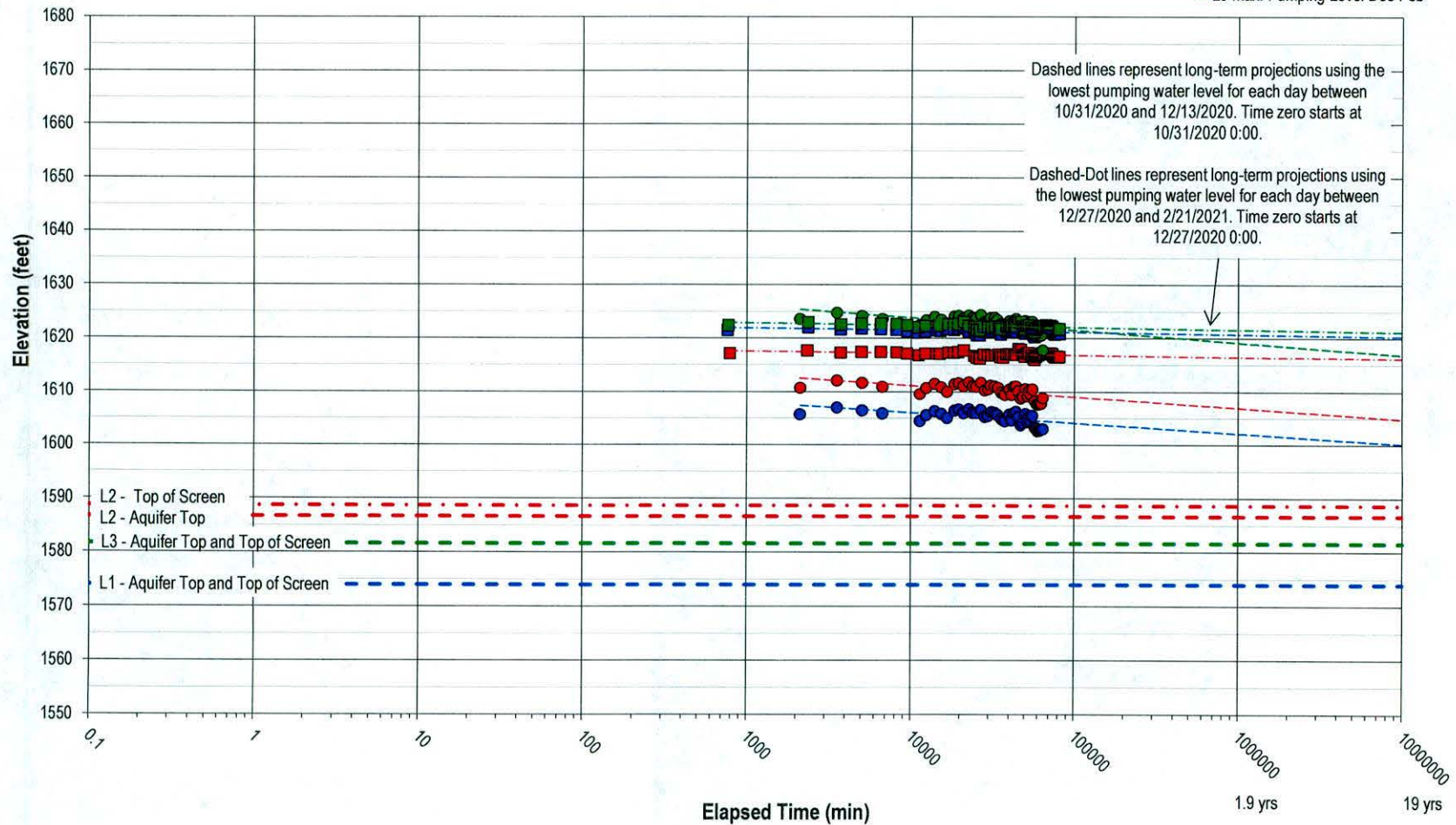






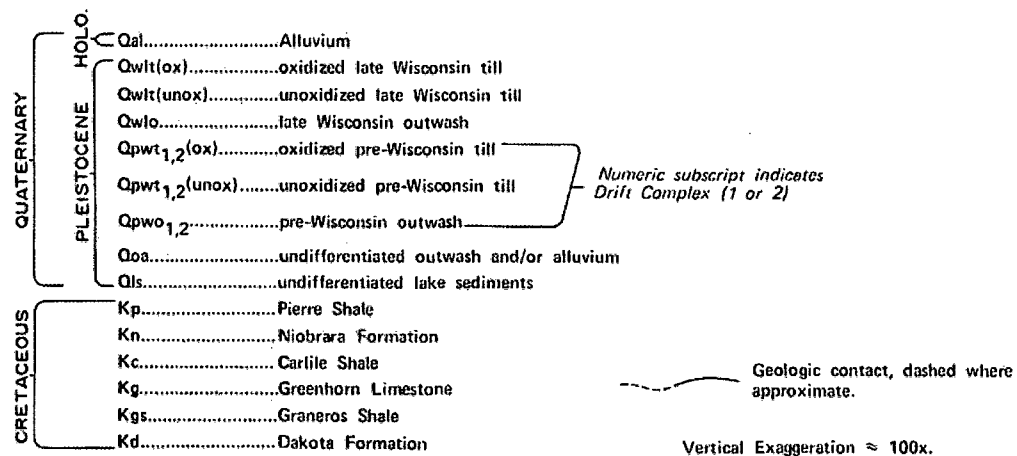
ELEVATION VS ELAPSED TIME (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
OCTOBER 31, 2020 THROUGH DECEMBER 13, 2020 AND
DECEMBER 27, 2020 THROUGH FEBRUARY 21, 2021

- L1 Max. Pumping Level Oct-Dec
- L1 Max. Pumping Level Dec-Feb
- L2 Max. Pumping Level Oct-Dec
- L2 Max. Pumping Level Dec-Feb
- L3 Max. Pumping Level Oct-Dec
- L3 Max. Pumping Level Dec-Feb

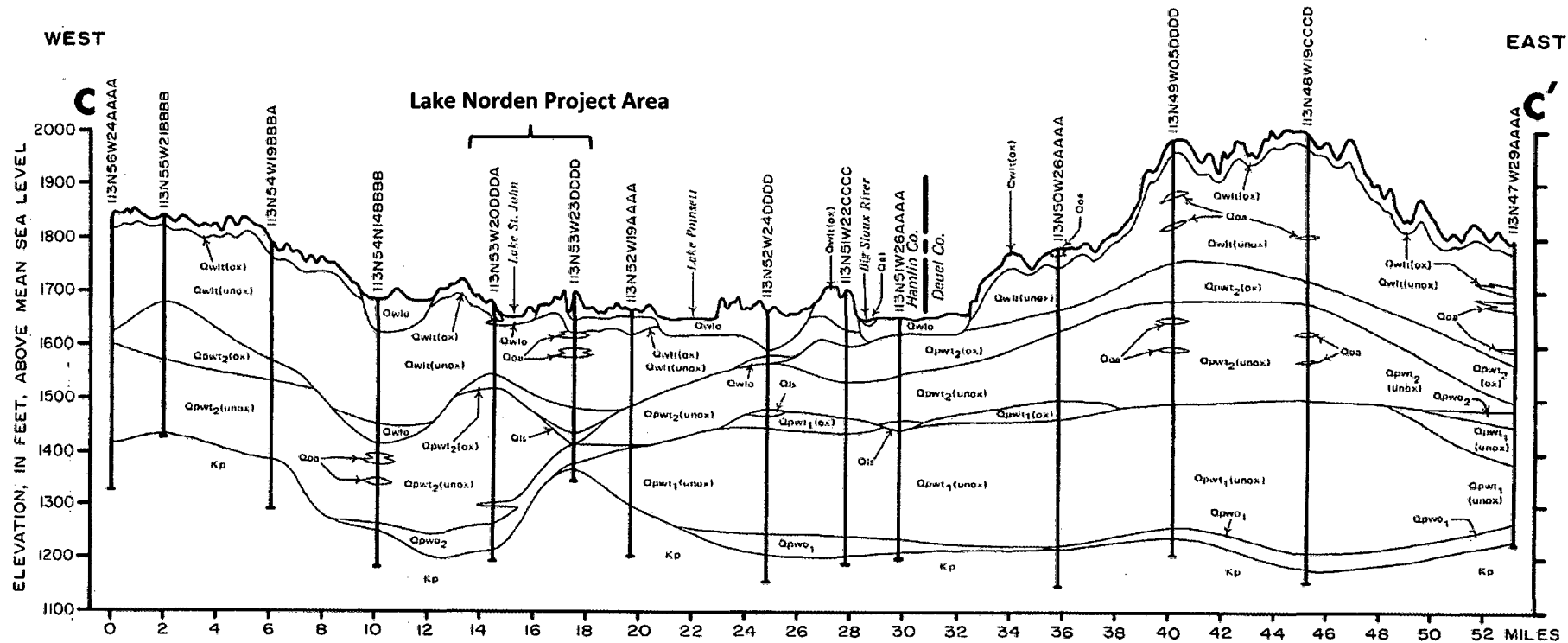
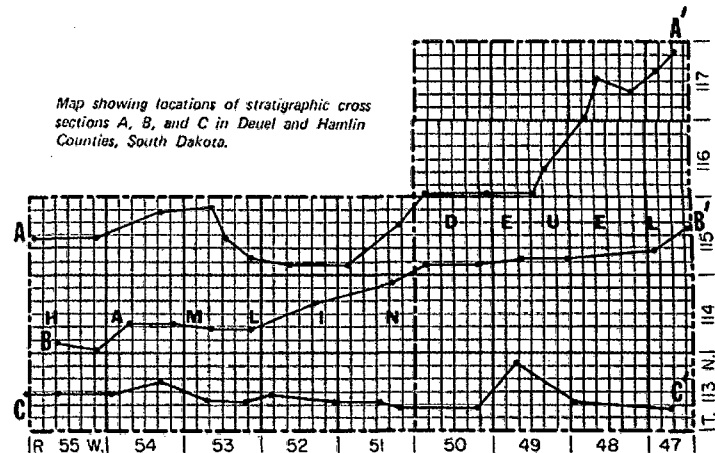


**30-Day Aquifer Pumping Test
Prairie Coteau Well Field
Lake Norden, SD**

APPENDIX A



Map showing locations of stratigraphic cross sections A, B, and C in Deuel and Hamlin Counties, South Dakota.



Source: South Dakota Geological Survey, Bulletin 27, Plate 2. Stratigraphic cross sections, Deuel and Hamlin Counties, South Dakota (D.R. Beissel and J. P. Gilbertson, 1987).

30-Day Aquifer Pumping Test
Prairie Coteau Well Field
Lake Norden, SD

APPENDIX B

SOUTH DAKOTA WATER WELL COMPLETION REPORT

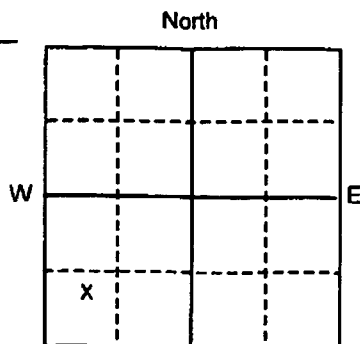
11-02

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WWell Owner: CITY OF LAKE NORDENCounty HAMLIN

Business Name: _____

Address: PO BOX 213City, State, Zip: LAKE NORDEN SD 57248Ground Elev. = 1656.96

Please mark well location with an "X"



Well Completion Date

10-1-2018

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well
METHOD OF DRILLING:
DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40.0 LB/FT	10.00 IN	0.0 FT	83.0 FT	16.00 IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWELDF	32	54.0 Lb/gal	0.0 Ft	80.0 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure _____

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 10.00 Inches Length 20.0 FeetMaterial SSSlot Size .30 Set From 83.0 Feet to 97.0 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____

☐ No, Why Not? _____

Lab to which water quality sample sent for analysis _____

WELL LOG:

DEPTH

FORMATION	FROM	TO
TOP SOIL	0	2
YELLOW MIXED SAND fine-med	2	18
BLUE CLAY	18	24
GREY FINE SAND	24	29
BLUE CLAY soft	29	35
GREY MED-COURSE	35	57
BLUE CLAY SOFT	57	83
YELLOW MED-COURSE	83	97

STATIC WATER LEVEL

FEET

If flowing: closed in pressure _____

PSI

GPM flow 40 through 10 Inch pipeControlled by ☒ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ Pumped Describe: _____

☐ Bailed

☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

Lake Norden Well L1

well on west side of Pelican PassThis well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

RECEIVED

FEB 04 2019

Date: _____

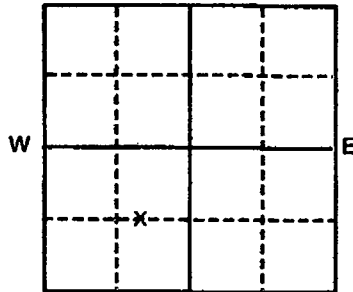
WATER RIGHTS
PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLIN

North

Please mark well
location with an "X"

Well Completion Date

5-8-2018

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
sch40 LB/FT	10 IN	+2 FT	83 FT	11 3/4 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GrtweiDF	30	54 Lb/gal	0 Ft	80 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure _____

SCREEN:

☐ Perforated pipe ☒ Manufactured
Diameter 10 Inches Length 20 FeetMaterial Stainless SteelSlot Size 30 Set From 83 Feet to 103 Feet

Other information _____

WAS A PACKER OR SEAL USED? ☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☒ Yes, How? HTH☐ No, Why Not? _____Lab to which water
quality sample sent for analysis

SDPHL

Well Owner: City of Lake Norden

Business Name: _____

Address: PO Box 213City, State, Zip: Lake Norden ☒ SD ☒ 57248Ground Elev. = 1671.63

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	1
YELLOW SANDYCLAY	1	3
YELLOW SAND	3	8
YELLOW CLAY	8	10
YELLOW SAND	10	13
BLUE CLAY	13	34
YELLOW CLAY	34	85
GREY SAND FINE	85	103
BLUE CLAY	103	

STATIC WATER LEVEL 5 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ Pumped Describe: SUBMERSIBLE☐ Bailed☐ Other

Pumping Level Below Land Surface

51.7 Ft. After 26 Hrs. pumped 500 GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

well #1 east side of Pelican PassLake Norden Well L2This well was drilled under license # 689 and this
report is true and accurate.Drilling firm: Kaiser Well Drilling Inc.

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

RECEIVED

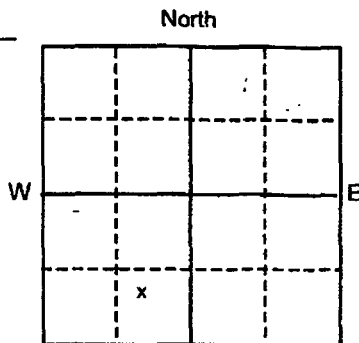
FEB 04 2019

Date: _____

WATER RIGHTS
PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location 1/4 SW 1/4 Sec 15 Twp 113N Rg 53WCounty HAMLINPlease mark well
location with an "X"

Well Completion Date

10-17-2018Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (identify source)

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40.0 LB/FT	10.00 IN	0.0 FT	87.0 FT	16.00 IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
GRTWELDF	32	54.0 Lb/gal	0.0 Ft	84.0 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure
pressure pull method

SCREEN:

☐ Perforated pipe ☒ Manufactured
 Diameter 10.00 Inches Length 20.0 Feet
Material SSSlot Size .30 Set From 87.0 Feet to 107.0 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____

☐ No, Why Not? _____
Lab to which water
quality sample sent for analysis _____Well Owner: CITY OF LAKE NORDEN

Business Name: _____

Address: PO BOX 213City, State, Zip: LAKE NORDEN SD 57248Ground Elev. = 1668.62

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	2
SAND MIXED	2	18
GRAVEL MED-COURSE	18	20
BLUE CLAY	20	40
YELLOW CLAY	40	78
BLUE CLAY	78	87
SAND MED-FINE	87	101

STATIC WATER LEVEL

8

FEET

If flowing: closed in pressure _____

PSI

GPM flow _____

through _____

Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____

GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ Pumped Describe: 300 GPM - Sub. Pump
☐ Bailed
☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

Lake Norden Well L3

2nd Well East side Pelican PassThis well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

RECEIVED

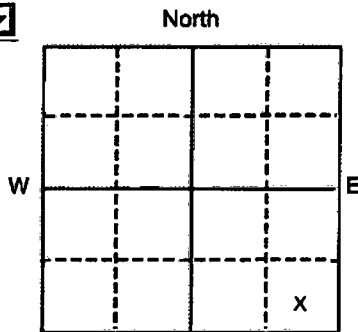
FEB 04 2019

WATER RIGHTS
PROGRAM

Date: _____

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11-02

Location SE ¼ SE ¼ Sec 16 Twp 113N Rg 53WCounty HAMLINPlease mark well
location with an "X"

Well Completion Date

07/29/2020

1 Mile

Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (Identify source) _____

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40 LB/FT	2.5 IN	+2 FT	62 FT	6 IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
grtweldf	4	54 Lb/gal	0 Ft	62 Ft
_____	_____	_____ Lb/gal	_____ Ft	_____ Ft

Describe grouting procedure

PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured
 Diameter 2.5 Inches Length 20 Feet
 Material SCH 40 PVC
 Slot Size 25 Set From 62 Feet to 82 Feet

Other information _____

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material? _____

Describe packer(s) and location _____

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How? _____☒ No, Why Not? _____Lab to which water
quality sample sent for analysis _____OBSERVATION WELL
NO PUMP INSTALLED

Well Owner: _____

Business Name: CITY OF LAKE NORDENAddress: PO BOX 213City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

Ground Elev. = 1660

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	1.5
YELLOW CLAY	1.5	8
FINE SAND GREY	8	20
FINE-MED	20	30
BLUE CLAY	30	32
FINE SAND	32	38
BLACK DIRT	38	48
FINE-MED	48	60
MEDIUM	60	70

STATIC WATER LEVEL 4.5 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced flow rate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ Pumped Describe: PUMPED WITH AIR 75gpm☐ Bailed☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

MED- COURSE 70-82

BLUE CLAY 82-104

YELLOW CLAY 104-160

Big Sioux Aquifer

LAKE NORDEN PARK OBSERVATION WELL

This well was drilled under license # 689 and this report is true and accurate.Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative: _____

Signature of Well Owner or Equitable Property Holder: _____

Date: 7/19/2020

RECEIVED

AUG 24 2020

WATER RIGHTS
PROGRAM

SOUTH DAKOTA WATER WELL COMPLETION REPORT

11- 02

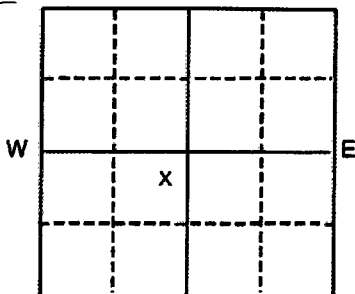
Location NE ¼ SW ¼ Sec 15 Twp 113N Rg 53W

County HAMLIN



North

Please mark well location with an "X"



Well Completion Date

07/28/2020



Distance to nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)?
ft. from _____ (Identify source)

PROPOSED USE:

☐ Domestic/Stock Irrigation ☒ Municipal Industrial ☐ Business Institutional ☐ Test holes ☒ Monitoring well

METHOD OF DRILLING:

DIRECT ROTARY

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
40 LB/FT	3 IN	+2 FT	93 FT	6 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
grtwelddf	5	54 Lb/gal	0 Ft	93 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

PRESSURE PULL

SCREEN:

☐ Perforated pipe ☒ Manufactured

Diameter 2.5 Inches Length 20 Feet

Material SCH 40 PVC

Slot Size 25 Set From 93 Feet to 103 Feet

Other information

WAS A PACKER OR SEAL USED?

☐ Yes ☒ No

If so, what material?

Describe packer(s) and location

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How?

☒ No, Why Not?

Lab to which water quality sample sent for analysis

**OBSERVATION WELL
NO PUMP INSTALLED**

Well Owner:

Business Name: CITY OF LAKE NORDEN

Address: PO BOX 213

City, State, Zip: LAKE NORDEN ☒ SD ☒ 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
TOP SOIL	0	1
SANDY YELLOW CLAY	1	4
YELLOW GRAVEL MED- COURSE	4	18
BLUE CLAY	18	63
YELLOW CLAY	63	84
YELLOW FINE-MED	84	87
BLACK FINE SAND	87	97
YELLOW MED-COURSE	97	103

STATIC WATER LEVEL 8.3 FEET

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

Reduced flow rate _____ GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe: PUMPED WITH AIR 60gpm

☐ Bailed

☐ Other

Pumping Level Below Land Surface

_____ Ft. After _____ Hrs. pumped _____ GPM

_____ Ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate: _____ GPM

REMARKS

JOHN LARSON OBSERVATION WELL

This well was drilled under license # 689 and this report is true and accurate.

Drilling firm: KAISER WELL DRILLING INC

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder:

RECEIVED

AUG 24 2020

Date

8/19/2020

**WATER RIGHTS
PROGRAM**

[illegible]

OWNER: Banner Associates, Inc.		BORING/WELL NO. L2MW-D		PAGE 1 OF 1 PAGES	
LOCATION: Lake Norden Prairie Coteau Aquifer Well Field		SCREEN: Schedule 40 PVC, Slotted			
Nested Well North of L2		DIAMETER: 5-inch		SLOT NO. 25	
DATE COMPLETED: 3/3/2021		SETTING: 110.7 - 100.7			
DRILLING COMPANY: Kaiser Well Drilling		SAND PACK: Red Flint Sand and Gravel, 5-100lb bags #50			
		SETTING: 113 - 98 (estimated)			
DRILLING METHOD: Mud Rotary		CASING: Schedule 40 PVC			
SAMPLING METHOD: Cuttings		SETTING: 110.7 - +1.86			
OBSERVER: Mitch Kannenberg		SEAL TYPE: Wyo-Ben Grout Well DF (11-50lb bags)			
DEPTH REFERENCE POINT: ground surface		SETTING: 98-1 (Enviroplug Medium at surface)			
TOP OF PVC CASING ELEVATION: 1673.404 ft (top of 5-inch PVC)		DEVELOPMENT: Air-lift pumping and surging			
STICK-UP: 1.86 ft (PVC casing)		DURATION: 60 minutes, cleaned up fairly well			
SURFACE COMPLETION: 5-inch PVC & 8-inch steel protective cover		WATER LEVEL: 14.34 feet below ground surface at 12:00, 3/4/21			
REMARKS: 7.875 inch tricone roller bit, reamed with 8.75-inch		YIELD: ~ 100 - 125 gpm by air-lifting			
tricone roller bit.					
Sand and gravel particles are composed of quartz, chert, limestone, granite, shale, and very fine black particles that may be lignite.					

DEPTH IN FEET		Formation	Geologic Description
FROM	TO		
0.0	2.0	Topsoil	TOPSOIL, dark brown
2.0	7.0	Surficial Outwash	SAND, medium, dark reddish brown (individual grains multicolored), subangular to subrounded; trace dark-colored, angular to subangular gravel; little fine, subangular to rounded, clear to black sand; poorly sorted; mild effervescence with 10% HCL (fines)
7.0	10.0		SAND AND GRAVEL, yellow-brown, sand grains are coarse, multicolored, angular to subrounded; gravel is multicolored, angular to subangular; trace fine, subangular to rounded, mostly clear to back fine sand, trace silt, poorly sorted
10.0	16.0	Till (oxidized)	CLAY, yellow-brown; little fine, clear to black, subangular to subrounded sand; little black, angular gravel; little silt
16.0	17.0	Outwash (buried)	GRAVEL, brown, grains are multicolored, angular, little silt, little brown clay (may be slough from above), trace fine, subangular to rounded sand, poorly sorted
17.0	38.0	Till (unoxidized)	CLAY, blue-gray; trace multicolored, angular gravel
38.0	45.0	Till (oxidized)	CLAY, yellow-brown; trace fine, clear to black, angular to subrounded sand; trace multicolored, angular gravel; trace dark-colored silt
45.0	46.0	Outwash (buried)	SAND, medium to coarse, yellow-brown, subangular to subrounded; trace fine, mostly clear to black, subangular to subrounded sand; trace multicolored, angular to subangular gravel; trace yellow-brown clay; poorly sorted, mild effervescence with 10% HCL (fines)
46.0	89.0	Till (oxidized)	CLAY, yellow-brown; trace fine, clear to black, angular to subrounded sand; trace multicolored, angular gravel; trace dark-colored silt
89.0	110.0	Outwash (buried)	SAND, coarse, yellow-brown, subangular to subrounded; trace multicolored, angular to subangular gravel; poorly sorted, mild effervescence with 10% HCL (fines), clay and silt layers at 100 ft. and 107 to 108 ft.
110.0	113.0	Till (oxidized)	CLAY, yellow-brown; overdrilled for well installation

[illegible]

OWNER: Banner Associates, Inc.		BORING/WELL NO. NEMW		PAGE 1 OF 1 PAGES	
LOCATION: Lake Norden Prairie Coteau Aquifer Well Field			SCREEN: Schedule 40 PVC, Slotted		
452nd Avenue			DIAMETER: 2.5-inch		SLOT NO. 25
DATE COMPLETED: 3/12/2021			SETTING: 111.2 - 101.2		
DRILLING COMPANY: Kaiser Well Drilling			SAND PACK: Red Flint Sand and Gravel, 6-100lb bags #50		
			SETTING: 111 - 91		
DRILLING METHOD: Mud Rotary			CASING: Schedule 40 PVC 2.5 inch diameter		
SAMPLING METHOD: Cuttings			SETTING: 101.2 - +2.29		
OBSERVER: Mitch Kannenberg			SEAL TYPE: Wyo-Ben Grout Well DF (7-50lb bags)		
DEPTH REFERENCE POINT: ground surface			SETTING: 91-0 (Enviroplug Medium at surface)		
TOP OF PVC CASING ELEVATION: 1696.767 feet			DEVELOPMENT: Air-lift pumping and surging		
STICK-UP: 2.29 ft (PVC casing)			DURATION: 60 minutes plus		
SURFACE COMPLETION: 2.5-inch PVC & 8-inch steel protective cover			WATER LEVEL: 19.20 feet below ground surface at 14:00, 3/13/21		
REMARKS: 6-inch tricone roller bit			YIELD: ~ 25 gpm by air-lifting		
Sand and gravel particles are composed of quartz, chert, limestone, granite, shale, and very fine black particles that may be lignite.					
DEPTH IN FEET		Formation	Geologic Description		
FROM	TO				
0.0	3.0	Topsoil	TOPSOIL, dark brown		
3.0	6.0	Surficial Outwash	SILT, brown		
6.0	16.0	Surficial Outwash	SAND, coarse, yellow-brown (individual grains multicolored), subangular to subrounded; little multicolored, angular to subangular gravel; trace fine, clear to black, subangular to rounded, sand; poorly sorted		
16.0	23.0	Till (oxidized)	CLAY, yellow-brown; trace multicolored, angular to subangular gravel		
23.0	41.0	Till (unoxidized)	CLAY, blue-gray; trace fine to coarse, multicolored, subangular to rounded sand; trace multicolored, angular to subangular gravel; cobbles or boulder at 37 ft based on rig chatter		
41.0	48.0	Till (unoxidized)	CLAY, brown-gray; trace fine to coarse, multicolored, angular to rounded sand; trace multicolored, angular to subrounded gravel		
48.0	56.0	Till (unoxidized)	CLAY, blue-gray; trace fine, clear to black, subangular to rounded sand; trace clear to black, angular gravel		
56.0	63.0	Till (mildly oxidized)	CLAY, brown-gray; trace fine, multicolored, angular to rounded sand; trace multicolored, angular to subrounded gravel		
63.0	67.0	Till (mildly oxidized)	CLAY, light brown; trace fine, multicolored, subangular to rounded sand; trace multicolored, angular to subrounded gravel		
67.0	68.0	Outwash (buried)	SAND, medium to coarse, yellow-brown, angular to subrounded; and multicolored, subangular to angular gravel; trace fine, clear to black, rounded sand; poorly sorted		
68.0	96.0	Till (mildly oxidized)	CLAY, brown-gray; trace fine, multicolored, angular to rounded sand; little multicolored, angular to subangular gravel		
96.0	108.0	Outwash (buried)	SAND, medium to coarse, yellow-brown, subangular to subrounded; little multicolored, angular to subangular gravel; little light brown clay; poorly sorted, mild effervescence with 10% HCL (fines)		
108.0	110.0	Till (unoxidized)	CLAY, blue-gray; trace fine to coarse, multicolored, subangular to rounded sand; trace multicolored, angular to subangular gravel		

OWNER: Banner Associates, Inc.		BORING/WELL NO. SWMW-D		PAGE 1 OF 1 PAGES	
LOCATION: Lake Norden Prairie Coteau Aquifer Well Field		SCREEN: Schedule 40 PVC, Slotted			
Laker St., Lake Norden		DIAMETER: 2.5-inch		SLOT NO. 25	
DATE COMPLETED: 3/11/2021		SETTING: 157 - 147			
DRILLING COMPANY: Kaiser Well Drilling		SAND PACK: Red Flint Sand and Gravel, 5-100lb bags #50			
		SETTING: 157 - 142			
DRILLING METHOD: Mud Rotary		CASING: Schedule 40 PVC			
SAMPLING METHOD: Cuttings		SETTING: 147 - +2.01			
OBSERVER: Mitch Kannenberg		SEAL TYPE: Wyo-Ben Grout Well DF (10-50lb bags)			
DEPTH REFERENCE POINT: ground surface		SETTING: 142-0 (Enviroplug Medium at surface)			
TOP OF PVC CASING ELEVATION: 1676.056 ft (top of 5-inch PVC)		DEVELOPMENT: Air-lift pumping and surging			
STICK-UP: 2.01 ft (PVC casing)		DURATION: approximately 3 hours			
SURFACE COMPLETION: 2.5-inch PVC & 8-inch steel protective cover		WATER LEVEL: 17.76 feet below ground surface at ~10:00, 3/12/21			
REMARKS: 6 inch tricone roller bit		YIELD: ~ 25 gpm by air-lifting			
Sand and gravel particles are composed of quartz, chert, limestone, granite, shale, and very fine black particles that may be lignite.					

DEPTH IN FEET		Formation	Geologic Description
FROM	TO		
0.0	2.0	Topsoil	TOPSOIL, dark brown
2.0	17.0	Till (oxidized)	CLAY, yellow-brown; trace fine, clear to black, subangular to rounded sand; trace multicolored, angular to subangular gravel; trace silt
17.0	22.0	Till (unoxidized)	CLAY, blue-gray; trace fine to coarse, multicolored, subangular to rounded sand; trace multicolored, angular to subangular gravel, trace dark-colored silt
22.0	23.0		BOULDER, Milbank granite, freshly fractured (drilled chips)
23.0	40.0		CLAY, blue-gray; trace fine to coarse, multicolored, subangular to rounded sand; trace multicolored, angular to subangular gravel, trace dark-colored silt
40.0	45.0	Outwash (buried)	SAND, medium to coarse, brownish-gray, grains are multicolored, angular to rounded; some multicolored, angular to subangular gravel; trace fine, clear to black, subangular to rounded sand, poorly sorted, mild effervescence with 10% HCL (fines)
45.0	142.0	Till (unoxidized)	CLAY, blue-gray; trace fine to coarse, multicolored, subangular to rounded sand; trace multicolored, angular to subangular gravel, trace dark-colored silt
142.0	154.0	Outwash (buried)	SAND, medium to coarse, yellow-brown, subangular to subrounded; some multicolored, angular to subangular gravel up to 1-inch diameter; trace mostly clear to black, subangular to rounded fine sand, mild effervescence with 10% HCL (fines), moderately to poorly sorted, clay layer at 150 feet (~1 foot thick)
154.0	159.0	Till (unoxidized)	CLAY, blue-gray; trace fine to coarse, multicolored, subangular to rounded sand; trace multicolored, angular to subangular gravel, trace dark-colored silt

[illegible]



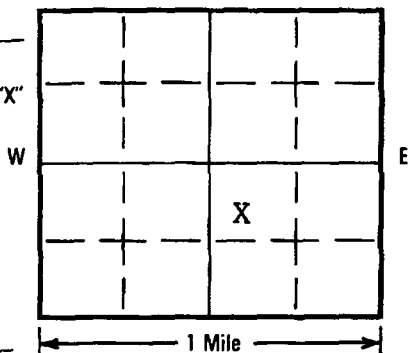
SOUTH DAKOTA WATER WELL COMPLETION REPORT

07-92

Location $\frac{1}{4}$ $\frac{1}{4}$ Sec 21 Twp 113 Rg 53
County Hamlin North

Hamlin

Please mark well location with an "X"



Well Completion Date

11/07/02

LOCATION: south

Distance from nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)? 60 ft. from septic (identify source).

PROPOSED USE:

- ☒ Domestic/Stock ☐ Municipal ☐ Business ☐ Test Holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

rotary

CASING DATA: ☐ Steel ☒ Plastic ☐ Other

If other describe

PIPEWEIGHT DIAMETER FROM TO HOLE DIAMETER
LB/FT 4 IN 0 FT 98 FT 6 1/2 IN
LB/FT IN FT FT IN
LB/FT IN FT FT IN

GROUTING DATA

Grout Type No. of Sacks Grout Weight From To
Quick Grout 13 lb./gal 0 ft 98 ft
lb./gal ft ft

Describe grouting procedure

SCREEN: ☐ Perforated pipe ☒ Manufactured

Diameter 4 IN Length 4 FEET

Material stainless steel

Slot Size 12 Set From 98 Feet to 102 Feet

Other information

WAS A PACKER OR SEAL USED? ☒ YES ☐ NO

If so, what material? Kpacker & Leader

Describe packer(s) and location? 96'

DISINFECTION: Was well disinfected upon completion?

☒ YES, How: HTH☐ NO, Why Not?

Laboratory sent to for water quality analysis

Well Owner: Morley Hauschildt

Business Name:

Address: 708 Lakeview ST

Lake Norden SD 57248

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
Loam	0	3
clay	3	12
clay	12	98
sand	98	102
clay	102	

STATIC WATER LEVEL 8' below Feet

If flowing: closed in pressure PSI

GPM flow through inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

Reduced Flowrate GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe:☐ Bailed☐ Other

Pumping Level Below Land Surface

10 ft. After 1 Hrs. pumped 20 GPM

ft. After Hrs. pumped GPM

If pump installed, pump rate 10 GPM

REMARKS

RECEIVED

DEC 02 2002

WATER RIGHTS PROGRAM

This well was drilled under license # 463

And this report is true and accurate.

Drilling firm Steffl Drilling & Pump

Signature of License Representative

Signature of Well Owner or Equitable Property Holder

Date: November 10, 2002

STATE OF SOUTH DAKOTA WELL DRILLERS REPORT

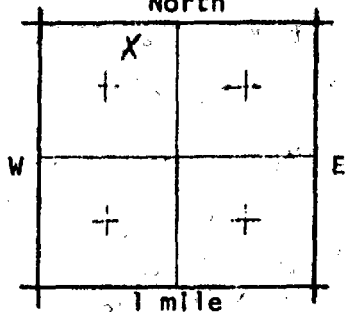
Korpen-Kaskie DW-01845

Location NE 1/4 Sec 21 Twp 113 Rg 53-53

County

Hamlin

North



Please mark well location with an "X"

Well Completion Date 9-27-84

PROPOSED USE:

☒ Domestic ☐ Municipal ☐ Test Holes
☐ Irrigation ☐ Industrial ☐ Stock

Method of Drilling:

Rotary

WELL CONSTRUCTION:

Diameter of hole 9 3/4 inches Depth 143 feetCasing: ☐ Steel ☒ Plastic ☐ Other

Specify _____

Pipe Weight Diameter From To

SDR-21 lb/ft 5 inches 0 feet 143 feet
lb/ft inches feet feetWas a well screen used? ☒ Yes ☐ No

If Not Specify _____

Screen Type Plastic PVC Slot Size _____Length 20 ft Diameter 5"Was Casing left open end? ☐ Yes ☒ NoWas a Packer or seal used? ☒ Yes ☐ NoIf so what material? AsbestosWas well gravel packed? ☒ Yes ☐ NoWas well grouted? ☒ Yes ☐ NoDescribe grouting procedure Cement onoutside of pipe with Tensar lineTo what depth? 60-115 FeetWhat was grouting material? CementIf cement, how many sacks? 8

Location of packer(s) and screen or perforated

pipe 115-123 123-143WAS WELL PLUGGED OR ABANDONED ☐ Yes ☒ No

If so how and with what material?

Well Owner:

Name

Bud Korpen

Address

Lake Norden, SD

Well Log:

Depth

Formation

From

To

See theAttached LogSTATIC WATER LEVEL 14 Feet

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

If other; specify _____

Can well be completely shut off? _____

WELL TEST DATA:

☒ Pumped50 GPM☐ Bailed

Describe: _____

☐ Other _____

Pumping Level Below Land Surface

_____ ft. After _____ Hrs. pumped _____ GPM

_____ ft. After _____ Hrs. pumped _____ GPM

_____ ft. After _____ Hrs. pumped _____ GPM

Remarks:

This well was drilled under license # 94

and this report is true and accurate.

Drilling Firm Huron Drilling Co.Signed Don G. ObergDate 9-28-8410-22-84

HURON DRILLING INC. DRILLERS LOG

Norfolk Co

Korpen-Kaskie DW-01845

PAGE NO.

Bar Korpen
JOB NAME

John Norfolk SD
LOCATION

Aug 21 1964
DATE

72
RIG NO.

Karl O
FOREMAN

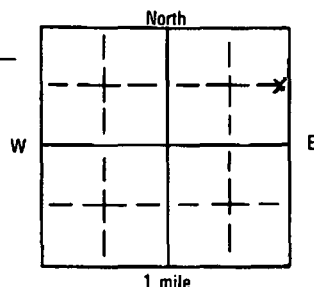
Jt No.	DEPTH	TIME	REMARKS
1	20	2:54	0-5 Kill
2	40	2:27	5-20 yellow clay
3	60	2:49	20-31 "
4	80	3:05	31-40 Gray clay
5	100	3:35	40-60 "
6	120	4:00	60-80 "
7	140	4:25	80-100
8	160	4:45	100-120 Clay = little gravel tops
9			120-130 Blue clay
10			130-136 Blue clay
			136-140 Gravel coarse
			140-150 Clay
			150-160 Clay

SOUTH DAKOTA WATER WELL COMPLETION REPORT

10-85

Location E 1/4 NE 1/4 Sec 15 Twp 113N Rg 53WCounty Hamlin

Please mark well location with an "X"

Well Completion Date 7-14-89

PROPOSED USE:

☐ Domestic ☐ Municipal ☐ Test Holes
☐ Irrigation ☐ Industrial ☒ Stock
Method of Drilling: Rotary

CASING DATA:

☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
<u>SDR21</u> LB/FT	<u>5</u> IN	<u>0</u> FT	<u>22</u> FT	<u>8 7/8</u> IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUT:

Was the well grouted? ☒ YES ☐ NOTo what depth? 45 FEETWhat is grouting material? CementIf cement, number of sacks? 7Describe grouting procedure Pressure Grouted Through Tremie pipe

What was grout weight? _____ LB/GAL

SCREEN: ☐ Perforated pipe ☒ ManufacturedDiameter 5 IN Length 20 FEETMaterial PlasticSlot Size 40 Set From 72 Feet To 92 Feet

Slot Size _____ Set From _____ Feet To _____ Feet

Slot Size _____ Set From _____ Feet To _____ Feet

Other information _____

Was a packer or seal used? ☐ YES ☒ NO

If so, what material? _____

Describe packer(s) and location? _____

Was well disinfected upon completion? ☒ YES ☐ NOExplain Chlorine Circulated before + during gravel packingBacteriological analysis ☐ YES ☒ NO

Laboratory sent to _____

Well Owner:

Name Earl IsaacsonAddress RR1 Box 97 Lake Norden S.D.Well Log: _____ Depth 57248

Formation	From	To
Black Soil	0	2
Yellow Clay	2	18
Brown Clay	18	24
Brown + Gray Clay	24	30
Blue Clay	30	52
Yellow Clay	52	56
Blue Clay (firm)	56	72
Yellow sand + clay lenses	72	92
Gray Clay (soft)	92	96
Gray Clay (firm)	96	98

STATIC WATER LEVEL 45 Feet

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

If other, specify _____

Can well be completely shut in? _____

WELL TEST DATA:

☐ Pumped Developed w/ air☐ Bailed Describe: Produced 5 gpm☐ Other _____

Pumping Level Below Land Surface

_____ ft. After _____ Hrs. pumped _____ GPM

_____ ft. After _____ Hrs. pumped _____ GPM

_____ ft. After _____ Hrs. pumped _____ GPM

REMARKS:

Poor formation
Continuous mixing of sand +
Clay lenses. pumped 5 gpm
w/ air

This well was drilled under license # 4

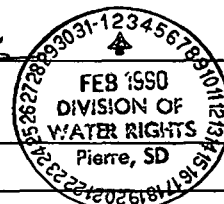
And this report is true and accurate.

