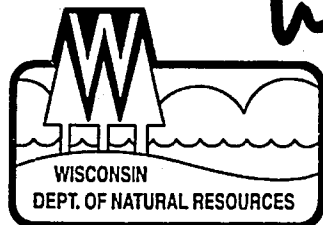


W2006-0097

XH

04-25-06



State of Wisconsin | DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor  
Scott Hassett, Secretary

101 S. Webster St.  
Box 7921  
Madison, Wisconsin 53707-7921  
Telephone 608-266-2621  
FAX 608-267-3579  
TTY Access via relay - 711

April 25, 2006

DEBORAH BREIVOGEL CLERK  
CITY OF RHINELANDER  
135 SOUTH STEVENS STREET  
RHINELANDER WI 54501

Project Number: W-2006-0097  
PWSID#: 74401261  
DNR Region: NOR  
County: ONEIDA

SUBJECT: WATER SYSTEM FACILITIES WELL SITE APPROVAL.

Dear Ms. Breivogel:

The Wisconsin Department of Natural Resources, Division of Water, Bureau of Drinking Water and Groundwater, is conditionally approving a well site investigation report for the following project. The report is of sufficient detail to meet the requirements of s. NR 811.13 (3), Wis. Adm. Code.

Water system name: City of Rhineland  
Date received: 2/6/06  
Engineering firm: Town & Country Engineering, Inc., Madison  
Professional Engineer: Warren O. Myers  
Regional DNR Contact: Bill Dobbins, Rhineland, 715-365-8923

Project description: The February, 2006, well site investigation report is for the well site for well No. 7. The Department is hereby approving the well site subject to the conditions below.

The City owned well site for future well No. 7 is located in the northwestern portion of the City at the north dead end of South Fox Ranch Road and in the NW ¼ of the NW ¼ of Section 10, T36N, R8E, City of Rhineland, Oneida County, Wisconsin. The trapezoidal shaped property will have approximate property boundaries with lengths of 100 feet, 120 feet, 97.4 feet, and 124 feet. The final well will be centered on the site. In March 1987, 10-inch test well No. 17 was constructed approximately 74 feet to the southeast of the final well site. A 10-inch screen was installed in the test well from the 55-foot depth to the 80-foot depth. Other test wells were previously constructed in the area, including test well No. 9 located approximately 5 feet to the southeast of test well No. 17. Reportedly, only test well No. 17 still exists.

It has been indicated that along with the plans and specifications to be submitted to the Department for the construction of the final well, a proposal will be submitted for cleaning out, test pumping, and sampling test well No. 17 for inorganics, volatile organics, synthetic organics, and radionuclides.

The construction of the final well is not being approved at this time. It is noted that the well will be constructed with 30-inch temporary well casing to 80 feet, 22-inch or 24-inch protective well casing to 53 feet, an inner 18-inch well casing to 60 feet and 18-inch well screen from 60 feet to 80 feet. The annular space surrounding the 18-inch well screen and casing will be backfilled with gravel pack from the bottom of the well up to the ground surface. The annular space surrounding the 22-inch or 24-inch well casing



will be provided with a bentonite grout seal at the 60-foot depth and then grouted with neat cement. The 30-inch well casing will be pulled back and removed from the well during the grouting process as possible. A 400 to 700 gallon per minute final pump production rate is planned.

It is expected that the well water will be aggressive and that therefore, it will be necessary to install corrosion control chemical addition equipment in the well No. 7 pumphouse. Chlorine will also be fed for disinfection purposes.

**Variations being issued to Chapter NR 811, Wis. Adm. Code: None.**

**Approval condition related to Chapter NR 811, Wis. Adm. Code:**

1. Existing test well No. 17 shall be permanently abandoned and a completed DNR Well Abandonment Report submitted to the Department before well No. 7 is placed in service.
2. Plans and specifications shall be submitted to the Department for the construction of well No. 7 and the subsequent written approval of the Department obtained, prior to starting construction of the well.
3. The final plans to be submitted to the Department for the construction of well No. 7 shall include a site plan map that indicates the final dimensions of the well site, the site topography, and the location of the final well on the site.

**Approval conditions related to other Department requirements: None.**

**Approval constraints:** This approval is valid for two years from the date of approval and is subject to the conditions listed above. If construction or installation of the improvements has not commenced within two years the approval shall become void and a new application must be made and approval obtained prior to commencing construction or installation.

This approval is based upon the representation that the plans submitted to the Department are complete and accurately represent the project being approved. Any approval of plans that do not fairly represent the project because they are incomplete, inaccurate, or of insufficient scope and detail is voidable at the option of the Department.

**Appeal rights:** The project was reviewed in accordance with s. 281.41, Statutes for compliance with Chapters NR 108 and NR 811 Wis. Adm. Code and is hereby approved in accordance with s. 281.41, Statutes subject to the conditions listed above. If you believe you have a right to appeal this decision, you may file a written request for a contested case hearing pursuant to s. 227.42, Wis. Stats., or file for judicial review under s. 227.52 and 227.53, Statutes. You have 30 days after this approval is mailed to file your written request for hearing or file and serve your petition for judicial review. Your request for hearing or petition for judicial review must name the Secretary of the Department as respondent. This notice is provided pursuant to s. 227.48, Statutes.

**Recommendations:** The following recommendations are based on staff review of the project. The owner is not required to implement the recommendations in order to comply with the approval.

1. It is recommended that if possible the two private homes located directly to the south-southeast of the well site be connected to City water and sanitary sewer mains and the private wells and septic systems be permanently abandoned in order to prevent them from acting as avenues of groundwater contamination to the City well.

2. It is recommended that the well site be large enough to facilitate the future addition of water treatment improvements if ever needed. The larger the well site the greater the direct groundwater protection that will be provided.
3. The Department agrees that the City should clean out, pump, and sample test well No. 17. It is recommended that the water quality data be evaluated and shared with the Department for review and comment, prior to starting construction of final well No. 7.
4. It is recommended that a pilot hole be constructed at the site of the final well to evaluate the geology at that location before starting construction of the final well.

STATE OF WISCONSIN  
DEPARTMENT OF NATURAL RESOURCES

For the Secretary



Norman A. Hahn, Jr., P.E.  
Public Water Supply Section  
Bureau of Drinking Water and Groundwater  
608-267-7661

cc: John Zatopa – Superintendent, Water and Wastewater Utilities, City of Rhinelander, 135 S. Stevens Street, P.O. Box 658, Rhinelander, WI 54501  
Warren Myers – Town & Country Engineering, Inc., 5225 Verona Road, Building 4, Box 44451, Madison, WI 53744-4451  
Bill Dobbins – DNR, Rhinelander  
Michelle DeBrock-Owens – DNR, Rhinelander  
Norm Hahn – DNR, DG/2 Reviewer w/attachment  
Peter Feneht – PSC, Madison

DEPARTMENT OF NATURAL RESOURCES

PUBLIC WELL REVIEW

Form 3300-44

REVIEWED BY N. HANN

DATE 4/24/07

Utility \_\_\_\_\_ OTM \_\_\_\_\_ Other \_\_\_\_\_

City or P.O. \_\_\_\_\_ County \_\_\_\_\_

FWS Name CITY OF RHINELANDER No. 7 Well Type \_\_\_\_\_

Location \_\_\_\_\_ 1/2 Sec. \_\_\_\_\_ T \_\_\_\_\_ R \_\_\_\_\_

Nearest Well \_\_\_\_\_ Utility Well \_\_\_\_\_

Site: Inspection by \_\_\_\_\_ Size \_\_\_\_\_  
 Flooding \_\_\_\_\_ Hazards \_\_\_\_\_

Test Well \_\_\_\_\_ Abandonment \_\_\_\_\_

Protective Casing: Prime \_\_\_\_\_ Spec. \_\_\_\_\_ Thickness \_\_\_\_\_

Screen Description: \_\_\_\_\_

Grout: Thickness \_\_\_\_\_ Mix \_\_\_\_\_

Bentonite Circulation \_\_\_\_\_ Exposure to Formation \_\_\_\_\_  
 Method \_\_\_\_\_

Pumping Test: Capacity \_\_\_\_\_ Length \_\_\_\_\_ P & A \_\_\_\_\_

Chlorine Residual \_\_\_\_\_ Disinfection \_\_\_\_\_ Formation Samples \_\_\_\_\_ Blasting \_\_\_\_\_

Drilling Method \_\_\_\_\_

Formations:	Existing	Existing	Proposed
Well No.	_____	_____	_____
Drift	_____	_____	_____
Other Unconsolidated	_____	_____	_____
Silurian (Niagara) Dolomite	_____	_____	_____
Maquoketa Shale	_____	_____	_____
Galena-Platteville Dolomite	_____	_____	_____
St. Peter Sandstone	_____	_____	_____
Prairie du Chien Dolomite	_____	_____	_____
Cambrian	_____	_____	_____
Sandstones	_____	_____	_____
Precambrian	_____	_____	_____
TOTAL DEPTH	_____	_____	_____
Specific Capacity (gpm/ft)	<u>13.13</u>	_____	_____

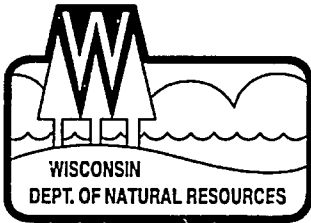
SWL = 8.875' PM = 50.75 @ 550 gpm

Chemical Analysis

Well No.	TEST WELL NO. 17 (3/10/87)	_____	_____
Alk	<u>50</u>	_____	_____
Ca	<u>12</u>	_____	_____
Cl	<u>1</u>	_____	_____
F	_____	_____	_____
Hard	<u>40</u>	_____	_____
Fe	<u>20.10</u>	_____	_____
Mg	_____	_____	_____
Mn	<u>20.05</u>	_____	_____
NO <sub>2</sub> + NO <sub>3</sub>	<u>0.30</u>	_____	_____
Na	<u>3.5</u>	_____	_____
SO <sub>4</sub>	<u>9</u>	_____	_____
T. Res.	<u>64</u>	_____	_____
pH	<u>5.9</u>	_____	_____
LANGELIER INDEX @ 50°F	_____	_____	_____

Bacti Records

Dates	_____
Safe	_____
Unsafe	_____
Total	_____



**State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES**

Jim Doyle, Governor  
Scott Hassett, Secretary

Box 7921  
101 South Webster Street  
Madison, Wisconsin 53707-7921  
TELEPHONE 608-266-2621  
FAX 608-267-3579  
TDD 608-267-6897

February 10, 2006

DEBORAH BREIVOGEL CLERK  
CITY OF RHINELANDER  
135 SOUTH STEVENS STREET  
PO BOX 658  
RHINELANDER WI 54501

**Acknowledgement of Receipt**

The Department has received the following plan submittal and request for Department approval in accordance with s. 281.41 Statutes. If you have questions regarding the status of the project review, please contact the listed review engineer.

*DATE RECEIVED:* February 6, 2006

*OWNER:* RHINELANDER, CITY

*SUBMITTING ENGINEER:* WARREN O. MYERS, P.E.

*PROJECT TYPE:* Report for New Wells (Construction/Investigation)

*PROJECT DESCRIPTION:* WELL #7 SITE INVESTIGATION REOPRT.

*DNR PROJECT NUMBER:* W-2006-0097

*DNR REGION:* NORTHERN

*DNR REVIEWER:* NORM HAHN

(608) 267-7661

FAX: (608) 267-7650

E-MAIL: [norman.hahnjr@DNR.STATE.WI.US](mailto:norman.hahnjr@DNR.STATE.WI.US)

*Copy To:*

WARREN O. MYERS, P.E.  
TOWN & COUNTRY ENGINEERING INC  
5225 VERONA ROAD BLDG #4  
PO BOX 44451  
MADISON WI 53744 4451

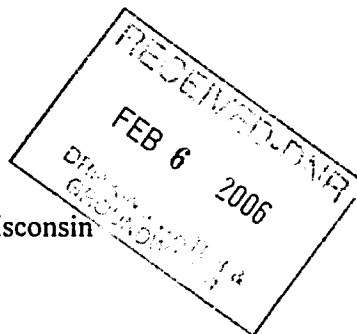
TOWN & COUNTRY  
ENGINEERING, INC.

February 2, 2006

5225 VERONA RD BLDG 4  
PO BOX 44451  
MADISON, WI 53744-4451  
(608) 273-3350 (fax) 273-3391  
(e-mail) tce@tcengineers.net



Mr. Lee Boushon, P.E.  
Public Water Supply Section  
Department of Natural Resources  
101 S Webster Street - DG/2  
Madison WI 53703



Subject: Well Site Investigation Report  
New Well No. 7 - City of Rhinelander, Wisconsin

Dear Mr. Boushon:

Attached for your review and approval is a well site investigation report for a new well in the City of Rhinelander. Because of the granite bedrock, wells of sufficient capacity and quality characteristics to act as public water supplies are difficult to find in the Rhinelander area. For many years the City has had an ongoing program of geophysical exploration and test well drilling to attempt to locate potential sites for future well development. The site at which this new well is proposed was found and test wells were constructed in 1986 and 1987. Data from these test wells is included in this report.

The City is the recipient of a STAG Grant from the Environmental Protection Agency to assist in construction of this new well. It is anticipated that this grant will be received later this year and the City wishes to be prepared to proceed immediately with the drilling of a new well. Therefore, we are submitted this well site investigation report and asking that the department review the report so that well construction might begin in the spring or early summer of this year.

If you have any questions about the well site or the project intended by the City, please feel free to contact me at your convenience.

Very truly yours,  
TOWN & COUNTRY ENGINEERING, INC.



Warren O. Myers, P.E.  
President

J:\JOB\S\Rhinelande\RI-16-12\SpecRpts\Site Invest. DNR Letter.doc

WOM:bjs

cc: Mr. John Zatopa, Water and Sewer Superintendent, City of Rhinelander (135 S. Stevens Street, Rhinelander, WI 54501)

Mr. Philip Parkinson, City Attorney/Administrator, City of Rhinelander (135 S. Stevens Street, Rhinelander, WI 54501)

cc: Bill Dobbins w/ report 2/13/06



*File*

RECEIVED-DNR  
FEB 15 2006  
DRINKING WATER &  
GROUNDWATER



**LETTER OF TRANSMITTAL**

**Town & Country Engineering, Inc.**

5225 Verona Rd., Bldg. 4

P.O. Box 44451

Madison, Wisconsin 53744-4451

Phone: (608) 273-3350 Fax: (608) 273-3391

tce@tcengineers.net

**To:** WI DNR  
101 South Webster Street  
DG/2  
Madison WI 53703

**Date** February 14, 2006  
**Job No.** RI 16  
**Subject** Well Site Investigation Report  
**Attention** Mr. Norm Hahn

Sent to you for the following reason:

For Approval       For Review & Comment       Revise and Resubmit  
 For Your Use       Review Completed       Returned

No.	Copies	Description
1	1	Well Site Investigation Report - New Well No. 7, City of Rhinelander

Please do not hesitate to contact us with any questions.

**Copy:**      **Sent By:** Warren Myers, P.E.  
*Wm*

**Hahn, Norman A.**



**From:** Dobbins, William G  
**Sent:** Wednesday, February 22, 2006 8:28 AM  
**To:** Hahn, Norman A.  
**Subject:** RE: The proposed Rhinelander well site.

Norm -

I don't know what Rhinelander test wells remain. The City has been guarding this property for years. When the paper mill tried to put a sludge landfill in the area the City had a fit and won the battle to keep it far away.

FYI - I was supposed to go to Land O'Lakes today for well startup but it was delayed again - they are still getting positive bacti samples from it and Sam's must still be trying to develop Antigo well #19 - they continue to postpone the grouting.

Bill

---

**From:** Hahn, Norman A.  
**Sent:** Tuesday, February 21, 2006 3:20 PM  
**To:** Dobbins, William G  
**Subject:** RE: The proposed Rhinelander well site.

Hi Bill. Thank you very much for the pictures and comments. I just spoke with Warren Myers for the second time today. We discussed.

1. He will have the local surveyor confirm the correct 1/4, 1/4 section.
2. He will attempt to obtain a well log for the last 10-inch test well (#17) drilled on the site by LNW in 1987.
3. He will determine what test wells still exist on the property. Bill, do you know?
4. If test well #17 still exists he will talk to the City about pumping it again and sampling for all of the IOC, VOCs, SOC, and rad WQ parameters required for new municipal wells as a precaution.
5. He will provide a site plan of the property including the property boundaries, test well locations and final well location. He said this may take several weeks because he will have to get the surveyor involved.
6. He will provide a profile plan view of the construction details of the proposed final well.   
*↙ ~ 1200' to 1500'*
7. He will check into the design and cost of a sanitary sewer to hook up the nearby homes and alert the City to the same. I don't think we can require this because they are greater than 400 feet away but we can recommend it.
3. I told him I would let him know if the NOR wetlands staff have any concerns.

Let me know if you have any additional comments. Thanks again!

---

**From:** Dobbins, William G  
**Sent:** Tuesday, February 21, 2006 2:31 PM  
**To:** Hahn, Norman A.  
**Subject:** RE: The proposed Rhinelander well site.

Norm -



This is what the site looks like:

<< File: P1010005.JPG >> Looking east - the well would be between the road and airport fence

<< File: P1010006.JPG >> Looking north to the airport

<< File: P1010007.JPG >> Looking west

<< File: P1010008.JPG >> Looking south towards a wetland and Hoist Lake

<< File: P1010009.JPG >> Looking southeast with the house, large garage and septic

<< File: P1010010.JPG >> Industrial building about 1/2 mile to the south

<< File: P1010011.JPG >> The next building adjacent to the one above

My major concern is the septic tanks just to the south. Should the City be asked to hook up sewer to the homes on South Fox Ranch Road?

Fisheries didn't have any concerns about this site. Our wetland folks aren't around but I'll run it by them and let you know if there are any objections.

Bill

---

**From:** Hahn, Norman A.  
**Sent:** Tuesday, February 21, 2006 10:36 AM  
**To:** Dobbins, William G  
**Subject:** The proposed Rhinelander well site.

Hi Bill. Have you had a chance to review the well site investigation report for the Rhinelander well? Any comments that you have would be appreciated.  
Thanks.

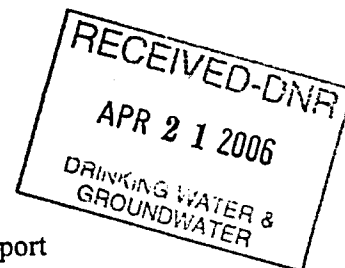
TOWN & COUNTRY  
ENGINEERING, INC.

April 20, 2006



5225 VERONA RD BLDG 4  
PO BOX 44451  
MADISON, WI 53744-4451  
(608) 273-3350 (fax) 273-3391  
(e-mail) tce@tcengineers.net

Mr. Norm Hahn  
Public Water Supply Section  
Department of Natural Resources  
101 S Webster Street - DG/2  
Madison WI 53703



Subject: Supplemental Information - Well Site Investigation Report  
New Well No. 7 - City of Rhinelander, Wisconsin

Dear Norm:

Attached is the supplemental information you requested for the well site investigation report for a new well in the City of Rhinelander. Your telephoned questions or requests for additional information and our responses are as follows:

- Please submit a site map of the area showing any remaining test wells and the proposed property lines of the well/pump house site. Response: *A site map is attached. No formal property survey has yet been done to create a separate well parcel, but this survey will be completed upon DNR acceptance of the Well Site Investigation Report. The well parcel dimensions shown on the attached site map are somewhat flexible because the City already owns the airport property on which the new well construction is proposed. If you wish to have different dimensions the City is open to your recommendations.*
- Please submit a profile drawing of the proposed well. Response: *A profile drawing is included on the site map. As per our discussions, the gravel pack is proposed to be extended to about seven (7) feet above the top of the screen. The depth of the grout will be fifty-three (53) feet below grade.*
- Please provide a construction log of Test Well No. 17 and any test pumping results, particularly water quality results. Response: *The informal construction log of Test Well No. 17 was included in the Appendix in the original Well Site Investigation Report submittal, as was all available test pumping results for both quantity and quality. We have no formal constructor's report. We agree that it would be desirable to perform a complete scan for contaminants, including SOC's, VOC's, IOC's and radioactivity, on a test well before the money is put into the drilling and testing of a permanent well. Test Well No. 17 is still in place and was located in the field. The location is shown on the site map. This is the only test well which was found. The exposed part of the well casing has been bent, apparently by construction equipment used to place fill in this area. However, it may be possible to clean out this test well and to reinsert a test and pump it for a period of time, and then to take the desired samples for chemical testing. We will incorporate this approach into the project plans and specifications.*



cc: Bill Dobbins - 4/24/06

- Is the proposed well location in the NW ¼, NW ¼, Section 10, or the NE ¼, NW ¼, Section 10 as indicated on Page 7? Response: *The well will be located in the NW ¼, NW ¼, not in the NE ¼, NW ¼, Section 10 as indicated on Page 7. This is a typographical error and we ask that you so correct Page 7 of the submitted report copies.*

If you have any additional questions about the well site or the project intended by the City, please feel free to contact me at your convenience.

Very truly yours,  
TOWN & COUNTRY ENGINEERING, INC.



Warren O. Myers, P.E.