Drilling firm Bullis Bros

Signature of License Representative:

Se Earl Bullis

Signature of Well Owner:

Date 7-14-89

SOUTH DAKOTA WATER WELL COMPLETION REPORT

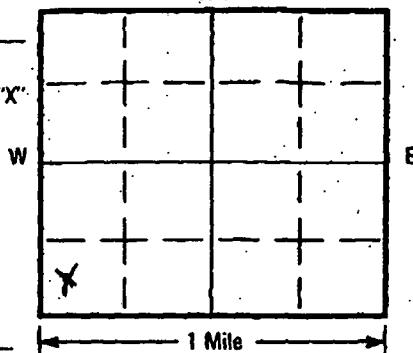
07-92

Location SW 1/4 SW 1/4 Sec 10 Twp 113N Rg 53W
County Hanlin

Please mark well location with an "X"

Well Completion Date

8-18-09



LOCATION:

Distance from nearest potential pollution source (septic tank, abandoned well,

feed lot, etc.) 1000 ft. from old well (identify source)

PROPOSED USE:

☒ Domestic/Stock ☐ Municipal ☐ Business ☐ Test Holes
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

Direct RotaryCASING DATA: ☐ Steel ☒ Plastic ☐ Other

If other describe _____

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
<u>Sch 40</u> LB/FT	<u>5</u> IN	<u>266</u> FT	<u>92</u> FT	<u>8 1/2</u> IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN
_____ LB/FT	_____ IN	_____ FT	_____ FT	_____ IN

GROUTING DATA

Grout Type	No. of Sacks	Grout Weight	From	To
<u>Grout Wash</u>	<u>8</u>	<u>5 1/2</u> lb./gal	<u>0</u> ft	<u>80</u> ft
<u>DF</u>		_____ lb./gal	_____ ft	_____ ft

Describe grouting procedure pressure pull methodSCREEN: ☐ Perforated pipe ☒ ManufacturedDiameter 5 IN Length 10 FEETMaterial plasticSlot Size #35 Set From 92 Feet to 102 Feet

Other information _____

WAS A PACKER OR SEAL USED? ☐ YES ☐ NO

If so, what material? _____

Describe packer(s) and location? _____

DISINFECTION: Was well disinfected upon completion?

☒ YES, How: 12.5 Table☐ NO, Why Not? _____

Laboratory sent to for water quality analysis

None
no pump installedWell Owner: Travis and Kim Hymans

Business Name: _____

Address: PO Box 395
Hayti, SD 57241

WELL LOG:

FORMATION	DEPTH	
	FROM	TO
Top Soil	0	1
yellow clay	0	10
yellow sand	10	18
Blue clay	18	87
yellow clay	87	92
yellow Mixed Gravel	92	102

STATIC WATER LEVEL 21 Feet

If flowing: closed in pressure _____ PSI

GPM flow _____ through _____ inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other _____

Reduced Flowrate _____ GPM

Can well be completely shut in? _____

WELL TEST DATA:

☒ PumpedDescribe: air lift☐ Bailed☐ Other

Pumping Level Below Land Surface

25 ft. After 2 Hrs. pumped 100 GPM

_____ ft. After _____ Hrs. pumped _____ GPM

If pump installed, pump rate _____ GPM

REMARKS

RECEIVED

SEP 17 2009

WATER RIGHTS
PROGRAMThis well was drilled under license # 689

And this report is true and accurate.

Drilling firm Kaiser Well DrillingSignature of License Representative: [Signature]Signature of Well Owner or Equitable Property Holder: [Signature]Date: 9-11-09

Bentley DW

Well location and depth provided by City. No log available.

Ag Testing - Consulting

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN

SD 57248

Invoice No. : 1340835
Date Received : 03/17/2021
Date Reported : 03/18/2021

Lab Number : 2426

Results For : BANNER/LAKE NORDEN

Location :

Sample ID : SWMW-D 154 LAKER

pH	7.8
Total Dissolved Solids (TDS) Est, ppm	1154
Electrical Conductivity, mmho/cm	1.92
Cations / Anions, me/L	25.6 / 25.3

	ppm
Sodium, Na	75
Potassium, K	22
Calcium, Ca	289.2
Magnesium, Mg	88
Total Hardness, CaCO ₃	1089
Nitrate, NO ₃ -N	0.1 (SAFE)
Sulfate, SO ₄ -S	278
Chloride, Cl	9
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	470
Total Alkalinity, CaCO ₃	387
Fluoride, F	0.23
Total Iron, Fe	1.10
Manganese, Mn	4.15

* < - Not Detected / Below Detection Limit

Reviewed By : Raymond Ward

3/18/2021

Copy : 1

Page 2 of 4

Date: 2021-03-24 16

Web site

4007 Cherry Ave. P.O. Box 788

Phone: 402-234-1400

www.wardlab.com

Redwood, Nebraska 68448-0788

WARD

Laboratories, Inc.



Ag Testing - Consulting

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN SD 57248

Invoice No. : 1340524
Date Received : 03/12/2021
Date Reported : 03/15/2021

Lab Number : 2253

Results For : LAKE NORDEN/BANNER

Location :

Sample ID : SWMW-S PARK

pH	7.8
Total Dissolved Solids (TDS) Est, ppm	1206
Electrical Conductivity, mmho/cm	2.01
Cations / Anions, me/L	24.7 / 26.1

	ppm
Sodium, Na	87
Potassium, K	19
Calcium, Ca	183.4
Magnesium, Mg	135
Total Hardness, CaCO ₃	1020
Nitrate, NO ₃ -N	< 0.1 (SAFE)
Sulfate, SO ₄ -S	265
Chloride, Cl	18
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	548
Total Alkalinity, CaCO ₃	452
Fluoride, F	0.12
Total Iron, Fe	0.06
Manganese, Mn	2.66

*< - Not Detected / Below Detection Limit

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3/15/2021

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Page 3 of 4

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Fax : 308-234-1920

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4507 Cherry Ave., P.O. Box 726
Kearney, Nebraska 68848-0726

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45359 193RD ST
LAKE NORDEN

SD 57248

Invoice No. : 1340524
Date Received : 03/12/2021
Date Reported : 03/15/2021
Lab Number : 2254

Results For : LAKE NORDEN/BANNER

Location :

Sample ID : 2020MW BS PARK MW

pH	7.8
Total Dissolved Solids (TDS) Est. ppm	1246
Electrical Conductivity, mmho/cm	2.08
Cations / Anions, me/L	26.2 / 26.4

	ppm
Sodium, Na	92
Potassium, K	23
Calcium, Ca	195.4
Magnesium, Mg	142
Total Hardness, CaCO ₃	1079
Nitrate, NO ₃ -N	< 0.1 (SAFE)
Sulfate, SO ₄ -S	286
Chloride, Cl	16
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	490
Total Alkalinity, CaCO ₃	405
Fluoride, F	0.14
Total Iron, Fe	4.42
Manganese, Mn	2.71

*< - Not Detected / Below Detection Limit

Reviewed By : Nick Ward

3/15/2021

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www.wardlab.com

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Kearney, Nebraska 68848-0788

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Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN SD 57248

Invoice No. : 1343140
Date Received : 04/19/2021
Date Reported : 04/20/2021

Lab Number : 3867

Results For : CITY OF LAKE NORDEN

Location :

Sample Date: 4/14/2021

Sample ID : L2-PULLED FROM WATER PLANT

pH	7.5
Total Dissolved Solids (TDS) Est, ppm	994
Electrical Conductivity, mmho/cm	1.66
Cations / Anions, me/L	19.5 / 19.4

	<u>ppm</u>
Sodium, Na	41
Potassium, K	7
Calcium, Ca	222.2
Magnesium, Mg	77
Total Hardness, CaCO ₃	876
Nitrate, NO ₃ -N	0.2 (SAFE)
Sulfate, SO ₄ -S	211
Chloride, Cl	4
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	371
Total Alkalinity, CaCO ₃	305
Fluoride, F	0.35
Total Iron, Fe	< 0.01
Manganese, Mn	0.09

"<" - Not Detected / Below Detection Limit

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4/21/2021

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Laboratories, Inc.



Ag Testing - Consulting

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN

SD 57248

Invoice No. : 1340524
Date Received : 03/12/2021
Date Reported : 03/15/2021
Lab Number : 2252

Results For : LAKE NORDEN/BANNER

Location :

Sample ID : L2MW-D

pH	7.7
Total Dissolved Solids (TDS) Est, ppm	936
Electrical Conductivity, mmho/cm	1.56
Cations / Anions, me/L	18.7 / 19.5

	ppm
Sodium, Na	43
Potassium, K	6
Calcium, Ca	213.3
Magnesium, Mg	72
Total Hardness, CaCO ₃	833
Nitrate, NO ₃ -N	< 0.1 (SAFE)
Sulfate, SO ₄ -S	194
Chloride, Cl	4
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	442
Total Alkalinity, CaCO ₃	364
Fluoride, F	0.30
Total Iron, Fe	0.02
Manganese, Mn	0.43

< - Not Detected / Below Detection Limit

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3/15/2021

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Kearney, Nebraska 68645-0788

Ag Testing - Consulting

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN

SD 57248

Invoice No. : 1340835
Date Received : 03/17/2021
Date Reported : 03/18/2021

Lab Number : 2427

Results For : BANNER/LAKE NORDEN

Location :

Sample ID : EMW2 103

pH	7.7
Total Dissolved Solids (TDS) Est, ppm	931
Electrical Conductivity, mmho/cm	1.55
Cations / Anions, me/L	20.5 / 20.3

	ppm
Sodium, Na	45
Potassium, K	18
Calcium, Ca	234.3
Magnesium, Mg	76
Total Hardness, CaCO ₃	902
Nitrate, NO ₃ -N	< 0.1 (SAFE)
Sulfate, SO ₄ -S	208
Chloride, Cl	5
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	436
Total Alkalinity, CaCO ₃	359
Fluoride, F	0.30
Total Iron, Fe	0.01
Manganese, Mn	0.14

*< - Not Detected / Below Detection Limit

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3/18/2021

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4007 Cherry Ave., P.O. Box 788
Kearney, Nebraska 68848-0788

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45530 193RD ST
LAKE NORDEN

SD 57248

Invoice No. : 1340524
Date Received : 03/12/2021
Date Reported : 03/15/2021

Lab Number : 2251

Results For : LAKE NORDEN/BANNER

Location :

Sample ID : L3MW-S

pH	7.8
Total Dissolved Solids (TDS) Est, ppm	608
Electrical Conductivity, mmho/cm	1.01
Cations / Anions, me/L	12.1 / 12.0

	ppm
Sodium, Na	68
Potassium, K	5
Calcium, Ca	98.7
Magnesium, Mg	49
Total Hardness, CaCO ₃	452
Nitrate, NO ₃ -N	10.9 (UNSAFE)
Sulfate, SO ₄ -S	47
Chloride, Cl	15
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	478
Total Alkalinity, CaCO ₃	394
Fluoride, F	0.25
Total Iron, Fe	3.45
Manganese, Mn	0.25

"<" - Not Detected / Below Detection Limit

Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN

SD 57248

Invoice No. : 1340524
Date Received : 03/12/2021
Date Reported : 03/15/2021

Lab Number : 2251

Results For : LAKE NORDEN/BANNER

Location :

Sample ID : L3MW-S

pH	7.8
Total Dissolved Solids (TDS) Est, ppm	608
Electrical Conductivity, mmho/cm	1.01
Cations / Anions, me/L	12.1 / 12.0

	ppm
Sodium, Na	68
Potassium, K	5
Calcium, Ca	98.7
Magnesium, Mg	49
Total Hardness, CaCO ₃	452
Nitrate, NO ₃ -N	10.9 (UNSAFE)
Sulfate, SO ₄ -S	47
Chloride, Cl	15
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	478
Total Alkalinity, CaCO ₃	394
Fluoride, F	0.25
Total Iron, Fe	3.45
Manganese, Mn	0.25

*< - Not Detected / Below Detection Limit

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Laboratories, Inc.



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Account No. : 57502

Water Analysis Report

KAISER WELL DRILLING
45550 193RD ST
LAKE NORDEN SD 57248

Invoice No. : 1340835
Date Received : 03/17/2021
Date Reported : 03/18/2021

Lab Number : 2428

Results For : BANNER/LAKE NORDEN

Location :

Sample ID : NEMW 108

pH	7.7
Total Dissolved Solids (TDS) Est, ppm	851
Electrical Conductivity, mmho/cm	1.42
Cations / Anions, me/L	18.8 / 18.5

	ppm
Sodium, Na	39
Potassium, K	17
Calcium, Ca	198.7
Magnesium, Mg	83
Total Hardness, CaCO ₃	838
Nitrate, NO ₃ -N	0.1 (SAFE)
Sulfate, SO ₄ -S	154
Chloride, Cl	4
Carbonate, CO ₃	< 1.0
Bicarbonate, HCO ₃	538
Total Alkalinity, CaCO ₃	443
Fluoride, F	0.32
Total Iron, Fe	2.32
Manganese, Mn	0.76

*< - Not Detected / Below Detection Limit

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3/18/2021

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Kearney, Nebraska 68848-0783

Appendix D

Aquifer Test Summary Data Sheet

30-Day Aquifer Pumping Test Banner Associates, Inc. Prairie Coteau Well Field Lake Norden, SD

Client: Banner Associates, Inc.	Site: Lake Norden Prairie Coteau Well Field
Task: 30-Day Aquifer Testing in L2	City/State: Lake Norden, SD
Project Number: 5509BAN02	

Pumping Well Information

Pumping Well	Pump	Generator or Power Supply
Pumping Well(s): L2	Make: Grundfos	Make: na
Screen Setting (ft bg): 83-103	Intake (ft bg): 82	Power (ie. 3-ph 480 V): 480V power drop at well site
Well Radius (in): 5-inch (10-inch diameter)	Column Diameter (in): 4	Horsepower: na
Stickup Height (ft): 1.963	Power (ie. 3 ph, 480 V): 480V	Owner / Rental Source: na
Static Water Level (ft bTOC): 12.05	Horsepower: 15	Adjustable: Yes / No na
Measuring/Reference Point: mark at top of casing	Owner / Rental Source: owned by City	Max. Allowable Amp Draw (Amps): na
Sand Meter Type: Other: none	Type: Submersible	Max. Allowable Frequency (Hz): na
Sand Concentration (mg/L): na		Max. Allowable Drawdown (ft): na
		Max. Allowable Motor Temp. (F): na
Notes:		

Aquifer Test Information

Test Type: Constant-Rate Test																																																																						
Purpose of Test: Quantitative Analysis																																																																						
Date of Test: 3/17/2021 - 4/16/2021 (pumping period)																																																																						
Flow Rate Measurement: ☒ Totalizer, ☐ Acoustic Meter, ☐ Mag Meter, ☐ Orifice Weir, ☒ Other: Permanently installed at water treatment plant.																																																																						
Assisting Subcontractor: ☐ not applicable, ☒ Name: Banner																																																																						
Wellhead Manifold and Discharge: Water was pumped to the water treatment plan and was not discharged near the pumped well.																																																																						
Pumping Well(s): L2 <table border="1"> <thead> <tr> <th></th> <th>Pumping Rate (gpm)</th> <th>Pumping Duration (hr)</th> <th>Recovery Duration (hr)</th> <th>Start Date</th> <th>Start Time</th> <th>End Date</th> <th>End Time</th> <th>Maximum Drawdown (ft)</th> <th>Specific Capacity (gpm/ft)</th> </tr> </thead> <tbody> <tr> <td>Pumping</td> <td>353</td> <td>720</td> <td>—</td> <td>3/17/2021</td> <td>11:00 AM</td> <td>4/16/2021</td> <td>11:16 AM</td> <td>53.01</td> <td>6.66</td> </tr> <tr> <td>Recovery</td> <td>—</td> <td>—</td> <td>340</td> <td>4/16/2021</td> <td>11:16 AM</td> <td>4/30/2021</td> <td>3:20 PM</td> <td>—</td> <td>—</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Pumping Rate (gpm)	Pumping Duration (hr)	Recovery Duration (hr)	Start Date	Start Time	End Date	End Time	Maximum Drawdown (ft)	Specific Capacity (gpm/ft)	Pumping	353	720	—	3/17/2021	11:00 AM	4/16/2021	11:16 AM	53.01	6.66	Recovery	—	—	340	4/16/2021	11:16 AM	4/30/2021	3:20 PM	—	—																																								
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Pumping	353	720	—	3/17/2021	11:00 AM	4/16/2021	11:16 AM	53.01	6.66																																																													
Recovery	—	—	340	4/16/2021	11:16 AM	4/30/2021	3:20 PM	—	—																																																													
Notes: L2 is not individually metered and is manifolded (along with other City wells) before the meter. Wells 1, 2, 3, and 9, in the City's Big Sioux aquifer well field, operated periodically throughout the Test.																																																																						

Appendix D

Aquifer Test Summary Data Sheet

30-Day Aquifer Pumping Test Banner Associates, Inc. Prairie Coteau Well Field Lake Norden, SD

Client: Banner Associates, Inc.	Site: Lake Norden Prairie Coteau Well Field
Task: 30-Day Aquifer Testing in L2	City/State: Lake Norden, SD
Project Number: 5509BAN02	

Observation Well(s) Information

Well ID	Well Depth (ft bg)	Screen Setting (ft bg)	Stickup Height (ft)	Distance to Pumping L2 (ft)	Static Water Level (ft bTOC)	Water Level Type (M/T)	Measuring/ Reference Point	Transducer Type	Logger Sample Rate (min)	Drawdown at End of Test (ft)	Recovery (Recovery= Pumping Period)** (%)
L1	97	83 - 97	5.095	559	0.63	M/T	TOC	SCADA - TE KPSI 320	2	21.89	100
L2	103	83 - 103	1.963	0	12.05	M/T	TOC	SCADA - TE KPSI 320	2	53.01	100
L3	107	87 - 107	3.098	360	10.60	M/T	TOC	SCADA - TE KPSI 320	2	21.03	100
NEMW	111.2	101.2 - 111.2	2.29	4,324	20.95	M/T	TOC	LevelTroll 500, 30 psig	2	-0.34 *	na
NNMW	106.6	96.6 - 106.6	2.40	3,674	13.18	M/T	TOC	LevelTroll 500, 30 psig	2	7.14	99
EMW2	103.7	93.7 - 103.7	1.65	396	11.88	M/T	TOC	LevelTroll 500, 30 psig	2	20.61	100
L3MW-S	21.1	11.6 - 21.1	1.75	396	16.13	M/T	TOC	LevelTroll 500, 15 psig	2	-1.87 *	na
SWMW-S	31	26 - 31	2.50	1,383	5.92	M/T	TOC	LevelTroll 500, 30 psig	2	-0.68 *	na
BS Park MW	82	62 - 82	1.60	1,374	5.87	M/T	TOC	LevelTroll 500, 30 psig	2	-0.68 *	na
SWMW-D	157	147 - 157	2.01	5,271	19.39	M/T	TOC	LevelTroll 500, 100 psig	2	1.46	99
NMW	103	93 - 103	1.53	971	13.62	M/T	TOC	LevelTroll 500, 30 psig	2	13.50	99
L2MW-I	55.6	50.6 - 55.6	1.94	44	29.86	M/T	TOC	LevelTroll 500, 30 psig	2	-8.02 *	na
L2MW-D	110.7	100.7 - 110.7	1.86	49	13.42	M/T	TOC	LevelTroll 500, 30 psig	2	27.86	100

Notes:

* Negative drawdown at the end of Test indicates that water levels rose during the Test and were not influenced from pumping in L2.

** Recovery percentages represent the maximum observed recovery (using trend adjusted data) in the transducer data after ~14 days of recovery.

Additional Information

- Weather Data: ☒ Precipitation, ☒ Barometric Pressure, ☒ Temperature
Discussion: Precipitation, barometric, and temperature data were downloaded for KSDHAYT15 (Lake Norden SD), Hayti, SD from WeatherUnderground (https://www.wunderground.com/dashboard/pws/KSDHAYT15).
- Permits: NA.
- Nearby High Capacity or Domestic Wells (Yes, No, or describe): The City's other high capacity wells are completed in the Big Sioux aquifer located approximately 3 miles west of the Prairie Coteau well field. The other City wells did not interfere with the Test.
- Water Quality Samples: Water quality samples were collected by Kaiser Well Drilling on 4/14/2021. Laboratory results are provided in Appendix D.
Notes:

Footnotes:

F = fahrenheit

ft = feet

ft bg = feet below grade/ground

hr = hour

Hz = Hertz

in = inch

mg/L = milligrams per Liter

min = minute

na = not applicable

ph = phase

TOC = top of casing

TOS = top of sounding tube

V = volt

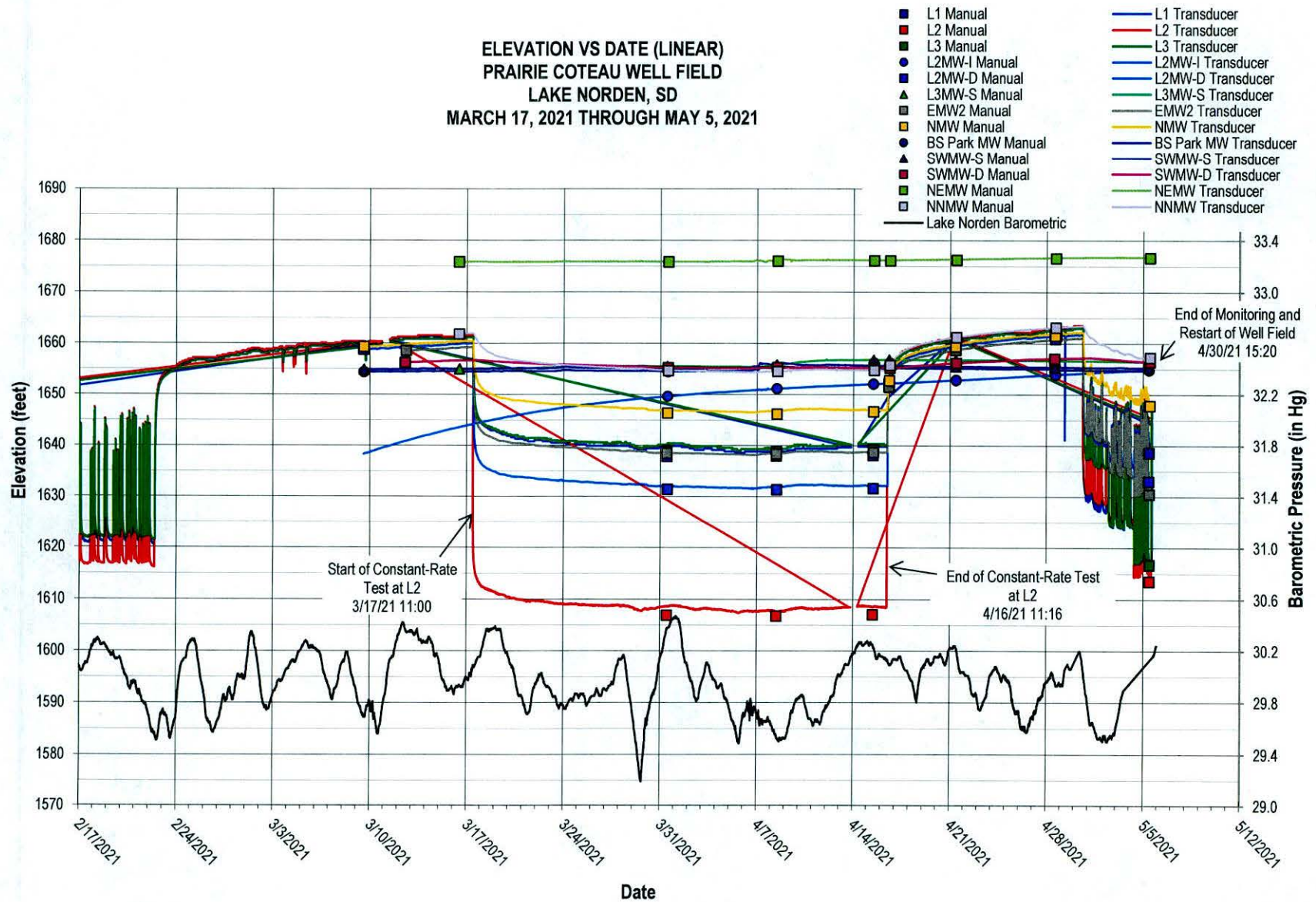
gpm/ft = gallons per minute per foot of drawdown

M/T = Manual Measurement or Transducer

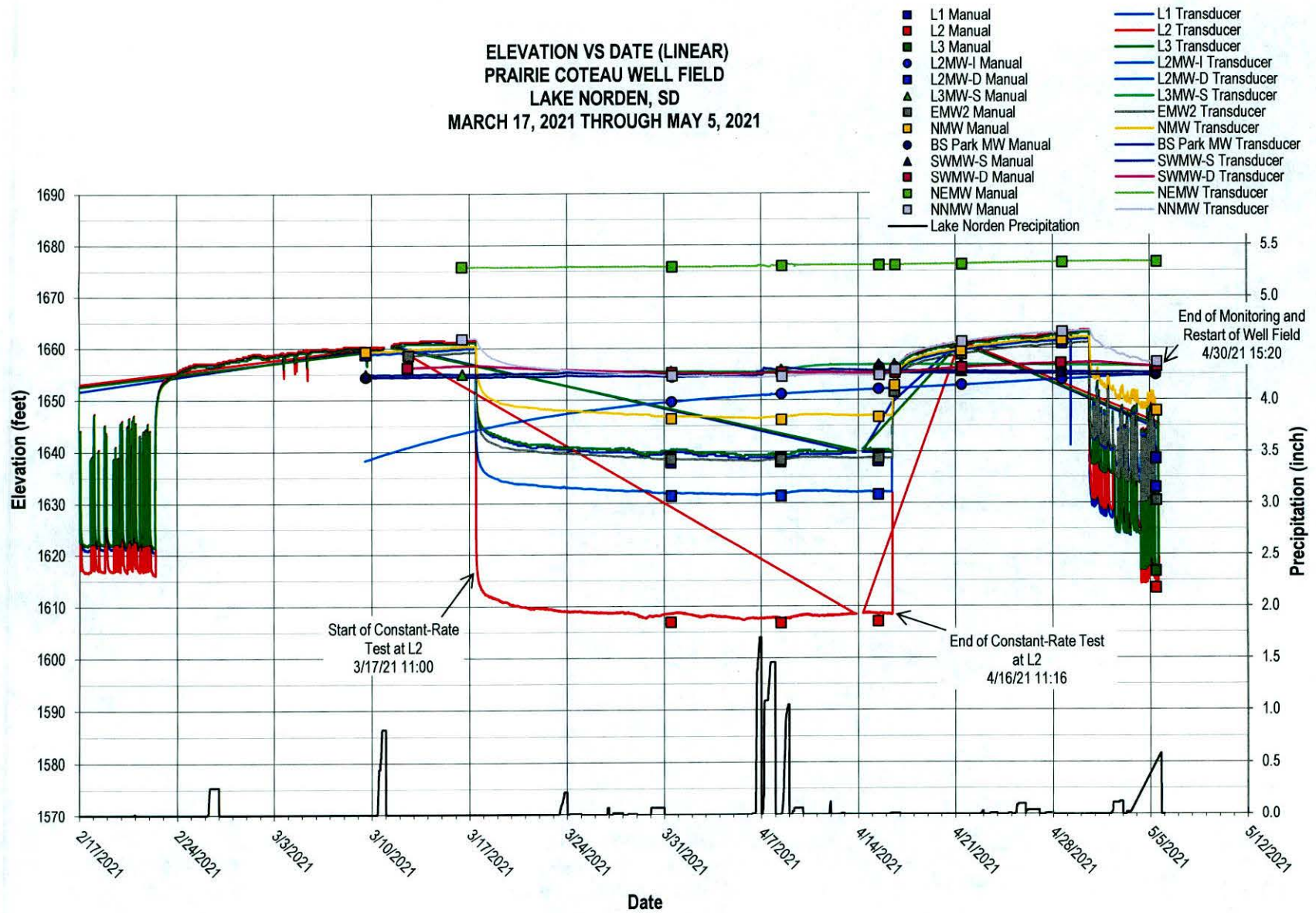
30-Day Aquifer Pumping Test
Prairie Coteau Well Field
Lake Norden, SD

APPENDIX E

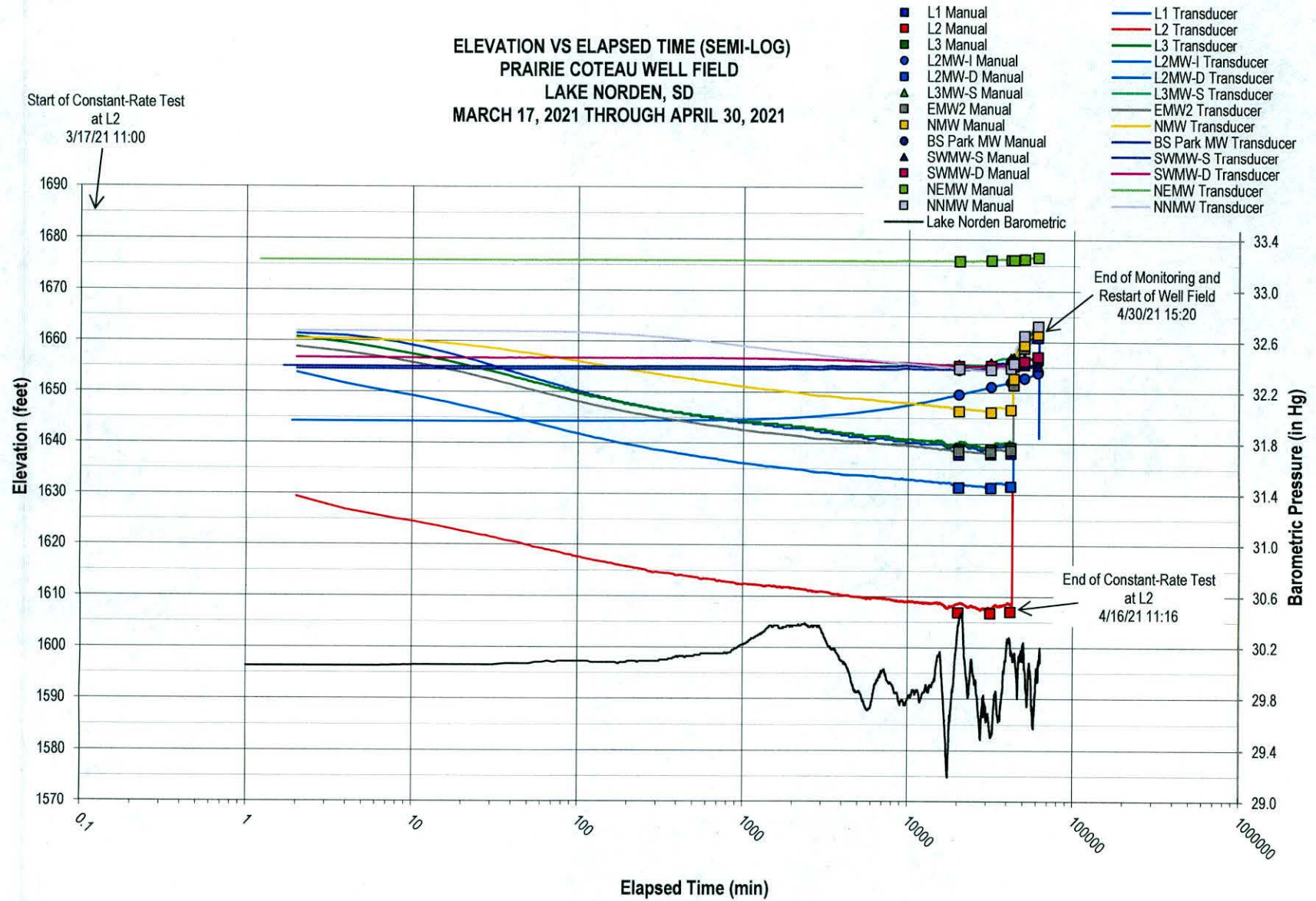
**ELEVATION VS DATE (LINEAR)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
MARCH 17, 2021 THROUGH MAY 5, 2021**



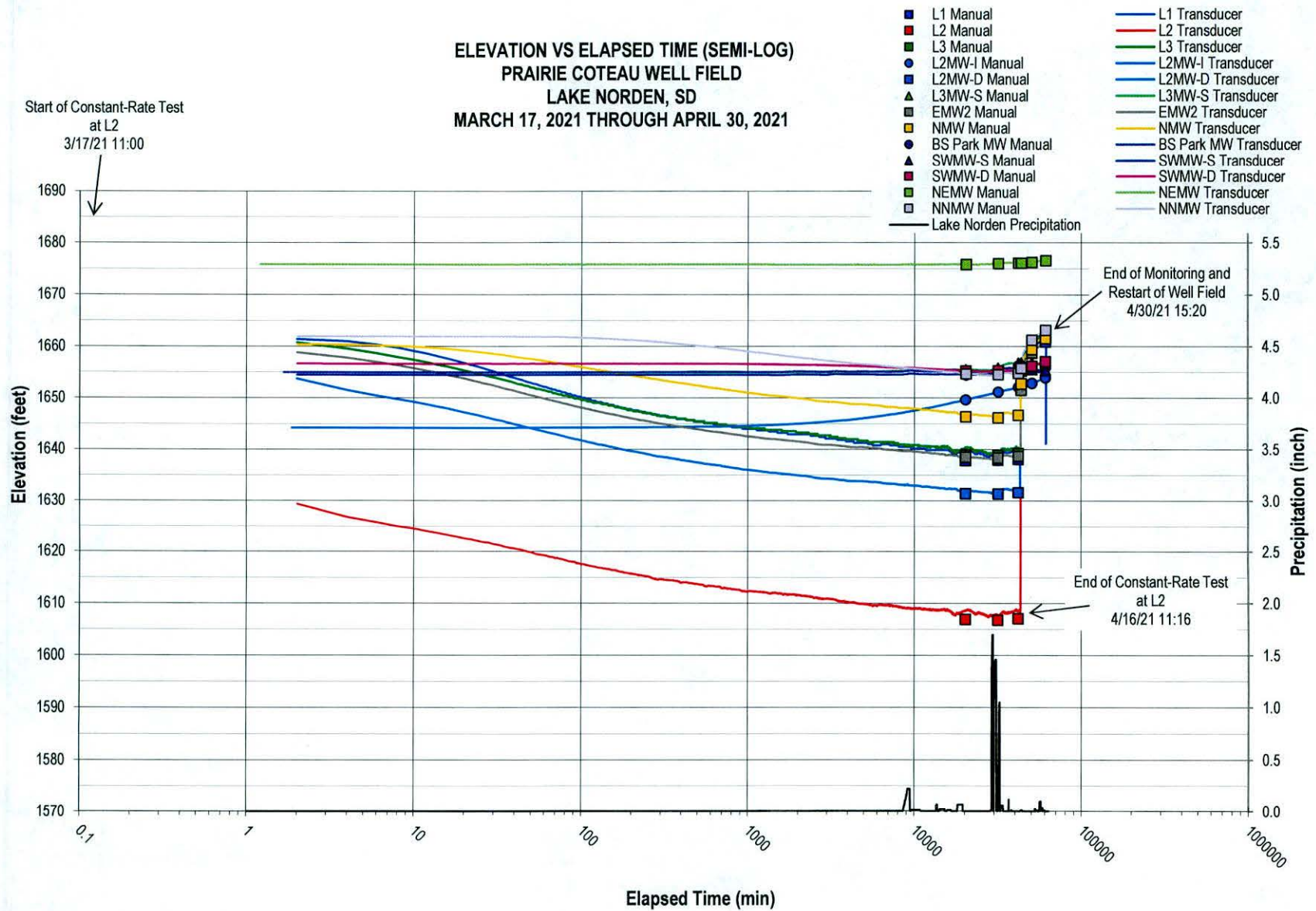
**ELEVATION VS DATE (LINEAR)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
MARCH 17, 2021 THROUGH MAY 5, 2021**



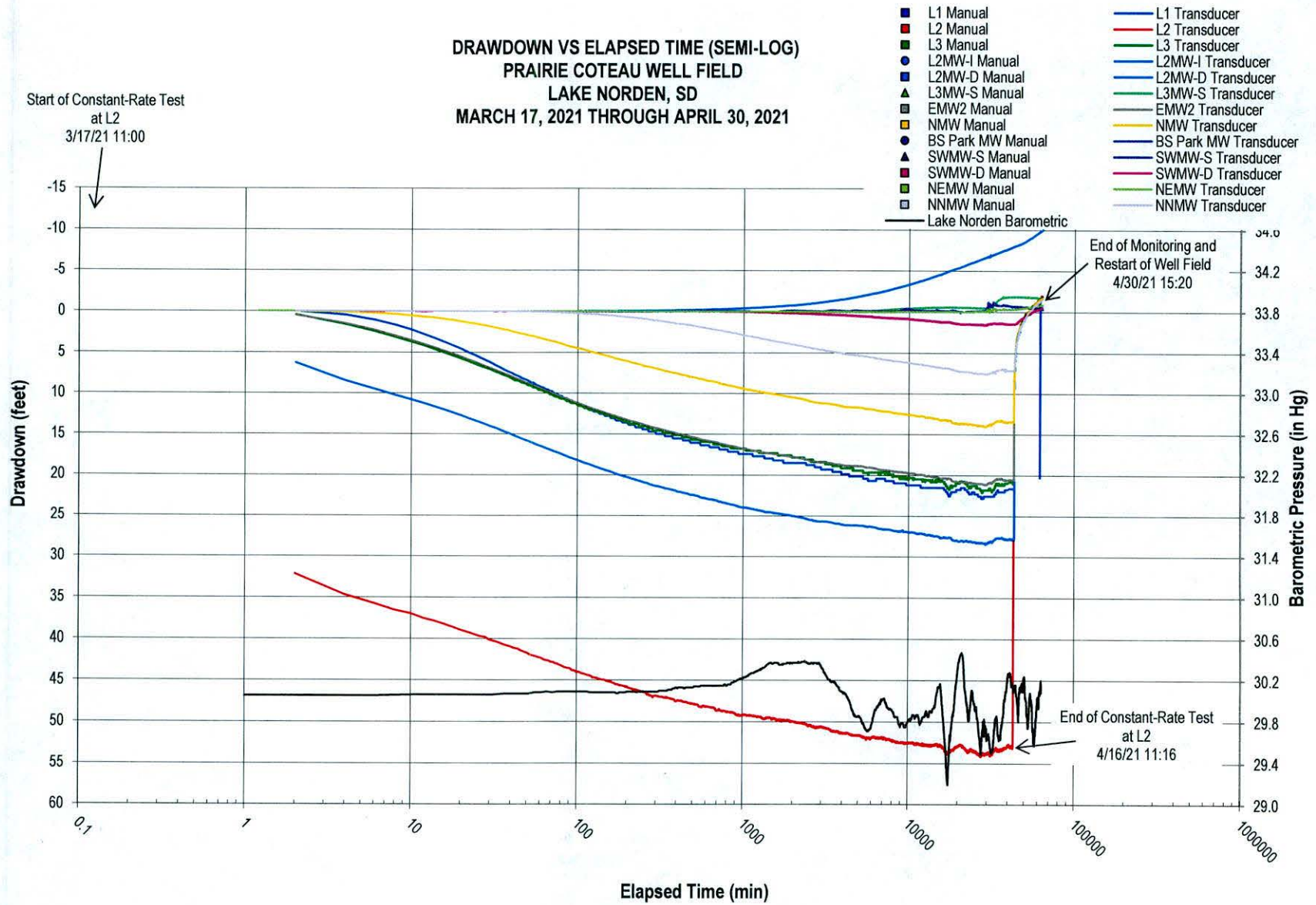
**ELEVATION VS ELAPSED TIME (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
MARCH 17, 2021 THROUGH APRIL 30, 2021**



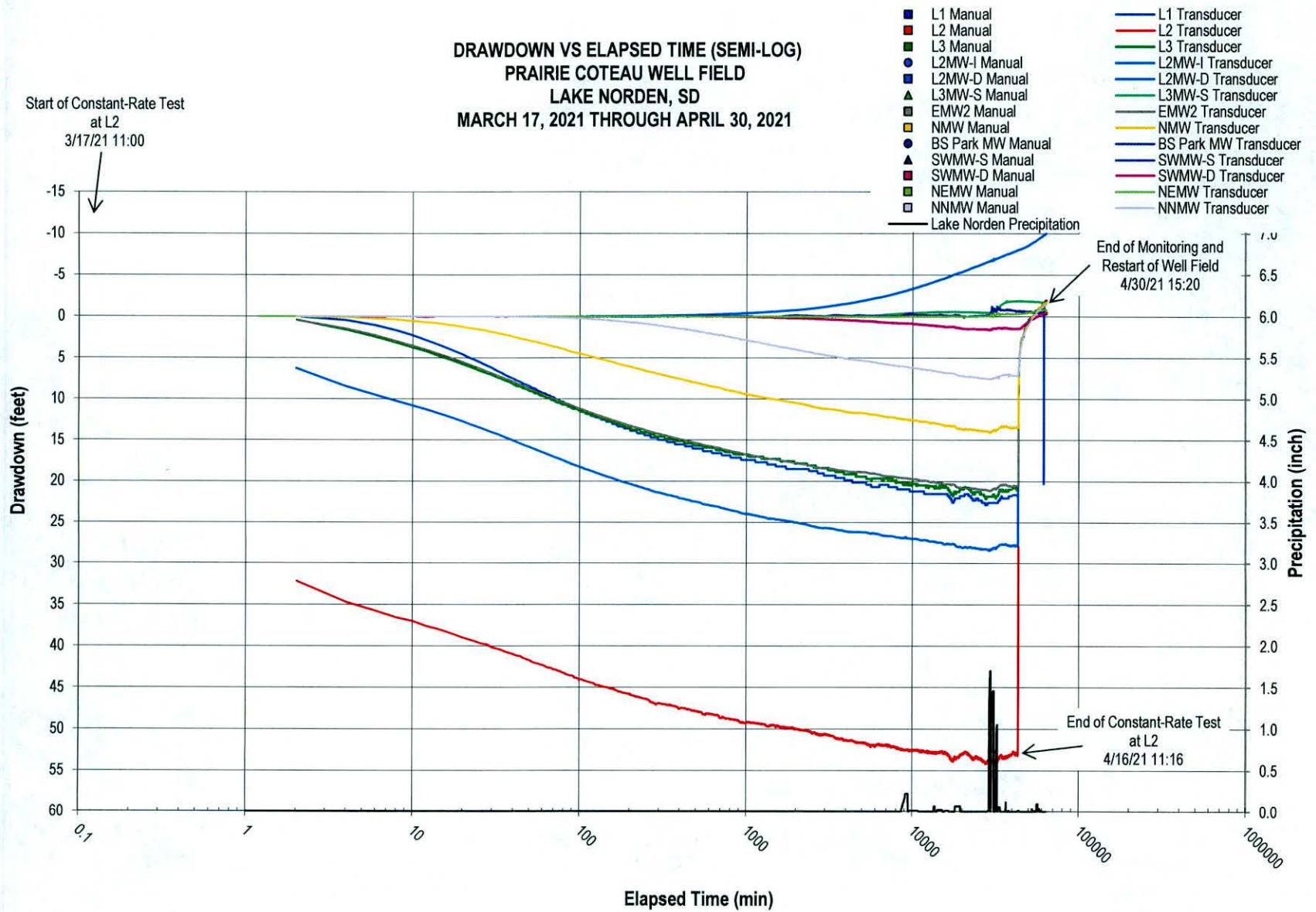
ELEVATION VS ELAPSED TIME (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
MARCH 17, 2021 THROUGH APRIL 30, 2021



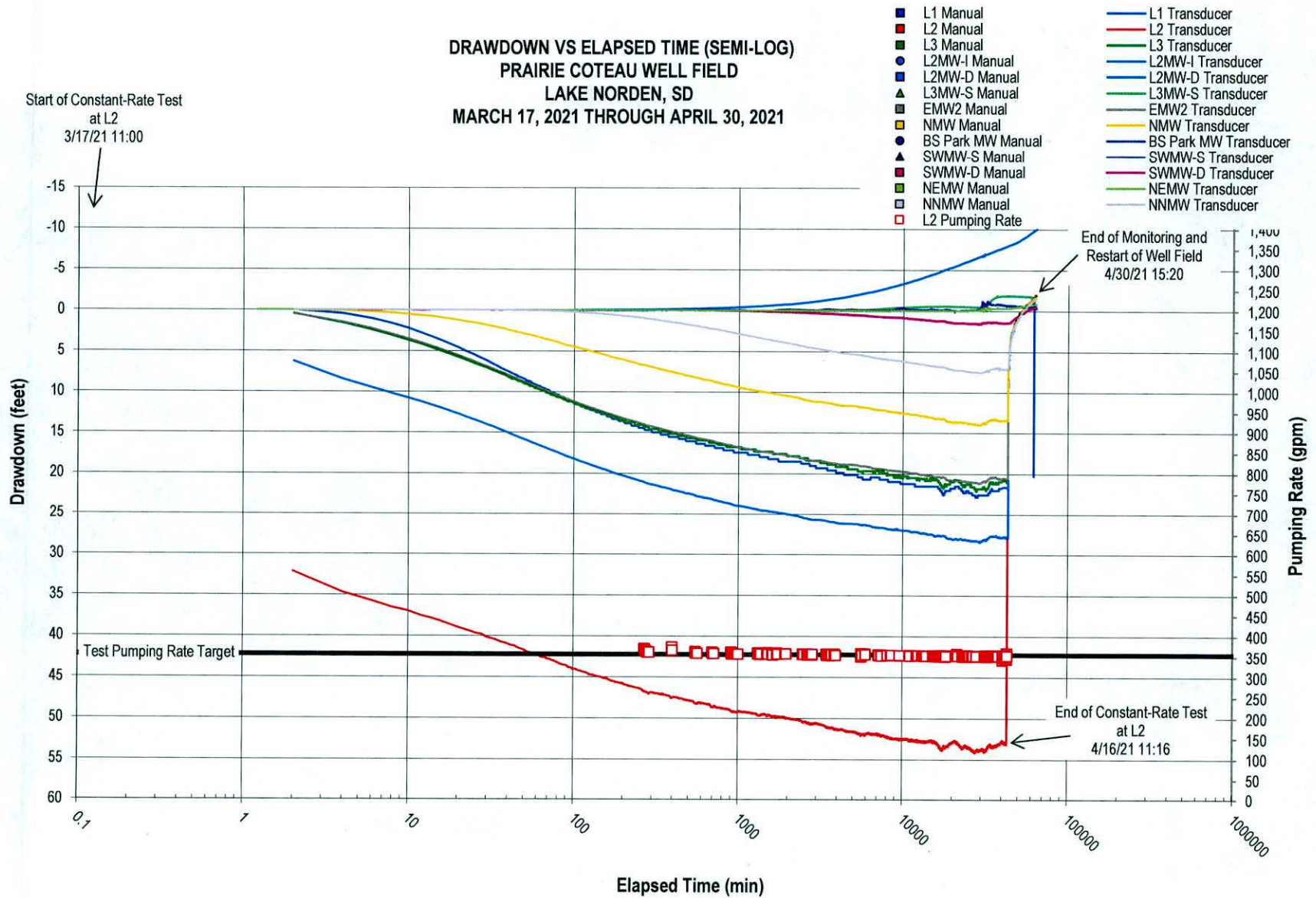
**DRAWDOWN VS ELAPSED TIME (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
MARCH 17, 2021 THROUGH APRIL 30, 2021**



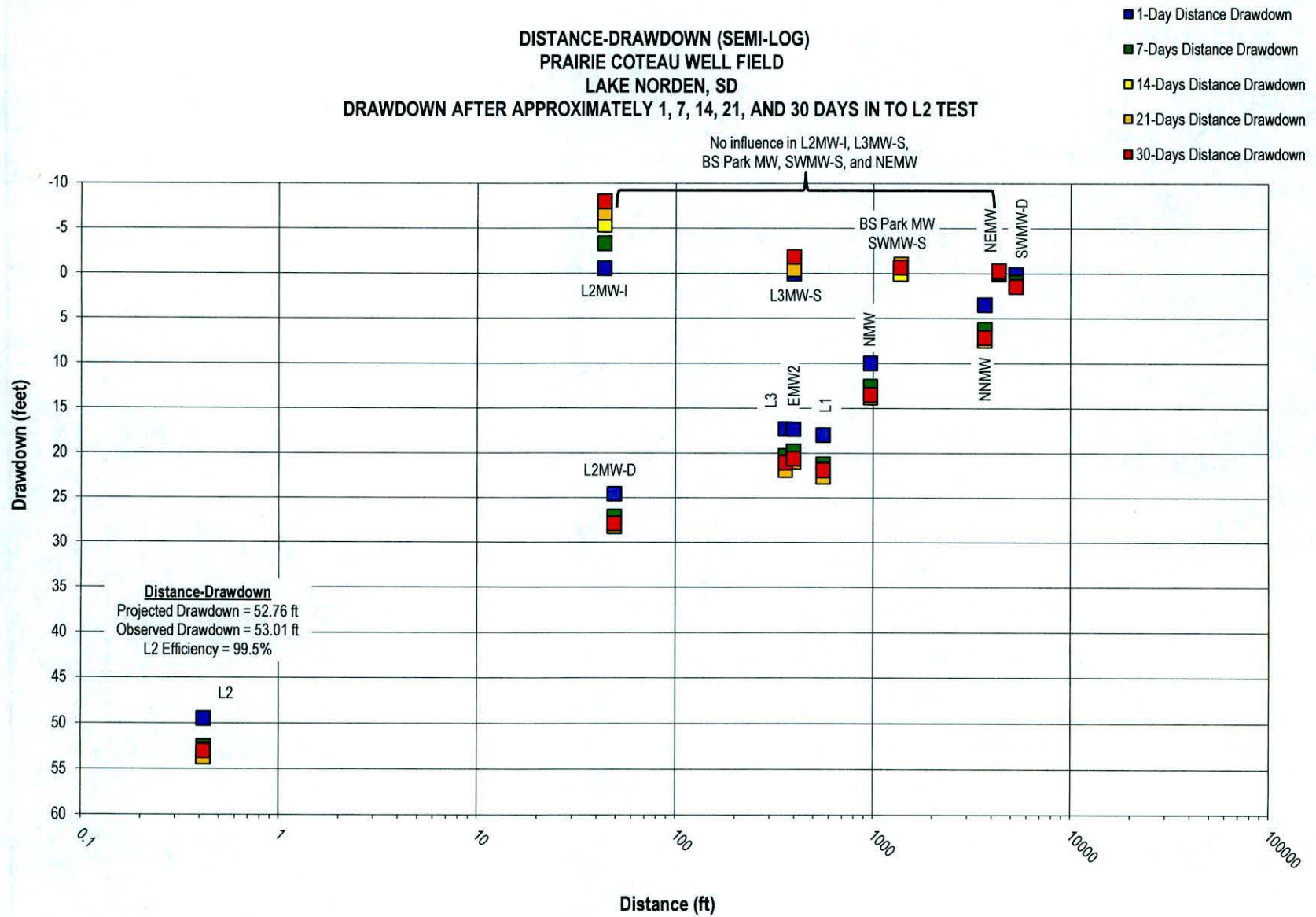
DRAWDOWN VS ELAPSED TIME (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
MARCH 17, 2021 THROUGH APRIL 30, 2021



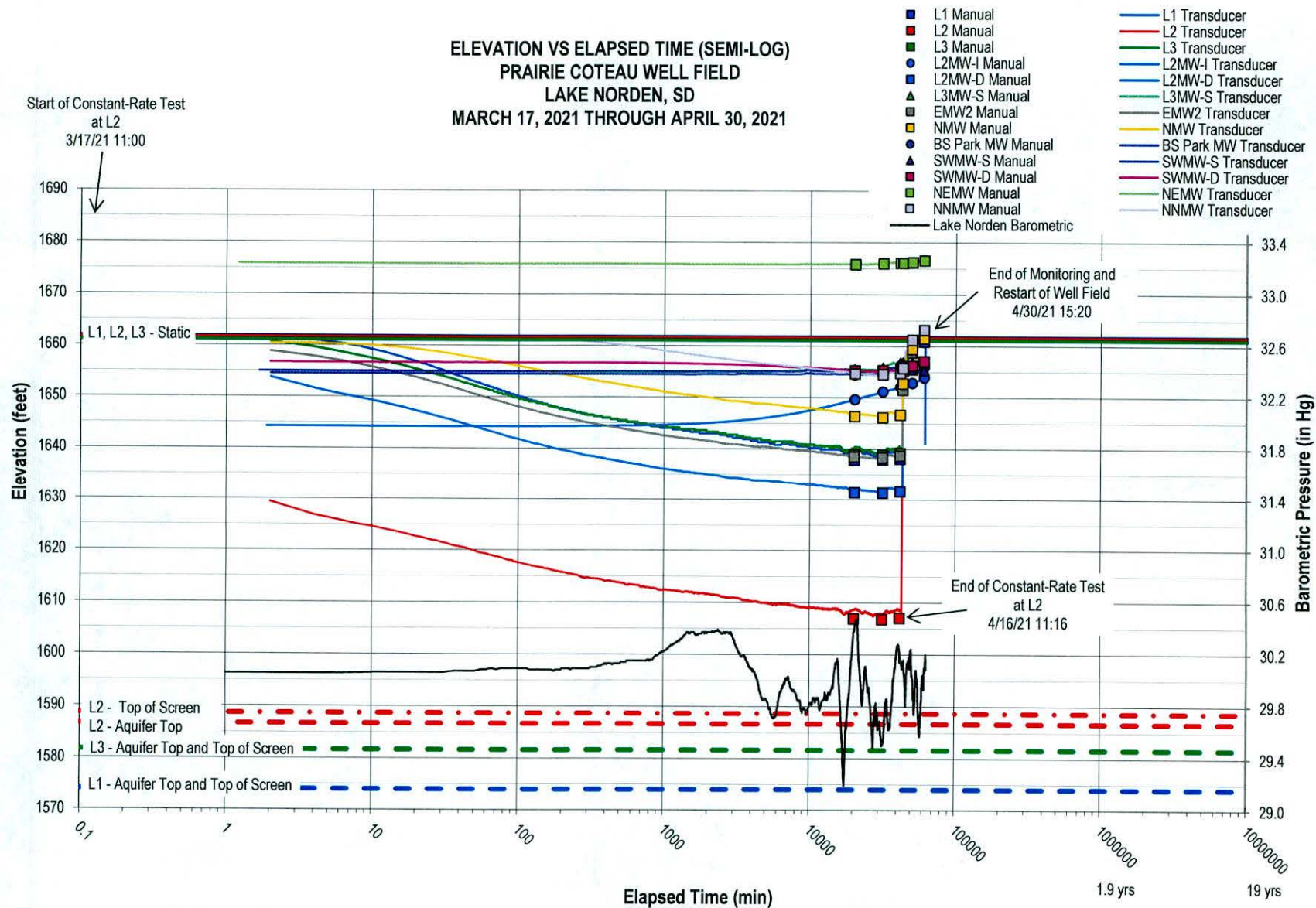
**DRAWDOWN VS ELAPSED TIME (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
MARCH 17, 2021 THROUGH APRIL 30, 2021**



DISTANCE-DRAWDOWN (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
DRAWDOWN AFTER APPROXIMATELY 1, 7, 14, 21, AND 30 DAYS IN TO L2 TEST

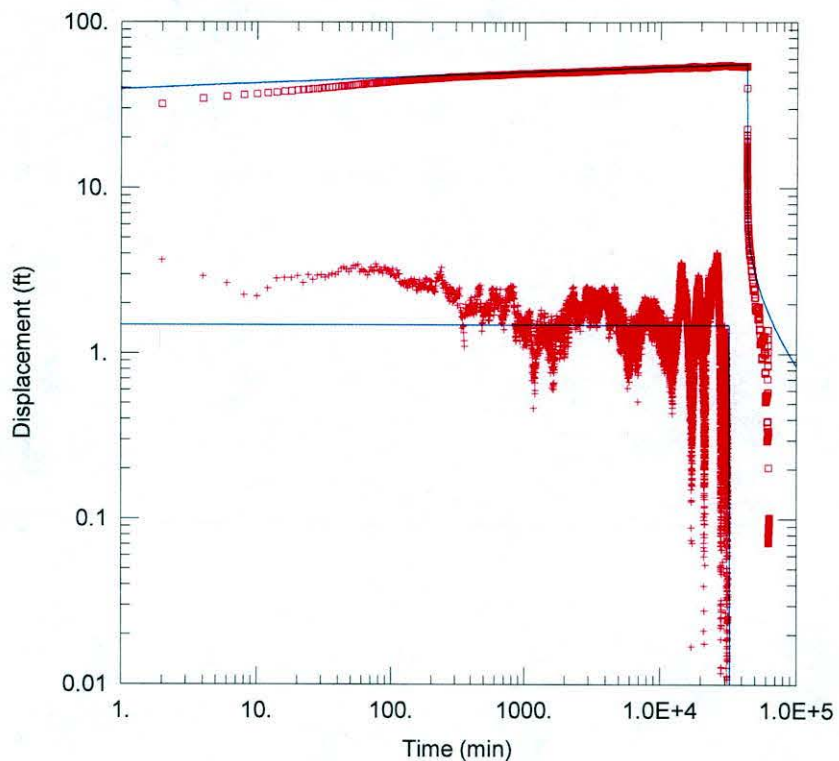


**ELEVATION VS ELAPSED TIME (SEMI-LOG)
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD
MARCH 17, 2021 THROUGH APRIL 30, 2021**



30-Day Aquifer Pumping Test
Prairie Coteau Well Field
Lake Norden, SD

APPENDIX F



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\VL2 conf theis.aqt

Date: 05/10/21

Time: 14:55:52

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L2 transducer	2701840.16	288814.25

SOLUTION

Aquifer Model: Confined

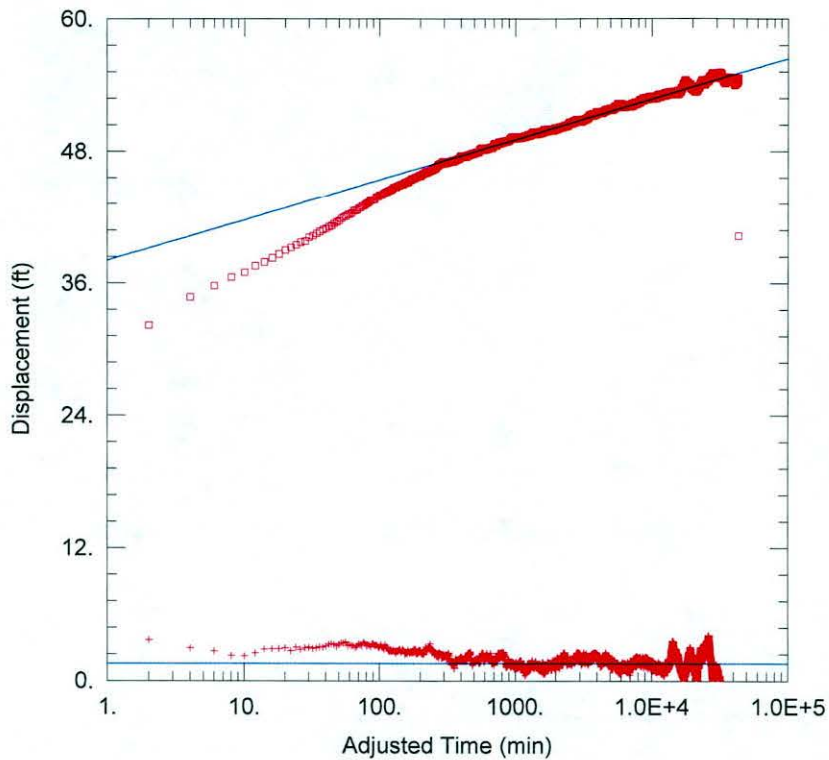
Solution Method: Theis

T = 3650.7 ft²/day

S = 3.627E-11

Kz/Kr = 1.

b = 18. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L2 conf cj.aqt

Date: 05/10/21

Time: 14:57:04

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 18. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

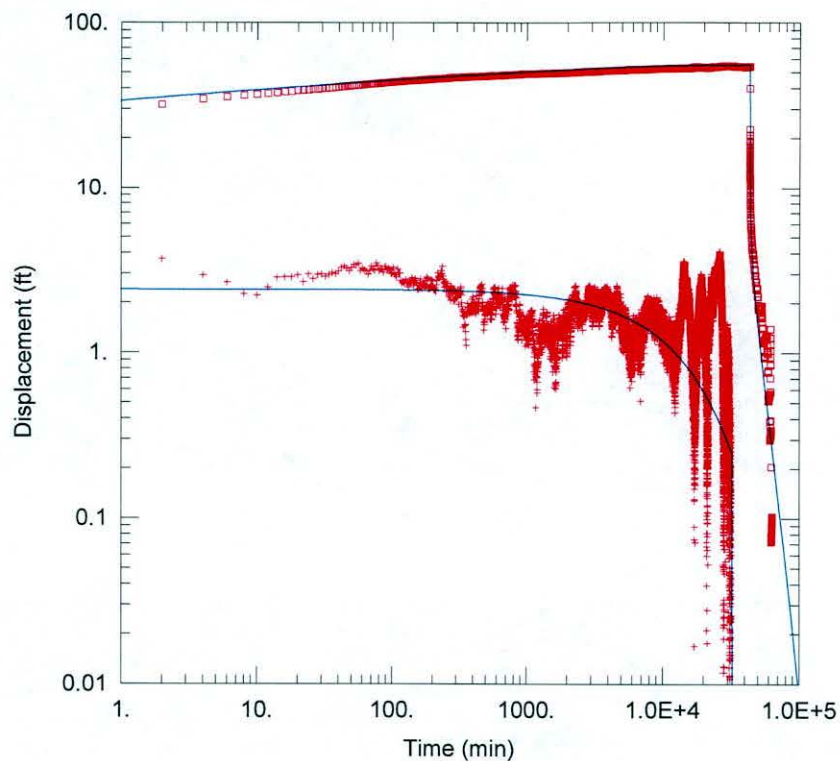
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 3398.7 ft²/day

S = 4.311E-10



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\VL2 leaky hj.aqt

Date: 05/10/21

Time: 14:54:59

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L2 transducer	2701840.16	288814.25

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

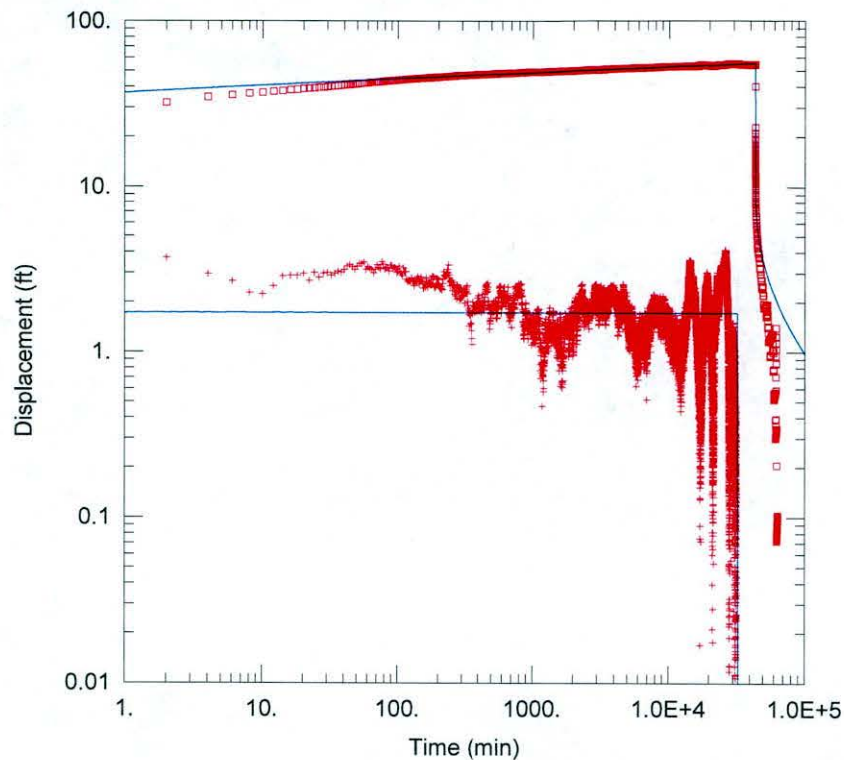
T = 2255.9 ft²/day

S = 5.976E-6

r/B = 1.148E-5

Kz/Kr = 1.

b = 18. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L2 leaky nw.aqt

Date: 05/10/21

Time: 14:55:30

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 18. ft

Aquitard Thickness (b'): 72. ft

Anisotropy Ratio (Kz/Kr): 1.

Aquitard Thickness (b''): 1. ft

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L2 transducer	2701840.16	288814.25

SOLUTION

Aquifer Model: Leaky

T = 1560.7 ft²/day

r/B = 1.148E-5

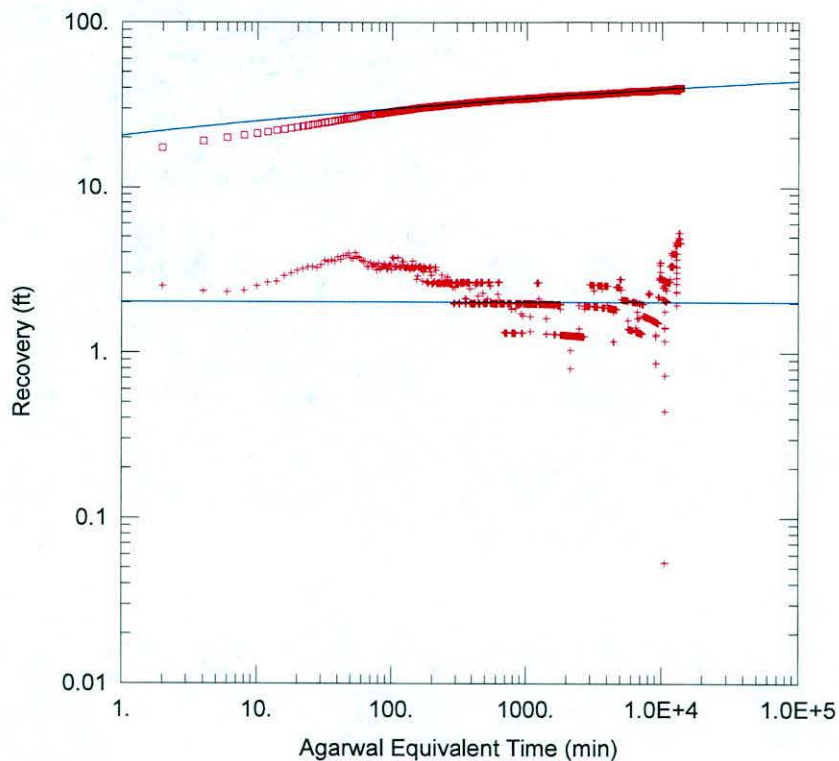
T2 = 0.0155 ft²/day

Solution Method: Neuman-Witherspoon

S = 6.724E-10

β = 0.5321

S2 = 1.



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\VL2 conf theis agarwal.aqt
 Date: 05/11/21 Time: 10:32:11

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

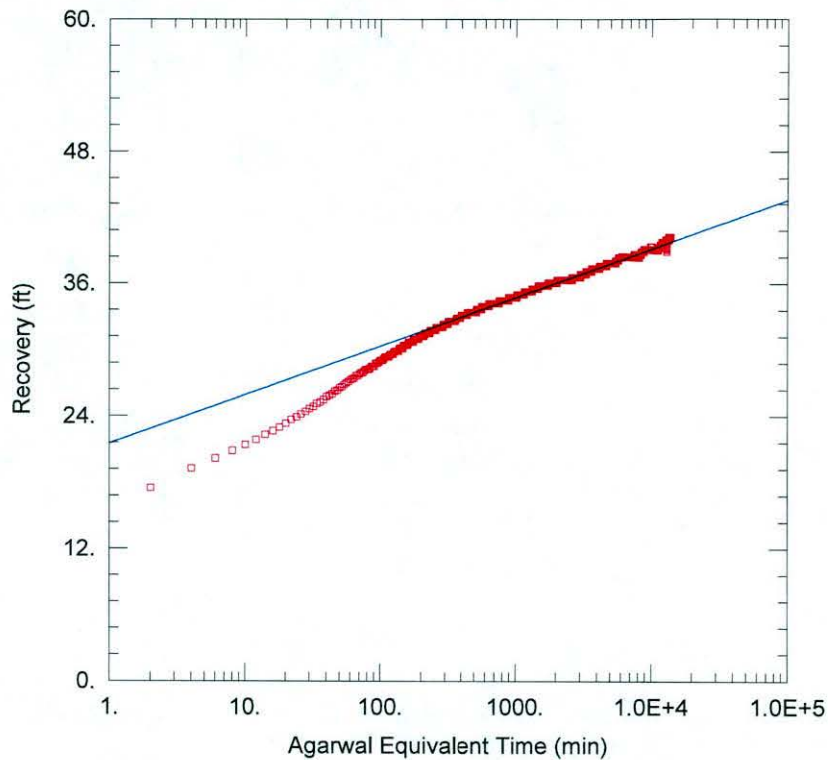
WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L2 transducer	2701840.16	288814.25

SOLUTION

Aquifer Model: Confined
 $T = 2682.3 \text{ ft}^2/\text{day}$
 $Kz/Kr = 1$

Solution Method: Theis
 $S = 0.0003157$
 $b = 18. \text{ ft}$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L2 conf cj agarwal.aqt
 Date: 05/11/21 Time: 10:25:17

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

AQUIFER DATA

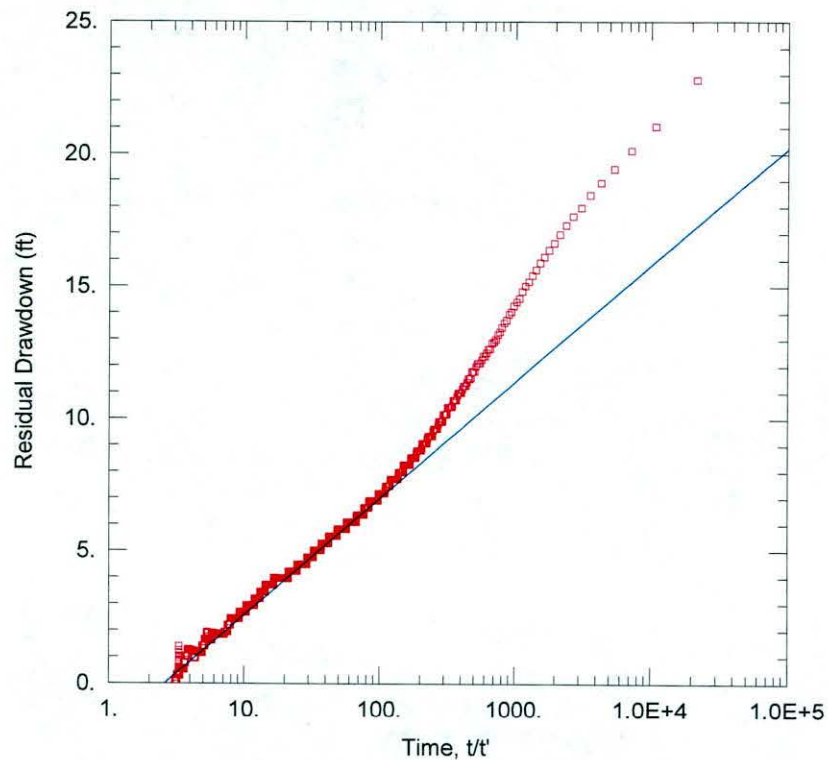
Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L2 transducer	2701840.16	288814.25

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob
 T = 2826.9 ft²/day S = 0.0001159



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\L2 conf theis recovery.aqt

Date: 05/10/21

Time: 14:56:04

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 18. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
□ L2 transducer	2701840.16	288814.25

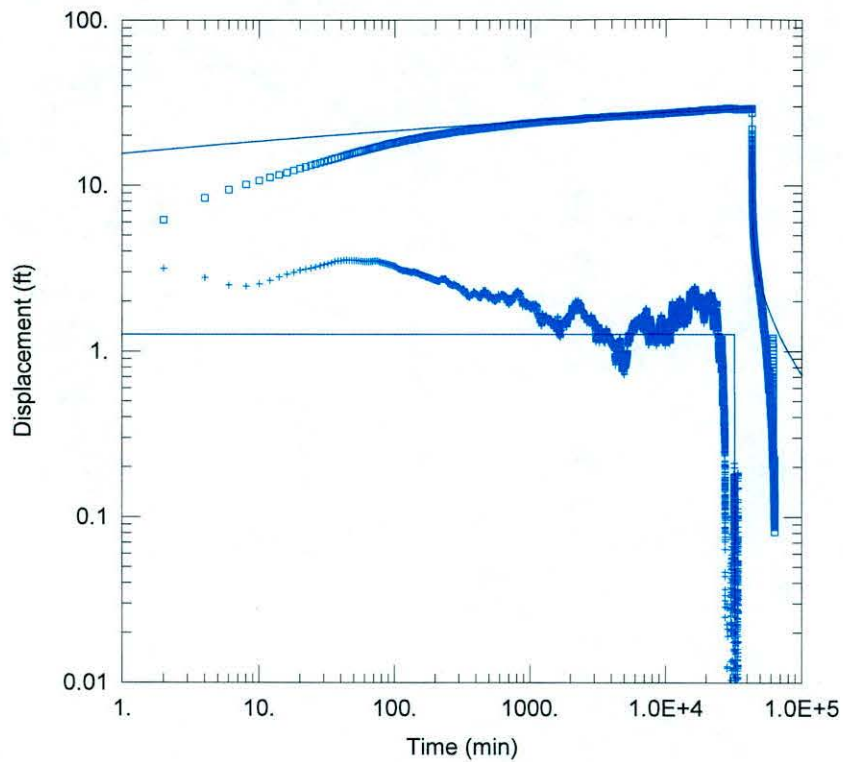
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 2826.9 \text{ ft}^2/\text{day}$

$S/S' = 2.624$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L2MW-D conf theis.aqt
 Date: 05/10/21 Time: 14:02:48

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2	2701840.16	288814.25	L2MW-D Transducer	2701826.553	288861.522

SOLUTION

Aquifer Model: Confined

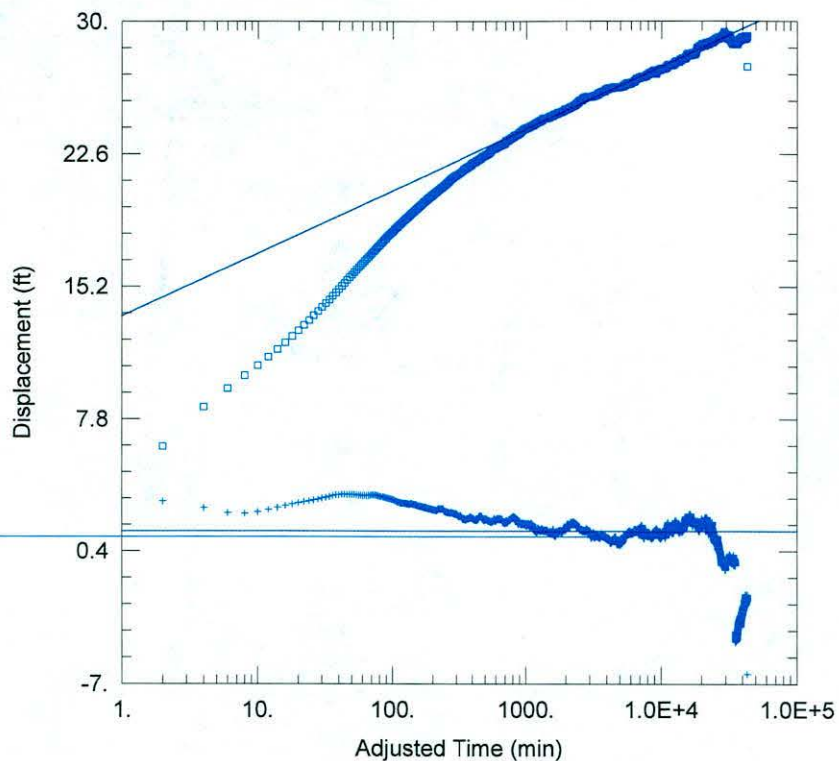
Solution Method: Theis

T = 4244.9 ft²/day

S = 1.239E-8

Kz/Kr = 1.

b = 21. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\L2MW-D conf cj.aqt

Date: 05/10/21

Time: 14:02:26

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 21. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L2MW-D Transducer	2701826.553	288861.522

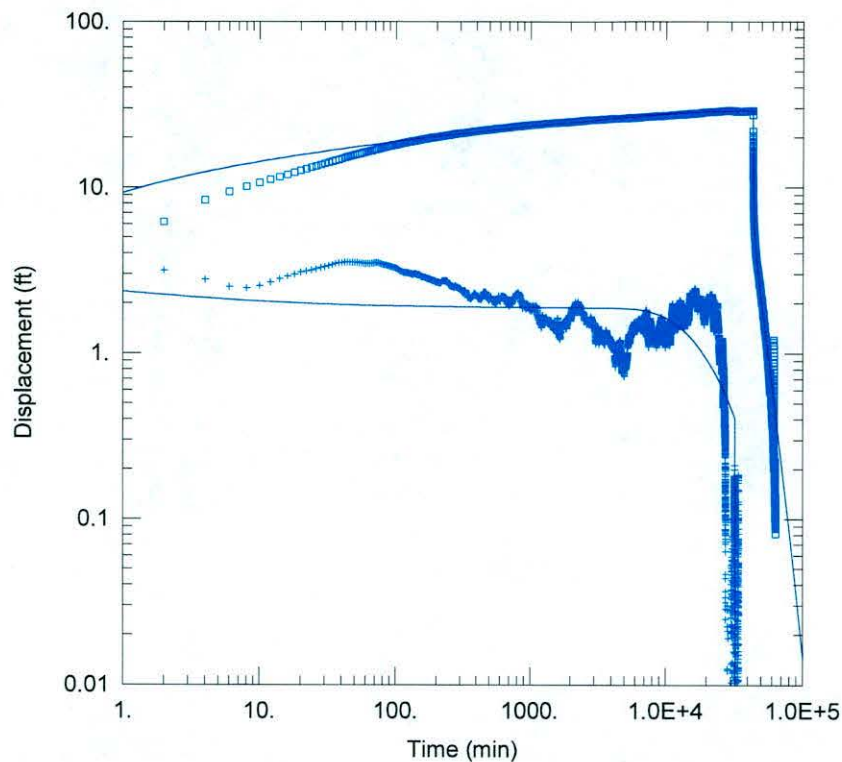
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 3573.2 ft²/day

S = 2.979E-7



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L2MW-D leaky hj.aqt

Date: 05/10/21

Time: 14:02:03

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 21. ft

Anisotropy Ratio (K_z/K_r): 1.