President

J:\JOB#SRrhineland\RI-16-12\SpecRpts\Site Invest. DNR Letter - Supplemental Info.doc

WOM:wom

cc: Mr. John Zatopa, Water and Sewer Superintendent, City of Rhineland (135 S. Stevens Street, Rhineland, WI 54501)

Mr. Philip Parkinson, City Attorney/Administrator, City of Rhineland (135 S. Stevens Street, Rhineland, WI 54501)

RECEIVED-DNR  
 APR 21 2006  
 DRINKING WATER &  
 GROUNDWATER

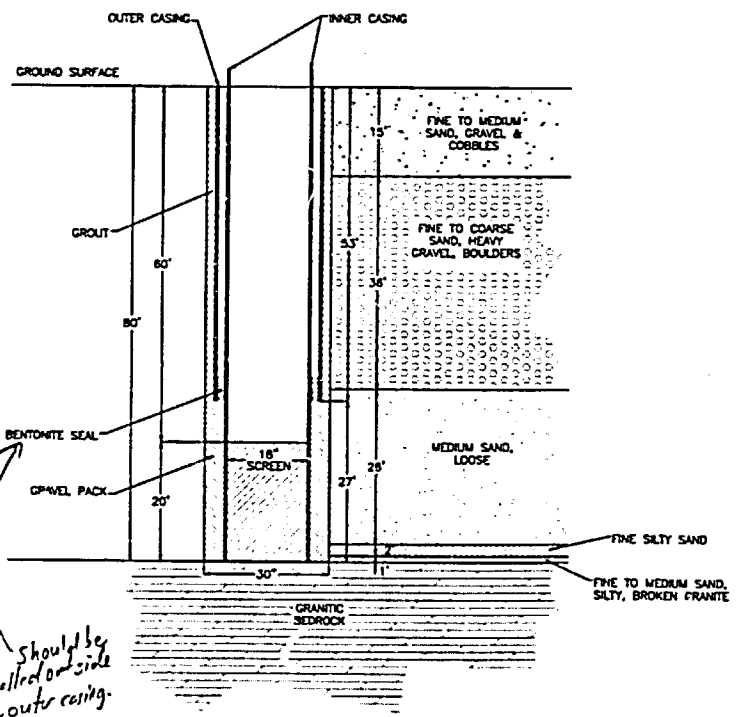
TOWN & COUNTRY  
 ENGINEERING, INC.  
 8223 VERONA ROAD, BURLINGAME, CA 94010  
 TEL: (415) 337-3330 FAX: (415) 337-3331

PROPOSED WELL #7 SITE PLAN AND PROFILE

2008 FOX RANCH ROAD  
 WELL SITE INVESTIGATION

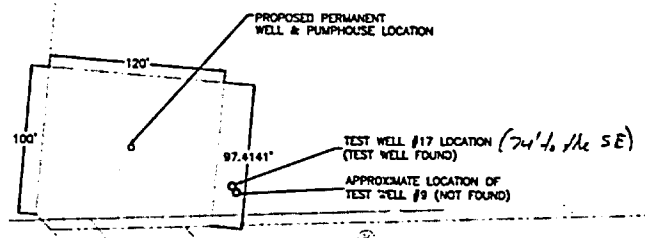
City of Menlo Park, California

DATE	04/15/06
BY	...
SCALE	AS SHOWN
PROJECT	...
SHEET	1

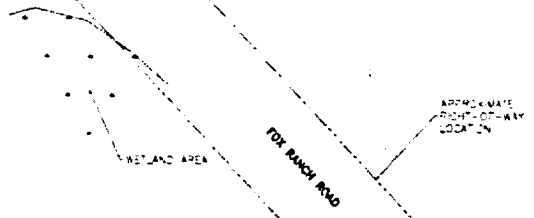


*Should be installed outside the outer casing.*

**SITE PLAN**



*File*



*File*

REVIEWED AND APPROVED BY THE  
DIV. OF WATER  
DEPT. OF NATURAL RESOURCES IN  
ACCORDANCE WITH SEC. 281.42 WIS.  
STATS. SUBJECT TO THE CONDITIONS  
SET FORTH IN THE LETTER OF APPROVAL

APPROVAL NUMBER W2006-0097  
APPROVAL DATE 4-25-06

WELL SITE INVESTIGATION REPORT  
New Well No. 7

City of Rhinelander, Wisconsin

February 2006

RECEIVED-DNR  
FEB 6 2006  
DIVISION OF WATER &  
GROUNDWATER



**TOWN & COUNTRY ENGINEERING, INC.**  
5225 Verona Rd. Bldg. 4, P.O. Box 44451  
Madison, WI 53744-4451  
Phone: (608) 273-3350 □ Fax: (608) 273-3391

**WELL SITE INVESTIGATION REPORT**  
**New Well No. 7**

---

City of Rhinelander, Wisconsin

February 2006

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## **APPENDICES**

Appendix A -	Excerpts from September 1986 – Water Supply System Study (Foth & Van Dyke)
Appendix B -	Excerpts from April 14, 1987 – Update of Groundwater Investigation (Foth & Van Dyke)

**WELL SITE INVESTIGATION REPORT**  
**Well No. 7**

City of Rhinelander, Wisconsin

a) Regional Flood Elevation

The elevation of the nearest floodplain is approximately 1550 feet USGS. The approximate site elevation is 1590 feet. The nearest defined floodplain is more than a mile away. Figure No. 1 on the following page is a copy of part of the two spliced USGS quadrangle maps for the area showing the proposed well site. A copy of the applicable floodplain map is shown on the second following page. (Figure No. 2)

b) Past and Present Uses of the Proposed Site

The site and property eastward are presently zoned for airport use. However, the runways and the terminal are nearly  $\frac{3}{4}$  mile away. The site is covered with coniferous growth and has been undisturbed for many years.

Two parcels several hundred feet to the south are used for residential development. The land about  $\frac{1}{3}$  to  $\frac{1}{2}$  mile to the south is used for industry.

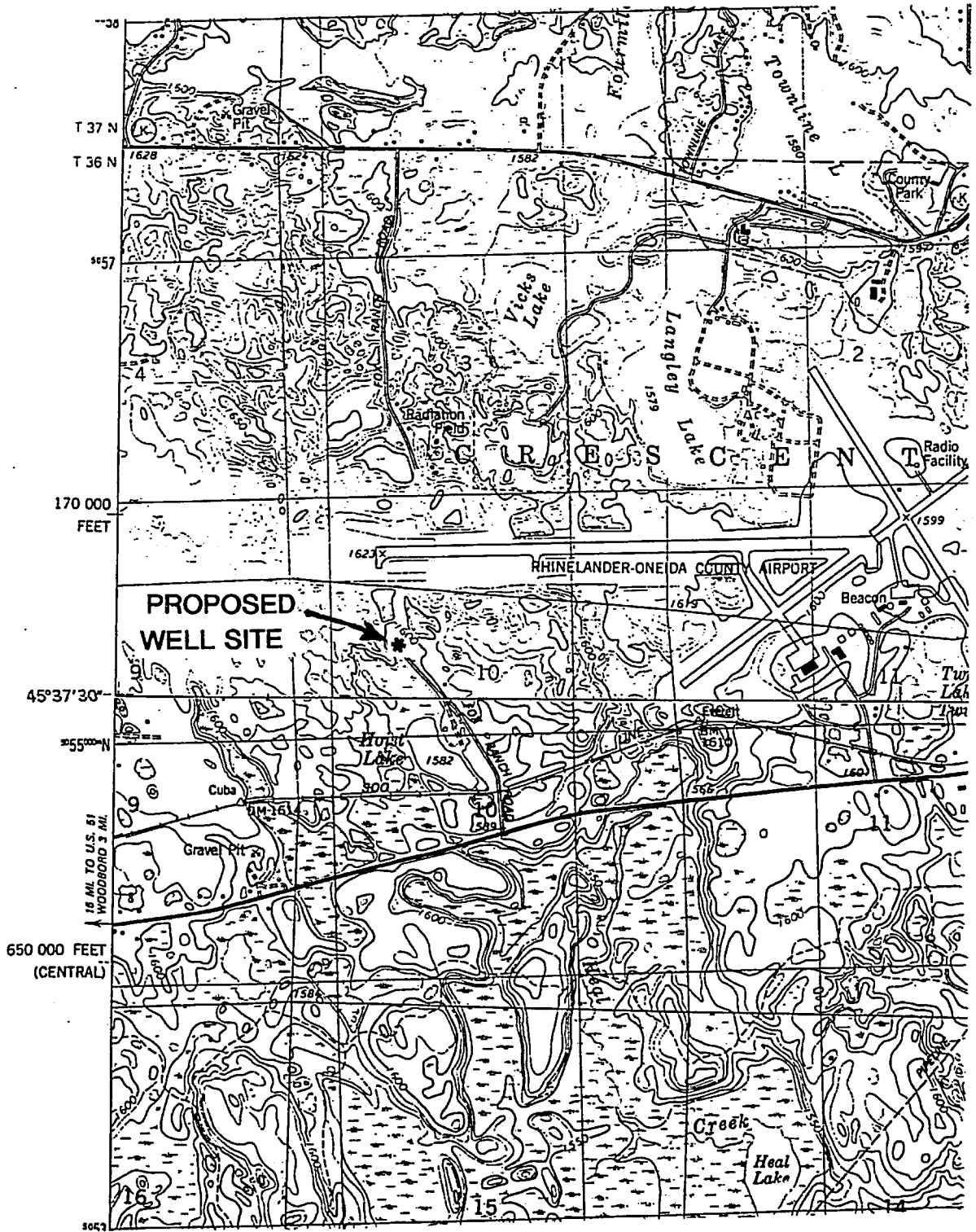
c) Potential Contamination Sources Within  $\frac{1}{2}$  Mile of the Well Location

Residential parcels with private wells and septic waste disposal systems are located about 800 and 1400 feet southeast of the proposed well site. Otherwise, the next closest contaminant sources identified are industrial parcels located about  $\frac{1}{2}$  mile to the south of the proposed well site. A railroad track is also located in that area. And, of course, because the proposed well site is on City airport property, an airport runway is in the vicinity. However, the airport terminal and equipment facilities are located about  $\frac{3}{4}$  mile to the east. A site to the north of the airport is labeled on Figure 1 as "radiation field". This site was a U.S. Forest Service research site where the effects of airborne radiation on trees was studied. This site is not believed to represent high potential for radioactivity contamination. See attached Potential Contamination Use Map. (Figure No. 3)