Aquitard Thickness (b'): 79. ft

Aquitard Thickness (b''): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L2MW-D Transducer	2701826.553	288861.522

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush

$T = 1441. \text{ ft}^2/\text{day}$

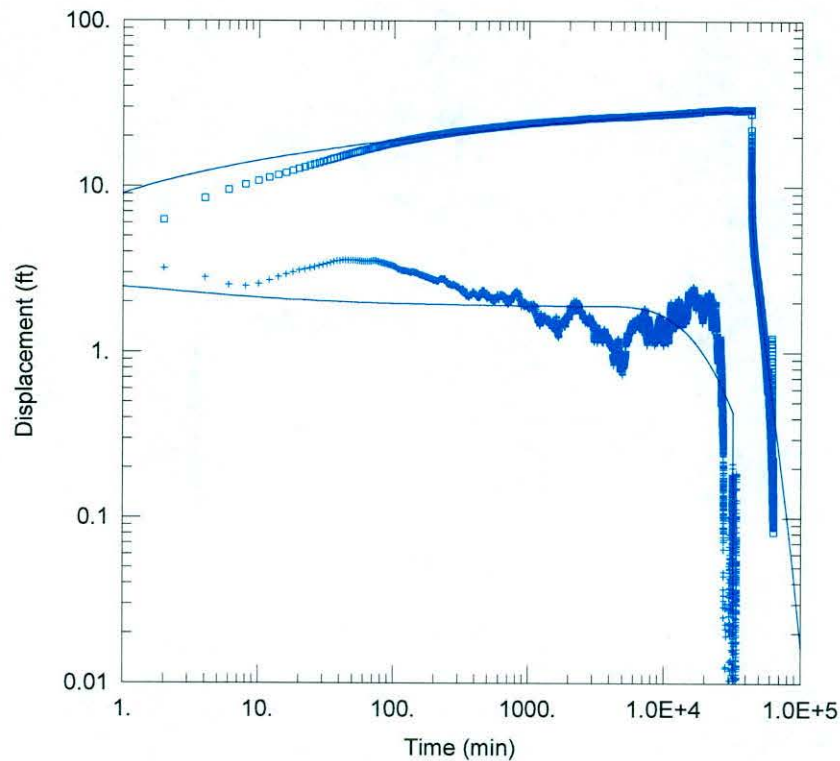
$S = 3.2\text{E-}5$

$r/B' = 0.02348$

$\beta' = 0.09315$

$r/B'' = 0.$

$\beta'' = 0.$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L2MW-D leaky nw.aqt
 Date: 05/10/21 Time: 14:01:27

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

AQUIFER DATA

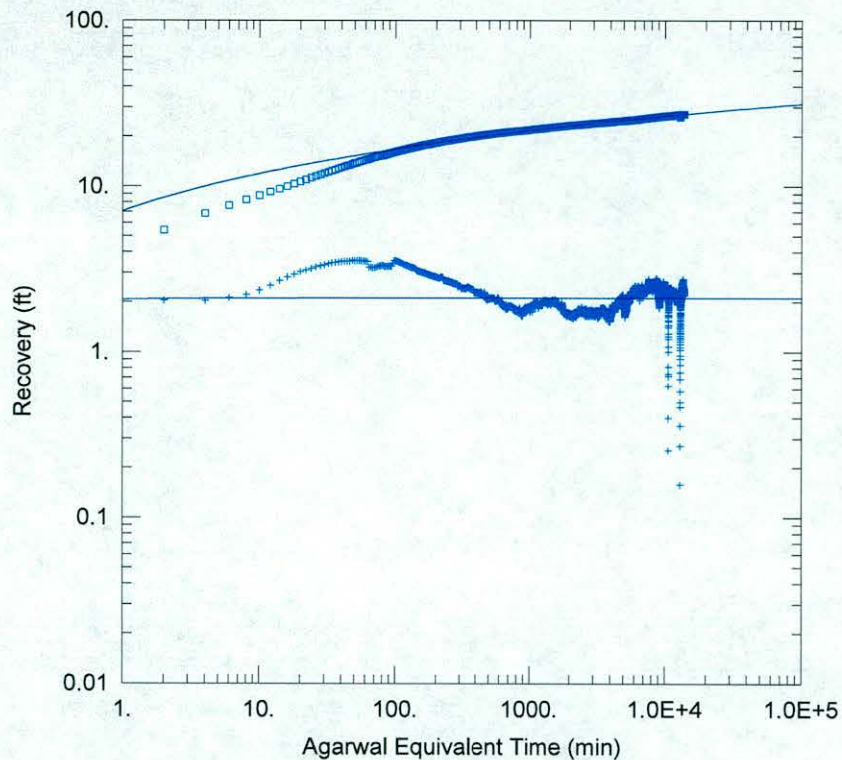
Saturated Thickness: 21. ft Anisotropy Ratio (Kz/Kr): 1.
 Aquitard Thickness (b'): 79. ft Aquitard Thickness (b''): 1. ft

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2	2701840.16	288814.25	L2MW-D Transducer	2701826.553	288861.522

SOLUTION

Aquifer Model: Leaky Solution Method: Neuman-Witherspoon
 $T = 1440.9 \text{ ft}^2/\text{day}$ $S = 4.016\text{E-}5$
 $r/B = 0.02346$ $\beta = 0.08358$
 $T2 = 1.44\text{E+}8 \text{ ft}^2/\text{day}$ $S2 = 1.$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L2MW-D conf theis agarwal.aqt
 Date: 05/10/21 Time: 14:34:22

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2	2701840.16	288814.25	L2MW-D Transducer	2701826.553	288861.522

SOLUTION

Aquifer Model: Confined

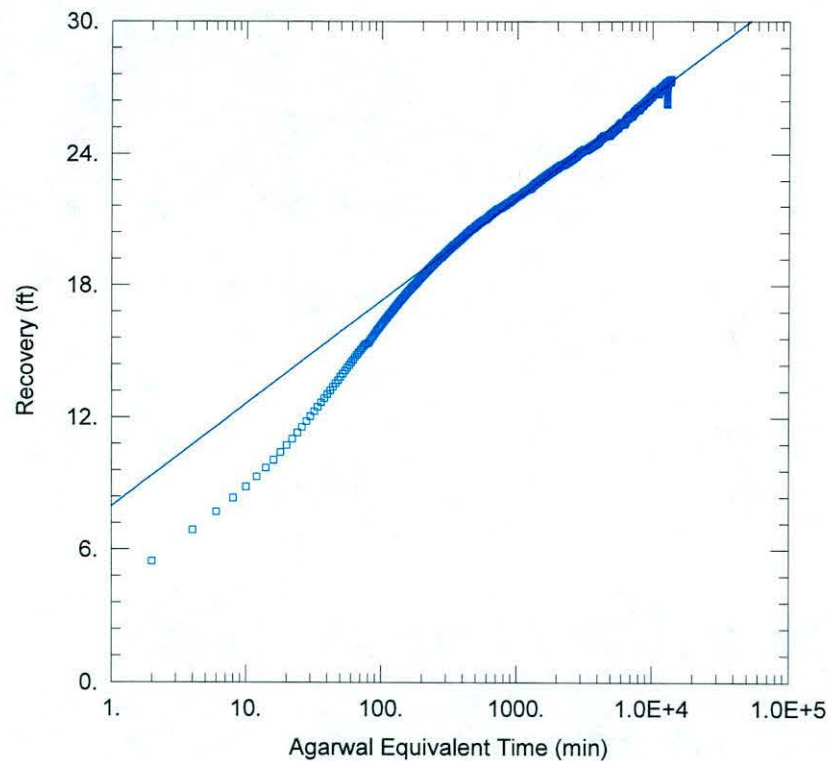
Solution Method: Theis

T = 2550.4 ft²/day

S = 5.863E-5

Kz/Kr = 1.

b = 21. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\VL2MW-D conf cj agarwal.aqt
 Date: 05/11/21 Time: 10:33:23

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

AQUIFER DATA

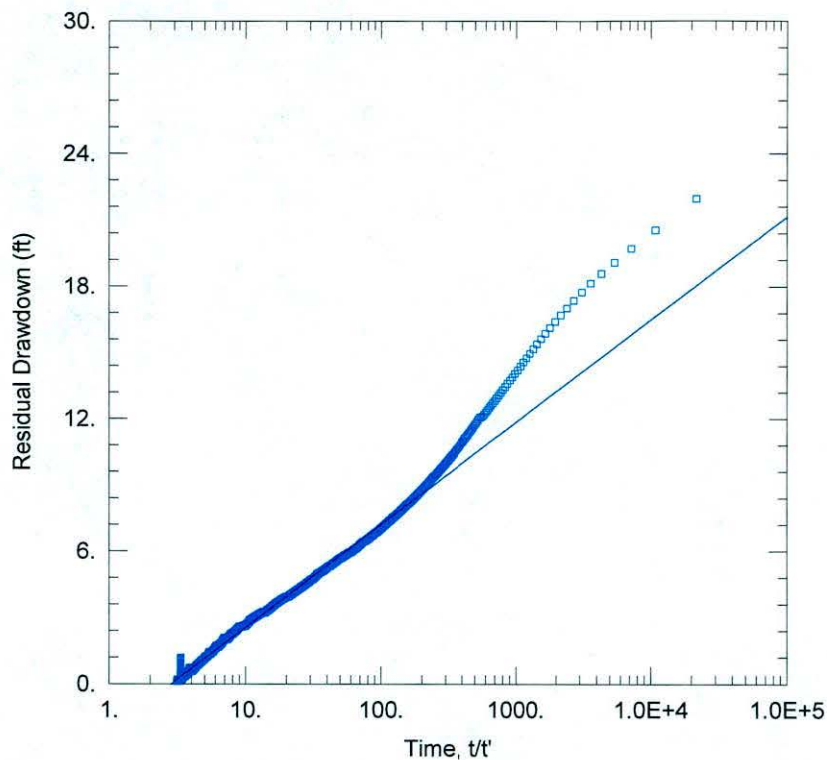
Saturated Thickness: 21. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2	2701840.16	288814.25	L2MW-D Transducer	2701826.553	288861.522

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob
 T = 2670.6 ft²/day S = 3.37E-5



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L2MW-D conf theis recovery.aqt

Date: 05/10/21

Time: 14:04:23

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 21. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
□ L2MW-D Transducer	2701826.553	288861.522

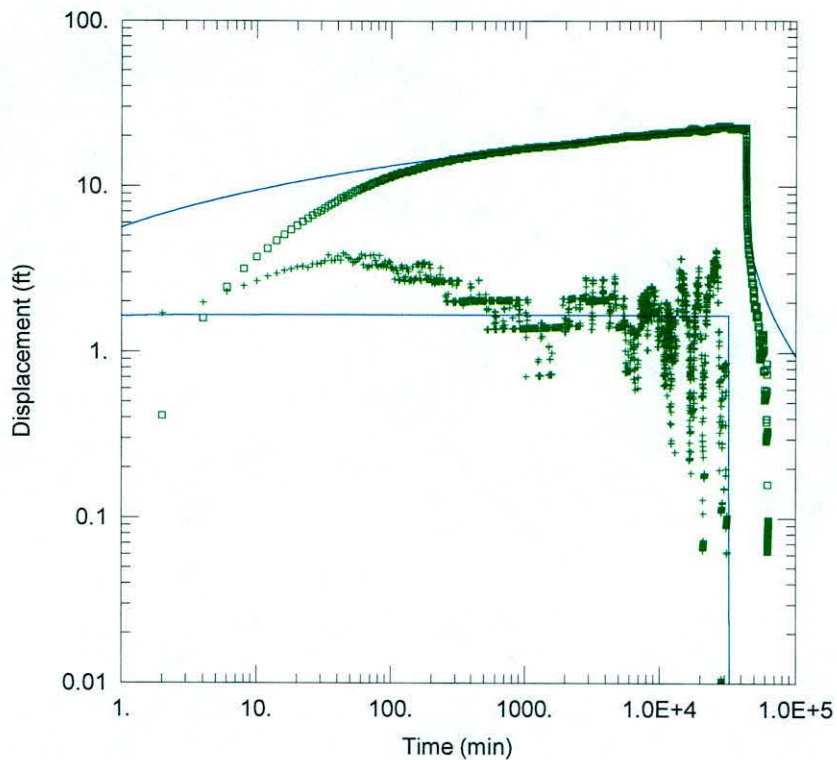
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 2678.9 \text{ ft}^2/\text{day}$

$S/S' = 2.818$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L3 conf theis.aqt

Date: 05/10/21

Time: 16:33:48

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L3 transducer	2702196.315	288763.149

SOLUTION

Aquifer Model: Confined

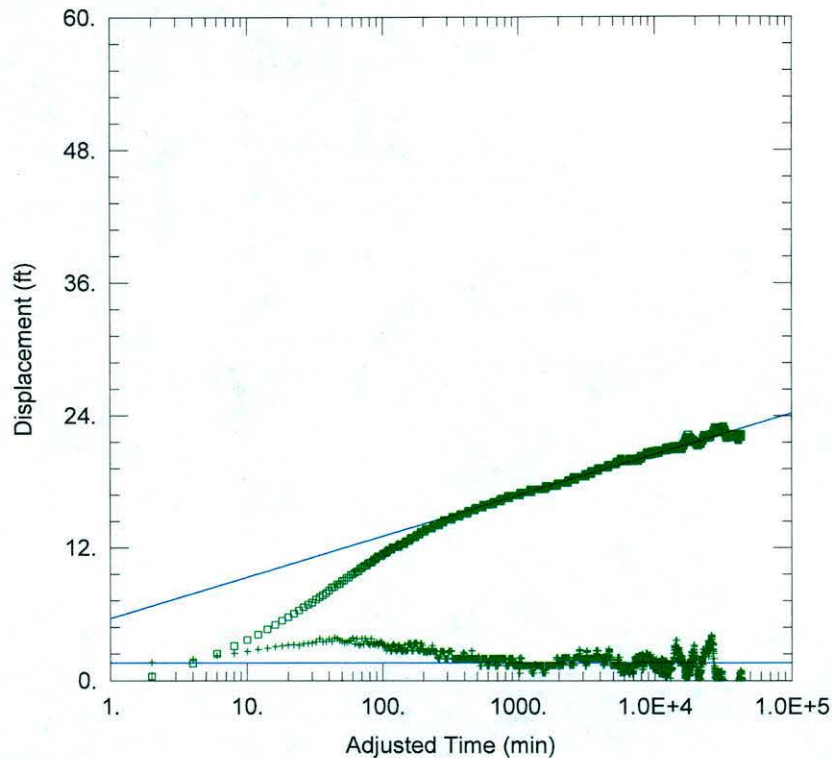
Solution Method: Theis

T = 3249.8 ft²/day

S = 1.382E-6

Kz/Kr = 1.

b = 14. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\3 conf cj.aqt

Date: 05/10/21

Time: 16:33:10

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 14. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L3 transducer	2702196.315	288763.149

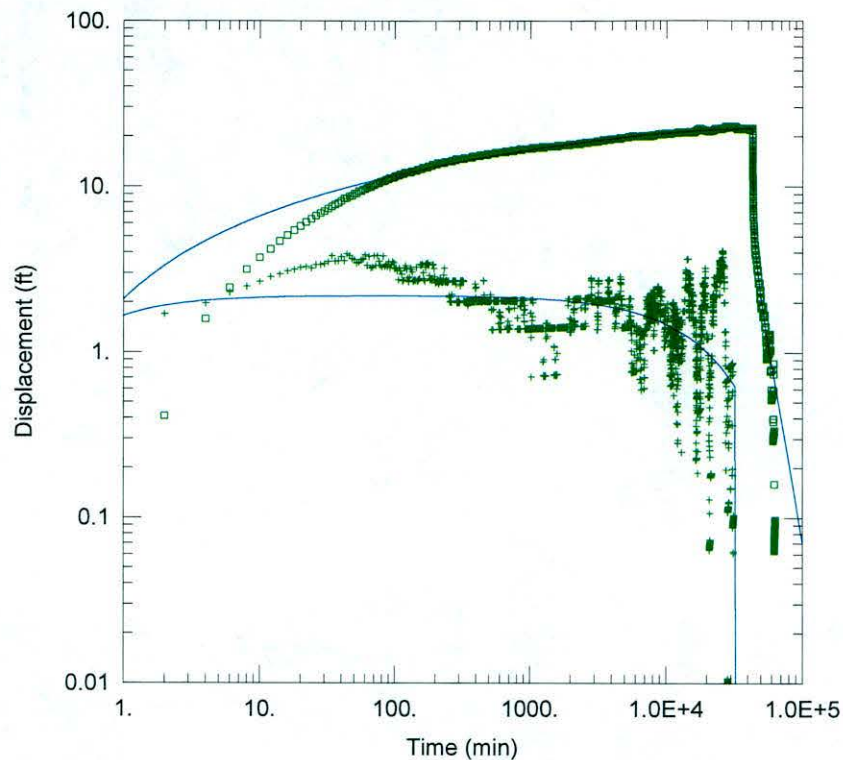
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 3343. ft²/day

S = 1.239E-6



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L3 leaky hj.aqt

Date: 05/10/21

Time: 16:32:22

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L3 transducer	2702196.315	288763.149

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

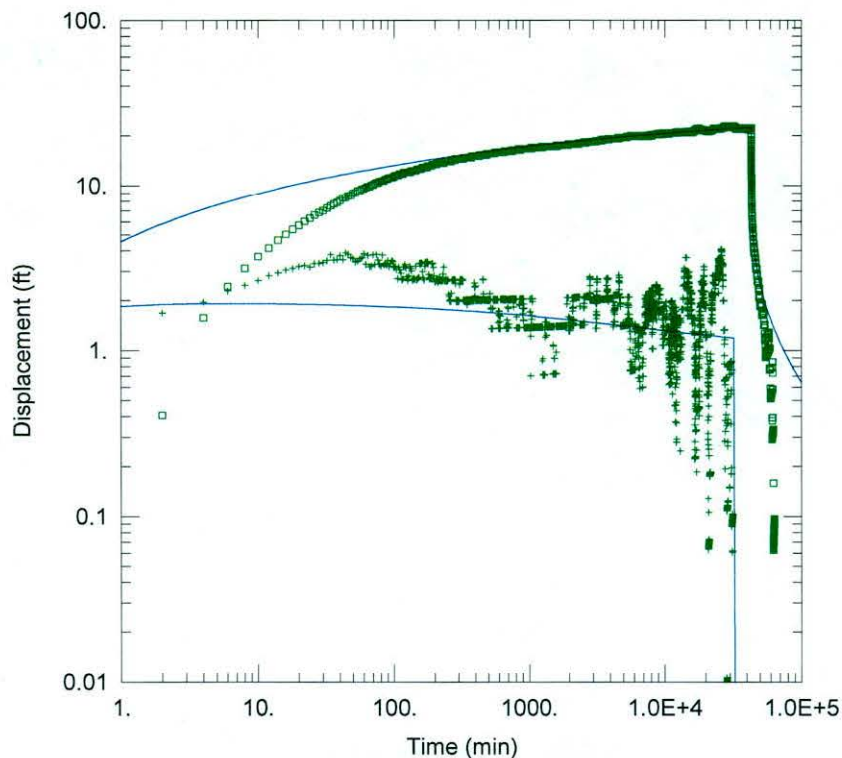
T = 2464.2 ft²/day

S = 1.503E-5

r/B = 0.006674

Kz/Kr = 1.

b = 14. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L3 leaky nw.aqt

Date: 05/10/21

Time: 16:34:09

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 14. ft

Anisotropy Ratio (K_z/K_r): 1.

Aquitard Thickness (b'): 67. ft

Aquitard Thickness (b''): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L3 transducer	2702196.315	288763.149

SOLUTION

Aquifer Model: Leaky

Solution Method: Neuman-Witherspoon

$T = 2720.7 \text{ ft}^2/\text{day}$

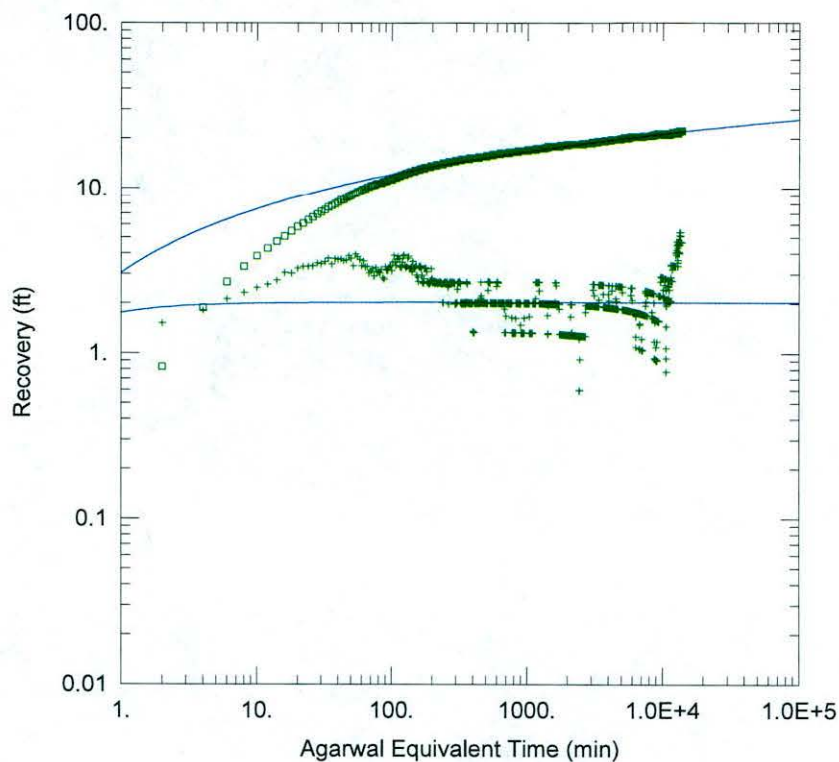
$S = 3.442\text{E-}6$

$r/B = 1.0\text{E-}5$

$\beta = 0.001775$

$T2 = 1.44\text{E+}8 \text{ ft}^2/\text{day}$

$S2 = 1.0\text{E-}10$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L3 conf theis agarwal.agt

Date: 05/10/21

Time: 16:32:50

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L3 transducer	2702196.315	288763.149

SOLUTION

Aquifer Model: Confined

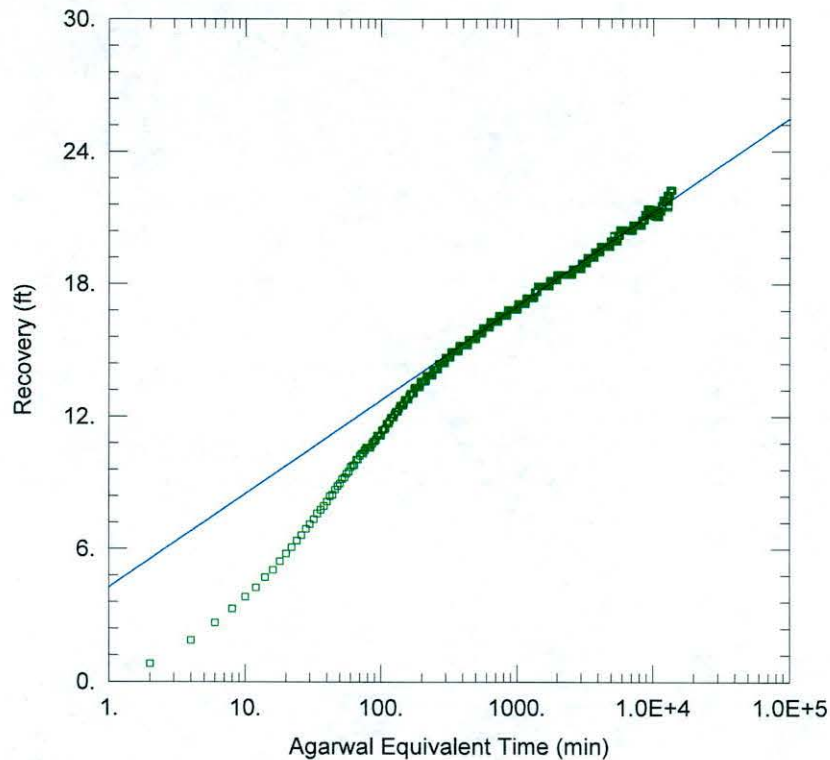
Solution Method: Theis

T = 2677. ft²/day

S = 8.266E-6

Kz/Kr = 1.

b = 14. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L3 conf cj agarwal.aqt
 Date: 05/11/21 Time: 10:36:06

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

AQUIFER DATA

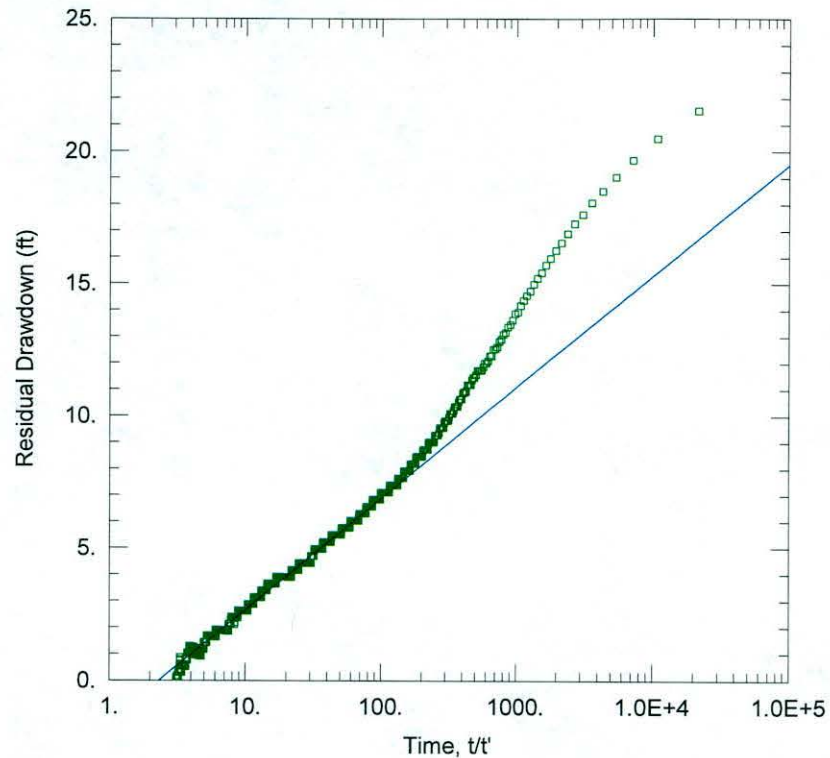
Saturated Thickness: 14. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L3 transducer	2702196.315	288763.149

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob
 T = 2935.2 ft²/day S = 3.462E-6



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L3 conf theis recovery.aqt

Date: 05/10/21

Time: 16:32:33

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 14. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L3 transducer	2702196.315	288763.149

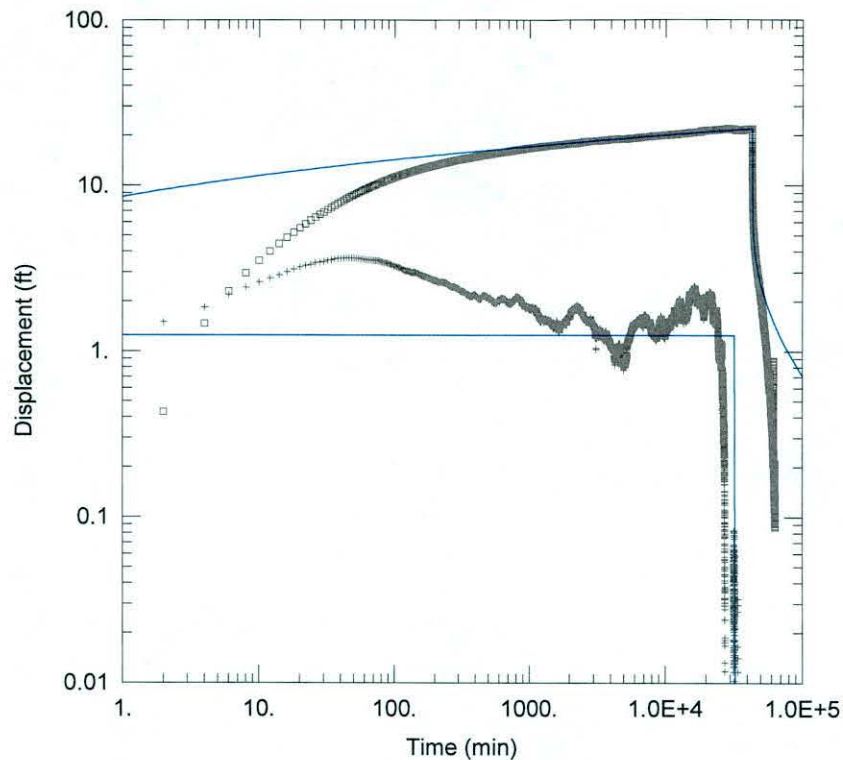
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 2960.1 \text{ ft}^2/\text{day}$

$S/S' = 2.338$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\EMW2 conf theis.aqt

Date: 05/10/21

Time: 15:32:23

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
EMW2 transducer	2702229.812	288744.154

SOLUTION

Aquifer Model: Confined

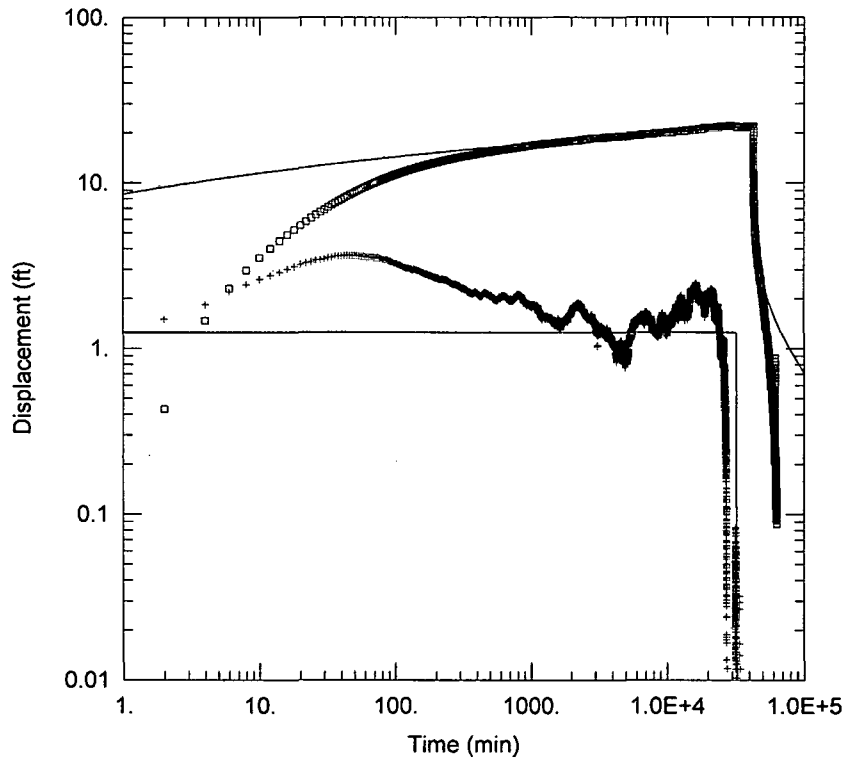
Solution Method: Theis

T = 4297.2 ft²/day

S = 4.698E-8

Kz/Kr = 1.

b = 15. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\EMW2 conf theis.aqt

Date: 05/10/21

Time: 15:32:23

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
EMW2 transducer	2702229.812	288744.154

SOLUTION

Aquifer Model: Confined

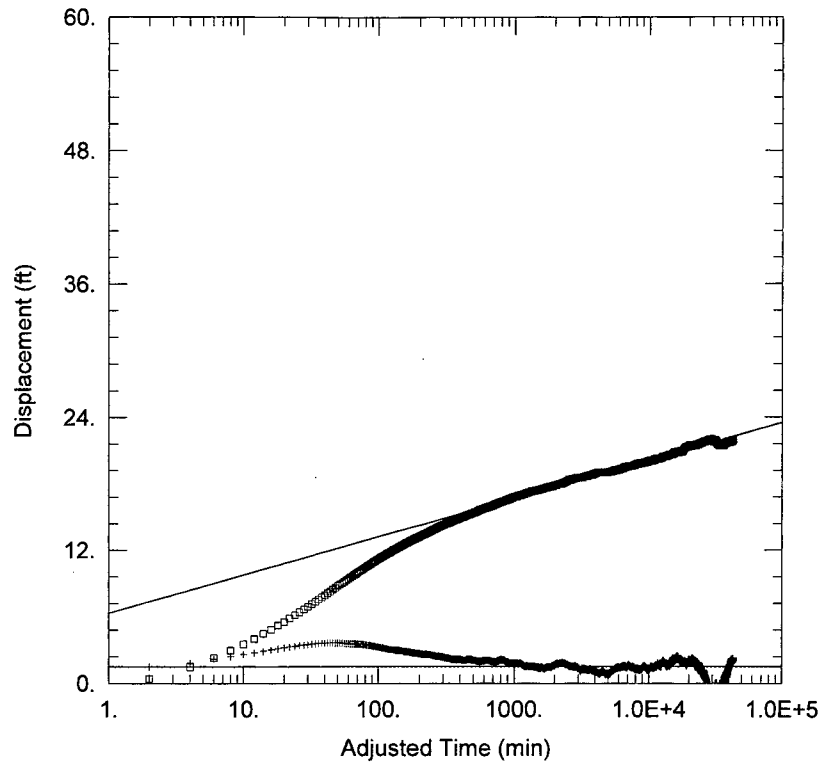
Solution Method: Theis

T = 4297.2 ft²/day

S = 4.698E-8

Kz/Kr = 1.

b = 15. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\EMW2 conf cj.aqt

Date: 05/10/21

Time: 15:33:46

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
EMW2 transducer	2702229.812	288744.154

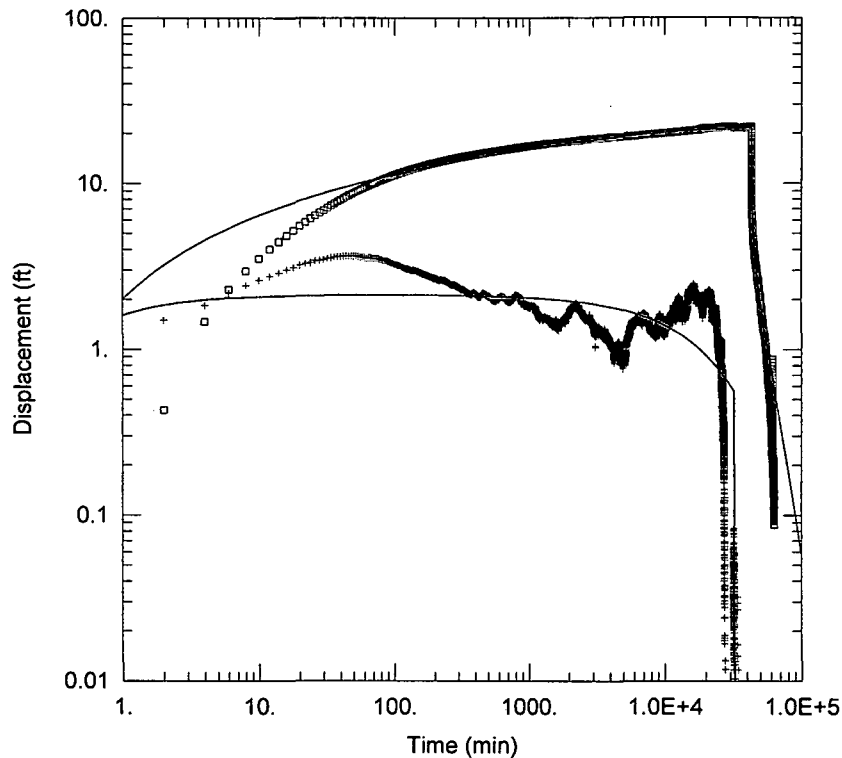
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

$T = 3624.7 \text{ ft}^2/\text{day}$

$S = 5.232\text{E-}7$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\EMW2 leaky hj.agt

Date: 05/10/21

Time: 15:32:02

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
EMW2 transducer	2702229.812	288744.154

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

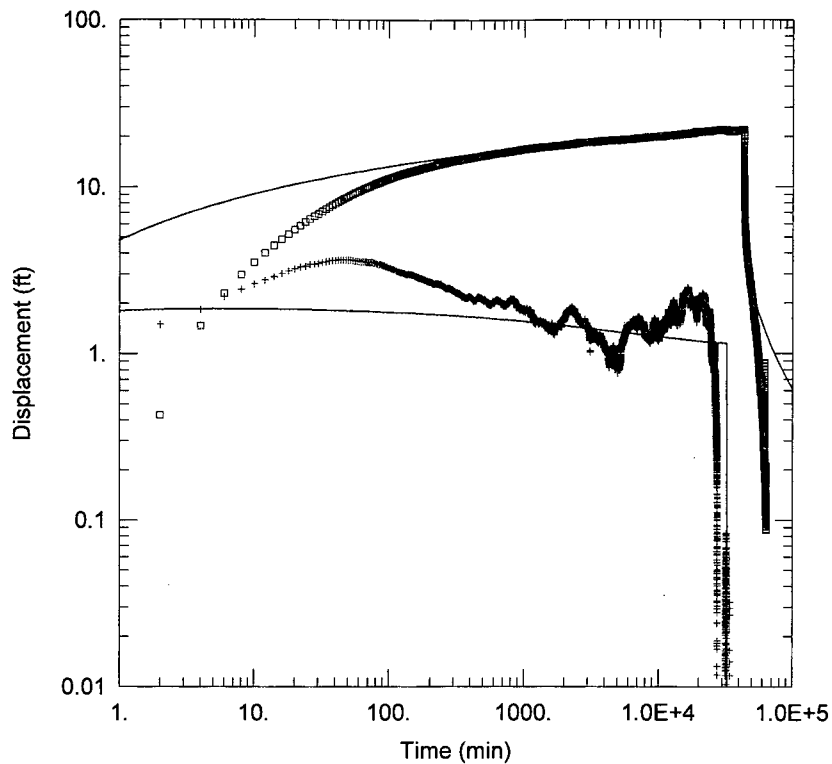
$T = 2516.1 \text{ ft}^2/\text{day}$

$S = 1.275\text{E-}5$

$r/B = 0.006915$

$Kz/Kr = 1.$

$b = 15. \text{ ft}$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\EMW2 leaky nw.aqt

Date: 05/10/21

Time: 15:31:35

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (K_z/K_r): 1.

Aquitard Thickness (b'): 70. ft

Aquitard Thickness (b''): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
EMW2 transducer	2702229.812	288744.154

SOLUTION

Aquifer Model: Leaky

Solution Method: Neuman-Witherspoon

$T = 2843.7 \text{ ft}^2/\text{day}$

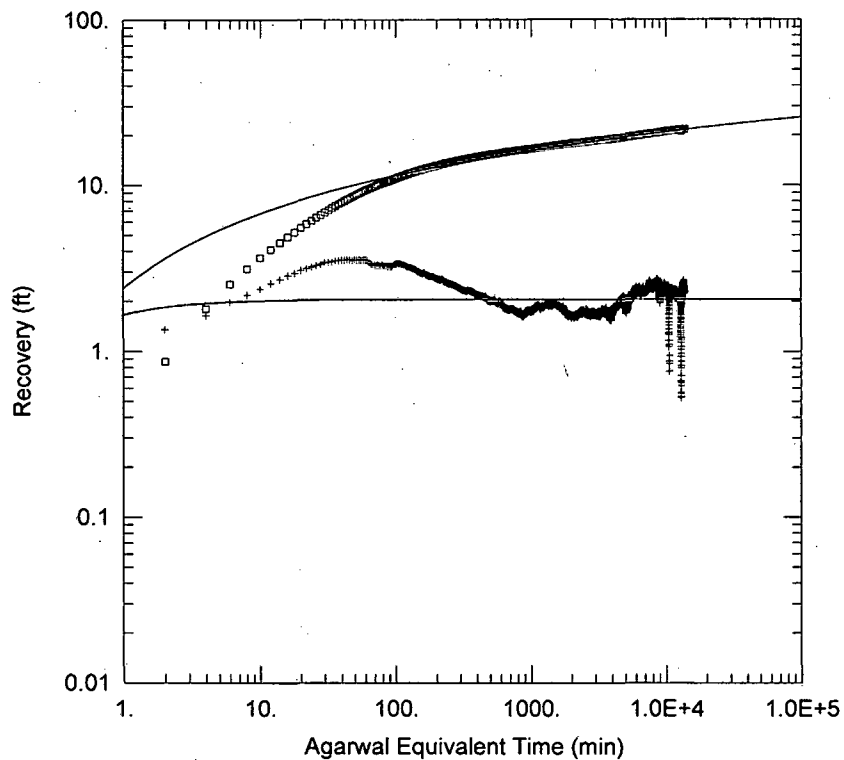
$S = 2.382\text{E-}6$

$r/B = 1.0\text{E-}5$

$\beta = 0.001621$

$T2 = 1.44\text{E+}8 \text{ ft}^2/\text{day}$

$S2 = 1.0\text{E-}10$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\EMW2 conf theis agarwal.agt
 Date: 05/10/21 Time: 15:33:13

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	EMW2 transducer	2702229.812	288744.154

SOLUTION

Aquifer Model: Confined

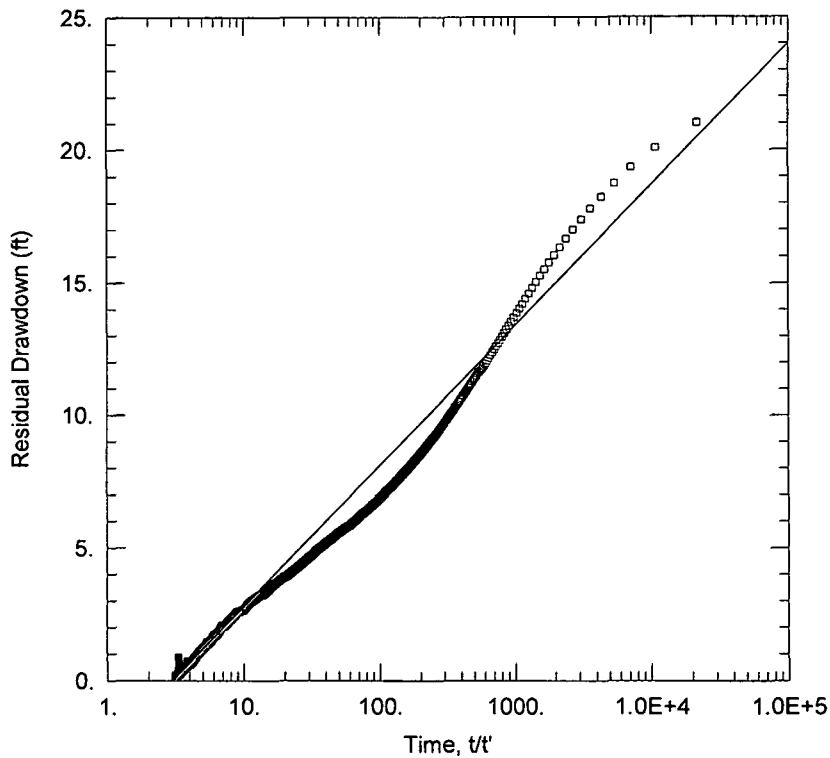
Solution Method: Theis

T = 2614.9 ft²/day

S = 9.967E-6

Kz/Kr = 1.

b = 15. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\EMW2 conf theis recovery.aqt

Date: 05/10/21

Time: 15:32:45

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 15. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
o EMW2 transducer	2702229.812	288744.154

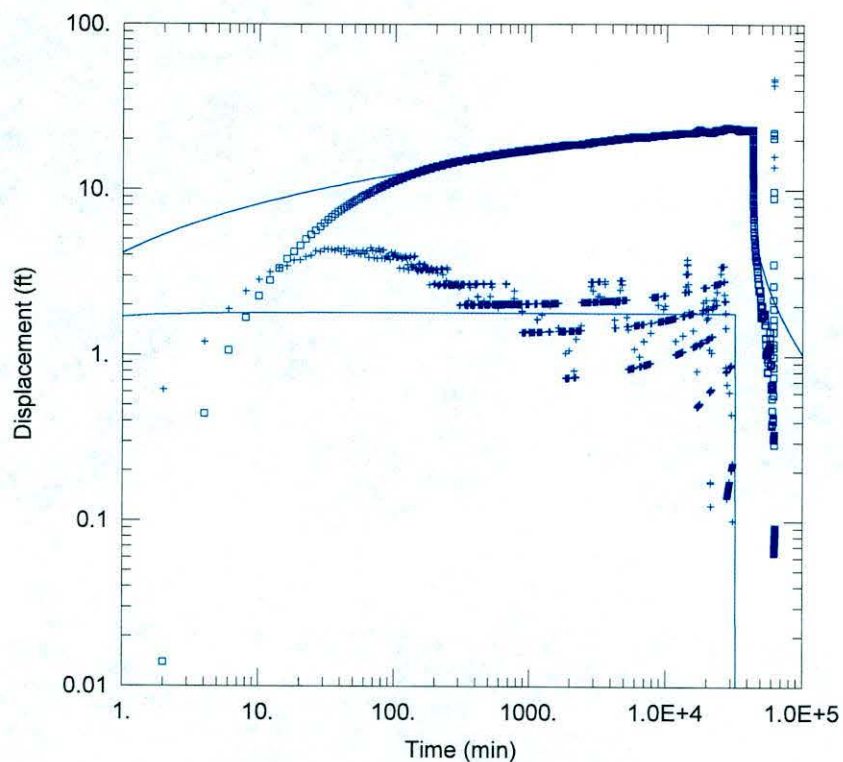
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 2351.3 \text{ ft}^2/\text{day}$

$S/S' = 2.944$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\VL1 conf theis.agt

Date: 05/10/21

Time: 15:50:07

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L1 transducer	2701439.593	288424.386

SOLUTION

Aquifer Model: Confined

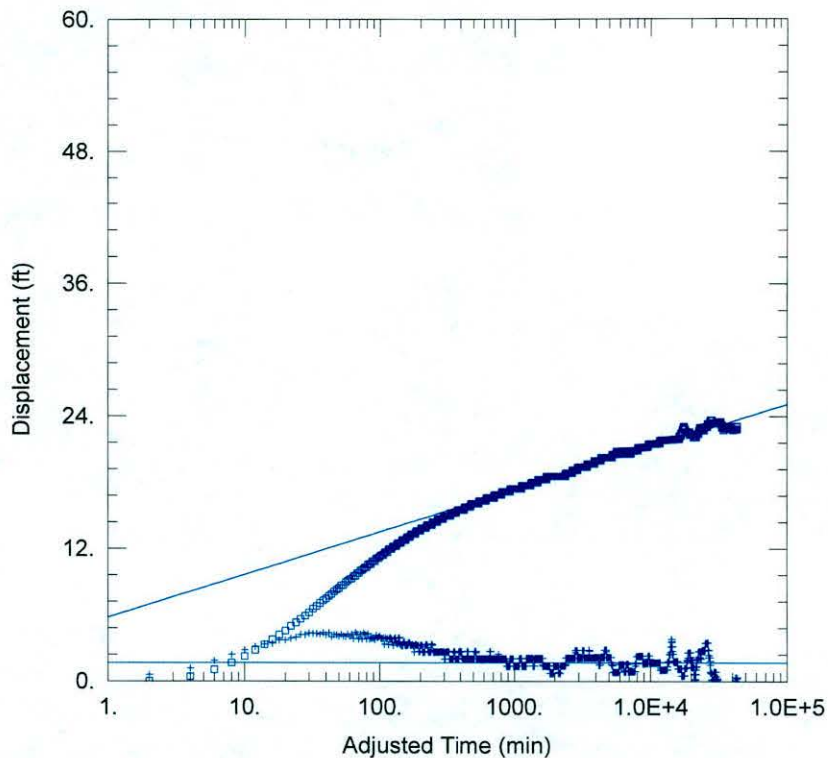
Solution Method: Theis

T = 3000.4 ft²/day

S = 1.641E-6

Kz/Kr = 1.

b = 14. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L1 conf cj.aqt

Date: 05/10/21

Time: 15:51:13

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 14. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L1 transducer	2701439.593	288424.386

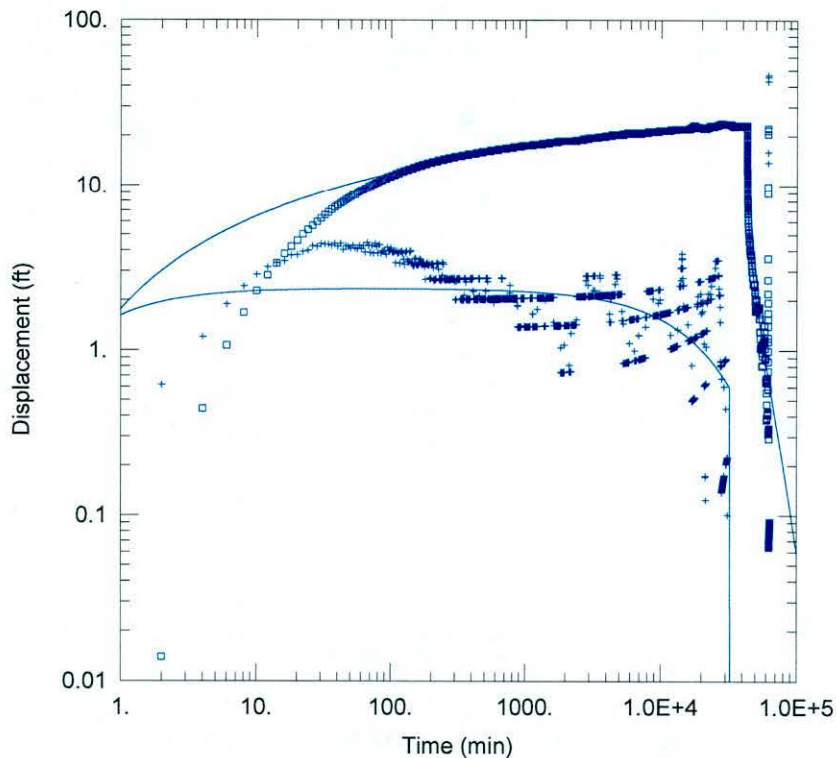
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 3222.3 ft²/day

S = 5.061E-7



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L1 leaky hj.aqt

Date: 05/10/21

Time: 15:49:32

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L1 transducer	2701439.593	288424.386

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

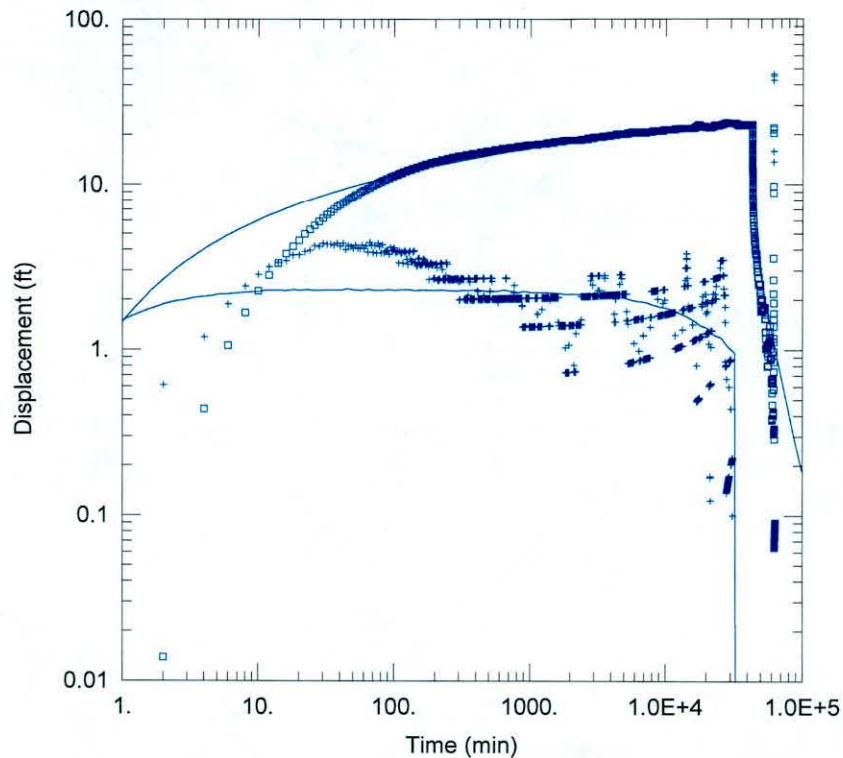
T = 2300.3 ft²/day

S = 7.666E-6

r/B = 0.007999

Kz/Kr = 1.

b = 14. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L1 leaky nw.aqt

Date: 05/10/21

Time: 15:49:06

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 14. ft

Anisotropy Ratio (K_z/K_r): 1.

Aquitard Thickness (b'): 26. ft

Aquitard Thickness (b''): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L1 transducer	2701439.593	288424.386

SOLUTION

Aquifer Model: Leaky

Solution Method: Neuman-Witherspoon

$T = 2278. \text{ ft}^2/\text{day}$

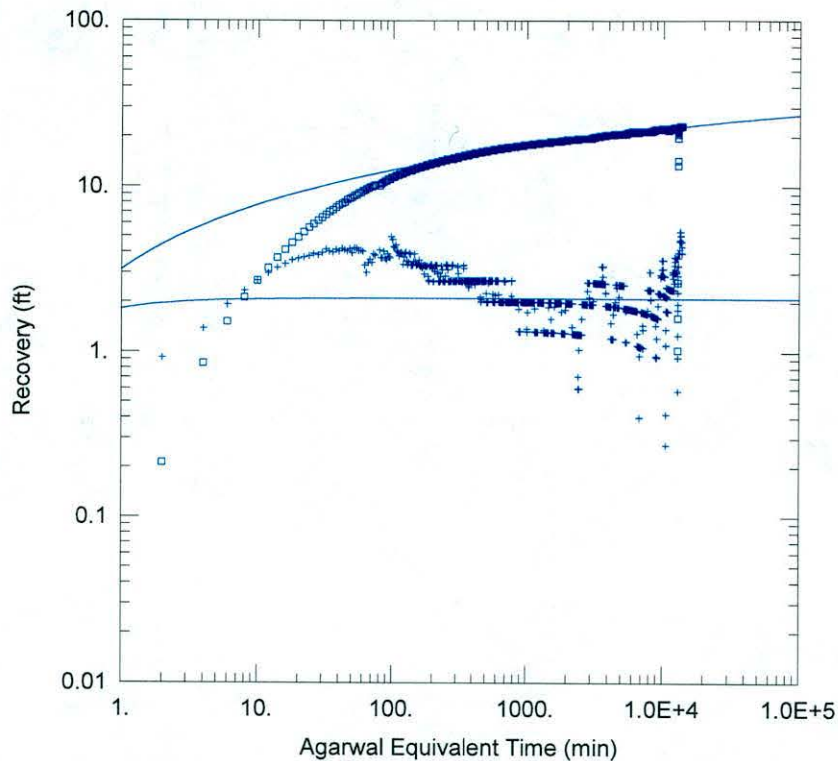
$S = 9.101\text{E-}6$

$r/B = 0.007586$

$\beta = 0.00129$

$T2 = 0.02377 \text{ ft}^2/\text{day}$

$S2 = 0.9578$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\VL1 conf theis agarwal.aqt

Date: 05/10/21

Time: 15:50:52

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L1 transducer	2701439.593	288424.386

SOLUTION

Aquifer Model: Confined

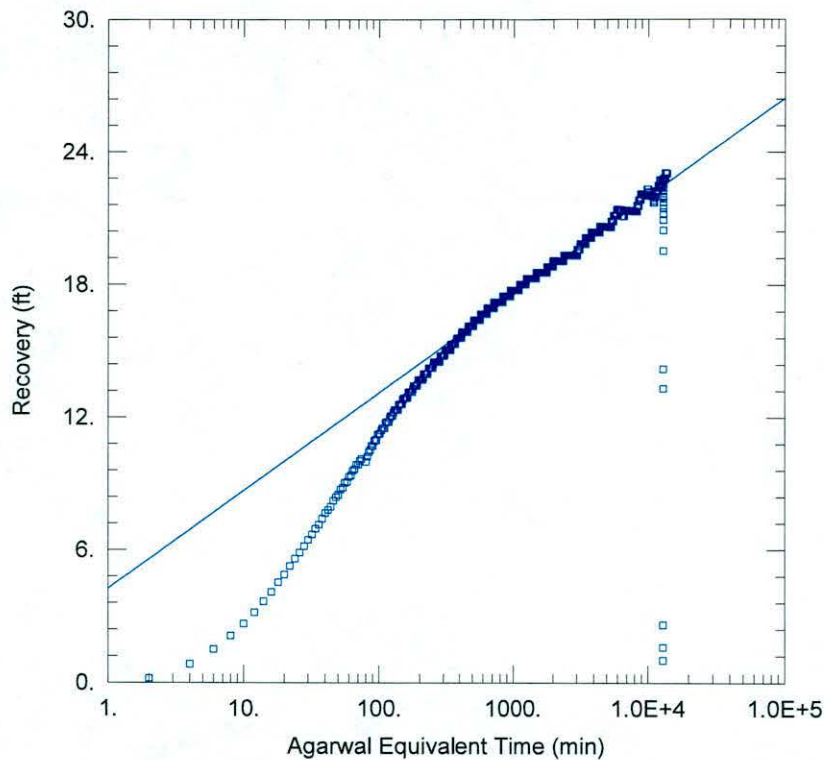
Solution Method: Theis

T = 2578.4 ft²/day

S = 3.366E-6

Kz/Kr = 1.

b = 14. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\L1 conf cj agarwal.agt

Date: 05/11/21

Time: 10:47:47

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 14. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	L1 transducer	2701439.593	288424.386

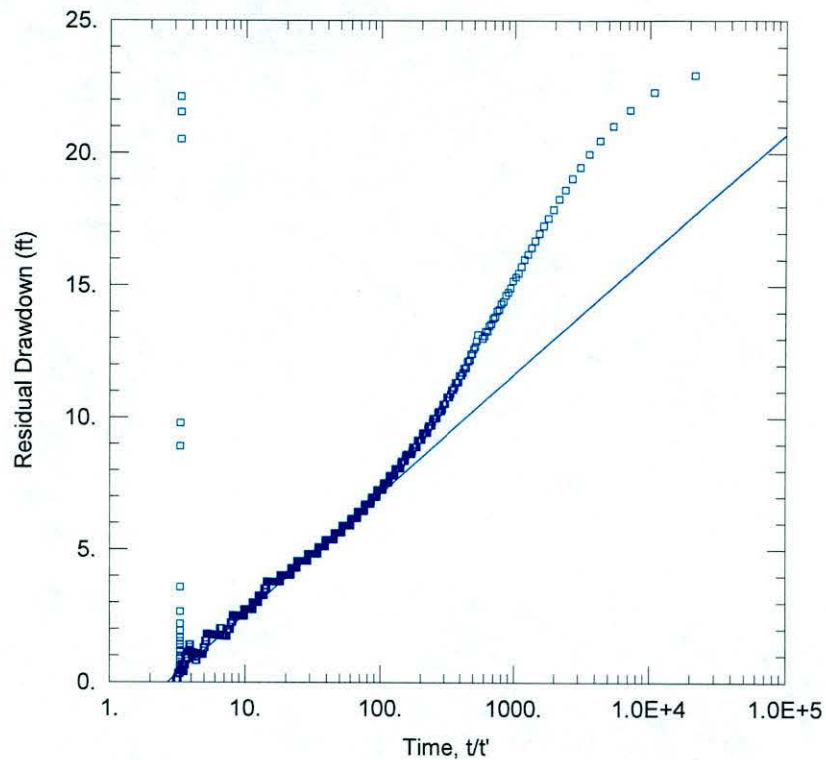
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

$T = 2806.5 \text{ ft}^2/\text{day}$

$S = 1.532\text{E-}6$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\L1 conf theis recovery.aqt

Date: 05/10/21

Time: 15:50:22

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 14. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
L1 transducer	2701439.593	288424.386

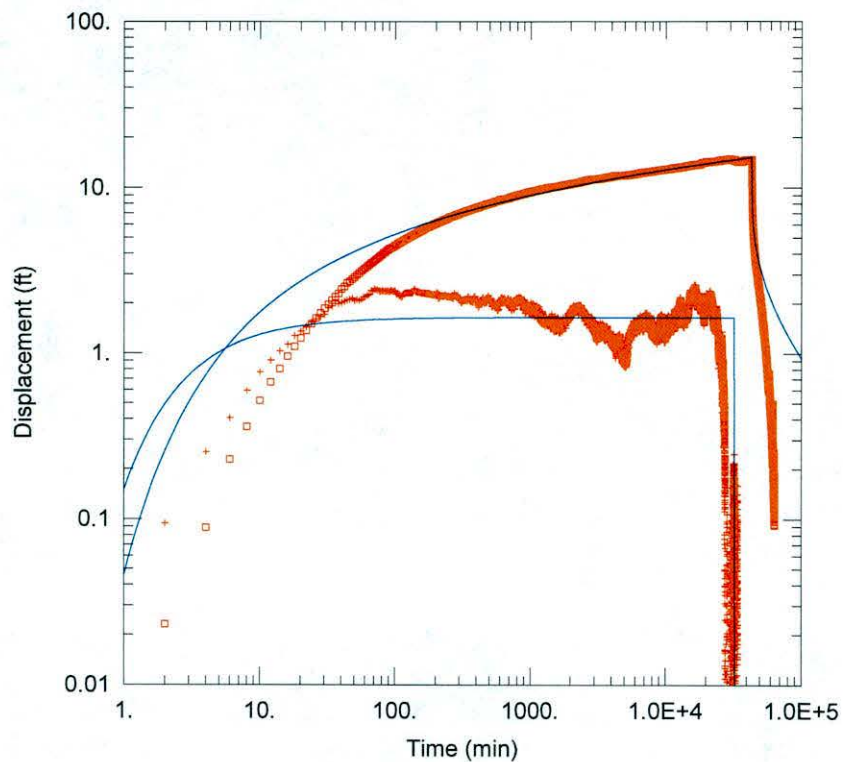
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 2750. ft²/day

S/S' = 2.72



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NMW conf theis.aqt

Date: 05/10/21

Time: 16:49:51

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
NMW transducer	2701727.518	289778.493

SOLUTION

Aquifer Model: Confined

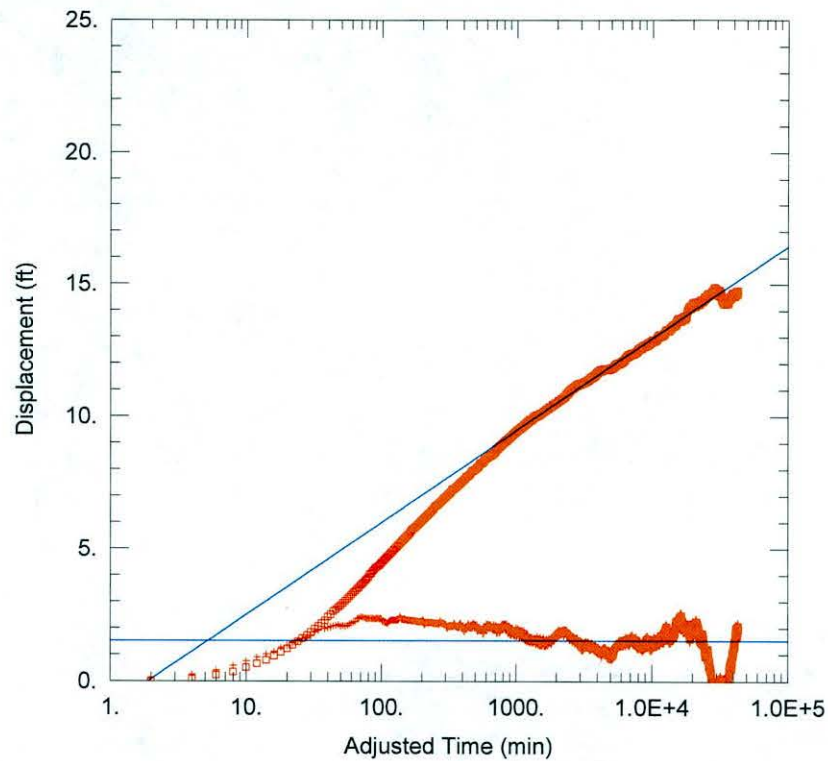
Solution Method: Theis

T = 3262. ft²/day

S = 2.322E-5

Kz/Kr = 1.

b = 19. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\NMW conf cj.aqt

Date: 05/10/21

Time: 16:47:11

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 19. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
NMW transducer	2701727.518	289778.493

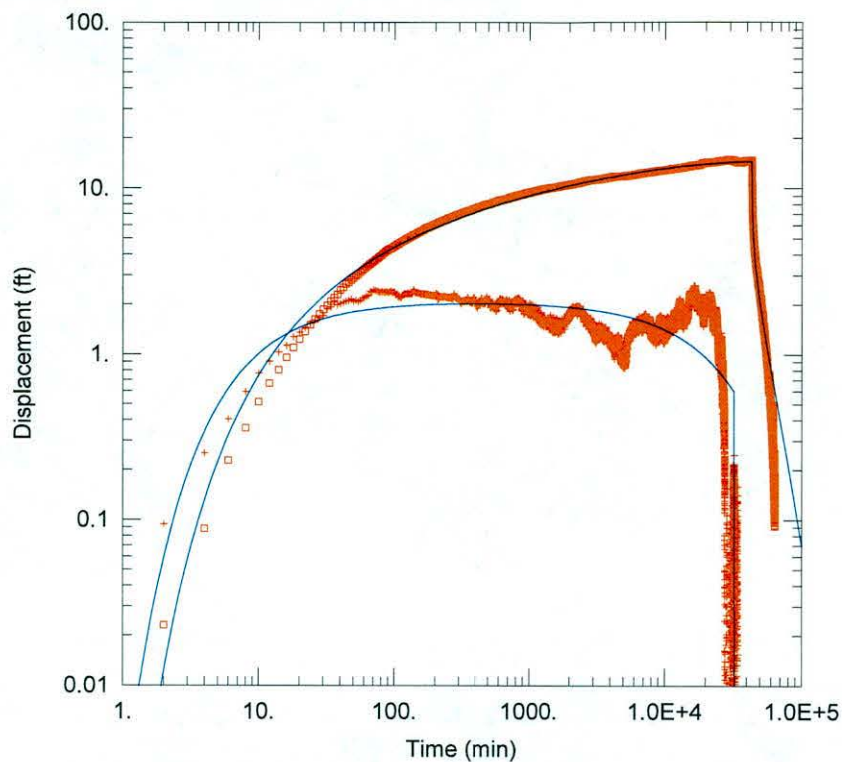
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 3576.7 ft²/day

S = 1.14E-5



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NMW leaky hj.aqt

Date: 05/10/21

Time: 16:45:07

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
NMW transducer	2701727.518	289778.493

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

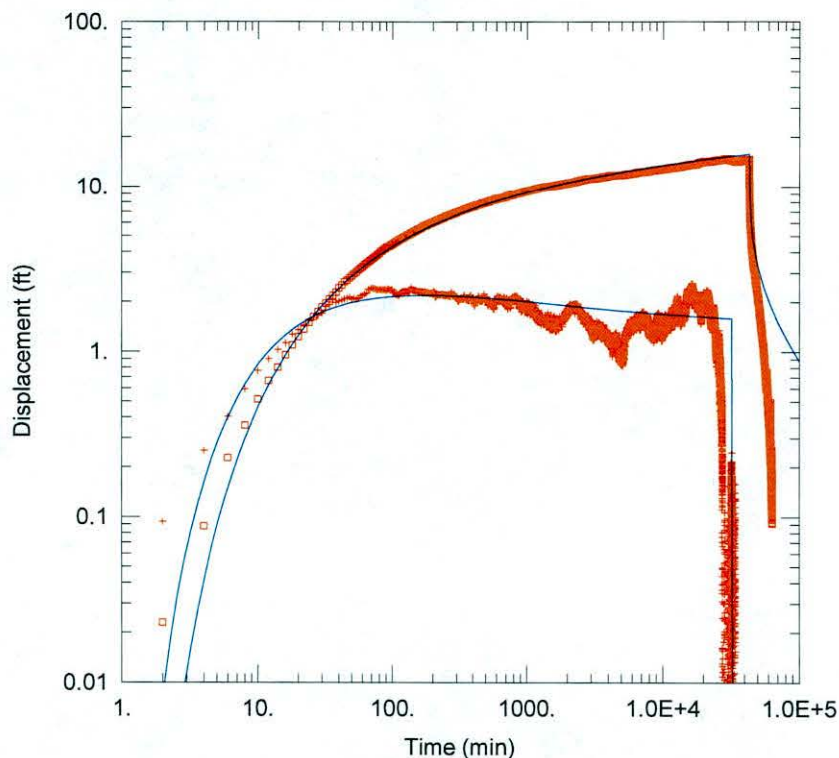
T = 2576.9 ft²/day

S = 5.507E-5

r/B = 0.03354

Kz/Kr = 1.

b = 19. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\NMW leaky nw.aqt

Date: 05/10/21

Time: 16:47:39

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 19. ft

Anisotropy Ratio (K_z/K_r): 1.

Aquitard Thickness (b'): 66. ft

Aquitard Thickness (b''): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
NMW transducer	2701727.518	289778.493

SOLUTION

Aquifer Model: Leaky

Solution Method: Neuman-Witherspoon

$T = 1851.2 \text{ ft}^2/\text{day}$

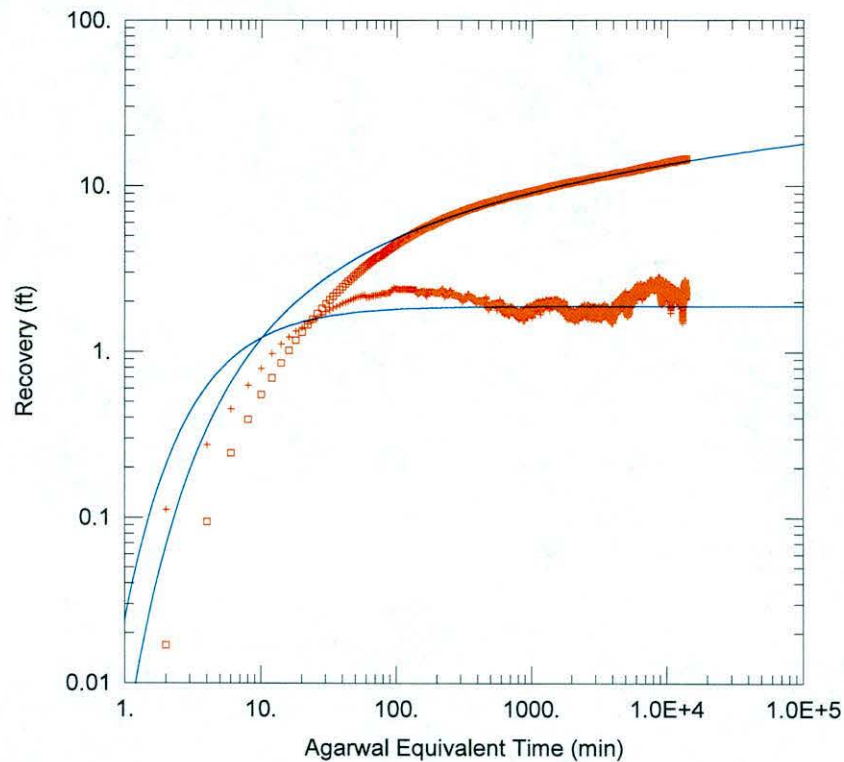
$S = 6.177\text{E-}5$

$r/B = 0.04571$

$\beta = 0.05537$

$T2 = 2.605\text{E+}7 \text{ ft}^2/\text{day}$

$S2 = 1.0\text{E-}10$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NMW conf theis agarwal.aqt
 Date: 05/10/21 Time: 16:48:49

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	NMW transducer	2701727.518	289778.493

SOLUTION

Aquifer Model: Confined

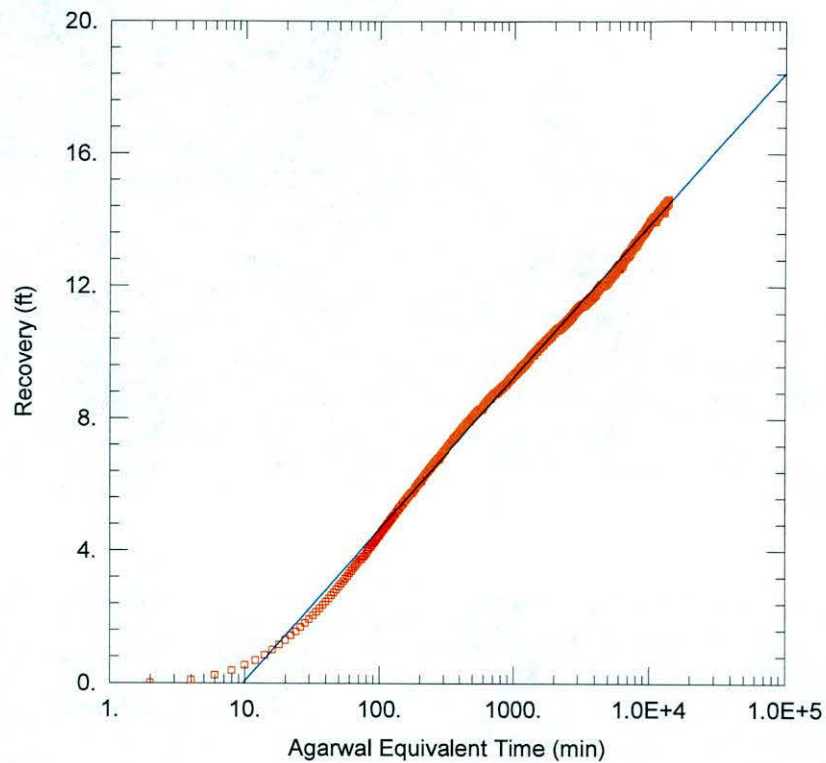
Solution Method: Theis

$T = 2841.1 \text{ ft}^2/\text{day}$

$S = 3.733\text{E-}5$

$Kz/Kr = 1.$

$b = 19. \text{ ft}$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NMW conf cj agarwal.aqt
 Date: 05/11/21 Time: 10:50:25

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

AQUIFER DATA

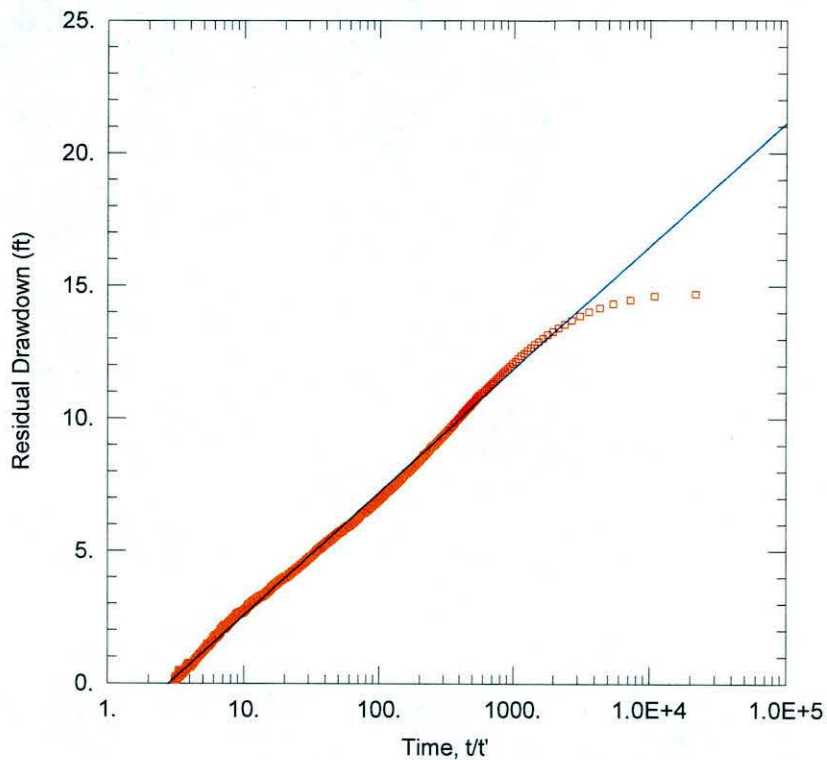
Saturated Thickness: 19. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	NMW transducer	2701727.518	289778.493

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob
 T = 2713.2 ft²/day S = 4.373E-5



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NMW conf theis recovery.aqt

Date: 05/10/21

Time: 16:45:37

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 19. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
NMW transducer	2701727.518	289778.493

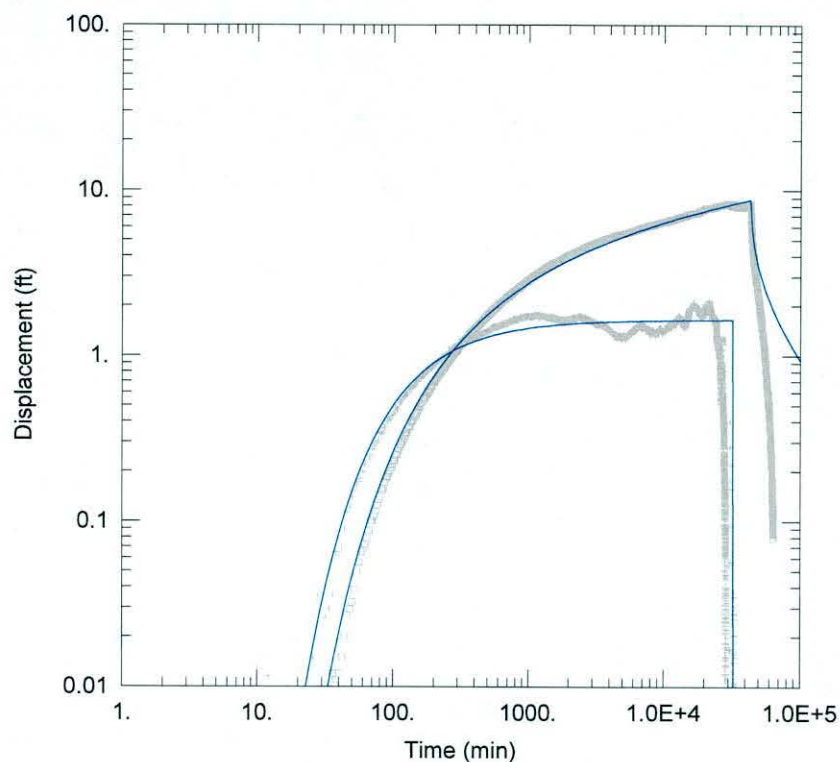
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 2684.8 \text{ ft}^2/\text{day}$

$S/S' = 2.773$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NNMW conf theis.aqt

Date: 05/10/21

Time: 14:24:32

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
NNMW	2701941.46	292486.668

SOLUTION

Aquifer Model: Confined

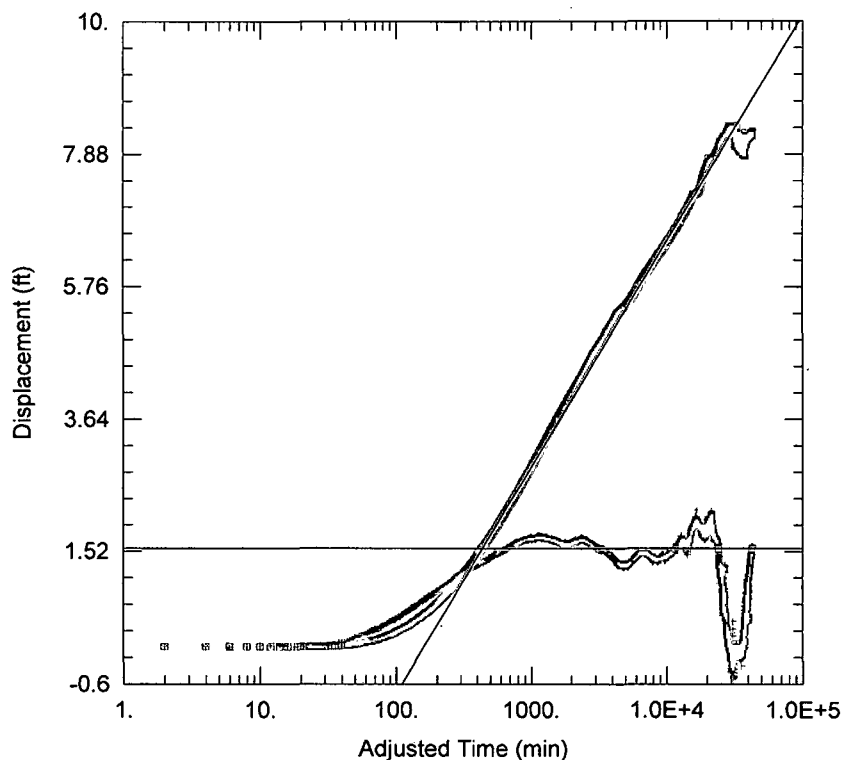
Solution Method: Theis

T = 3289.1 ft²/day

S = 8.124E-5

Kz/Kr = 1.

b = 18. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NNMW conf cj.aqt

Date: 05/10/21

Time: 14:25:34

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 18 ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
□ NNMW	2701941.46	292486.668

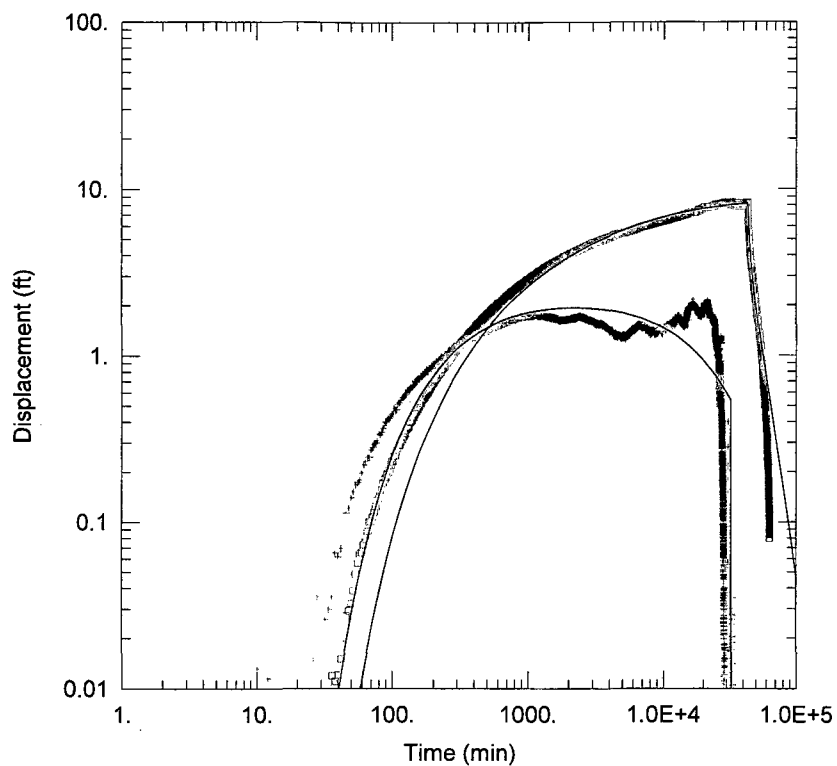
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 3444.1 ft²/day

S = 6.407E-5



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\NNMW leaky hj.aqt

Date: 05/10/21

Time: 14:26:10

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	NNMW	2701941.46	292486.668

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

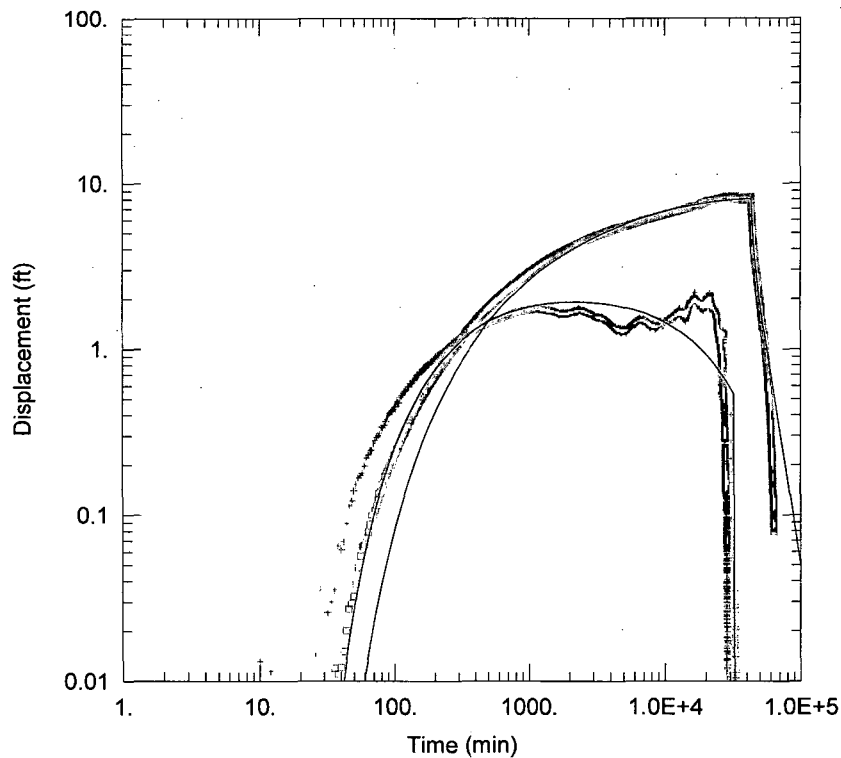
T = 2279.3 ft²/day

S = 0.0001069

r/B = 0.2048

Kz/Kr = 1.

b = 18. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NNMW leaky nw.aqt

Date: 05/10/21

Time: 14:26:53

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 18. ft

Anisotropy Ratio (Kz/Kr): 1.