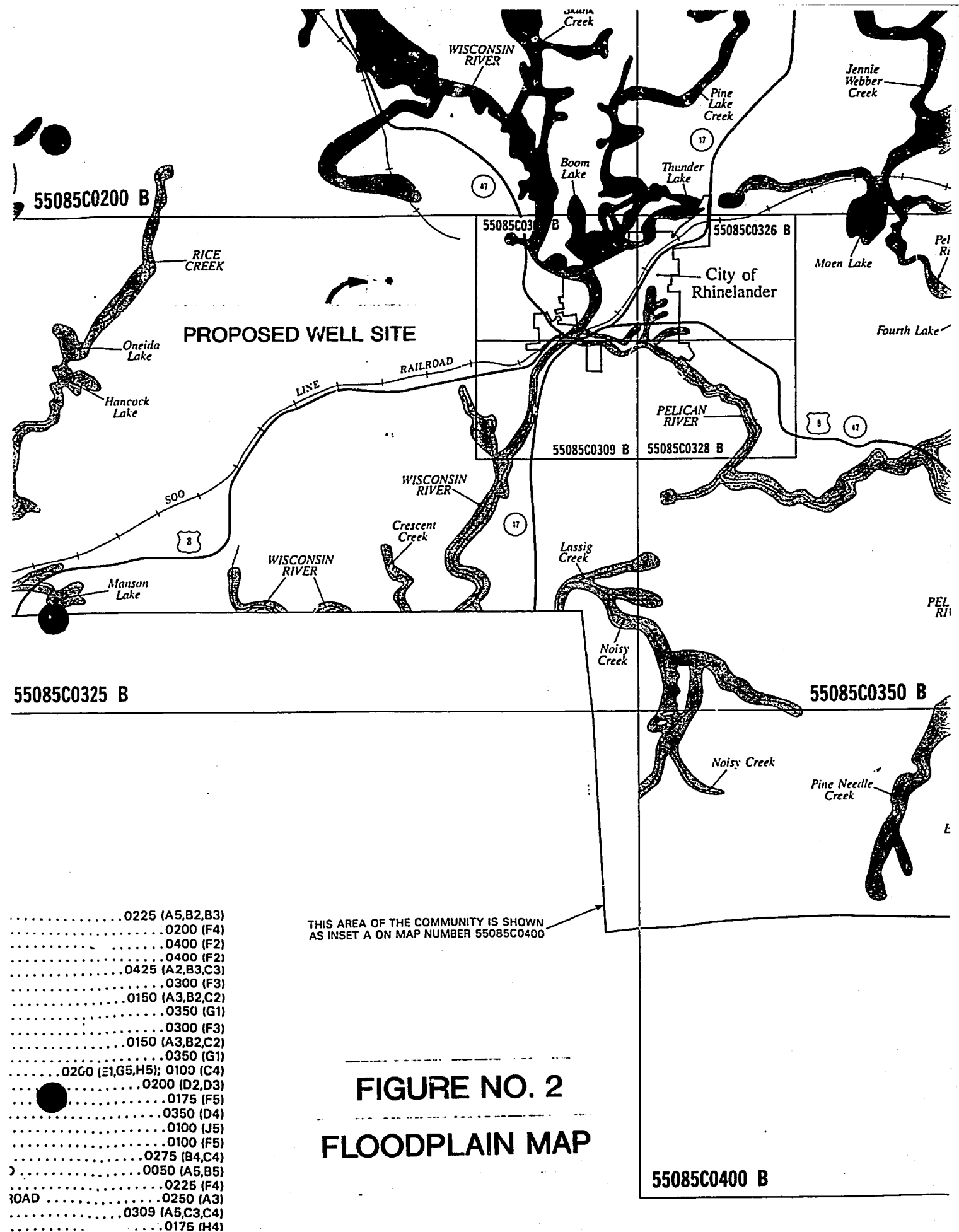
about  $\frac{1}{2}$  mile  
N-NE



FIGURE NO. 1



LOCATION MAP



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55085C0309 B

55085C0326 B

55085C0309 B

55085C0328 B

55085C0325 B

55085C0350 B

55085C0400 B

**PROPOSED WELL SITE**

City of Rhinelander

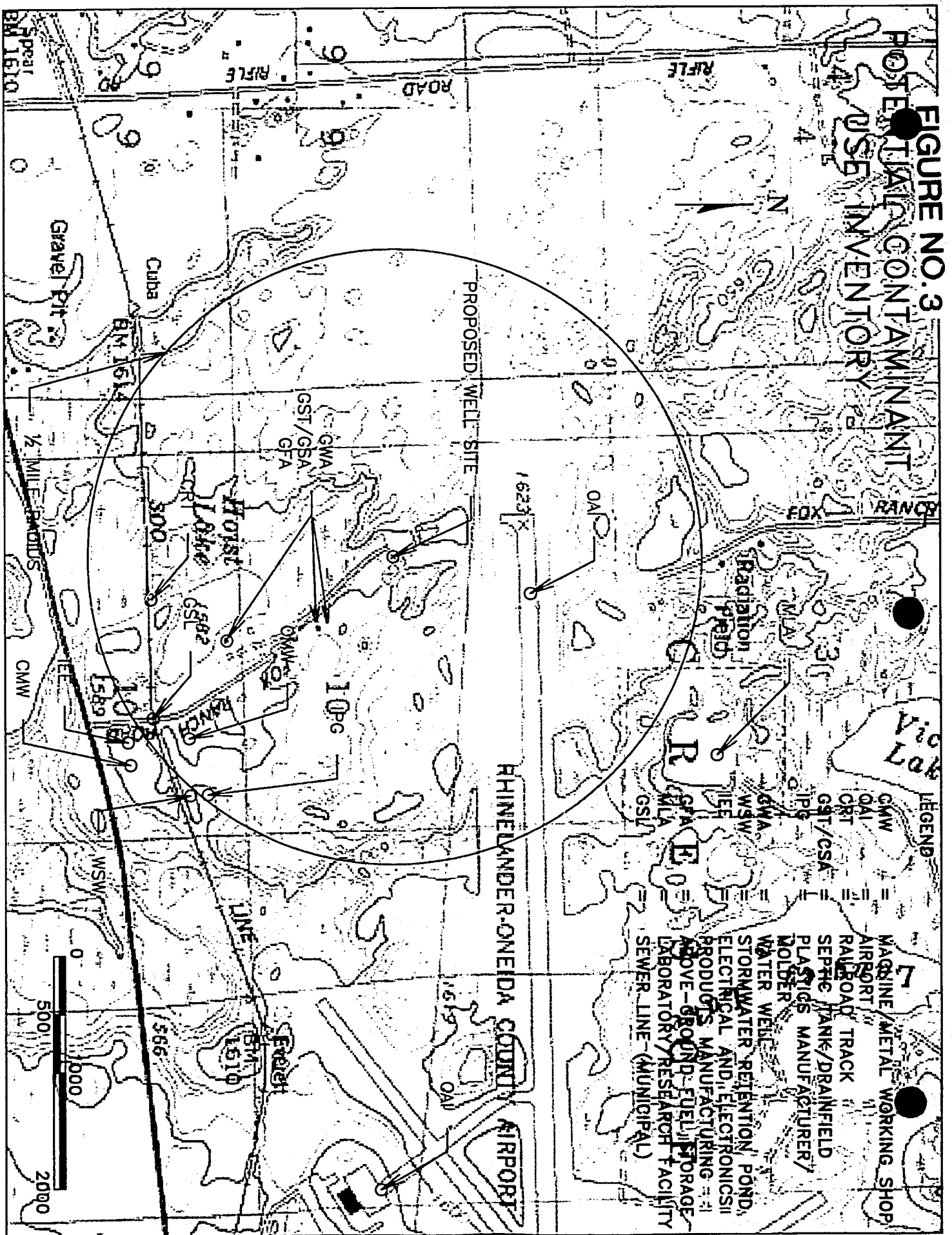
THIS AREA OF THE COMMUNITY IS SHOWN AS INSET A ON MAP NUMBER 55085C0400

**FIGURE NO. 2  
FLOODPLAIN MAP**

- ..... 0225 (A5,B2,B3)
- ..... 0200 (F4)
- ..... 0400 (F2)
- ..... 0400 (F2)
- ..... 0425 (A2,B3,C3)
- ..... 0300 (F3)
- ..... 0150 (A3,B2,C2)
- ..... 0350 (G1)
- ..... 0300 (F3)
- ..... 0150 (A3,B2,C2)
- ..... 0350 (G1)
- ..... 0200 (E1,G5,H5); 0100 (C4)
- ..... 0200 (D2,D3)
- ..... 0175 (F5)
- ..... 0350 (D4)
- ..... 0100 (J5)
- ..... 0100 (F5)
- ..... 0275 (B4,C4)
- ..... 0050 (A5,B5)
- ..... 0225 (F4)
- ..... 0250 (A3)
- ..... 0309 (A5,C3,C4)
- ..... 0175 (H4)

FIGURE NO. 3

POTENTIAL CONTAMINANT  
USE INVENTORY



LEGEND

- MAGNINE/METAL WORKING SHOP
- AIRPORT
- RAILROAD TRACK
- SEPTIC TANK/DRAINFIELD
- PLASTICS MANUFACTURER/MOLDER
- WATER WELL
- STORMWATER RETENTION POND
- ELECTRICAL AND ELECTRONICS PRODUCTS MANUFACTURING
- LABORATORY/RESEARCH FACILITY
- LABORATORY/RESEARCH FACILITY SEWER LINE (MUNICIPAL)



d) Proposed Final Well Capacity

700 gallons per minute (gpm) is the goal. However, a capacity as low as 400 gallons per minute would be acceptable.

e) Direction of Groundwater Flow

Based upon the elevations of lakes in the area, the groundwater flow at the proposed well site is believed to be southeasterly. The groundwater divide is believed to be about two miles north-northeast of the proposed well site.

f) Recharge Area for the Well

The recharge area is expected to extend several miles to the northwest of the proposed well site. The following page, labeled Figure 4-7, is taken from a 1992 report prepared by Foth & Van Dyke entitled "Baseline Well Head Protection Study – Proposed Airport Well Field". This report was commissioned at the time a paper company proposed a waste sludge landfill in the area of the well site. (Plans for this landfill were later abandoned.) The figure represents the predicted capture zone of a municipal well pumped continuously at 675 gpm with 1.0 feet of recharge per year, using an analytical groundwater flow model, QuickFlow (Rumbaugh, 1991).

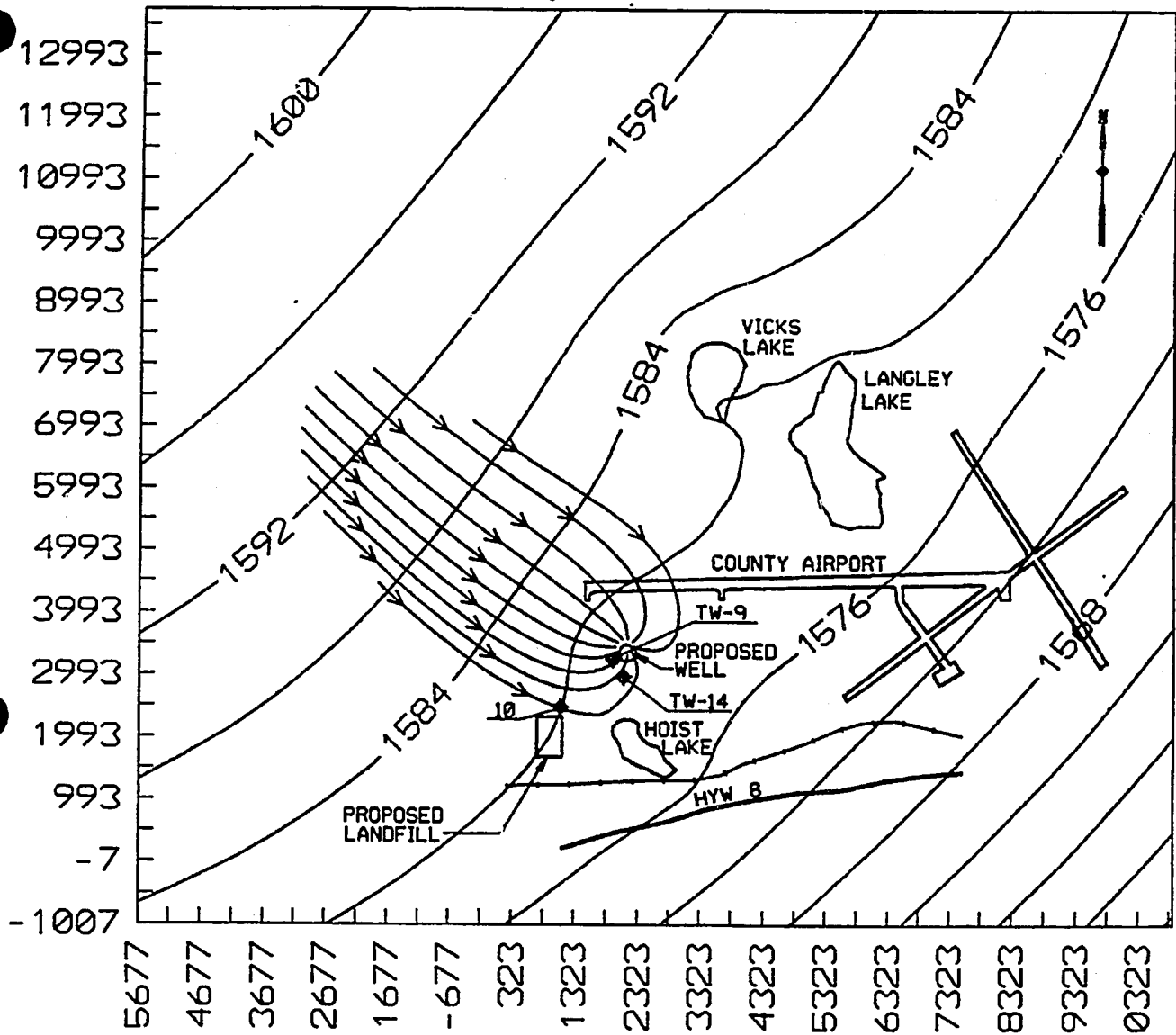
g) Zone of Influence Calculations

The anticipated cone of depression, assuming 30 days of continuous pumping at 700 gpm with no recharge, was calculated utilizing the modified Theis nonequilibrium equation. This equation is described on page 219 of "Ground Water and Wells" Second Edition, Fletcher G. Driscoll. The Theis equation is used to estimate the proposed well zone of influence as follows:

$$s = \frac{264Q}{T} \log \frac{0.3Tt}{r^2S}$$

where:

- s = drawdown, in feet, at any point in the vicinity of a well discharging at a constant rate
- Q = pumping rate, in gallons per minute (gpm)
- T = coefficient of transmissivity of the aquifer, in gallons per day per foot (gpd/ft)
- t = time since pumping started, in days
- r = distance, in feet, from the center of a pumped well to a point where the drawdown is measured
- S = coefficient of storage (dimensionless)



K = 110 FT/D  
 AQUIFER BASE = 1480 FT.  
 GRADIENT = 0.003 FT/FT  
 WELL = 675 GPM  
**RECHARGE = 1 FT/YR**

13

CITY OF RHINELANDER	
<b>FIGURE 4-7</b> SENSITIVITY ANALYSIS MODEL PREDICTED CAPTURE ZONE FOR PROPOSED MUNICIPAL WELL. RECHARGE = 1.0 FT/YR	
Scale: AS SHOWN	Date: APRIL, 1992
Prepared By: Foth & Van Dyke	By: JRB

The estimate of zone of influence will be based upon a conservative 55,000 gpd/ft coefficient of transmissivity estimate from the earlier test well drilling program. To solve the equation the following values were utilized:

- s = 1 foot
- Q = 700 gpm. This is the desired volume for the new well
- T = 55,000 gpd/ft. This value was obtained from a 1987 test pumping report
- T = 30 days
- r = distance in feet from center of pumped well to point of analysis
- S = 0.20, this value is the estimated coefficient of storage for coarse grained material in an unconfined aquifer (Reference Page 737)

Utilizing the above information, which should be conservative, the calculated zone of influence from the center of the pumping well for 30 days of continuous pumping is 1117 feet. If a smaller coefficient of storage, for example 0.10, is assumed, r becomes 1580 feet. If 0.05 is assumed, r becomes 2235 feet.

*1,200 feet will make a good WHPA*

h) Wetlands

The proposed well site is located at the west edge of the Rhinelander airport property. There are several small wetlands in the vicinity of the well site. A larger wetland, which is immediately adjacent to Hoist Lake, begins about 300 feet south of the well site. A copy of the DNR wetlands inventory map of the area is shown on the following page. (Figure No. 4)

i) Aquifer to be Used

The well will be in unconsolidated formations above granite bedrock. Granite is expected to be encountered at a depth of eighty feet.

j) Well Location

City of Rhinelander. <sup>NW</sup> NE ¼, NW ¼, Section 10, Township 36 North, Range 8 East.

See the copy of plat book map on the second following page. (Figure 5)

k) Boundaries of the Site and Location of the Well on the Site

The City owns the property proposed for the well site. The closest property line is located 100 feet to the south. The proposed well site will be separated from the rest of the City property by land survey.

# County ONEIDA

## FIGURE NO. 4

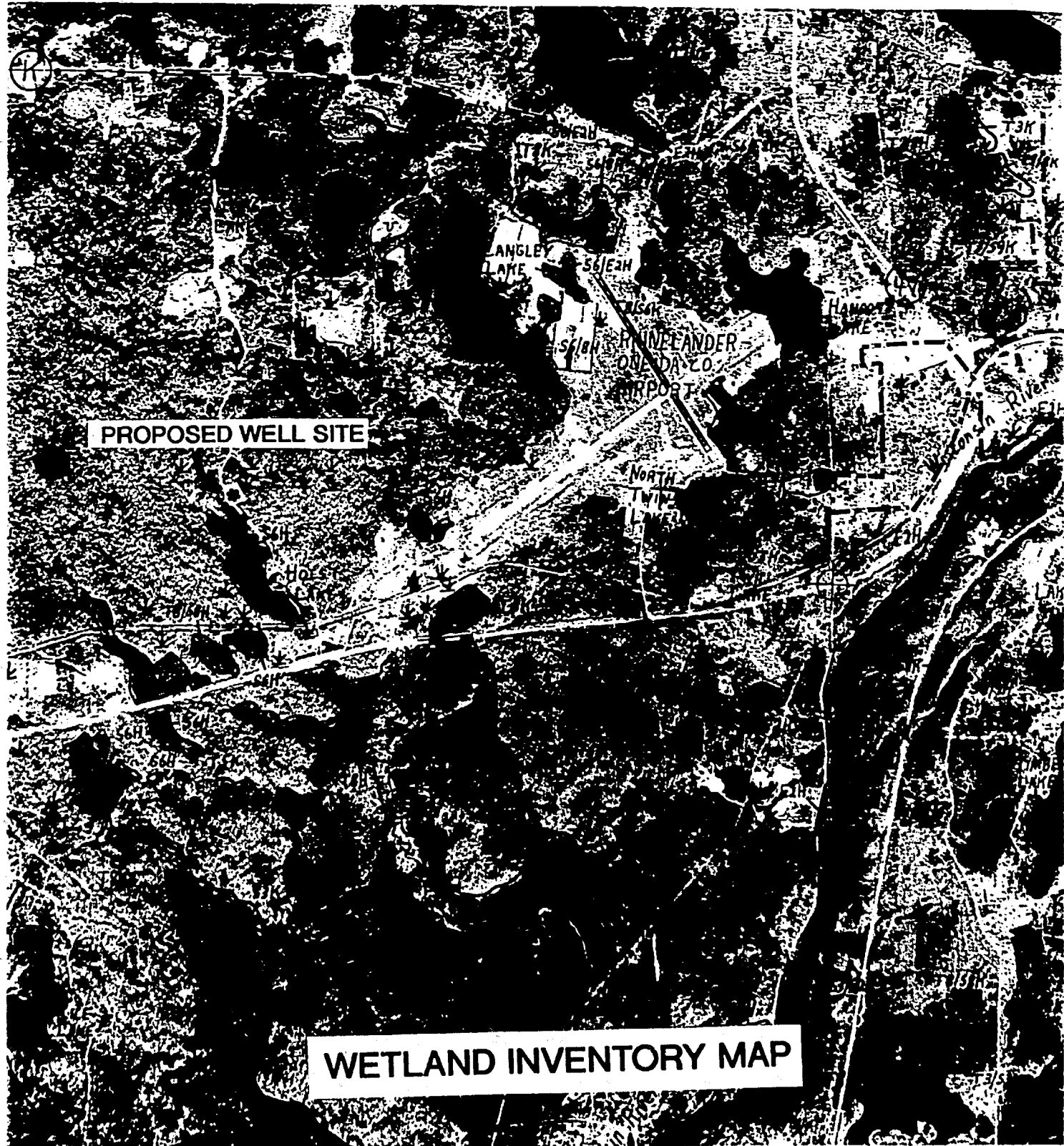
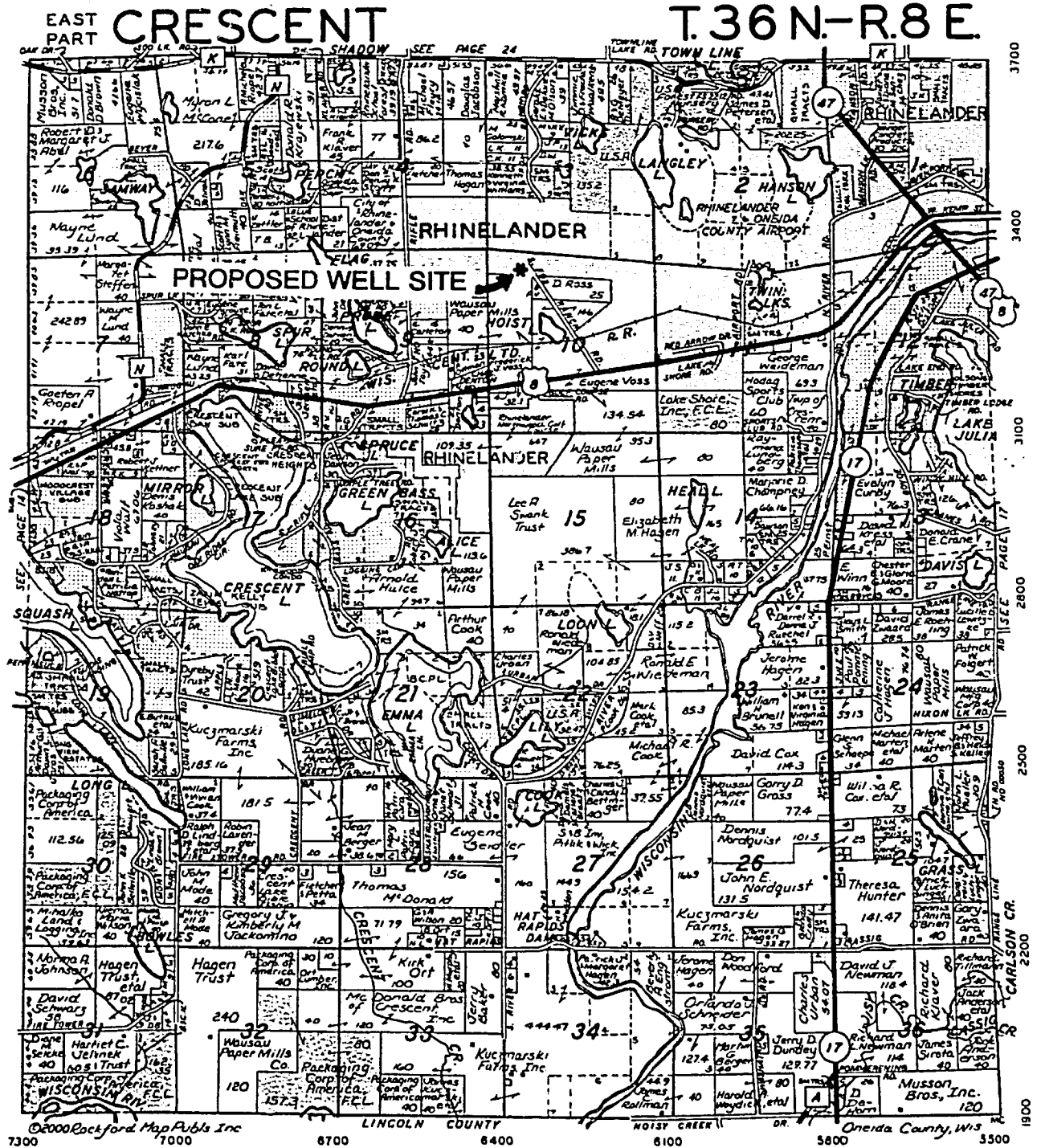