Aquitard Thickness (b'): 71. ft

Aquitard Thickness (b''): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
NNMW	2701941.46	292486.668

SOLUTION

Aquifer Model: Leaky

Solution Method: Neuman-Witherspoon

T = 2284.1 ft²/day

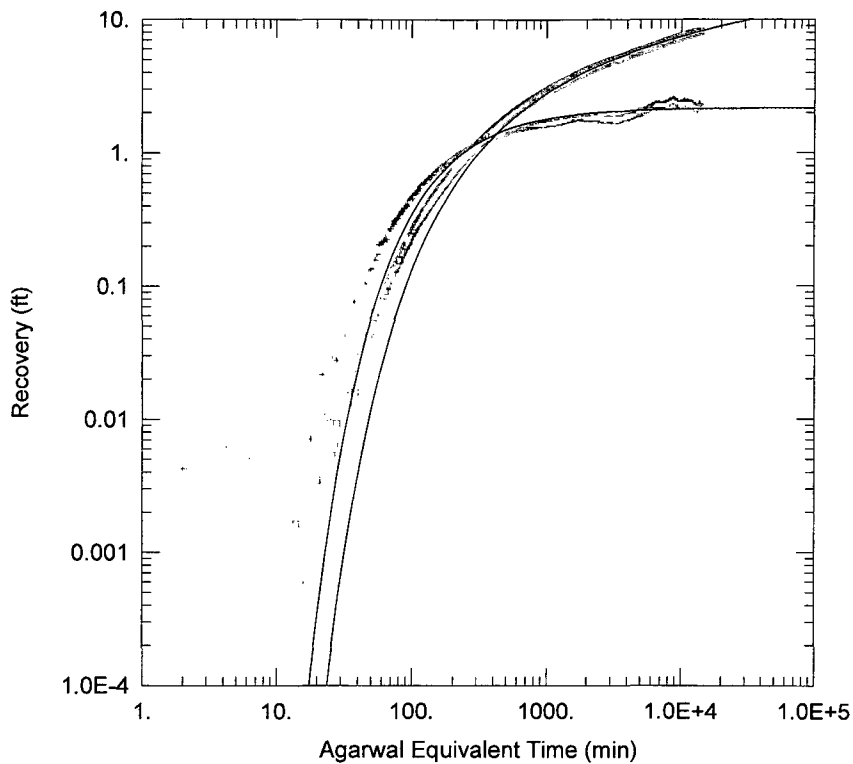
S = 0.0001066

r/B = 0.2039

β = 1.056E-5

T2 = 0.02746 ft²/day

S2 = 0.9617



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NNMW conf theis agarwal.aqt
 Date: 05/10/21 Time: 14:39:33

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	NNMW	2701941.46	292486.668

SOLUTION

Aquifer Model: Confined

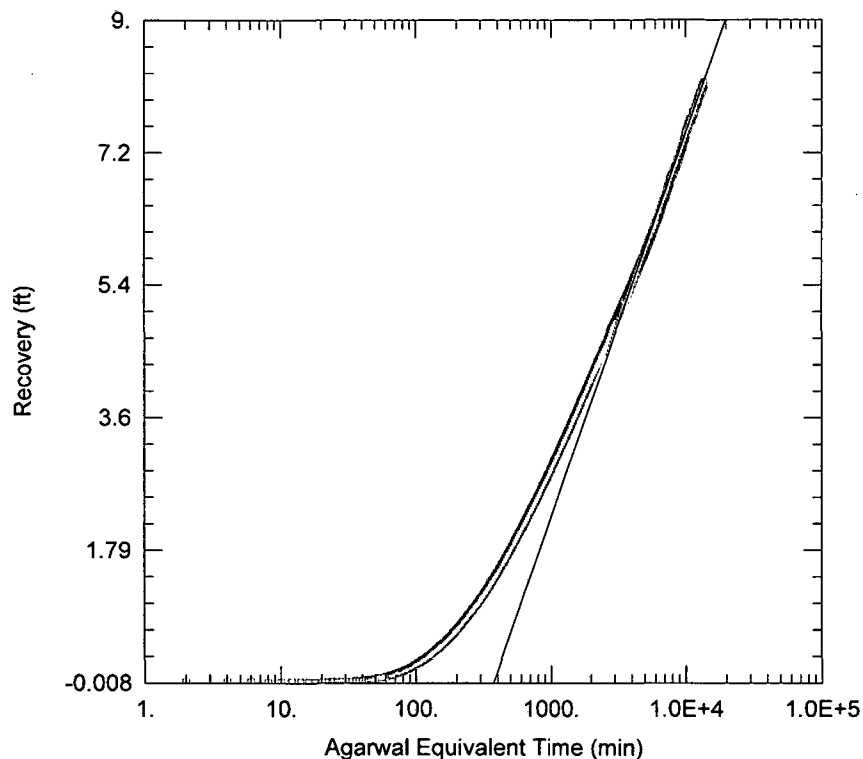
Solution Method: Theis

T = 2510.8 ft²/day

S = 9.566E-5

Kz/Kr = 1.

b = 18. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NNMW conf cj agarwal.aqt

Date: 05/11/21

Time: 10:52:43

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 18 ft

Anisotropy Ratio (K_z/K_r): 1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
□ NNMW	2701941.46	292486.668

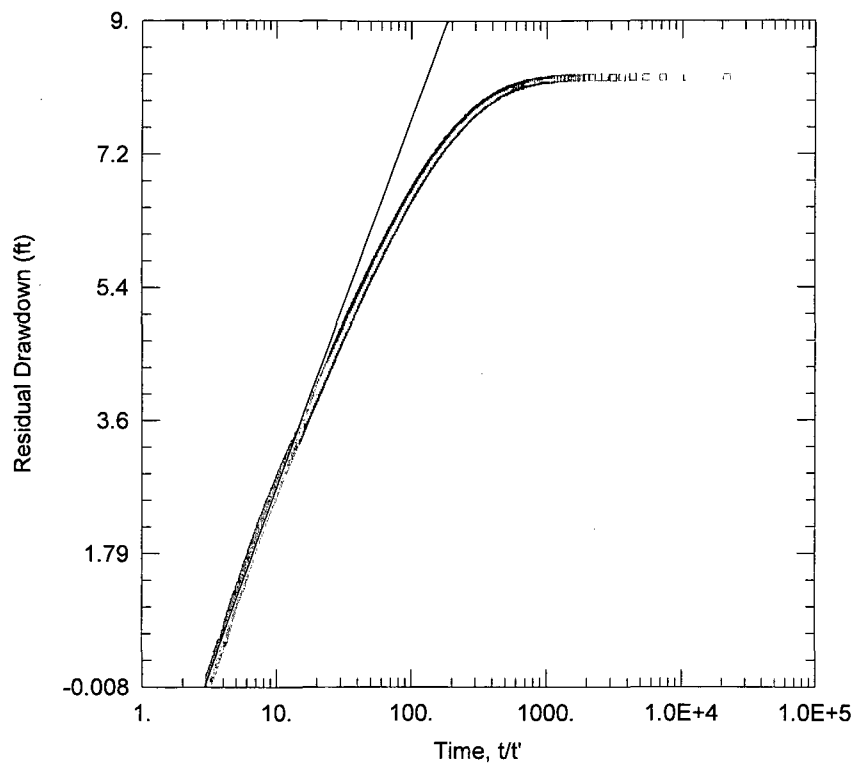
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 2382.7 ft²/day

S = 0.000103



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\NNMW conf theis recovery.aqt

Date: 05/10/21

Time: 14:27:07

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 18. ft

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
NNMW	2701941.46	292486.668

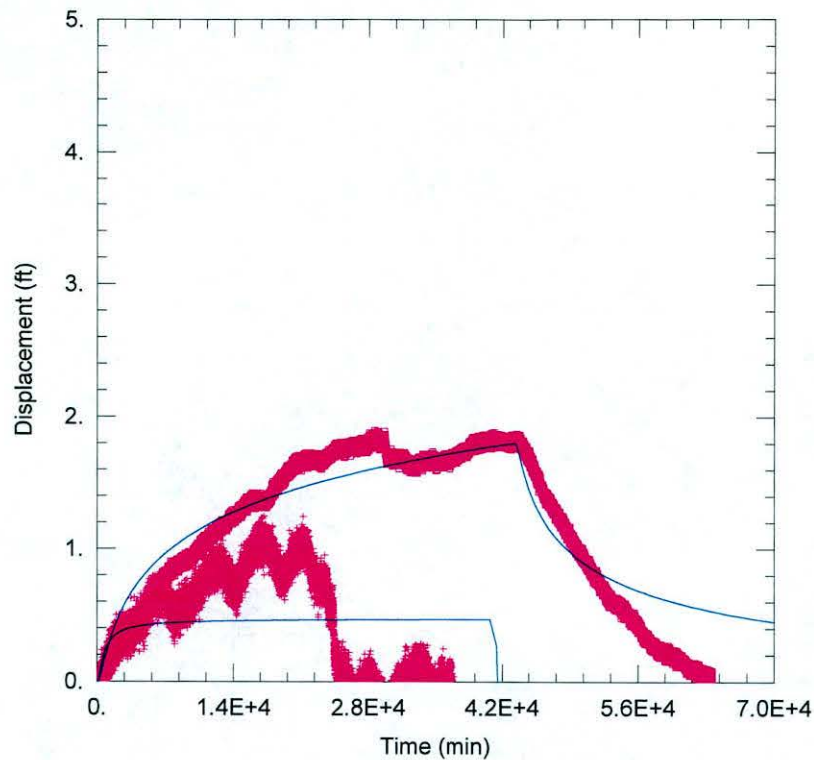
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 2495 \text{ ft}^2/\text{day}$

$S/S' = 2.92$



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\SWMW-D conf theis.aqt

Date: 05/10/21

Time: 16:58:16

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
□ SWMW-D transducer	2698144.111	285055.651

SOLUTION

Aquifer Model: Confined

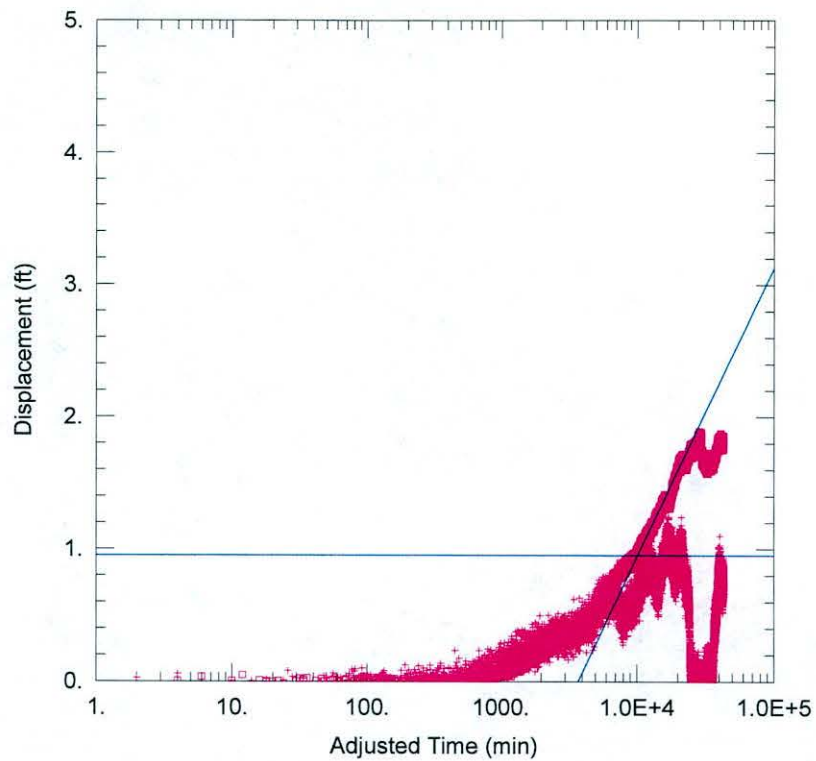
Solution Method: Theis

T = 1.134E+4 ft²/day

S = 0.0006335

Kz/Kr = 1.

b = 12. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\SWMW-D conf cj.aqt
 Date: 05/11/21 Time: 10:55:51

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

AQUIFER DATA

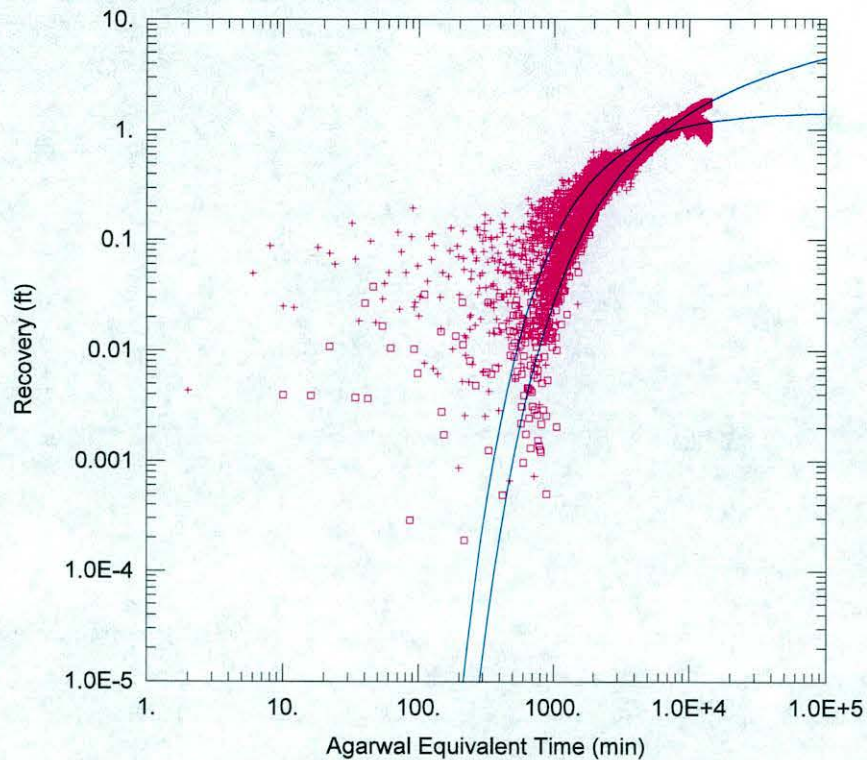
Saturated Thickness: 12. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	SWMW-D transducer	2698144.111	285055.651

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob
 T = 5685.6 ft²/day S = 0.001193



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\SWMW-D conf theis agarwal.aqt

Date: 05/10/21

Time: 16:59:13

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
□ SWMW-D transducer	2698144.111	285055.651

SOLUTION

Aquifer Model: Confined

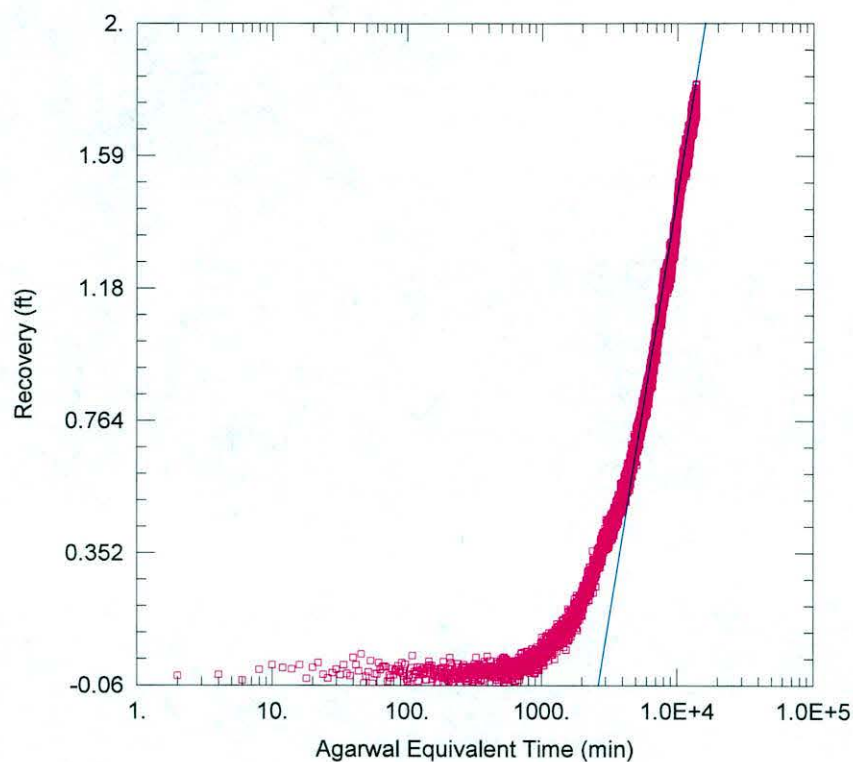
Solution Method: Theis

T = 3756.5 ft²/day

S = 0.001018

Kz/Kr = 1.

b = 12. ft



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesol\SWMW-D conf cj agarwal.aqt

Date: 05/11/21

Time: 10:58:02

PROJECT INFORMATION

Company: LRE Water

Client: Banner

Project: 5509BAN01

Location: Lake Norden, SD

Test Well: L2

Test Date: 2021

AQUIFER DATA

Saturated Thickness: 12. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25

Observation Wells

Well Name	X (ft)	Y (ft)
□ SWMW-D transducer	2698144.111	285055.651

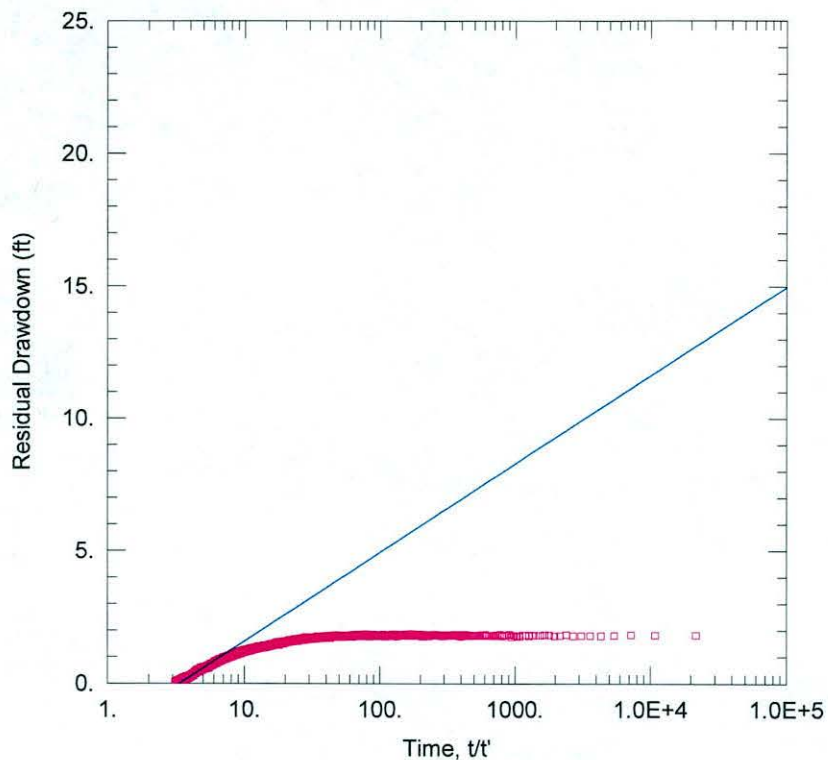
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 4729.1 ft²/day

S = 0.0007421



WELL TEST ANALYSIS

Data Set: C:\Projects\Lake Norden\Aqtesolv\SWMW-D conf theis recovery.aqt
 Date: 05/10/21 Time: 16:58:33

PROJECT INFORMATION

Company: LRE Water
 Client: Banner
 Project: 5509BAN01
 Location: Lake Norden, SD
 Test Well: L2
 Test Date: 2021

AQUIFER DATA

Saturated Thickness: 12. ft Anisotropy Ratio (K_z/K_r): 1.

WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (ft)	Y (ft)	Well Name	X (ft)	Y (ft)
L2 transducer	2701840.16	288814.25	SWMW-D transducer	2698144.111	285055.651

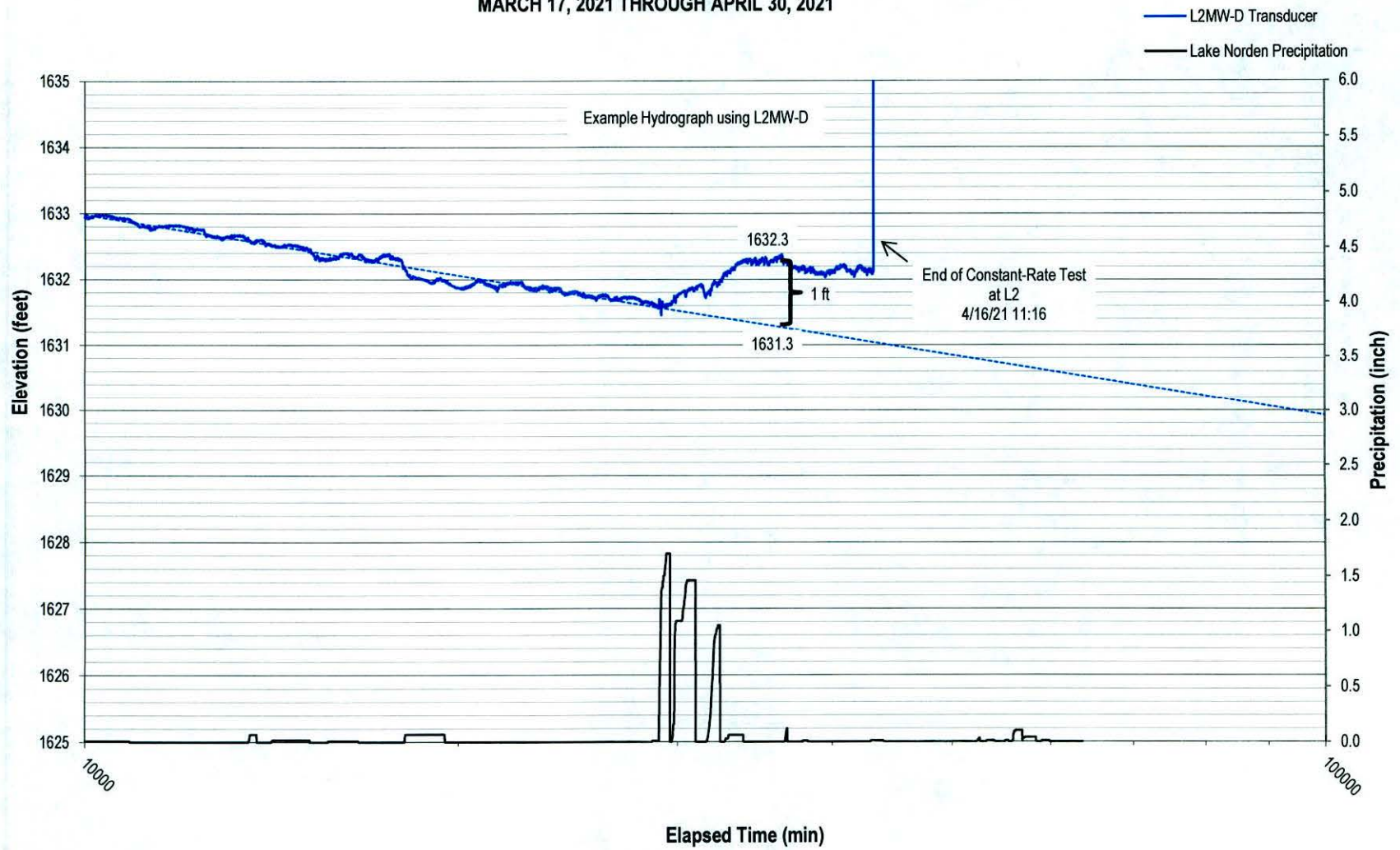
SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)
 $T = 3726.6 \text{ ft}^2/\text{day}$ $S/S' = 3.303$

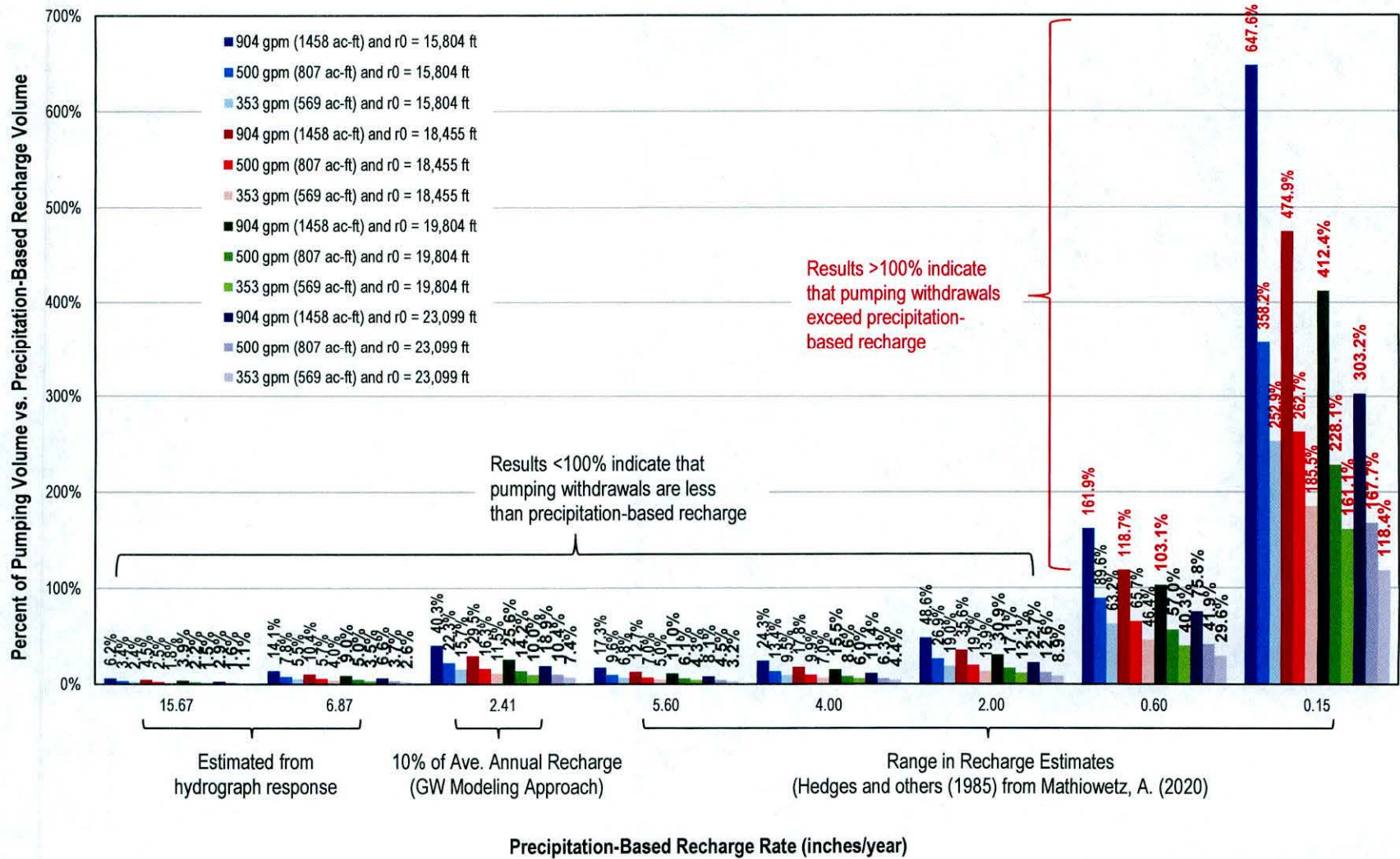
30-Day Aquifer Pumping Test
Prairie Coteau Well Field
Lake Norden, SD

APPENDIX G

ELEVATION VS ELAPSED TIME (SEMI-LOG)
 PRAIRIE COTEAU WELL FIELD
 LAKE NORDEN, SD
 MARCH 17, 2021 THROUGH APRIL 30, 2021



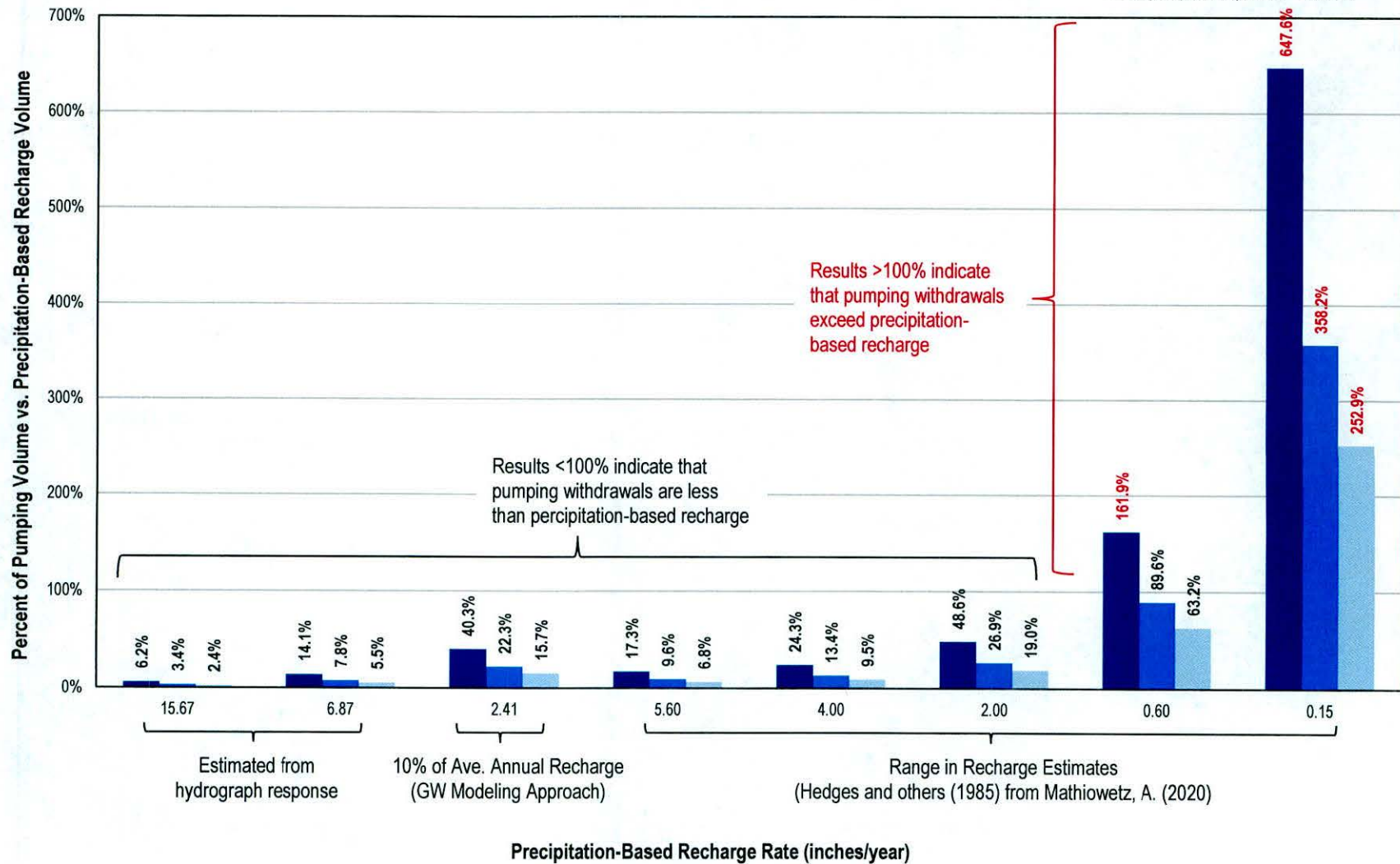
PERCENT OF PUMPING VOLUME VS. PRECIPITATION-BASED RECHARGE VOLUME
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD



PERCENT OF PUMPING VOLUME VS. PRECIPITATION-BASED RECHARGE VOLUME
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD

$r_0 = 15,804$ ft

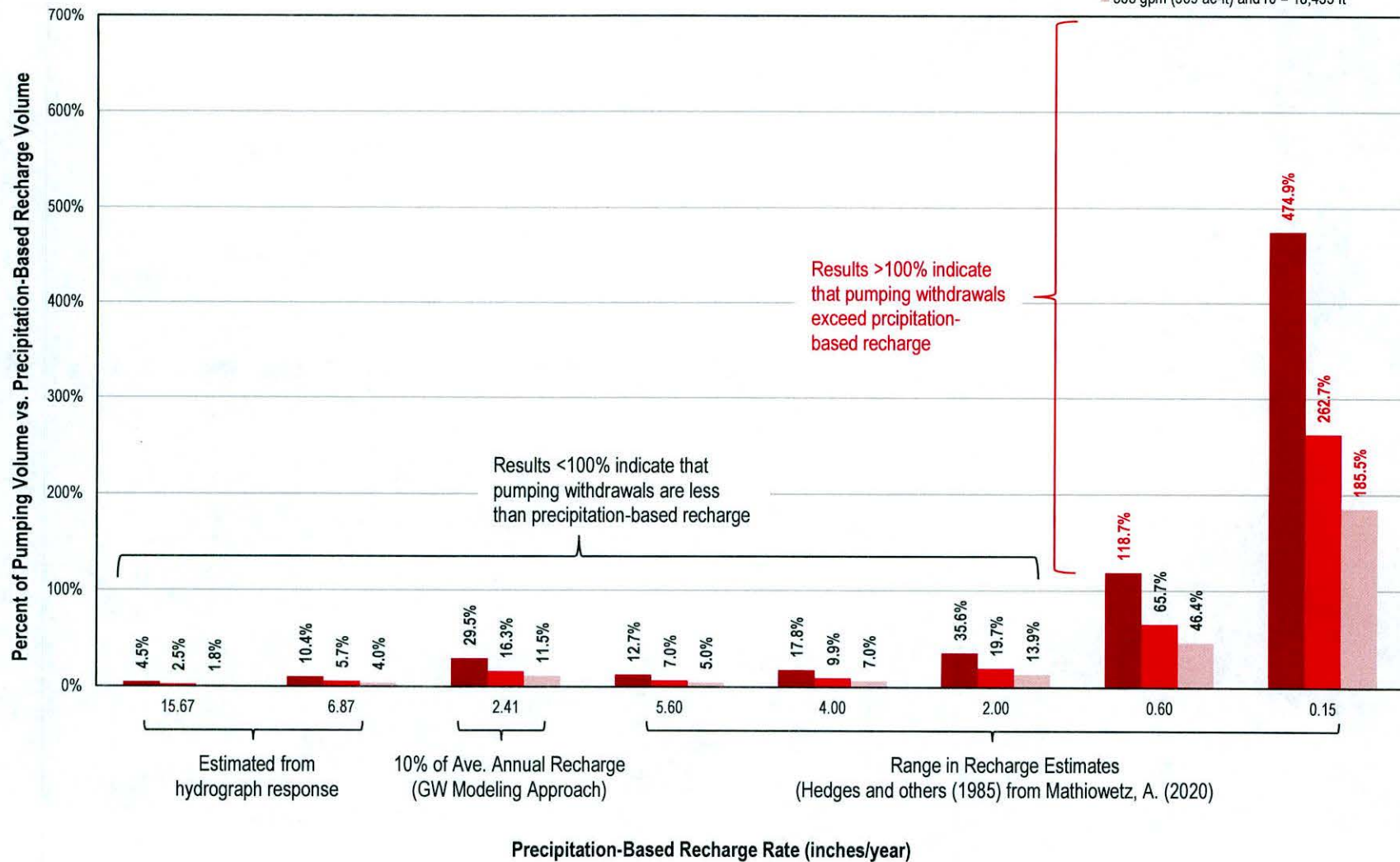
- 904 gpm (1458 ac-ft) and $r_0 = 15,804$ ft
- 500 gpm (807 ac-ft) and $r_0 = 15,804$ ft
- 353 gpm (569 ac-ft) and $r_0 = 15,804$ ft



PERCENT OF PUMPING VOLUME VS. PRECIPITATION-BASED RECHARGE VOLUME
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD

$r_0 = 18,455$ ft

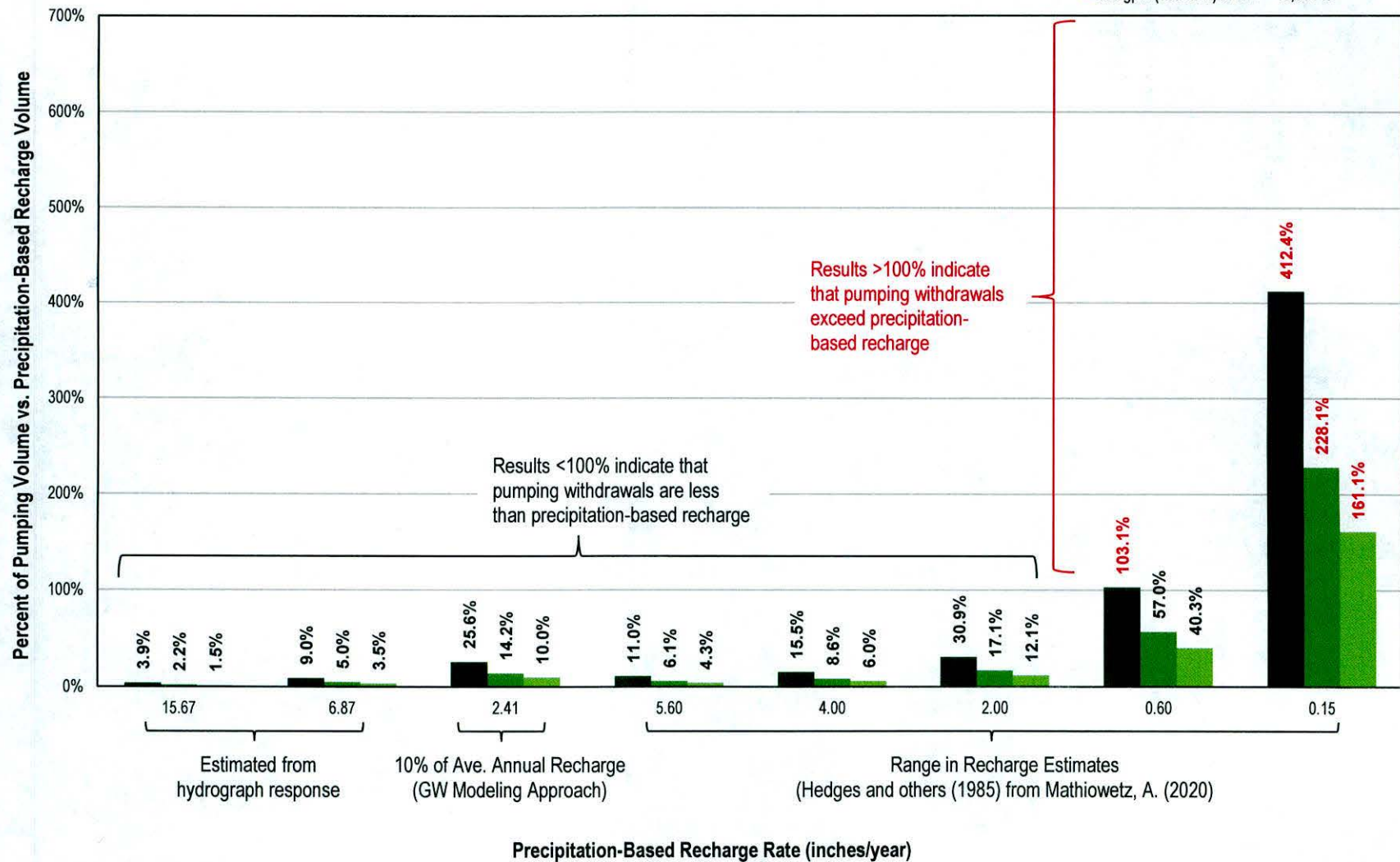
- 904 gpm (1458 ac-ft) and $r_0 = 18,455$ ft
- 500 gpm (807 ac-ft) and $r_0 = 18,455$ ft
- 353 gpm (569 ac-ft) and $r_0 = 18,455$ ft



PERCENT OF PUMPING VOLUME VS. PRECIPITATION-BASED RECHARGE VOLUME
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD

$r_0 = 19,804$ ft

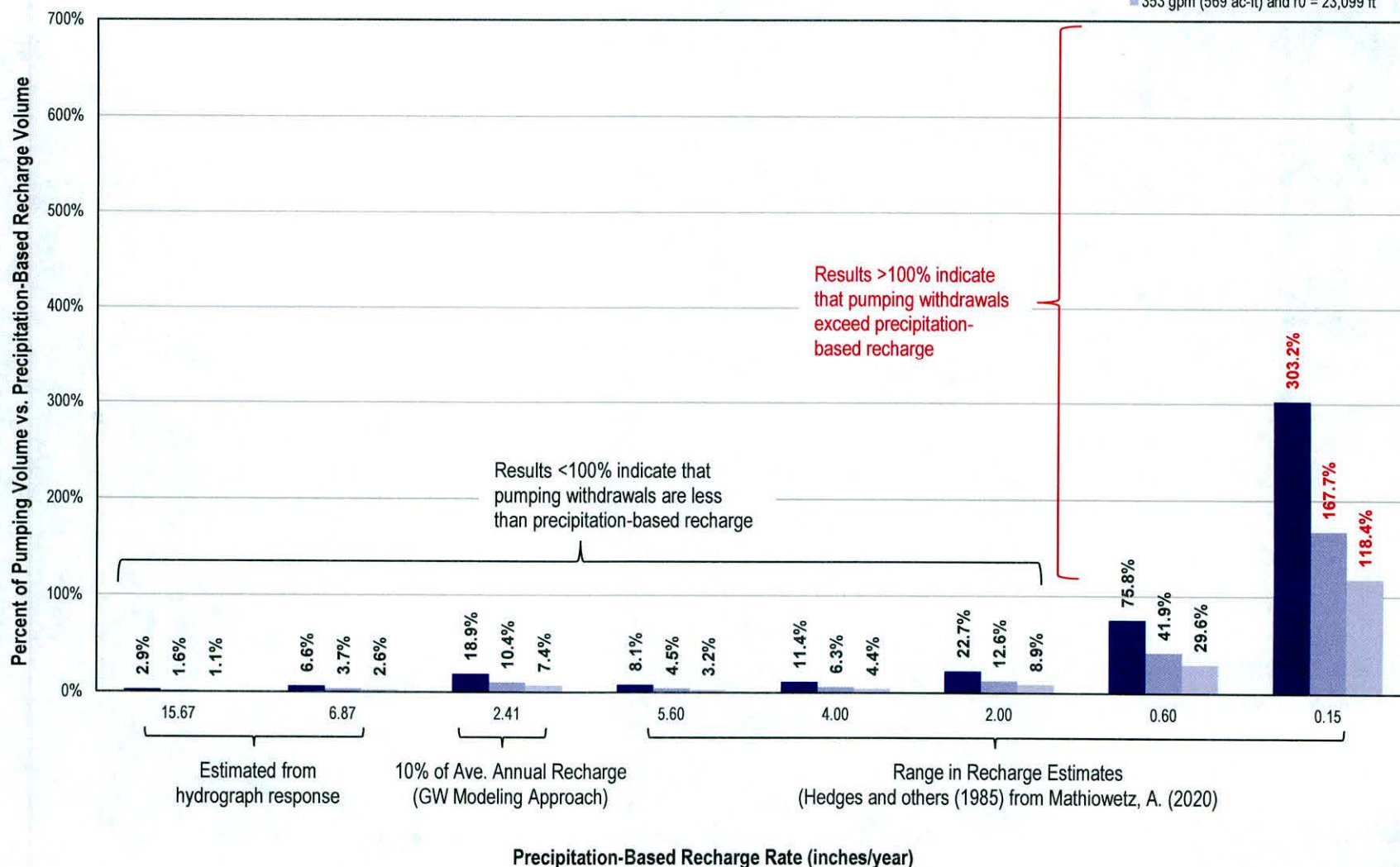
- 904 gpm (1458 ac-ft) and $r_0 = 19,804$ ft
- 500 gpm (807 ac-ft) and $r_0 = 19,804$ ft
- 353 gpm (569 ac-ft) and $r_0 = 19,804$ ft



PERCENT OF PUMPING VOLUME VS. PRECIPITATION-BASED RECHARGE VOLUME
PRAIRIE COTEAU WELL FIELD
LAKE NORDEN, SD

$r_0 = 23,099$ ft

- 904 gpm (1458 ac-ft) and $r_0 = 23,099$ ft
- 500 gpm (807 ac-ft) and $r_0 = 23,099$ ft
- 353 gpm (569 ac-ft) and $r_0 = 23,099$ ft



Gronlund, Eric

From: Gronlund, Eric
Sent: Wednesday, June 2, 2021 4:22 PM
To: Dennis Odens
Cc: Mathiowetz, Adam (DENR)
Subject: Lake Norden

Dennis - Not certain who this should this question be directed to but I'll start with you. Please forward as you deem appropriate.