FIGURE NO. 5



PLAT BOOK MAP



l) Topography of the Site

The site is relatively flat.

See the 10 foot contour map discussed under (a) above. No detailed site topographical map has yet been prepared. The site will be graded so that all drainage is away from the well.

m) Results from Previous Test Wells

In past years a program of electrical resistivity profile lines, electrical resistivity depth sounds and seismic refraction soundings were performed in and around the City of Rhinelander in an attempt to identify favorable test well locations. Based upon this information, fourteen test wells were drilled. Of these fourteen test wells, only five were deemed promising enough to warrant test pumping. Of these five which were test pumped, two (numbers 9 and 14), both in the vicinity of the intersection of Fox Ranch Road with the southern boundary of the airport property, west of the City, were found to have production suitable for permanent well development. At the time of the test well drilling program the nearest water main was located far from the site. Since that time industrial development west of the City has brought the water main much closer to the site, making development of a new water supply source much more economically feasible. The site of test well no. 9, on the airport property, is chosen for the next City well because the City already owns the property. Copies of excerpts from the 1986 report are included as an appendix to this well site investigation report.

n) Final Well Construction Details

It is anticipated that the well will be a gravel pack well, drilled to approximately 80 feet below the surface. The hole diameter will be 30 inches. This hole will be drilled using 30 inch temporary casing, which will be pulled during the grouting process. An eighteen inch casing with a 20 foot screen attached will then be installed to the bottom of the hole. A 22" or 24" casing will be suspended over the eighteen inch casing with screen. The gravel pack will then be placed around the screen up to the top of the screen (60 feet below the surface). A bentonite seal will be placed between the 18" casing and the 22" or 24" casing. The annular space between the formation and the 22" or 24" casing will be grouted to the surface to provide a sanitary seal.

o) The Anticipated Annual Volume of Water to Be Withdrawn and Compatibility with the Existing Water Supply Facilities

It is anticipated that this well will be used to supply about ¼ of the annual water usage of the City. Based upon 2004 PSC reports, this will amount to about 131,169,500 gallons annually, or about 360,000 gallons per day. This equates to about 8½ hours of operation per day.

The well will be of the same type as the other existing wells in the Rhinelander water system. It is not near enough (over two miles distant) to those other wells to influence the pumping characteristics of those wells. The type of treatment anticipated is already used at the other wells. Therefore, this well will be compatible with the existing supply facilities.

p) Location and Data from Any Piezometers

None. See Appendix for additional hydrogeologic investigation data.

q) Summary Evaluation, Need for Possible Water Treatment

The City of Rhinelander has two sources of water supply, the Well 4 – Well 5 complex, the output from which is treated in a single chlorine contact tank, and Well 6 which is used primarily as a standby well because the water is corrosive and that well is not set up to feed sodium hydroxide to control the corrosivity. If either of these sources fails or must be taken off line for extended maintenance, the City risks not having enough water to meet peak demands, particularly in hot weather seasons. A new well is needed.

Bedrock in the vicinity of Rhinelander has been characterized as dioritic intrusive rock; granite intrusive rock and metavolcanic rock. These forms of bedrock do not transmit water freely. Groundwater supplies in the vicinity of the City are derived almost exclusively from glacial drift. The City has conducted several geophysical and test well drilling programs over the years to find an area of glacial drift/outwash which holds sufficient water for a municipal well. Only one site with significant potential has been discovered. This report covers that site.

Test wells constructed in 1986 and 1987 indicate that an 80 foot deep, gravel pack well can be constructed at this location, with the expectation that it will produce 600-700 gallons per minute. The water from the test well was acidic, low in alkalinity, low in iron and low in manganese. The raw water from a well in this location is expected to be corrosive, requiring chemical addition to alter its corrosivity. Chlorine would be fed to disinfect the water. No hydrocarbon or radioactivity analyses were made on the water from the 1986-1987 test pumping program. No iron/manganese

removal treatment or softening is anticipated to be necessary. If sodium hydroxide feed is determined to be the corrosivity treatment of choice these facilities may be sized in anticipation of drilling another similar sized well somewhere in the same vicinity, with treatment occurring at this location.

# APPENDIX

**Excerpts from September 1986**

**Water Supply System Study**

**Foth & Van Dyke**

## VIII. GROUNDWATER EXPLORATION - 1986

This section is a review of data obtained by test well drilling and geophysical work during this year in an additional effort to find sites suitable for the construction of more water supply wells. This has been an ongoing program for a number of years. A previous report presented the data obtained from test well work carried out in 1983. At that time, nine (9) test wells were drilled in the western portion of the City and in the general area of Well No. 2. No production wells were developed as a result of that work.

### A. Test Well Drilling

This year, to date, fourteen (14) test wells have been drilled by the Rhinelander Well Drilling Company. Data regarding this drilling work is shown on Table No. 2 and the locations are indicated on Figure No. 3. The majority of these test wells were located in the vicinity of the Rhinelander-Oneida County Airport to the west of the City. There are two (2) exceptions, however. Test Well No. 5-86 is located at the site of Test Well No. 1-83. The latest test well here is eight (8) inch rather than six (6) inch which allows for the installation of a larger test pump. The results were not favorable, however. The other exception is Test Well 7-86 which was drilled to the south of Production Well No. 5.

Five (5) of the fourteen (14) test wells were deemed to be worthy of test pumping. All of these, except for No. 5-86, are located at the western edge of the airport. The depths of these four (4) test wells (No.'s 3, 4, 9 and 14) range from 75 to 84 feet. Of these four (4), No.'s 9 and 14 were the most promising and provided the greatest volume of water with the least drawdown. (Test pumping data is included in Appendix B.) Based on this data, this area looks most favorable for the construction of a permanent well or wells. Before this step is taken, however, a more thorough aquifer testing program must be carried out to insure that the volume of water which can be developed is adequate and that the quality is acceptable. ★

## TABLE NO. 2

## CITY OF RHINELANDER

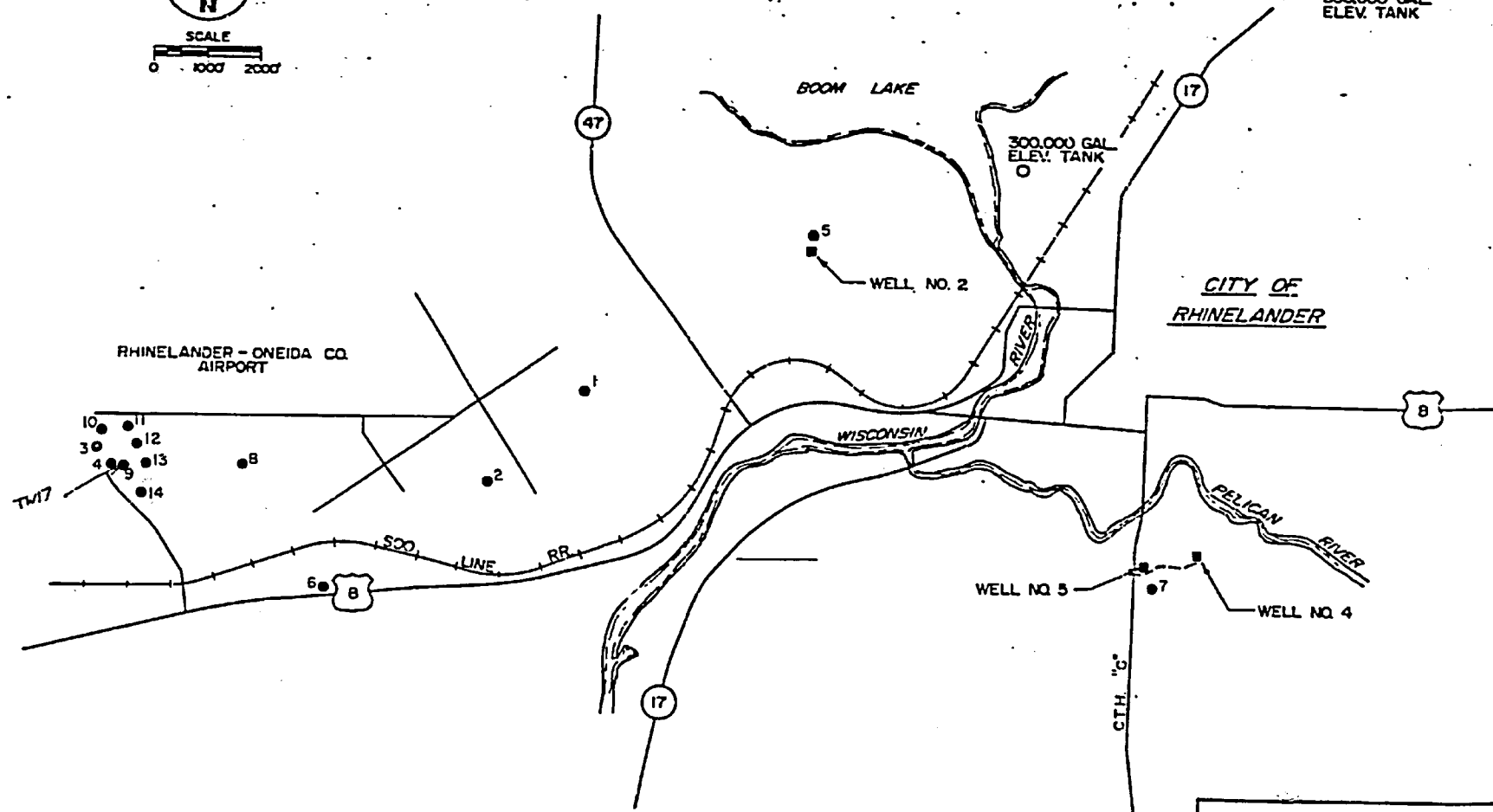
## 1986 TEST WELLS

Test Well No.	Location	Depth (ft)	Test Pumped	Comments
1	Airport - East	90	No	
2	Airport - Southeast	51	No	
3	Airport - West	75	Yes	195 gpm - 3 hr test
4	Airport - West	82	Yes	256 gpm - 8 hr test
5	Lois St. North of Well 2	85	Yes	200 gpm - Less than 1 hr
6	Airport South Hwy. 8	73	No	
7	South of Well 5	72	No	
8	Airport - West	52	No	
9	Airport - West	80	Yes	319 gpm - 12 hr test
10	Airport - West	82	No	
11	Airport - West	72	No	
12	Airport - West	72	No	
13	Airport - West	65	No	
14	Airport - West	84	Yes	312 gpm - 24 hr test



SCALE  
0 1000 2000

500,000 GAL  
ELEV. TANK



1986 TEST WELL LOCATIONS

**Foth & Van Dyke**  
Engineering/Architectural Division

2727 S. Ridge Road  
P. O. Box 71912  
Green Bay, Wisconsin 54307-9912  
920-997-2288

FIGURE NO. 6



1. COUNTY			CHECK (✓) ONE:			Name																	
			<input type="checkbox"/> Town			<input type="checkbox"/> Village			<input type="checkbox"/> City														
2. LOCATION			3. NAME			OWNER <input type="checkbox"/> AGENT AT TIME OF DRILLING CHECK (✓) ONE																	
% Section or Gov't. Lot			Section			Township			Range			City of Rhinelander											
OR - Grid or Street No.			Street or Road Name			ADDRESS						Test Hole #3											
AND - If available subdivision name, lot & block No.			POST OFFICE						ZIP CODE														
4. Distance in feet from well to nearest: (Record answer in appropriate block)		Building		Sanitary Bldg. Drain		Sanitary Bldg. Sewer		Floor Drain Connected To:		Storm Bldg. Drain		Storm Bldg. Sewer											
		C.I.		Other		C.I.		Other		C.I.		Other											
Street Sewer		Other Sewers		Foundation Drain Connected to:		Sewage Sump		Clearwater Sump		Septic Tank		Holding Tank											
San.		Storm		C.I.		Other		Sewer		Sewage Sump		Clearwater Sump											
Sewage Sump		Clearwater Dr.		Sewage Sump		Clearwater Sump		Sewage Absorption Unit		Manure Hopper or Retention or Pneumatic Tank		Sewage Pit											
Sewage Bed		Sewage Trench		Subsurface Pumproom		Barn Gutter		Animal Barn Pan		Animal Yard		Silo With Pit											
Glass Lined Storage Facility		Silo w/o Pit		Earthen Storage Or Pit		Earthen Storage Trench		Earthen Manure Basin		Temporary Manure Stack or Platform		Watertight Liquid Manure Tank or Basin											
Manure Pressure Pipe		Subsurface Gasoline or Oil Tank		Waste Pond or Land Disposal Unit (Specify Type)		Manure Storage Basin		Concrete Floor Only		Concrete Floor and Partial Concrete Walls		Other (Describe)											
5. Well is intended to supply water for:						9. FORMATIONS																	
						Kind						From (ft.)		To (ft.)									
6. DRILLHOLE						Sand & Clay						Surface		25									
Dia. (in.)		From (ft.)		To (ft.)		Dia. (in.)		From (ft.)		To (ft.)		Clay, Sand, Gravel (Grey)		25		75							
6		Surface						75															
7. CASING LINER, CURBING AND SCREEN						10. TYPE OF DRILLING MACHINE USED																	
Material, Weight, Specification						<input type="checkbox"/> Cable Tool						<input type="checkbox"/> Rotary-hammer w/drilling mud & air		<input type="checkbox"/> Jetting with									
Dia. (in.)						Mfg. & Method of Assembly						<input type="checkbox"/> Rotary-air w/drilling mud		<input checked="" type="checkbox"/> Rotary-hammer & air		<input type="checkbox"/> Air							
6		Steel Casing		Surface		75		<input type="checkbox"/> Rotary-w/drilling mud		<input type="checkbox"/> Reverse Rotary		<input type="checkbox"/> Water											
8. GROUT OR OTHER SEALING MATERIAL						11. MISCELLANEOUS DATA																	
Kind						From (ft.)						To (ft.)		Well construction completed on		March 3		1986					
Surface														Well is terminated		inches		<input type="checkbox"/> above final grade					
																Well disinfected upon completion		<input type="checkbox"/> Yes <input type="checkbox"/> No					
																Well sealed watertight upon completion		<input type="checkbox"/> Yes <input type="checkbox"/> No					
Yield Test: _____ Hrs. at _____ GPM						Depth from surface to normal water level _____ Ft.						Depth of water level when pumping _____ Ft. Stabilized <input type="checkbox"/> Yes <input type="checkbox"/> No						Water sample sent to _____ laboratory on _____ 19____					

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

1. COUNTY <b>Oneida</b>		CHECK (✓) ONE: <input checked="" type="checkbox"/> Town <input type="checkbox"/> Village <input type="checkbox"/> City		Name <b>Crescent</b>	
2. LOCATION		3. NAME <input type="checkbox"/> OWNER <input type="checkbox"/> AGENT AT TIME OF DRILLING CHECK (✓) C		City of Rhinelander	
OR - Grid or Street No. Street or Road Name		ADDRESS		Test Hole # 4 1986	
AND - If available subdivision name, lot & block No.		POST OFFICE		ZIP CODE	
4. Distance in feet from well to nearest: (Record answer in appropriate block)		Building		Sanitary Bldg. Drain	
		Sanitary Bldg. Sewer		Floor Drain Connected To:	
		Storm Bldg. Drain		Storm Bldg.	
		C.I. Other C.I. Other		C.I. Sewer Other Sewer C.I. Other C.I. Other	
Street Sewer		Other Sewers		Foundation Drain Connected to:	
San. Storm C.I. Other		Sewer		Sewage Sump	
Clearwater Dr. Clearwater Sump		C.I. Other		Clearwater Sump Septic Tank	
Holding Tank		Sewage Absorption Unit		Manure Hopp- Retention or Pneumatic Ta	
Seepage Pit Seepage Bed Seepage Trench					
Privy		Pit: Nonconforming Existing		Subsurface Pumproom	
Pet Waste Pit Well Pump Tank		Nonconforming Existing		Barn Gutter	
				Animal Barn Pen	
				Animal Yard	
				Silo With Pit	
				Glass Lined Storage Facility	
				Silo w/o Pit	
				Earthen Silage Storage Or Pit	
				Earthen Manure	
Temporary Manure Stack or Platform		Watertight Liquid Manure Tank or Basin		Manure Pressure Pipe	
				Subsurface Gasoline or Oil Tank	
				Waste Pond or Land Disposal Unit (Specify Type)	
				Manure Storage Basin	
				Concrete Floor Only	
				Concrete Floor and Partial Concrete Walls	
				Other (Describe)	
5. Well is intended to supply water for:				9. FORMATIONS	
				Kind	
				From (ft.) To (ft.)	
6. DRILLHOLE				sand & gravel	
Dia. (in.) From (ft.) To (ft.) Dia. (in.) From (ft.) To (ft.)				Surface	
8				20	
Surface 32				medium sand	
				20 70	
				fine sand & clay	
				70 73	
7. CASING, LINER, CURBING AND SCREEN				large sand &	
Material, Weight, Specification				73 82	
Dia. (in.) Mfg. & Method of Assembly From (ft.) To (ft.)					
8				60	
				Surface	
6				67	
s.s. screen 15 slot					
6				73	
12 slot					
				73 82	
20 slot					
All materials removed when finished testing.				10. TYPE OF DRILLING MACHINE USED	
8. GROUT OR OTHER SEALING MATERIAL				<input type="checkbox"/> Cable Tool <input type="checkbox"/> Rotary-hammer w/drilling mud & air <input type="checkbox"/> Jetting with	
Kind From (ft.) To (ft.)				<input type="checkbox"/> Rotary-air w/drilling mud <input checked="" type="checkbox"/> Rotary-hammer & air <input type="checkbox"/> Air	
Surface				<input type="checkbox"/> Rotary-w/drilling mud <input type="checkbox"/> Reverse Rotary <input type="checkbox"/> Water	
				Well construction completed on <b>April 2</b> 19 <b>8</b>	
11. MISCELLANEOUS DATA				Well is terminated <input type="checkbox"/> above <input type="checkbox"/> below final grade	
Yield Test: <b>7.5</b> Hrs. at <b>245</b> GPM				Well disinfected upon completion <input type="checkbox"/> Yes <input type="checkbox"/> No	
Depth from surface to normal water level <b>5</b> Ft.				Well sealed watertight upon completion <input type="checkbox"/> Yes <input type="checkbox"/> No	
Depth of water level when pumping <b>53</b> Ft. Stabilized <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No					
Water sample sent to _____ laboratory on _____ 19__					
Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.					
Signature _____				Business Name and Complete Mailing Address _____	
Registered Well Driller					