Adam Mathiowetz is currently reviewing the report by LRE that analyzed the pump test at Lake Norden's Prairie Coteau aquifer well field.

Th original application proposed to appropriate an annual volume of 1,458 acre feet of water at a maximum pump rate of 2.11 cubic feet of water per second (947 gpm). The annual volume equates to pumping 95% of the time. Does the city still intend to request the maximum pump rate and annual volume requested as set forth on the original application? As you know through our discussions over the past months various pump rates and annual volume requirements have been discussed. The Water Rights Program seeks confirmation of the volume and pump rate intended to be developed from the Prairie Coteau aquifer.

If it is other than what is requested on the application, the city will need to submit a letter stating the amount (annual volume / maximum pump rate). As long as the request is not for a greater amount of water, public notice will not need to be published again.

Please feel free to contact Adam or me if you have questions.



Eric Gronlund, PE
Chief Engineer, Water Rights Program
Department of Agriculture and Natural Resources
523 E. Capitol Ave. Pierre SD, 57501
605.773.3352
danr.sd.gov

RECEIVED

JUN 07 2021

WATER RIGHTS
PROGRAM

CITY OF LAKE NORDEN

508 MAIN AVENUE
PO BOX 213
LAKE NORDEN, SD 57248-0213



"This institution is an equal opportunity provider, and employer."

Telephone 605-785-3602

Fax 605-785-3604

June 4, 2021

Eric Gronlund
Water Rights Program
523 E Capitol
Pierre SD 57501

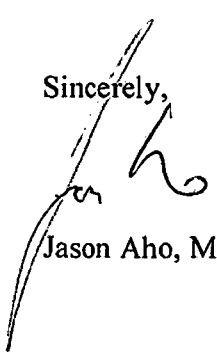
Re: Water Rights Permit Request 8433-3 amendment

Dear Mr. Gronlund:

LRE Water has completed the analysis of the Prairie Coteau aquifer where the City of Lake Norden has installed 3 wells. The LRE report outlines and recommends the volume of water to be withdrawn from the aquifer where the wells have been developed. This letter is written to amend our Water Rights Permit application 8433-3 to an annual volume withdrawal of 967 acre-ft with a maximum instantaneous diversion rate of 1.34 cfs. Please make this amendment and use these revised numbers as you consider permit application 8433-3.

We intend to submit another permit for a reservation for future water use in the Prairie Coteau Aquifer which will allow the city to continue to investigate this aquifer as a future water supply for the City of Lake Norden.

Sincerely,



Jason Aho, Mayor



**DEPARTMENT of AGRICULTURE
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 E. CAPITOL AVE
PIERRE SD 57501-3182
danr.sd.gov

June 16, 2021

NOTICE OF HEARING

TO: Jason Aho, Mayor
City of Lake Norden
PO Box 213
Lake Norden SD 57248

FROM: Eric Gronlund, Chief Engineer
Water Rights Program

SUBJECT: Scheduling of Hearing on Deferred Water Permit Application No. 8433-3, City of Lake Norden

On October 7, 2020, the South Dakota Water Management Board deferred Water Permit Application No. 8433-3 for further study in order for the city to provide information to assist with determining if there is unappropriated water available and the potential effect of pumping on existing users. Subsequently, the city undertook a 30-day aquifer pumping test at Lake Norden's Prairie Coteau aquifer well field. The analysis and results of the test performed by LRI Water was provided to the Water Rights Program on May 21, 2021.

Enclosed is DANR Water Rights Program's supplemental report and the Chief Engineer's revised recommendation on Application No. 8433-3. The recommendation is for APPROVAL of Application No. 8433-3 with qualifications as listed in the recommendation.

The Water Management Board will conduct a hearing to consider deferred Application No. 8433-3 at 9:30 AM (Central Time) on Wednesday, July 7, 2021, at the Floyd Matthew Training Center, Joe Foss Building, 523 E. Capitol Avenue, Pierre SD. **Please be aware a municipality is required to be represented by legal counsel in this administrative proceeding.** To participate in the hearing, you have two options:

Option 1. Attend the meeting in person at the Matthew Training Center in Pierre. Please note you will need to enter the Joe Foss Building from Capitol Avenue main entrance and check in at the lobby desk to get access to the Matthew Training Center meeting room.

Option 2. Audio/visual via the internet using Pexip. To be seen and heard requires a device equipped with a camera and microphone. No software install is necessary, the recommended web browser is Google Chrome. To participate, start Google Chrome and navigate to <https://ddn.sd.gov>. You will join the meeting by:

- Entering the Conference ID which is 25899
- Adding your name, and
- Selecting "guest" for the role.

Applicable provisions of the public notice published in the Hamlin Co. Herald Enterprise and Public Opinion on June 29, 2020, still apply.

Enclosure

c: Gregg Jorgenson, Banner Associates
Ann Mines Bailey, Assistant Attorney General

CERTIFICATION

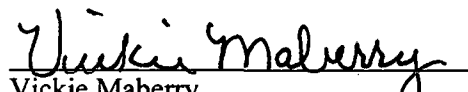
I hereby certify that on June 16, 2021, I have personally deposited with the United States mail at Pierre, South Dakota, first class postage, prepaid envelopes containing a Notice of Hearing dated June 16, 2021, regarding deferral of Water Right Permit Application No. 8433-3 and a revised recommendation, as addressed below:

Jason Aho, Mayor
City of Lake Norden
PO Box 213
Lake Norden SD 57248

Gregg Jorgenson
Banner Associates
PO Box 298
Brookings SD 57006

Sent Inter-office to:

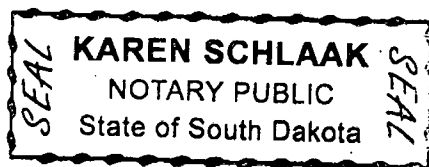
Ann Mines Bailey, Assistant Attorney General
1302 East Highway 14, Suite 1
Pierre SD 57501-8501


Vickie Maberry
Water Rights Program, DANR

STATE OF SOUTH DAKOTA)
) SS
COUNTY OF HUGHES)

Sworn to, before me, this 16th day of June, 2021.





Schlaak, Karen

From: Schlaak, Karen
Sent: Tuesday, July 21, 2020 2:51 PM
To: City of Lake Norden (cityln@itctel.com)
Cc: Gregg Jorgenson
Subject: Water Permit Application No. 8433-3
Attachments: Application No. 8433-3.pdf

Mayor Oho,

Attached is the chief engineer recommendation, Notice of Hearing and letter with instructions regarding the public notice for Application No. 8433-3, City of Lake Norden. As stated in the letter is it important that someone from your office contact the two papers to authorize publication and arrange for payment. This same information is being mailed to you.

Karen Schlaak

Water Rights Program
(605) 773-3352





**DEPARTMENT of AGRICULTURE
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 E. CAPITOL AVE
PIERRE SD 57501-3182
danr.sd.gov

**REVISED RECOMMENDATION OF CHIEF ENGINEER FOR WATER PERMIT
APPLICATION NO. 8433-3, City of Lake Norden**

Pursuant to SDCL 46-2A-2, the following is the revised recommendation of the Chief Engineer, Water Rights Program, Department of Agriculture and Natural Resources concerning Water Permit Application No. 8433-3, City of Lake Norden, Jason Aho, Mayor, PO Box 213, Lake Norden SD 57248.

The Chief Engineer is recommending APPROVAL of Application No. 8433-3 because 1) there is reasonable probability that there is unappropriated water available for the applicant's proposed use, 2) the proposed diversion can be developed without unlawful impairment of existing rights, 3) the proposed use is a beneficial use and 4) it is in the public interest with the following qualifications:

1. The wells approved under Water Permit No. 8433-3 will be located near domestic wells and other wells which may obtain water from the same aquifer. Water withdrawals under this Permit shall be controlled so there is not a reduction of needed water supplies in adequate domestic wells or in adequate wells having prior water rights.
2. The permit holder shall report to the Chief Engineer annually the amount of water withdrawn from the Prairie Coteau aquifer.
3. Water Permit No. 8433-3 authorizes a total annual diversion not exceeding 967 acre-feet of water annually from the Prairie Coteau aquifer.

See report on application for additional information.

Eric Gronlund, Chief Engineer
June 11, 2021

NOTE: The City of Lake Norden completed monitoring wells as part of the aquifer performance tests on the aquifer. South Dakota Department of Agriculture and Natural Resources (DANR) requests that the wells identified as NNMW, NEMW and SWMW-D become part of the state observation well network. This can be accomplished by the city agreeing to either transfer ownership of these three wells to the department, located in a right-of-way, or grant a perpetual easement to the State if located on property owned by the Permit holder.

For specific information regarding either granting ownership or entering into a perpetual easement, or both, for the State's access to the observation wells, please contact Adam Mathiowetz at (605) 773-3352.

SUPPLEMENTAL REPORT TO THE CHIEF ENGINEER
ON
WATER PERMIT APPLICATION NO. 8433-3
CITY OF LAKE NORDEN
JUNE 11, 2021

Water Permit Application No. 8433-3 proposes to appropriate 967 acre-feet of water annually (ac-ft/yr) at a maximum instantaneous diversion rate of 1.34 cubic feet of water per second (cfs) from three wells completed into the Prairie Coteau aquifer (97-114 feet deep) located in the SW $\frac{1}{4}$ Sec.15-T113N-R53W for municipal use. The well locations are approximately one mile east of the City of Lake Norden in Hamlin County.

This application was received by the DANR-Water Rights Program on June 29, 2020 and originally proposed to appropriate 1,458 ac-ft/yr at a maximum instantaneous diversion rate of 2.11 cfs. An initial review of the application determined further study was needed to assess the availability of unappropriated water. The Chief Engineer recommended deferral on July 21, 2020, and the application was public noticed for the October 2020 meeting of the Water Management Board. A constant pump rate aquifer performance test was designed by Banner Associates, Inc. to determine aquifer characteristics using recommendations and requirements provided by the DANR-Water Rights Program. The aquifer performance test was conducted from August 6 to August 21, 2020, with continued monitoring as required in the Temporary Permit To Use Public Waters issued by the Chief Engineer on July 27, 2020. At the October 7, 2020 Water Management Board meeting the board deferred the application for further study.

The Water Rights Program review of and subsequent report on the August 2020 aquifer performance test was completed on November 19, 2020. The review of the data indicated that only 57.8 ac-ft/yr was available for appropriation and the remainder of the request (1,420.2 ac-ft/yr) should be deferred for further study. In late 2020, the city's engineers, Banner Associates, Inc. (Banner), contracted with LRE Water (LRE) to reevaluate the August 2020 aquifer performance test data. LRE's review determined that it would be prudent to run a single well 30-day aquifer performance test. The pumping portion of the 2021 aquifer test began on March 17 and concluded on April 16 when the recovery portion of the test began. The recovery period started at the cessation of pumping on April 16 and went until April 30 following a video conference meeting between Banner, LRE, Water Rights Program staff, and DANR-Geological Survey Program staff that concluded enough recovery of the water level to pre-pumping/background conditions in the wells had occurred. The City of Lake Norden is allowed to keep pumping water under a temporary permit for continued testing until July 9, 2021 as long as monthly water level measurements from the 2020 monitoring (EMW and NMW) and pumping (L1, L2 and L3) wells are recorded and submitted to the Water Rights Program.

AQUIFER: Prairie Coteau (PCO)

Aquifer Characteristics:

The Prairie Coteau aquifer consists of many discontinuous and often lenticular bodies of glacial outwash (sand and gravel) that do not typically include surficial (at or very near land surface) or basal (in contact with or very near bedrock) aquifers, such as the Big Sioux and Altamont aquifers, respectively (Kume, 1985). The Prairie Coteau aquifer is the name used by the DANR-Water

Rights Program and accepted by the Water Management Board for discontinuous intermediate aquifers located on the Coteau des Prairies in northeastern South Dakota that are not a part of another named aquifer (Water Rights, 2021b, 2021c, and 2021d). These discontinuous outwash deposits can be in lenses separated by layers of glacial till (vertical separation) as well as being geographically separated (SDGS, 2020; Water Rights, 2021d). In Deuel and Hamlin Counties, the Prairie Coteau aquifer is generally buried by 30 feet or more of glacial till and underlies approximately 1,100 square miles in discontinuous deposits. The aggregate thickness, total thickness of all layered Prairie Coteau aquifer deposits regardless of hydrologic connection, in Deuel and Hamlin Counties where the aquifer is present, ranges from 4 to 144 feet (Kume, 1985).

The wells completed for this application and the subsequent monitoring wells are completed into a portion of the Prairie Coteau aquifer with an approximate elevation range of 1,560 to 1,580 feet above mean sea level (Water Rights, 2021c). The well completion reports indicate aquifer thickness ranging from 14 to 19 feet. The aquifer materials encountered during the drilling of the three pumping wells and two monitoring wells was fine to coarse sand ranging in color from yellow to grey as labeled by the well driller. Review of the well completion reports (Water Rights, 2021d) and lithologic logs (SDGS, 2021) indicate the local Prairie Coteau aquifer material is glacial outwash sand that has some fine sand and silt, or clay intermixed. Review of the analysis for the 2020 aquifer performance test (Banner, 2020) and the monitoring well completion reports for the monitoring wells drilled for the 30-day aquifer performance test as presented in the LRE report (2021) indicates the glacial outwash is primarily medium to coarse poorly sorted sand with varying amounts of gravel and minor amounts of silt and clay. The aquifer is confined at the City of Lake Norden's pumping wells, L1, L2 and L3, and the monitoring wells drilled for both the 2020 (Banner, 2020) and the 2021 (LRE, 2021) aquifer performance tests.

2021 AQUIFER PERFORMANCE TEST:

Technique and Methodology Review:

A 30-day constant rate aquifer performance test was conducted by the City of Lake Norden and Banner Associates, Inc. and analyzed by engineering firm LRE Water, Inc. using well L2 as production (pumping) wells and city wells L1 and L3, along with six monitoring wells completed into the Prairie Coteau aquifer, one monitoring well completed into the confining till layer above the Prairie Coteau aquifer, and three monitoring wells completed into the surficial and overlying Big Sioux: Brookings aquifer. All of these wells shown and labeled in Figure 1 are used throughout the LRE report (2021) and will be used throughout this report.

The background monitoring period of the aquifer performance test was from February 22 to March 17, 2021 (LRE, 2021). During that time, the City of Lake Norden's Prairie Coteau aquifer well field was completely shut down. The pumping portion of the aquifer performance test started at 11:00 am Central time on March 17 and was completed 30 days later at 11:16 am Central time on April 16, 2021. The recovery period was from 11:16 am Central time on April 16 to 3:20 pm on April 30, 2021. The recovery period was stopped after approximately 14 days instead of the more standard 30 days for this length of aquifer performance test. This was done after consultation between Banner Associates, LRE Water, the DANR-Geological Survey, and DANR-Water Rights Program staff via video conference to discuss the recovery of the wells. All wells had recovered to near or greater than 100% of pre-pumping static water levels. Therefore, it was decided the recovery period could be ended early and the city could resume pumping from their Prairie Coteau aquifer well field.

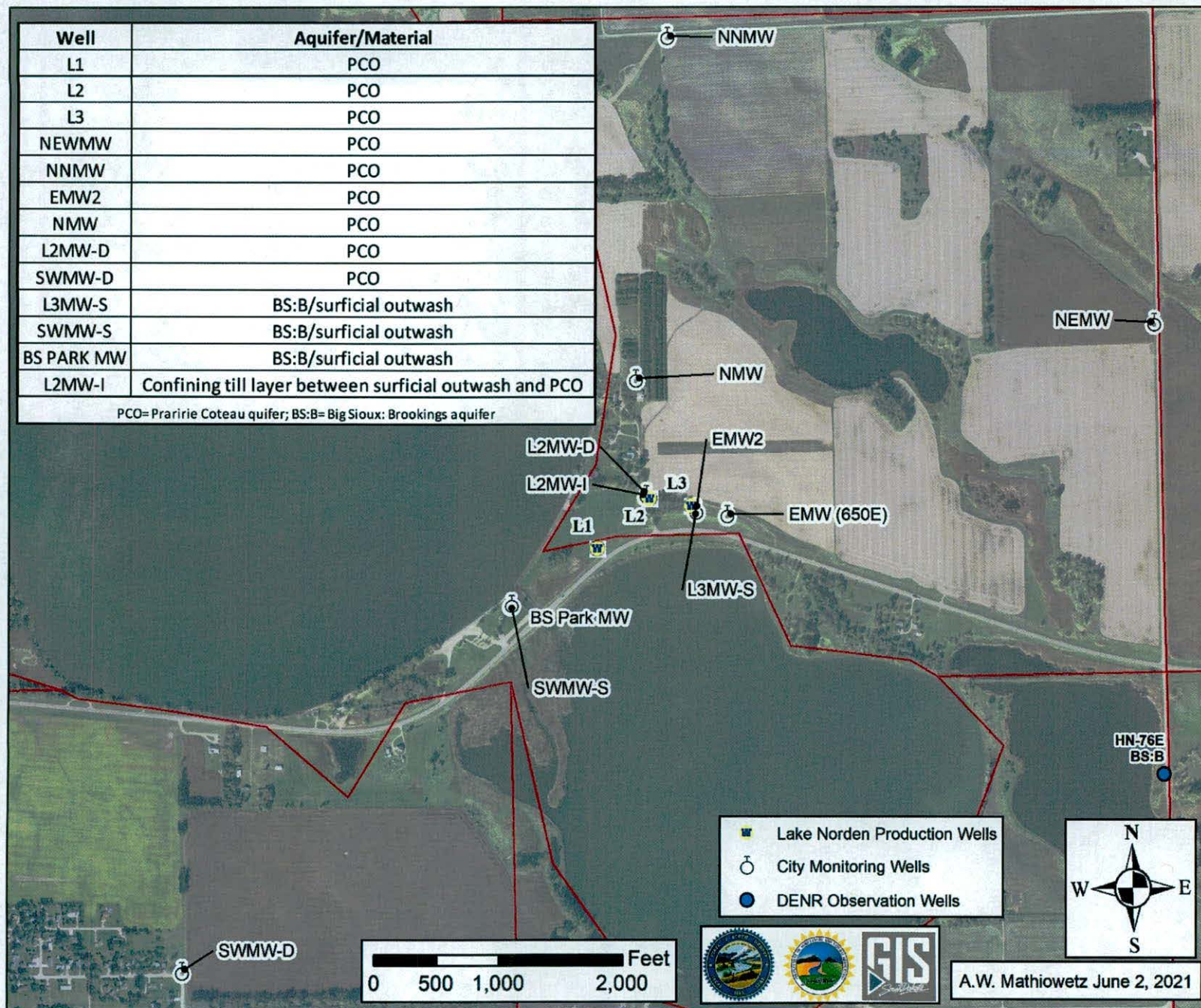


Figure 1-Map of wells used for the 2021 City of Lake Norden aquifer performance test

The water levels in wells L2MW-D, EMW2, NMW, NNMW, NEMW, SWMW-D, L2MW-I, L3MW-S, BS Park MW, and SWMW-S were measured using dedicated In-Situ LevelTroll pressure transducers with integrated data loggers (LRE, 2021). Wells L1, L2, and L3 were measured using dedicated and existing TE Connectivity KPSI 320 transducers with integrated Supervisory control and data acquisition (SCADA) communication to the city's water treatment plant installed (LRE, 2021). Manual water level measurements were collected periodically in the wells equipped with a transducer using an electronic water-level meter (LRE, 2021). An existing flow-rate meter connected to the SCADA system and located at the water treatment plant was used to record flow rates during the aquifer performance test (LRE, 2021). Pumping well L2 was pumped at an average rate of 353 gallons per minute (gpm). Figure 4 of the LRE (2021) report shows the pump rate from well L2 was very consistent for the duration of the aquifer performance test.

The methodology and equipment used to measure water levels for this aquifer performance test as well as how the aquifer performance test was conducted were consistent with or exceeded standard operating procedures and methods as set forth by the American Water Works Association (AWWA) (1998), United States Environmental Protection Agency (Osborne, 1993), Fetter (1980), and Driscoll (1986) among others. The aquifer performance test as conducted by Banner Associates, Inc. and reviewed by LRE Water is acceptable to the DANR-Water Rights Program.

The water level and time data collected during the whole aquifer performance test was analyzed using AQTESOLV software along with a diagnostic and qualitative review of the data by a licensed professional engineer (LRE, 2021). The AQTESOLV software was used to estimate Transmissivity (T) and Storativity (S) using the confined Theis (1935), confined Cooper-Jacob (1946), Agarwal Recovery method for each the confined Cooper-Jacob and confined Theis (Agarwal, 1980) leaky-confined Hantush-Jacob (1955), and leaky-confined Neuman-Witherspoon (1969) methods (LRE, 2021). The Theis recovery method was used to evaluate the ratio of storativity during pumping (S) and after pumping (S') to determine if negative boundaries (low or impermeable) or positive boundaries (recharge) were encountered during the aquifer performance test (LRE, 2021). A value of S/S' greater than 1 indicates a positive boundary condition and less than 1 indicates a negative boundary condition. A distance-drawdown analysis was completed to estimate a theoretical radius of influence (r_0) for the aquifer performance test's cone of depression in the Prairie Coteau aquifer.

The AQTESOLV software and the various methods and analyses used for this aquifer performance test are commonly used and accepted for analyzing aquifer performance test data. The methods and software used by LRE Water for the analysis of the aquifer performance test data is acceptable to the DANR-Water Rights Program.

Test Data Analysis Review:

The primary purposes of this constant-rate aquifer pumping test were to determine the aquifer characteristics and possible aquifer extent of Prairie Coteau aquifer at the City of Lake Norden's Prairie Coteau aquifer well field. The maximum measured drawdown in the pumping well, L2, was 53.01 feet (LRE, 2021). Appendix D of the LRE report (2021) is an "Aquifer Test Summary Data Sheet" that contains general information regarding well depth, screen setting, distance from

the pumping well, static water level, transducer type, and maximum drawdown amongst other useful data.

Transmissivity (T) values calculated using the various previously mentioned methods ranged from 1,441 to 4,729 ft²/day with a geometric mean of 2,721 ft²/day for the data used in the calculations (LRE, 2021). The hydraulic conductivity (K), T divided by aquifer thickness at each well, ranged from 69 to 394 ft/day with a geometric mean of 165 ft/day (LRE, 2021). These hydraulic conductivity values are within the general range of fine to coarse sand listed by Driscoll (1986) which is consistent with the geology shown on the well completion reports for the production and monitoring wells on file with the Water Rights Program (Water Rights, 2021d). Some of the calculated T and K values were not used in the statistics. This was due to "...either poor curve match, misalignment with other solutions, or results inconsistent with the conceptual model." Those are reasonable and acceptable reasons for excluding some data from the statistical analysis. Re-calculation of several of the analyses yielded comparable results when making the same assumptions as the LRE (2021) report (Halford Hydrology LLC, 2021; Halford and Kuniansky, 2002). Therefore, the hydraulic conductivity and transmissivity analyses can be assumed to have been completed properly when using the same assumptions as the LRE (2021) report.

The four distance-drawdown calculations completed to estimate the theoretical radius of influence (r_0) each had slightly different data set used for the calculation. Therefore, each calculation resulted in a different r_0 value. A brief explanation of the different data sets and the associated r_0 for each set of data used for the calculations are shown in Table 1. The two larger r_0 values used data after the aquifer had reached a stable drawdown but before precipitation that lead to recharge events that occurred on April 6 and 8, approximately 21 days into the pumping portion of the test.

Table 1- Radius of influence (r_0) estimates from distance-drawdown analysis (LRE, 2021)

r_0	Wells	Monitoring Well Data Set
15,804 ft	L2, L2MW-D, L3, EMW2, L1, NMW, NNMW, SWMW-D	Used data from all PCO wells that had pumping-induced drawdowns and use drawdowns measured at the end of the pumping period (note: drawdown influenced by recharge events on April 6 and 8)
18,455 ft	L2MW-D, L3, EMW2, NMW, NNMW	Use data from only select PCO wells that had pumping-induced drawdowns that exhibited a generally linear trend relative to each other and use drawdowns measured at the end of the pumping period. (note: drawdown influenced by recharge events on April 6 and 8)
19,804 ft	L2MW-D, L3, EMW2, NMW, NNMW	Used data from select PCO wells that had pumping induced drawdowns that exhibited a generally linear trend relative to each other and drawdowns from before the recharge events (21 days of pumping)
23,099 ft	L2MW-D, L3, EMW2, NMW, NNMW	Used data from select PCO wells that had pumping induced drawdowns that exhibited a generally linear trend relative to each other and adjusted drawdown data for the background trend of the aquifer and from before the recharge event (21 days of pumping)

Each of these four data sets used to calculate a theoretical r_0 were done to examine the impacts of several different factors on the calculated value. Each of the data sets were adjusted/selected in a valid manner to examine the impacts of the different factors on the calculated theoretical r_0 . The radius of influence, r_0 , is useful for estimating a likely minimum aquifer areal extent.

It was determined there are eight domestic wells located within approximately one mile of the Prairie Coteau aquifer well field (LRE, 2021). Two of the wells were determined to be completed into glacial aquifer materials that are stratigraphically above the aquifer the city's wells are completed into (LRE, 2021). The remaining six domestic wells appear to be completed into the same portion of the Prairie Coteau aquifer as the city's wells (LRE, 2021). The confined Cooper-Jacob method and the geometric mean values for T and S were used to estimate if potential drawdown after 1 year of continuous pumping at 595 gpm from the City of Lake Norden's Prairie Coteau aquifer well field could affect the six wells (LRE, 2021). The analysis concluded, that at the two closest domestic wells, there would be an estimated drawdown of 40 to 45 feet (LRE, 2021). Those wells had 51 to 63 feet of artesian head pressure above the top of the aquifer at the time of completion (LRE, 2021). The owner of these wells is known to the City of Lake Norden and did not indicate any adverse impacts associated with the city's past pumping or the pumping conducted for the 30-day aquifer performance test (LRE, 2021). The estimated drawdown at the more distant wells ranged from 28 to 33 feet at the conclusion of the test and the wells had artesian head pressures ranging from 88 to 139 feet when drilled (LRE, 2021). Water Rights Program review of the well completion reports and a re-calculation of several of the drawdown estimates (Cooper and Jacob, 1946) using the same values and assumptions as the LRE (2021) report yielded comparable results (Halford Hydrology LLC, 2021; Halford and Kuniansky, 2002).

The potential yield of the Prairie Coteau aquifer well field was estimated using the Cooper-Jacob method (LRE, 2021). The analysis was conducted using two different well efficiencies 85% and 99%, both determined from the 30-day aquifer performance test data but using different methods, and the geometric means for T and S and a pumping duration of one year (LRE, 2021). The results indicated a long-term yield of 550 to 600 gpm from the Prairie Coteau aquifer well field could be sustained while also maintaining at least 10 feet of water above the top of the well screens in L1, L2, and L3 and nearby domestic wells is possible (LRE, 2021). It was noted the Cooper-Jacob method (1946) does not include recharge and data from the aquifer performance test (see Figure 2) shows this portion of the Prairie Coteau aquifer can be rapidly recharged by a precipitation-recharge event (LRE, 2021). Therefore, calculations using longer pumping durations will likely overestimate the amount of drawdown. The effects of adding a fourth well to the well field, assumed to be located near SWMW-D, were evaluated and determined that well field yield may only increase to approximately 650 gpm (LRE, 2021). It was determined the limiting factors to the yield are aquifer thickness, and aquifer T and S, rather than the amount of recharge. The expected long-term yield of a well field does not necessarily represent the availability of unappropriated water in the aquifer (LRE, 2021).

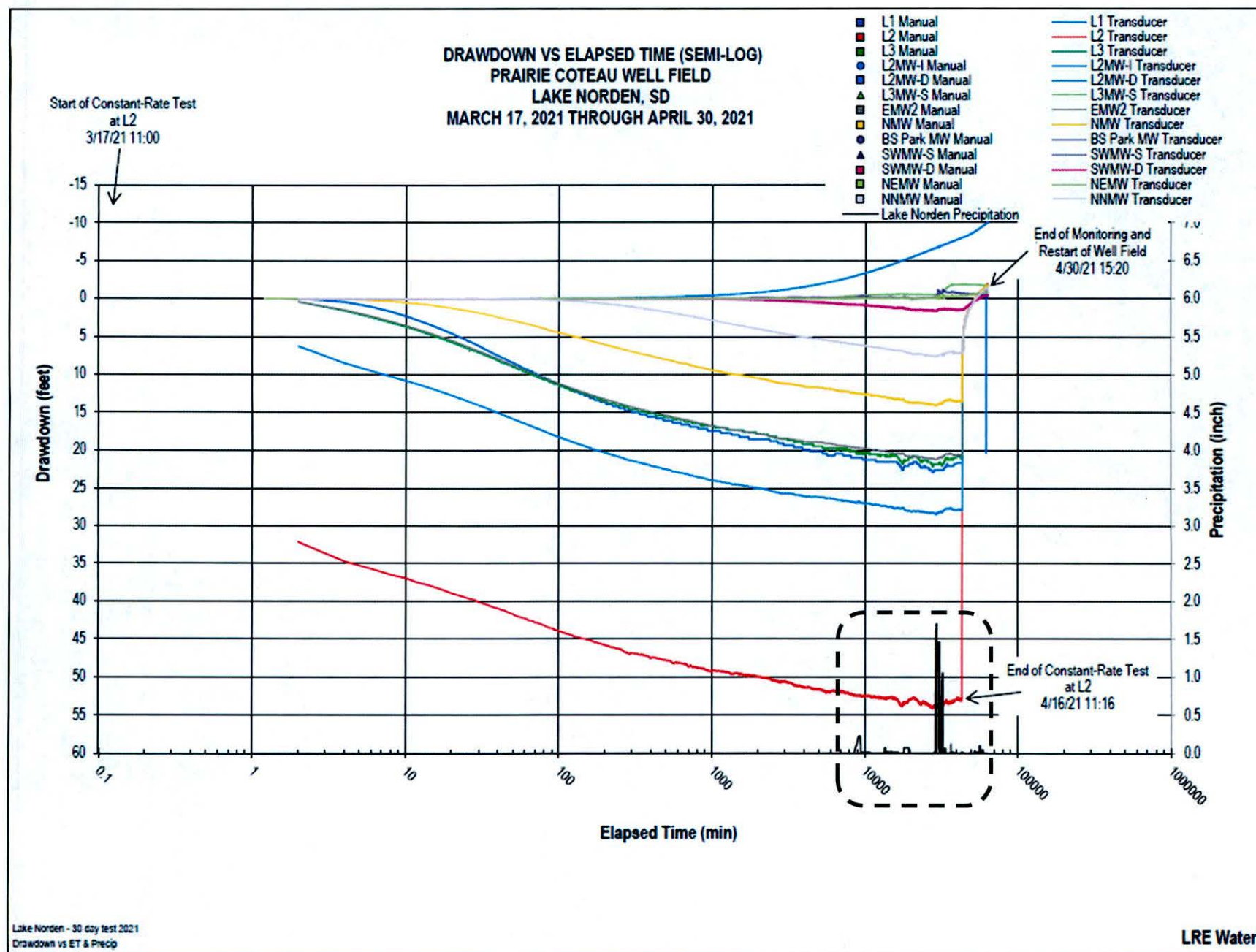


Figure 2- Drawdown vs. elapsed time and precipitation with recharge event indicated with black dashed box (modified from: LRE, 2021)

LRE (2021) concluded this portion of the Prairie Coteau aquifer, while lenticular and discontinuous, appears to recharge directly from the infiltration of precipitation (see Figure 2). While the exact location and mechanism of the recharge is unknown, it is likely a portion of this aquifer directly underlies surficial outwash, the Big Sioux: Brookings aquifer, or has an unconfined portion that is near land surface (LRE, 2021). It was noted there are multiple lines of evidence for the recharge including the observed water level rise following a precipitation event (see Figure 2), the lack of any observed negative boundary conditions, the S/S' values of 2.3 to 3.3 (positive boundary condition), and the superior water quality of the Prairie Coteau aquifer wells located near the city's Prairie Coteau aquifer well field (LRE, 2021).

A recharge analysis indicated an estimated range of 2 to 6 inches per year (in/yr) (LRE, 2021). Hedges and others (1985) estimated a recharge rate of 4.0 in/yr and 4.9 in/yr for the unconfined portions of the Prairie Coteau aquifer. Hedges and others (1985) also recommended a recharge range of 0.15 to 0.60 in/yr for buried confined aquifers be used by management and development programs. It was concluded at the 2 to 6 in/yr recharge rate an average annual withdrawal at a continuous rate of 550 to 600 gpm would not exceed the annual recharge rate (LRE, 2021). Furthermore, at the higher end of the range (6 in/yr), withdrawals at a continuous pumping rate of 904 gpm would not exceed average annual recharge (LRE, 2021). It was noted, "However, based on available data, the aquifer cannot likely sustain withdrawals from the City's Prairie Coteau well field at continuous pumping rates greater than 550 to 600 gpm (887 to 967 ac-ft/yr) without producing drawdown that would lower the water-levels to below the top of the aquifer." (LRE, 2021).

The recommendations in the report stated the City of Lake Norden's Prairie Coteau aquifer well field should be limited to 967 ac-ft/yr at a maximum instantaneous diversion rate of 1.34 cfs (600 gpm) and that long term monitoring of the water levels of the Prairie Coteau aquifer be conducted using at a minimum observation wells NNMW and EMW2, as well as the SCADA data from L1, L2, and L3 with a minimum frequency of once a month (LRE, 2021). The final recommendation listed in the aquifer performance test report is that additional water supply options be investigated to provide redundancy and continue to support population growth of the city (LRE, 2021).

SOUTH DAKOTA CODIFIED LAW (SDCL) 46-2A-9:

Pursuant to SDCL 46-2A-9, a permit to appropriate water may be issued only if there is a reasonable probability that there is unappropriated water available for this applicant's proposed use, that the proposed diversion can be developed without unlawful impairment of existing rights and that the proposed use is a beneficial use and in the public interest. This report will address the availability of unappropriated water and potential for unlawful impairment of existing water rights from the aquifer that are pertinent to this application.

WATER AVAILABILITY:

This application proposes to appropriate water from the Prairie Coteau aquifer. The probability of unappropriated water available from the aquifer can be evaluated by considering SDCL 46-6-3.1, which requires:

"No application to appropriate groundwater may be approved if, according to the best information reasonably available, it is probable that the quantity of water

withdrawn annually from a groundwater source will exceed the quantity of the average estimated annual recharge of water to the groundwater source. An application may be approved, however, for withdrawals of groundwater from any groundwater formation older than or stratigraphically lower than the Greenhorn formation in excess of the average estimated annual recharge for use by water distribution systems.”

While the applicant is a water distribution system as defined in SDCL 46-1-6(17), the Prairie Coteau aquifer is not stratigraphically lower/older than the Greenhorn Formation. Therefore, a comparison of average annual recharge and average annual withdrawals from the Prairie Coteau aquifer is required for this application.

Hydrologic Budget:

Recharge

The Prairie Coteau aquifer receives recharge from infiltration of precipitation and snowmelt where the aquifer is near land surface and permeable layers overlie it, leakage from adjacent aquifers with higher hydraulic head, and hydraulically connected surface water bodies and surficial aquifers with higher potentiometric surfaces (Leap, 1972). However, it is not clear what the specific source of recharge to this portion of the Prairie Coteau aquifer is. The most likely sources of recharge are infiltration of precipitation and snowmelt and a hydraulic connection to the Big Sioux: Brookings aquifer and/or nearby lakes.

Observation well data collected during the pumping portion of the 30-day aquifer performance test (see Figure 2) shows that water levels in this portion of the Prairie Coteau aquifer rapidly respond to precipitation-recharge events. The water levels in the observation wells and the pumping well L2 all rose immediately following a precipitation event that occurred over three days, April 6 to 8. This means it is highly likely that there is a direct connection with the aquifer to either the surface or unconfined and overlying aquifer material that readily provides recharge to this portion of the Prairie Coteau aquifer. However, there is not sufficient information available to determine where or by what mechanism this portion of the aquifer is recharged.

Hedges and others (1985) suggested a range of 0.15 to 0.6 inches per year (in/yr) be used for confined aquifers by management and development programs. It was further noted that locally where confined aquifers may encounter unconfined conditions the recharge rates may be within the range calculated for non-buried surficial aquifers (2.0 to 5.6 in/yr) (Hedges et. al, 1985). The nearest known non-buried surficial aquifer to this portion of the Prairie Coteau aquifer is the Big Sioux: Brookings aquifer. Hedges and others (1985) calculated a recharge rate of 4.0 in/yr by performing observation well data analysis. Recharge analysis using the water-table fluctuation (WTF) method was performed by LRE (2021) as part of the 30-day aquifer performance test analysis. The WTF method is used to estimate a percentage of precipitation that may enter an aquifer as recharge, but the WTF method is generally only considered applicable to unconfined aquifers. This portion of the Prairie Coteau aquifer is confined or mostly confined (SDGS, 2020; Water Rights, 2021d). However, review of the observation well data for the Big Sioux: Brookings and the Prairie Coteau aquifer observation wells show a nearly identical response to the precipitation event (LRE, 2021). The significant similarity in response to precipitation suggests

this portion of the Prairie Coteau aquifer, "...likely receives recharge from an unconfined source, in direct connection with the ground surface and infiltrating precipitation." (LRE, 2021).

The range of percentages of precipitation that would infiltrate to become recharge was from 28% to 93% with a geometric mean of 65% (LRE, 2021). LRE (2021) reported the City of Lake Norden has an average annual precipitation of 24.12 in/yr. Three different percentages, 65, 28, and 10 (10 percent is commonly used in groundwater modeling applications), were used to come up with recharge rates of 15.67 in/yr, 6.87 in/yr, and 2.41 in/yr, respectively (LRE, 2021). The average annual recharge for these three rates along with the values suggested by Hedges and others (1985) as previously mentioned and calculated for each of the four radii of influence as determined from the distance-drawdown calculations are shown in Table 2.

Table 2- Recharge rates, type of calculation, rate source, and average annual recharge

Recharge Rate (in/yr)	Type	Source	Average Annual Recharge (ac-ft/yr)			
			Radii of Influence (ft)			
			15,804	18,455	19,804	23,099
15.67	68% precip. infiltration	LRE, 2021	23,522.5	32,075.8	36,936.5	50,250.0
6.87	28% precip. infiltration		10,312.7	14,062.6	16,193.6	22,030.5
2.41	10% precip. infiltration		3,617.7	4,933.2	5,680.7	7,728.3
5.6	Range for non-buried surficial aquifers	Hedges et al, 1985	8,406.3	11,463.0	13,200.0	17,957.9
2			3,002.2	4,093.9	4,714.3	6,413.5
4	Obs. well data analysis for BS:B aquifer		6,004.5	8,187.8	9,428.6	12,827.0
0.6	Range for buried confined aquifers		900.7	1,228.2	1,414.3	1,924.1
0.15			225.2	307.0	353.6	481.0
Min			225.2	307.0	353.6	481.0
Max			23,522.5	32,075.8	36,936.5	50,250.0
BS:B= Big Sioux Brookings; obs.= observation; precip.= precipitation						

The range of estimated average annual recharge ranges from 225.2 ac-ft/yr to 50,250 ac-ft/yr. It is very unlikely that the upper ends of those ranges are reasonable. However, based on the observation well data collected during the 30-day aquifer performance test, it is reasonable that the recharge rate to this portion of the Prairie Coteau aquifer is between the upper limit of the buried confined aquifers, 0.6 in/yr, and the rate calculated for the nearby Big Sioux: Brookings aquifer, 4.0 in/yr. Therefore, the likely range of recharge rates to this portion of the Prairie Coteau aquifer is 900.7 ac-ft/yr to 12,827.0 ac-ft/yr using the four different theoretical radii of influence as approximate minimum aquifer areal extents.

Using the most conservative radius of influence, 15,804 ft, the estimated average annual recharge to this portion of the Prairie Coteau aquifer ranges from 900.7 to 6,004.5 ac-ft/yr. This range is very reasonable, uses the conservative theoretical areal extent for calculations, and based on the currently available information for this portion of the Prairie Coteau aquifer should be used for appropriating water from this portion of the Prairie Coteau aquifer. Based on lithologic logs

(SDGS, 2020) and well completion reports (Water Rights, 2021d) it is possible this portion of the Prairie Coteau aquifer extends further to the southeast toward Lake Poinsett and north toward Lake Marsh. However, when the application was originally filed with the Water Rights Program, there was insufficient information available to consider if there was a hydrologic connection between aquifer materials located near Lakes Poinsett and Marsh and this portion of the Prairie Coteau aquifer. The results of this aquifer performance test indicate that it is possible, but further drilling in the area is required to confirm.

Withdrawals:

Discharge from this portion of the Prairie Coteau aquifer occurs through well withdrawals (Water Rights, 2021c and 2021d) and likely through discharge to adjacent aquifers like the Big Sioux: Brookings and possibly to hydrologically connected surface water bodies. There is one existing water right authorized to withdraw water from the same portion of the Prairie Coteau aquifer the applicant proposes to use (Water Rights, 2021c), Water Permit No. 7163-3 for Travis or Kimberly Hyman. Water Permit No. 7163-3 authorizes the diversion of water at a maximum instantaneous diversion rate of 0.1 cfs for domestic purposes. Historically, the average annual water use by non-irrigation appropriations limited by instantaneous diversion rate has been less than 60 percent of full time pumping at the permitted diversion rate. That is an estimated annual use of 26.9 ac-ft/yr. The water use under Water Permit No. 7163-3 is likely much less than 26.9 ac-ft/yr because it is for domestic use and the 60 percent estimate is based off of review of submitted water use numbers and discussions with various large non-irrigation appropriators in the past. Furthermore, a Kingsbrook Rural water system valve was observed near the entrance to the Hyman's residence (LRE, 2021). A member of the Hyman residence stated the connection between the valve and the home had not yet completed but was planned for 2021 (LRE, 2021). Until such time as Water Permit No. 7163-3 is canceled or the Water Rights Program is informed that it is only maintained for standby purposes, the assumption of pumping 26.9 ac-ft/yr under Water Permit No. 7163-3 will be used.

There are several domestic wells on file with the Water Rights Program that appear to be completed into the same portion of the Prairie Coteau aquifer as the applicant's wells (Water Rights, 2021d). LRE (2021) reported there are six domestic wells completed into the Prairie Coteau aquifer within approximately one mile of the City of Lake Norden's Prairie Coteau aquifer well field. It is possible there are other domestic wells not on file with the Water Rights Program and outside of the area surveyed for the LRE (2021) report that may be completed into the same portion of the Prairie Coteau aquifer. Assuming 2.5 people per residence and a per capita daily water use of 72 gallons per day (Carter and Netizert, 2005), it is estimated a rural residence will use approximately 0.2 ac-ft/yr. The usage by rural domestic wells completed into the same portion of the Prairie Coteau aquifer as the applicant is very likely insignificant compared to the estimated recharge and the annual use proposed by this application.

Balance of Hydrologic Budget

This application proposes to appropriate 967 ac-ft/yr from a portion of the Prairie Coteau aquifer. Currently, the estimated average annual appropriative use is assumed to be 26.9 ac-ft/yr but is likely much less from this portion of the Prairie Coteau aquifer. The most likely average annual recharge ranges from 900.7 to 6,004.5 ac-ft/yr. The 900.7 ac-ft/yr recharge estimate uses the relatively conservative recharge rate of 0.60 in/yr and the smallest radius of influence calculation,

15,804 ft, as an estimated minimum aquifer areal extent. Considering the conservative nature of the recharge rate estimate, there is a reasonable probability unappropriated water is available for this proposed appropriation.

Observation Well Data:

Administrative Rule of South Dakota Section 74:02:05:07 requires that the Water Management Board shall rely upon the record of observation well measurements in addition to other data to determine that the quantity of water withdrawn annually from the aquifer does not exceed the estimated average annual recharge of the aquifer.

There are no DANR-Water Rights Program observation wells completed into this portion of the Prairie Coteau aquifer (Water Rights, 2021b). Two monitoring wells, EMW and NMW, were installed and used as part of the August 2020 aquifer performance test and an additional five monitoring wells were completed into this portion of the aquifer for the 2021 30-day aquifer performance test (LRE, 2021). Manual measurements taken from Prairie Coteau aquifer wells as required by the City of Lake Norden's temporary permit to use public waters or as part of the 2021 aquifer performance test are shown in Figure 3.

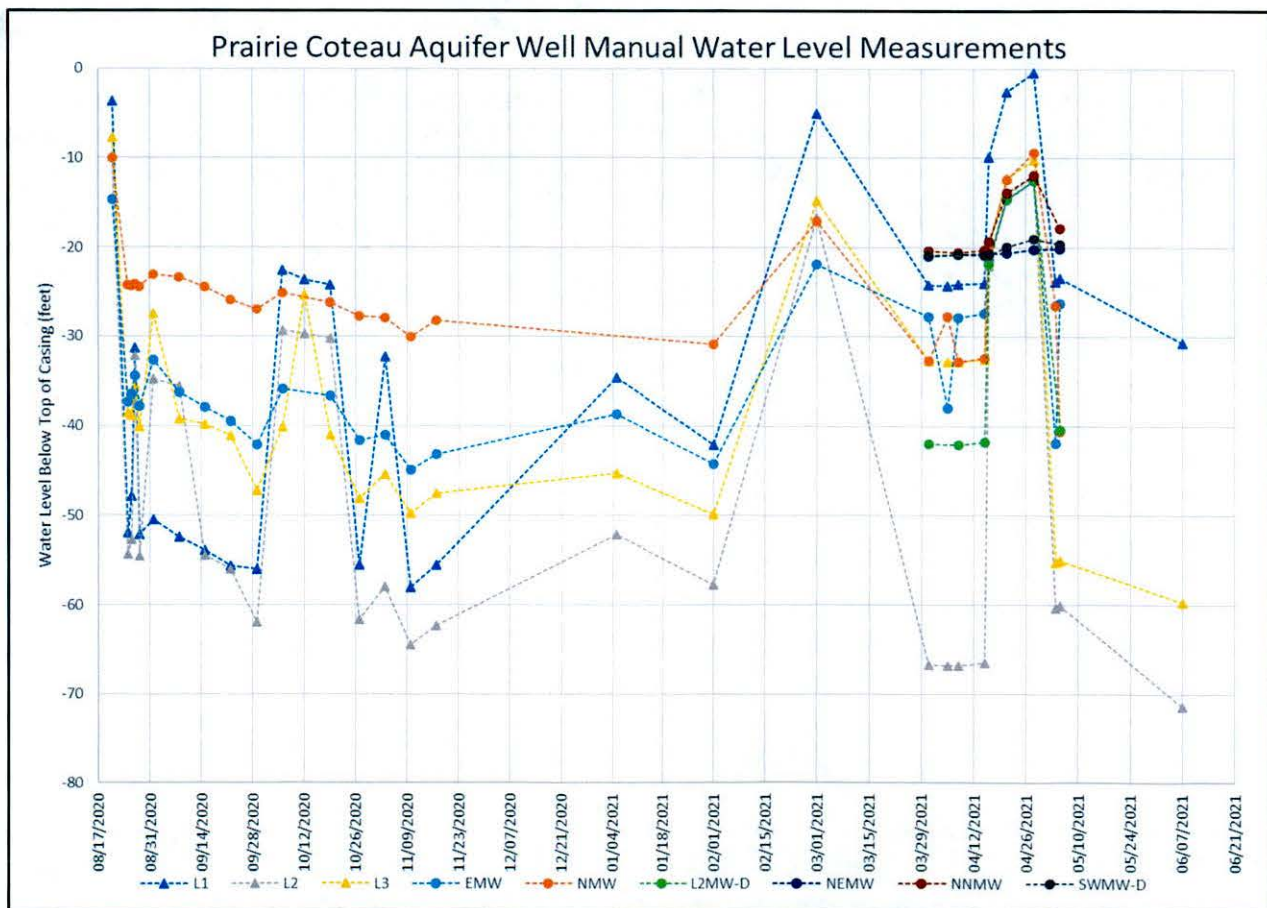


Figure 3- Prairie Coteau Aquifer Well Manual Water Level Measurements (Beck, 2020; Koistinen, 2021; Odens, 2021)

The water levels in the Prairie Coteau aquifers wells demonstrate the aquifer recovers once pumping has ceased and readily recovers after recharge events (e.g. infiltration of spring snowmelt). Furthermore, the manual water level data shown in Figure 3 and the continuous transducer water level data shown in Figure 2 are consistent with each other and both data sets support the information presented in and conclusions drawn from the LRE (2021) aquifer performance test analysis and report. Therefore, there is a reasonable probability unappropriated water is available for this proposed appropriation.

POTENTIAL FOR UNLAWFUL IMPAIRMENT OF EXISTING WATER RIGHTS:

Figure 4 shows the location of the production wells this application proposes to use, the appropriative well that is completed into this portion of the Prairie Coteau aquifer (Water Rights, 2021c), Prairie Coteau aquifer monitoring wells used for the 30-day aquifer performance test (LRE, 2021), and Prairie Coteau aquifer domestic wells that are completed into the same portion of the Prairie Coteau (LRE, 2021; Water Rights, 2021d). The well authorized by Water Permit No. 7163-3 is approximately 0.8 miles away from the nearest of the City of Lake Norden's wells (production well L2) (Water Rights, 2021c). The nearest domestic well is approximately 240 feet away from the nearest City of Lake Norden well (production well L2) (LRE, 2021; Water Rights, 2021d). No complaints regarding well interference were filed with the DANR-Water Rights Program for the duration of either the 2020 or the 2021 aquifer performance tests. Furthermore, there have been no complaints regarding well interference in Hamlin County (Water Rights, 2021a). In other counties, complaints regarding well interference from wells completed into the Prairie Coteau aquifer have been filed with the DANR-Water Rights Program. Most of the complaints have been unsubstantiated and were the result of inadequate depth setting for the pump inlet in the well (Water Rights, 2021a).

At the well sites for this application, the Prairie Coteau aquifer is under confined conditions. Generally, that means the water level of the aquifer can be subject to significant fluctuations caused by natural conditions and pumping. The drawdown created by pumping a well completed into a confined aquifer may extend a considerable distance from the well as shown by the data from the aquifer performance test. The City of Lake Norden has installed pressure transducers in their production wells (L1, L2 and L3) that are connected to their SCADA system (Beck, 2020) to ensure they do not accidentally pump their own wells dry. By self-limiting their wells, the city protects other nearby adequate domestic wells because there is generally more drawdown at a pumping well than at other locations. The artesian head pressure above the top of the aquifer at the City of Lake Norden's production wells was around 80 feet at the time of completion in late-spring and mid-fall of 2018.

South Dakota Codified Law (SDCL) 46-6-6.1 does not necessarily protect artesian head pressure as a means of delivery, and the Water Management Board has recognized in the past to place water to maximum beneficial use, a certain amount of drawdown may occur. In order to balance interests between appropriative use and delivery of water by artesian head pressure, the Water Management Board defined an "adversely impacted domestic well" in Administrative Rule of South Dakota (ARSD) 74:02:04:20(7) as:

"a well in which the pump intake was set at least 20 feet below the top of the aquifer at the time of construction or, if the aquifer is less than 20 feet thick, is as near to

the bottom of the aquifer as is practical and the water level of the aquifer has declined to a level that the pump will no longer deliver sufficient water for the well owner's needs".

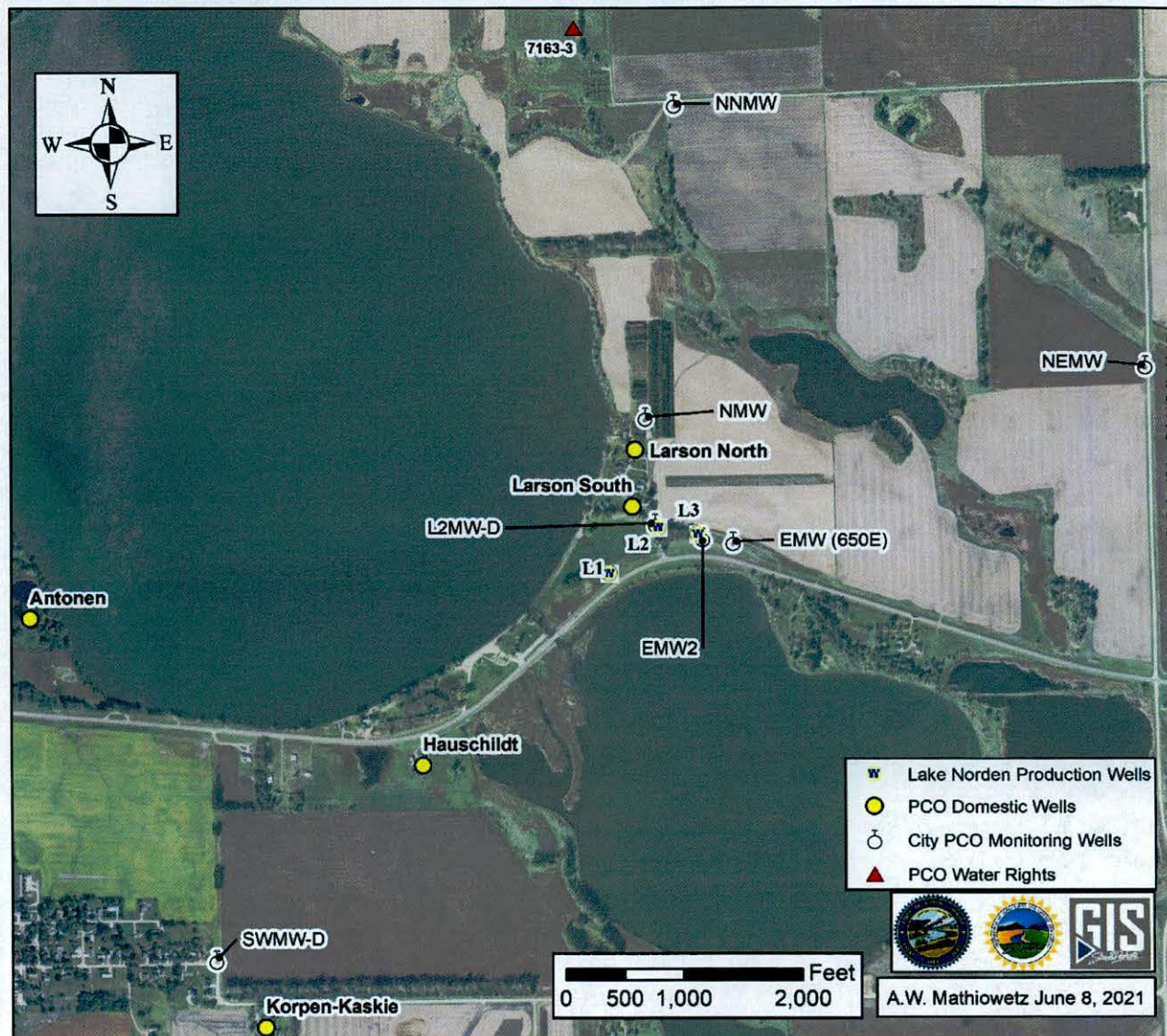


Figure 4- Prairie Coteau aquifer City of Lake Norden, appropriative, monitoring and domestic wells (LRE, 2021; Water Rights, 2021c and 2021d)

The Water Management Board considered the delivery of water by artesian head pressure versus maximum beneficial use of water issue for Water Right No. 2313-2 for Coca-Cola Bottling Company of the Black Hills (Water Rights, 1995). The Water Management Board adopted Findings of Facts and Conclusions of Law that noted reservation of artesian head pressure for delivery of water would be inconsistent with SDCL 46-1-4 which states, "general welfare requires that the water resources of the state be put to beneficial use to the fullest extent of which they are capable..." (Water Rights, 1995). Furthermore, the Water Management Board found if increased cost or decreased production as a result of impacts on artesian head pressure by legitimate users is to be considered an adverse impact it would also be in conflict with SDCL 46-1-4 (Water Rights,

1995). With that in mind, some existing well owners may need to lower their pumps to accommodate for deeper water levels. However, when considering the statute (SDCL 46-6-6.1), rule (ARSD 74:02:04:20(7)), and the artesian head pressure, well interference from this proposed diversion is not expected to unlawfully impair existing appropriative or domestic users with adequate wells. Continued monitoring of the water levels in the aquifer is recommended to establish a longer-term trend for the aquifer. Several of the monitoring wells used for the aquifer performance test may be given to DANR-Water Rights Program for continued monitoring as part of South Dakota's observation well network.

CONCLUSIONS:

1. Application No. 8433-3 proposes to appropriate up to 967 ac-ft/yr at a maximum instantaneous diversion rate of 1.34 cfs from a portion of the Prairie Coteau aquifer.
2. The Prairie Coteau aquifer is under confined conditions in the area of the well sites.
3. The applicant had a 30-day constant-rate aquifer performance test conducted by Banner Associates, Inc., an engineering firm, and analyzed by LRE Water, an engineering firm, in 2021.
4. The methodology for completing the aquifer performance test and analyzing the data is sound and within published standard operating procedures for conducting a constant-rate aquifer performance test.
5. Based on the observation well data and a hydrologic budget, there is a reasonable probability unappropriated water is available for this proposed appropriation.
6. It would be prudent to have several permanent observation wells monitored by the DANR-Water Rights Program completed into this portion of the Prairie Coteau aquifer. If possible, the wells used for the aquifer performance could be used as permanent observation wells through either the granting of easements or transfer of ownership to the department, or both.
7. There is a reasonable probability the diversion proposed by this application can be made without unlawfully impairing existing appropriative or domestic users with adequate wells.



Adam Mathiowetz, PE
SD DANR-Water Rights Program

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RECEIVED

AUG 03 2020

Form 8

WATER RIGHTS
PROGRAM

PROOF OF PUBLICATION

STATE OF SOUTH DAKOTA)
County of Codington) SS

I, Jackie Wettestal

certify that the attached printed Notice was taken

from the Watertown
Public Opinion

printed and published in Watertown

County of Codington and

state of South Dakota. The notice was published

in the newspaper on the following date:

July 29, 2020

Cost of Printing \$90.99

Jackie Wettestal
(Signature)

Office Manager
(Title)

7-31-2020
(Date Signed)

SOUTH DAKOTA DEPARTMENT OF ENERGY AND NATURAL RESOURCES

NOTICE OF HEARING on Application No. 8433-3 to Appropriate Water

Notice is given that City of Lake Norden, PO Box 213, Lake Norden SD 57248 has filed an application for a water permit to appropriate 1,458 acre-feet of water annually at a maximum pump rate of 2.11 cubic feet of water per second from three wells completed into the Prairie Coteau Aquifer (97-114 feet deep) located in the SW 1/4 Section 15-T113N-R53W for municipal use. This site is located one mile east of the city Lake Norden. South Dakota Codified Law (SDCL) 46-2A-4(10) provides that "if the applicant does not contest the recommendation of the Chief Engineer and no petition to oppose the application is received, the Chief Engineer shall act on the application pursuant to the Chief Engineer's recommendation and no hearing may be held before the board, unless the Chief Engineer makes a finding that an application, even if uncontested, presents important issues of public policy or public interest that should be heard by the board." In this case, the Chief Engineer finds that this application presents important issues of public interest that should be heard by the Water Management Board. The Chief Engineer is recommending DEFERRAL of Application No. 8433-3 for further study pursuant to SDCL 46-2A-2 and 46-2A-7. The deferral recommendation is so the city of Lake Norden can provide information to assist with determining if there is unappropriated water available and the potential effect of pumping on existing water users. These criteria need to be addressed as required by SDCL 46-2A-9 to determine whether a water right permit may be issued. The further study needed entails further delineation of either the aquifer boundaries or a 7-day aquifer performance test, or both. The Chief Engineer's recommendation and the application are available at <http://denr.sd.gov/public> or contact Ron Duvall for this information, or other information, at the Water Rights Program address provided below. The Water Management Board will consider this application at 1:00 pm, October 7, 2020 in the Matthew Training Center, Joe Foss Bldg, 523 E. Capitol Ave. Pierre SD. The Chief Engineer's recommendation is not final or binding upon the Board. The Board is authorized to 1) approve, 2) approve with qualifications, 3) defer, or 4) deny this application based on the facts presented at the public hearing. Any interested person who intends to participate in the hearing shall file a petition to oppose or support the application and the petition shall be filed with BOTH the applicant and Chief Engineer. The applicant must also file a petition if opposed to the Chief Engineer's recommendation. The Chief Engineer's address is "Water Rights Program, Foss Building, 523 E. Capitol, Pierre SD 57501 (605 773-3352)", and the applicant's mailing address is given above. A petition filed by either an interested person or the applicant must be filed by September 28, 2020.

The petition may be informal, but shall be in writing and shall include a statement describing the petitioner's interest in the application, the petitioner's reasons for opposing or supporting the application, and the signature and mailing address of the petitioner or the petitioner's legal counsel, if legal counsel is obtained. The hearing is an adversary proceeding and any party has the right to be present at the hearing and to be represented by a lawyer. These and other due process rights will be forfeited if they are not exercised at the hearing and decisions of the Board may be appealed to the Circuit Court and State Supreme Court as provided by law. The October 7, 2020 hearing date will be automatically delayed for at least 20 days upon written request to the Chief Engineer from the applicant or any person who has filed a petition to oppose or support the application. The request for an automatic delay must be filed by September 28, 2020. If an automatic delay is requested, the hearing will be rescheduled for a future Board meeting and personal notice will be provided to all petitioners regarding the time, date and location. Notice is given to individuals with disabilities that this hearing is being held in a physically accessible place. Please notify the Department of Environment and Natural Resources at least 48 hours before the hearing if you have a disability for which special arrangements must be made at the hearing. The telephone number for making arrangements is (605) 773-3352. Under SDCL 1-26-17(7) notices must state that "if the amount in controversy exceeds \$2,500.00 or if a property right may be terminated, any party to the contested case may require the agency to use the Office of Hearing Examiners by giving notice of the request to the agency no later than ten days after service of a notice of hearing issued pursuant to SDCL 1-26-17." This is a Notice of Hearing, service is being provided by publication, and the applicable date to give notice to the Chief Engineer is August 10, 2020. However, since this particular matter is a water permit application and not a monetary controversy in excess of \$2,500.00 or termination of a property right, the Chief Engineer disputes the applicability of this provision and maintains that the hearing must be conducted by the Board. As applicable, the following provides the legal authority and jurisdiction under which the hearing will be held and the particular statutes and rules pertaining to this application: SDCL 1-26-16 thru 1-26-28; SDCL 46-1-1 thru 46-1-9, 46-1-13 thru 46-1-16; 46-2-3.1, 46-2-9, 46-2-11, 46-2-17; 46-2A-1 thru 46-2A-12, 46-2A-14, 46-2A-15, 46-2A-20, 46-2A-21, 46-2A-23; 46-5-1.1, 46-5-2 thru 46-5-26, 46-5-30.2 thru 46-5-30.4, 46-5-31, 46-5-32 thru 46-5-34.1, 46-5-38 thru 46-5-39, 46-5-46, 46-5-47, 46-5-49; 46-6-1 thru 46-6-3.1, 46-6-6.1, 46-6-10, 46-6-13, 46-6-14, 46-6-21, 46-6-26; and Board Rules ARSD 74:02:01.01 thru 74:02:01.25.02, 74:02:01:35.01. Published once at the approximate cost of \$85.99. 90.99 (July 29, 2020)

RECEIVED

AUG 03 2020

WATER RIGHTS
PROGRAM

Form 8

PROOF OF PUBLICATION

STATE OF SOUTH DAKOTA)

County of Hamlin) SS

I, Lee Anne Dufek

certify that the attached printed Notice was taken

from the Hamlin County
Herald Enterprise

printed and published in Hayti

County of Hamlin and

state of South Dakota. The notice was published

in the newspaper on the following date:

July 29, 2020

Cost of Printing \$ 59.99

Lee Anne Dufek
(Signature)

Owner
(Title)

7-29-2020
(Date Signed)

16 / July 29, 2020

NOTICE OF HEARING ON APPLICATION NO. 8433-3 TO APPROPRIATE WATER

Notice is given that City of Lake Norden, PO Box 213, Lake Norden SD 57248 has filed an application for a water permit to appropriate 1,458 acre-feet of water annually at a maximum pump rate of 2.11 cubic feet of water per second from three wells completed into the Prairie Coteau Aquifer (97-114 feet deep) located in the SW 1/4 Section 15-T113N-R53W for municipal use. This site is located one mile east of the city Lake Norden.

South Dakota Codified Law (SDCL) 46-2A-4(10) provides that "if the applicant does not contest the recommendation of the Chief Engineer and no petition to oppose the application is received, the Chief Engineer shall act on the application pursuant to the Chief Engineer's recommendation and no hearing may be held before the board, unless the Chief Engineer makes a finding that an application, even if uncontested, presents important issues of public policy or public interest that should be heard by the board." In this case, the Chief Engineer finds that this application presents important issues of public interest that should be heard by the Water Management Board.

The Chief Engineer is recommending DEFERRAL of Application No. 8433-3 for further study pursuant to SDCL 46-2A-2 and 46-2A-7. The deferral recommendation is so the city of Lake Norden can provide information to assist with determining if there is unappropriated water available and the potential effect of pumping on existing water users. These criteria need to be addressed as required by SDCL 46-2A-9 to determine whether a water right permit may be issued. The further study needed entails further delineation of either the aquifer boundaries or a 7-day aquifer performance test, or both.

The Chief Engineer's recommendation and the application are available at <http://denr.sd.gov/public> or contact Ron Duvall for this information, or other information, at the Water Rights Program address provided below.

vided below.

The Water Management Board will consider this application at 1:00 pm, October 7, 2020 in the Matthew Training Center, Joe Foss Bldg, 523 E. Capitol Ave. Pierre SD. The Chief Engineer's recommendation is not final or binding upon the Board. The Board is authorized to 1) approve, 2) approve with qualifications, 3) defer, or 4) deny this application based on the facts presented at the public hearing.

Any interested person who intends to participate in the hearing shall file a petition to oppose or support the application and the petition shall be filed with BOTH the applicant and Chief Engineer. The applicant must also file a petition if opposed to the Chief Engineer's recommendation. The Chief Engineer's address is "Water Rights Program, Foss Building, 523 E Capitol, Pierre SD 57501 (605 773-3352)" and the applicant's mailing address is given above. A petition filed by either an interested person or the applicant must be filed by September 28, 2020.

The petition may be informal, but shall be in writing and shall include a statement describing the petitioner's interest in the application, the petitioner's reasons for opposing or supporting the application, and the signature and mailing address of the petitioner or the petitioner's legal counsel, if legal counsel is obtained. The hearing is an adversary proceeding and any party has the right to be present at the hearing and to be represented by a lawyer. These and other due process rights will be forfeited if they are not exercised at the hearing and decisions of the Board may be appealed to the Circuit Court and State Supreme Court as provided by law.

The October 7, 2020 hearing date will be automatically delayed for at least 20 days upon written request to the Chief Engineer from the applicant or any person who has filed a petition to oppose or support the application. The request for an automatic delay must be filed by September 28, 2020. If an automatic delay is requested, the hearing will be rescheduled for a future Board

meeting and personal notice will be provided to all petitioners regarding the time, date and location.

Notice is given to individuals with disabilities that this hearing is being held in a physically accessible place. Please notify the Department of Environment and Natural Resources at least 48 hours before the hearing if you have a disability for which special arrangements must be made at the hearing. The telephone number for making arrangements is (605) 773-3352.

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Published July 29, 2020, at total cost of \$59.99.

Instruction to Newspaper – Publish the Notice on July 29, 2020. The applicant is responsible for payment.

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Published once at an approximate cost of_____.



DENR
SOUTH DAKOTA

**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3182
denr.sd.gov

**NOTE: TO BE SURE OF PUBLICATION ON
THE CORRECT DATES, CONTACT
THE NEWSPAPERS RIGHT AWAY.**

July 22, 2020

City of Lake Norden
Jason Oho, Mayor
PO Box 213
Lake Norden SD 57248

Dear Mayor Oho:

Water Permit Application No. 8433-3 for municipal use has been examined and found to comply with the South Dakota Water Laws and applicable rules. A notice has been sent to the Hamlin Co Herald Enterprise printed at Hayti SD (Ph # 605 783-3636) and the Public Opinion printed at Watertown SD (Ph # 605 886-6901). You will need to contact the newspapers and authorize publication of this notice. For your information, a copy of the notice and the recommendation of the Chief Engineer are enclosed. Please review the notice prior to publication and notify this office, if you have any corrections or questions.

Be sure to contact the above newspapers to authorize publication of your Notice and to arrange for payment. Early contact with the papers can eliminate delays. Upon receiving authorization from you, the publishers have been instructed to publish your notice. The newspapers have also been instructed to send us the Proof of Publication. We must receive Proof of Publication before action can be taken on the application.

Sincerely,

Karen Schlaak

Karen Schlaak
Water Rights Program
(605) 773-3352

enclosures

NOTE: If you plan to contest any part of the Chief Engineer's recommendation, you must file a petition pursuant to the procedures outlined in the attached notice of hearing. The Water Management Board will then consider your concerns during a hearing on the application.

c: Gregg Jorgenson, Banner & Assoc.

Schlaak, Karen

From: Schlaak, Karen
Sent: Tuesday, July 21, 2020 2:42 PM
To: 'legals@thepublicopinion.com'
Subject: 8433-3, City of Lake Norden
Attachments: 8433-3public.wmb1.docx; FORM8.FRM.doc

Attached is a notice to be published on July 29, 2020.

The City of Lake Norden, Jason Oho, Mayor, PO Box 213, Lake Norden SD 57248 (605 758-3602) has been notified to contact you to authorize publication and arrange for payment.

Please send the affidavit or return the attached Proof of Publication form ASAP to the Water Rights Program, 523 E Capitol, Pierre SD 57501.

Let me know if you have questions. Please acknowledge receipt of this email.

Karen Schlaak
Water Rights Program
(605) 773-3352



Schlaak, Karen

From: Schlaak, Karen
Sent: Tuesday, July 21, 2020 2:54 PM
To: Hamlin County Publishing (hcp@itctel.com)
Subject: FW: 8433-3, City of Lake Norden
Attachments: 8433-3public.wmb1.docx; FORM8.FRM.doc

I should have added this notice is to be published in the Hamlin County Herald Enterprise.

From: Schlaak, Karen
Sent: Tuesday, July 21, 2020 2:41 PM
To: Hamlin County Publishing (hcp@itctel.com) <hcp@itctel.com>
Subject: 8433-3, City of Lake Norden

Attached is a notice to be published on July 29, 2020.

The City of Lake Norden, Jason Oho, Mayor, PO Box 213, Lake Norden SD 57248 (605 758-3602) has been notified to contact you to authorize publication and arrange for payment.

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Karen Schlaak
Water Rights Program
(605) 773-3352





**DEPARTMENT of AGRICULTURE
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 E. CAPITOL AVE
PIERRE SD 57501-3182
danr.sd.gov

JUL 13 2021

City of Lake Norden
Jason Aho, Mayor
PO Box 213
Lake Norden SD 57248

Dear Mayor Aho:

Enclosed is Water Permit No. 8433-3 authorizing the water diversion system and beneficial use of the water, not exceeding the limits as specified in the Water Permit.

We will schedule an inspection so that the Water License may be issued to you, thus completing your acquisition of a Water Right.

Sincerely,

Eric Gronlund, Chief Engineer
Water Rights Program
(605) 773-3352

enclosures

Report of Examination of Works and/or Application of Water to Beneficial Use For Permit No. 8433-3

I have this day, May 2, 2022, made a thorough examination of the water use system constructed by City of Lake Norden, PO Box 213, Lake Norden, SD 57248 of Permit No. 8433-3, bearing the priority of June 30, 2020 authorizing the diversion of 1.34 cu. ft. per second of the waters of the Prairie Coteau Aquifer for municipal use purposes, in Hamlin County.

A. Works used to divert the water:

Well Information:

- 1) Well Drilling Firm: Kaiser Well Drilling, Inc
- 2) No. of Wells 3
- 3) Depths: #1 – 97 ft; #2 – 103 ft; #3 – 101 ft feet
- 4) Well log is available Y

Casing:

- 1) Diameter 10 inches
- 2) Length #1 – 77 ft; #2 – 83 ft ; 87 ft feet
- 3) Type Plastic

Screen:

- 1) Type Stainless steel
- 2) Length All– 20 ft feet
- 3) Static water level 5 - 8 feet

Pump:

- 1) Make Submersibles
- 2) Model Unknown
- 3) Size Unknown
- 4) Capacity #1 – 350 ; #2 – 350 ; #3 – 250 ; Total – 950 GPM

Motor:

- 1) Make & Model Unknown
- 2) Horsepower rating #1 – 15; #2 – 15; #3 – 7.5 hp

B. Works used to transport water to place of use:

- 1) Type Buried plastic
- 2) Size 10 inches

D. Compliance with Permit Requirements:

- 1) Permit qualifications being abided by Y

Exceptions to compliance are: **If all three wells are pumped at the same time, the diversions will exceed the authorized permitted diversion.**

E. Condition and Location:

1. The system is in **excellent** condition with the point(s) of diversion located as follows: **WELL LOCATIONS From the SE corner Sec 15 T113N R53W; WELL # 1 1110 ft N 4580 ft W LAT 44.58953 LONG -97.18603 (SW ¼ SW ¼) WELL # 2 1320 ft N 4120 ft W LAT 44.59054 LONG -97.18446 (SW ¼ SW ¼) WELL # 3 1320 ft N 3530 ft W LAT 44.59037 LONG -97.18306 (SE ¼ SW ¼).**
2. The works are capable of diverting and conveying to the place of use **2.11** cu. ft. per second of water which is to be used for **municipal use**.
The license should be issued for **1.34** cfs.
3. All structures, wells and lands on map Y

F. Comments or other permit(s) associated with the project:

Dan Koistenen is the Water Superintendent at 605/881-5688 and Kendra is the City Secretary at 605/785-3602.

Mr. Koistenen was not sure about the pipe size but 10 inches seems reasonable.



Darrell W DeBoer
Water Rights Inspector
DANR, Water Rights Program

Date report completed: **November 9, 2022**

Note: Permitted for maximum pump rate of 1.34 cfs – city will need to limit diversions by not utilizing all wells at the same time.



0 0.075 0.15 0.3 0.45 0.6 Miles



Darrell DeBoer
Water Right Inspector
DANR-Water Rights Program



**DEPARTMENT of AGRICULTURE
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 E. CAPITOL AVE
PIERRE SD 57501-3182
danr.sd.gov

MAR 23 2023

8433-3

City of Lake Norden
c/o Jason Aho, Mayor
PO Box 213
Lake Norden SD 57248

Dear Mayor Aho:

Enclosed is Water License No. 8433-3. This is the final water right document completing your process of obtaining a Water Right. Also, included with your license is a map prepared by the staff engineer who conducted the investigation.

For your information SDCL 46-6-27 requires that if in the future the owner drills a replacement well and has no plan to use the old existing well, the old well is considered abandoned and must be plugged. Also, any well that is being used or is not considered abandoned must be valved and controlled, if flowing, or sealed and capped so that no leaking occurs either underground or at the surface.

As long as you use the water beneficially, as stated in the Water License, the State Water Laws provide that you have a continuing right to use the water. If you have any questions, please contact our office.

Sincerely,

Eric Gronlund, Chief Engineer
Water Rights Program
(605) 773-3352

enclosures

NOTE: Water Permit No. 8433-3 authorized a total of 1.34 cfs or 600 gallons per minute. The investigation of the water use system found the wells are capable of 2.11 cfs or 950 gallons per minute. The city will need to manage diversion from the three wells on a rotational basis in order not to exceed the licensed diversion rate of 1.34 cfs.

STATE OF SOUTH DAKOTA

WATER LICENSE NO. 8433-3

(1) City of Lake Norden, PO Box 213, Lake Norden SD 57248 made Application No. 8433-3, June 30, 2020 for a water permit to divert 1.34 cubic feet of water per second from three wells (Prairie Coteau Aquifer), Hamlin County, South Dakota for rural water system use purposes. Permit No. 8433-3, with a priority date of June 30, 2020 was approved July 7, 2021 and issued to the applicant for diversion of water with construction of the described water supply system and the application to beneficial use of said water completed.

(2) It is certified that the permit holder has complied with the provisions of South Dakota State Law relating to completion of the construction of the water supply system and is entitled to divert 1.34 cubic feet of water per second for beneficial use. The location of the diversion points: all from the SE corner of Section 15-T113N-R53W

- Well #1 – 1,110 ft N and 4,580 ft W (SW 1/4 SW 1/4)
Latitude 44.58953 Longitude -97.18603
- Well #2 – 1,320 ft N and 4,120 ft W (SW 1/4 SW 1/4)
Latitude 44.59054 Longitude -97.18446
- Well #3 – 1,320 ft N and 3,530 ft W (SE 1/4 SW 1/4)
Latitude 44.59037 Longitude -97.18306

(3) Pursuant to South Dakota Water Law 46-5-30.1 City of Lake Norden, PO Box 213, Lake Norden SD 57248 the holder and/or owner of Water Right No. 8433-3 is issued a license to appropriate water, the right to use 1.34 cubic feet of water per second from three wells (Prairie Coteau Aquifer) with a priority date of June 30, 2020 from the locations specified in (2) of this license for rural water system use purposes.

This license is subject to South Dakota State Law, any limitations or conditions listed in Water Right No. 8433-3 and subject to the following qualifications:

- The wells approved under Water Right No. 8433-3 will be located near domestic wells and other wells which may obtain water from the same aquifer. Water withdrawals under this Permit shall be controlled so there is not a reduction of needed water supplies in adequate domestic wells or in adequate wells having prior water rights.
- The water right holder shall report to the Chief Engineer annually the amount of water withdrawn from the Prairie Coteau aquifer.
- Water Right No. 8433-3 authorizes a total annual diversion not exceeding 967 acre-feet of water annually from the Prairie Coteau aquifer.


Eric Gronlund, Chief Engineer
Water Rights Program

Department of Agriculture and Natural Resources

MAR 23 2023
date



STATE OF SOUTH DAKOTA
***REISSUED WATER LICENSE NO. 8433-3**

(1) The City of Lake Norden, PO Box 213, Lake Norden SD 57248, made Application No. 8433-3, June 30, 2020, for a water permit to appropriate up to 967 acre-feet of water annually, with a maximum diversion rate of 1.34 cubic feet of water per second from groundwater, three wells (Prairie Coteau Aquifer), for *municipal purposes. Permit No. 8433-3, with a priority date of June 30, 2020, was approved July 7, 2021, and issued to the applicant for diversion of water and for the application of water to beneficial use.

*Water Right No. 8433-3 was issued March 23, 2023, listed the incorrect purpose of “rural water system use”. This license is being reissued to correct the purpose of water use to “municipal” as originally public noticed and permitted.

(2) It is certified that the water right holder has complied with the provisions of South Dakota State Law relating to completion of the construction of the water supply system and is entitled to divert 1.34 cubic feet of water per second for beneficial use. The locations of the diversion points are:

- Well #1: 1,110 ft N & 4,580 ft W of the SE corner Section 15-T113N-R53W (SW $\frac{1}{4}$ SW $\frac{1}{4}$) (Latitude 44.58953 & Longitude -97.18603)
- Well #2: 1,320 ft N & 4,120 ft W of the SE corner Section 15-T113N-R53W (SW $\frac{1}{4}$ SW $\frac{1}{4}$) (Latitude 44.59054 & Longitude -97.18446)
- Well #3: 1,320 ft N & 3,530 ft W of the SE corner Section 15-T113N-R53W (SE $\frac{1}{4}$ SW $\frac{1}{4}$) (Latitude 44.59037 & Longitude -97.18306)

(3) The amount of appropriation may not exceed 967 acre-feet annually. The water is to be used during the following described annual period: January 1 – December 31.

(4) Pursuant to South Dakota Water Law 46-5-30.1 the City of Lake Norden, the holder and/or owner of Water Right No. 8433-3 is reissued a license to appropriate up to 967 acre-feet of water annually, with a maximum diversion rate of 1.34 cubic feet of water per second from groundwater, three wells (Prairie Coteau Aquifer), with a priority date of June 30, 2020, from the locations specified in (2) of this license for *municipal purposes.

This license is subject to South Dakota Water Law, any limitations or conditions listed in Water Right No. 8433-3 and subject to the following qualifications:

1. The wells approved under Water Right No. 8433-3 will be located near domestic wells and other wells which may obtain water from the same aquifer. Water withdrawals under this Permit shall be controlled so there is not a reduction of needed water supplies in adequate domestic wells or in adequate wells having prior water rights.
2. The water right holder shall report to the Chief Engineer annually the amount of water withdrawn from the Prairie Coteau Aquifer.
3. Water Right No. 8433-3 authorizes a total annual diversion not exceeding 967 acre-feet of water annually from the Prairie Coteau Aquifer.



Adam Mathiowetz, PE
Acting Chief Engineer
Department of Agriculture and Natural Resources

MAR 12 2026

date