NOTE:

White Copy - Division's Copy  
Green Copy - Driller's Copy  
Yellow Copy - Owner's Copy

1. COUNTY <b>Oneida</b>			CHECK (✓) ONE: <input type="checkbox"/> Town <input type="checkbox"/> Village <input type="checkbox"/> City			Name <b>Near Airport</b>						
2. LOCATION OR - Grid or Street No.    Street or Road Name AND - If available subdivision name, lot & block No.			3. NAME <input type="checkbox"/> OWNER <input type="checkbox"/> AGENT AT TIME OF DRILLING CHECK (✓) ON: <b>City of Rhineander</b>			ADDRESS <b>Test Well # 9 1486</b>						
4. Distance in feet from well to nearest: (Record answer in appropriate block)			Sanitary Bldg. Drain C.I.    Other		Sanitary Bldg. Sewer C.I.    Other		Floor Drain Connected To: C.I. Sewer    Other Sewer					
Street Sewer San.    Storm		Other Sewers C.I.    Other		Foundation Drain Connected to Sewer    Sewage Sump Clearwater Dr.    Clearwater Sump		Sewage Sump C.I.    Other		Clearwater Sump    Septic Tank				
Privy		Pit: Nonconforming Existing Well    Pump		Subsurface Pumproom Nonconforming Existing		Barn Gutter		Animal Barn Pen    Animal Yard				
Temporary Manure Stack or Platform		Watertight Liquid Manure Tank or Basin		Manure Pressure Pipe		Subsurface Gasoline or Oil Tank		Waste Pond or Land Disposal Unit (Specify Type)				
Manure Storage Basin		Concrete Floor Only		Concrete Floor and Partial Concrete Walls		Other (Describe)						
5. Well is intended to supply water for:						9. FORMATIONS						
6. DRILLHOLE						Kind			From (ft.)		To (ft.)	
Dia. (in.)		From (ft.)		To (ft.)		Dia. (in.)		From (ft.)		To (ft.)		
8		Surface		30		8		Surface		40		
						sand, gravel, & boulders						
						sand & gravel (medium						
						sand to large gravel)			40		80	
7. CASING, LINER, CURBING AND SCREEN												
Dia. (in.)		Material, Weight, Specification		From (ft.)		To (ft.)						
8		Steel casing		Surface		51						
6		20 slot screen		51		71						
6		15 slot screen		71		80						
All materials removed from site after test completed.						INCORRECT 8/24/86 PIPES ETC STILL IN WELL						
8. GROUT OR OTHER SEALING MATERIAL						10. TYPE OF DRILLING MACHINE USED						
Kind			From (ft.)		To (ft.)		<input type="checkbox"/> Cable Tool		<input type="checkbox"/> Rotary-hammer w/drilling mud & air		<input type="checkbox"/> Jetting with	
			Surface				<input type="checkbox"/> Rotary-air w/drilling mud		<input checked="" type="checkbox"/> Rotary-hammer & air		<input type="checkbox"/> Air	
							<input type="checkbox"/> Rotary-w/drilling mud		<input type="checkbox"/> Reverse Rotary		<input type="checkbox"/> Water	
						Well construction completed on <b>April 21 1986</b> 19__						
11. MISCELLANEOUS DATA						Well is terminated _____ inches <input type="checkbox"/> above <input type="checkbox"/> below final grade						
Yield Test: <b>12</b>			Hrs. at <b>312</b> GPM			Depth from surface to normal water level <b>8</b> Ft.			Well disinfected upon completion <input type="checkbox"/> Yes <input type="checkbox"/> No			
Depth of water level when pumping <b>30</b> Ft.			Stabilized <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			Well sealed watertight upon completion <input type="checkbox"/> Yes <input type="checkbox"/> No						
Water sample sent to _____ laboratory on _____ 19__						Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.						
Signature						Business Name and Complete Mailing Address						
Registered Well Driller												

COUNTY <b>Oneida</b>		CHECK (✓) ONE: <input type="checkbox"/> Town <input type="checkbox"/> Village <input type="checkbox"/> City		Name							
2. LOCATION OR - Grid or Street No.    Street or Road Name		3. NAME <input type="checkbox"/> OWNER <input checked="" type="checkbox"/> AGENT AT TIME OF DRILLING CHECK (✓) ONE <b>City of Rhinelander</b>		ADDRESS <b>Test Hole #14</b>							
AND - If available subdivision name, lot & block No.		POST OFFICE		ZIP CODE							
4. Distance in feet from well to nearest: (Record answer in appropriate block)		Building	Sanitary Bldg. Drain C.I.    Other	Sanitary Bldg. Sewer C.I.    Other	Floor Drain Connected To: C.I. Sewer    Other Sewer	Storm Bldg. Drain C.I.    Other	Storm Bldg. Sewer C.I.    Other				
Street Sewer San.    Storm	Other Sewers C.I.    Other	Foundation Drain Connected to: Sewer    Sewage Sump Clearwater Dr.    Clearwater Sump	Sewage Sump C.I.    Other	Clearwater Sump	Septic Tank	Holding Tank	Sewage Absorption Unit Seepage Pit Seepage Bed Seepage Trench	Manure Hopper or Retention or Pneumatic Tank			
Privy	Pet Waste Pit	Pit: Nonconforming Existing Well Pump Tank	Subsurface Pumproom Nonconforming Existing	Barn Gutter	Animal Barn Pen	Animal Yard	Silo With Pit	Glass Lined Storage Facility	Silo w/o Pit	Earthen Silage Storage Trench	Earthen Manure Bas
Temporary Manure Stack or Platform	Watertight Liquid Manure Tank or Basin	Manure Pressure Pipe	Subsurface Gasoline or Oil Tank	Waste Pond or Land Disposal Unit (Specify Type)	Manure Storage Basin	Concrete Floor Only	Concrete Floor and Partial Concrete Walls	Other (Describe)			
5. Well is intended to supply water for: <b>Test well</b>				9. FORMATIONS							
6. DRILLHOLE				Kind				From (ft.)		To (ft.)	
8	Surface			80	<b>Caving Sand &amp; clay</b>				Surface	20	
					<b>Sand &amp; gravel-40 slot</b>				20	65	
					<b>Medium &amp; large sand</b>				65	80	
					<b>Sand &amp; clay</b>				80	84	
					<b>Bedrock</b>				84	-	
7. CASING, LINER, CURBING AND SCREEN Material, Weight, Specification Dia. (in.)    Mfg. & Method of Assembly				From (ft.)				To (ft.)			
6	<b>Stainless screen</b>			Surface				55			
	6' 12 slot										
	5' 20 slot										
	6' 25 slot										
	6' 15 slot										
8. GROUT OR OTHER SEALING MATERIAL				10. TYPE OF DRILLING MACHINE USED							
Kind				From (ft.)				To (ft.)			
Surface											
				<input type="checkbox"/> Cable Tool <input type="checkbox"/> Rotary-hammer w/drilling mud & air <input type="checkbox"/> Jetting with <input type="checkbox"/> Rotary-air w/drilling mud <input checked="" type="checkbox"/> Rotary-hammer & air <input type="checkbox"/> Air <input type="checkbox"/> Rotary-w/drilling mud <input type="checkbox"/> Reverse Rotary <input type="checkbox"/> Water							
11. MISCELLANEOUS DATA				Well construction completed on <b>June 25</b> 19 <b>86</b>							
Yield Test: _____ Hrs. at _____ GPM				Well is terminated _____ inches <input checked="" type="checkbox"/> above final grade <input type="checkbox"/> below							
Depth from surface to normal water level _____ Ft.				Well disinfected upon completion <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No							
Depth of water level when pumping _____ Ft.    Stabilized <input type="checkbox"/> Yes <input type="checkbox"/> No				Well sealed watertight upon completion <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No							
Water sample sent to _____ laboratory on _____ 19____											
Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.											
Signature _____				Business Name and Complete Mailing Address _____							
Registered Well Driller _____											



# Foth & Varadyke

Engineers/Architects

2737 S. Ridge Road P. O. Box 19012 Green Bay, Wisconsin 54307-9012 414/497-2500

## PUMP TEST OF WELL

DATE April 3, 1986

WELL NO. TW-4-86 OWNER City of Rhineland LOCATION North end of Fox Ranch Road

DIA. ORIFICE 6" X 4" STATIC LEVEL 6 FT. 6 1/2" IN. WELL DEPTH 82 FEET

DRILLED BY Rhineland Well Drilling LENGTH OF AIRLINE FT. x FT. DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE FT. TO TAIL PIPE FT. TESTED BY Dean Funk / Ray Weber

WE-11-86 located 335' southwest of TW-3-86

Reading Number	Time	Altitude GA. In Feet	Inches on Orifice	G.P.M.	Pumping Level 6'-6 1/2"	Drawdown In Feet	Specific Capacity	Sand Point D =	TW-10-86 D = 550	Water Appearance: Clear, Cloudy, Murky, Muddy, Sandy, Temp., Odor
Start	10:15				6.54				19'-10 1/2"	
	10:30		10	206	41.5		5.4			
	10:40		15 1/2	256	51.0	47	5.4			
	10:45		15 1/2	256	53.0	47	5.4			
	11:00		15 1/2	254	53.0	47	5.4			
	11:30		15 1/2	254	53.0	47	5.4			
	12:00		15 1/2	254	53.0	47	5.4			
	12:30		15 1/2	254	53.0	47	5.4			
	1:00		15 1/2	254	53.0	47	5.4			
	1:30		15 1/2	254	53.0	47	5.4		20'-2"	
	2:00		15 1/2	254	53.0	47	5.4			
	2:30		15 1/2	254	53.0	47	5.4		20'-2"	RECOVERY
	3:00		15 1/2	254	53.0	47	5.4			
	3:30		15 1/2	254	53.0	47	5.4		20'-2"	30 SECS 15
	4:00		15 1/2	254	53.0	47	5.4		20'-2"	1 MIN 7.6
	4:30		15 1/2	254	53.0	47	5.4			
	5:00		15 1/2	254	53.0	47	5.4			
	5:30		15 1/2	254	53.0	47	5.4		20'-2 1/2"	
	6:00		15 1/2	254	53.0	47	5.4			

## PUMP TEST OF WELL

DATE Apr-11 21, 1986

WELL NO. TW-9-86 OWNER City of Rhinelander

LOCATION 120' east of TW-4-86 and 17 north of fence or 230' east of west fence corner post.

DIA. ORIFICE 6" X 4" STATIC LEVEL 8 FT. 1 IN. WELL DEPTH 80 FEET

DRILLED BY Rhinelander Well Drilling LENGTH OF AIRLINE      FT. X DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE      FT. TO TAIL PIPE      FT. TESTED BY Dean Funk / Ray Weber

Top of screen @ 51' - 29 feet

Reading Number	Time	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level	Drawdown in Feet	Specific Capacity		Water Appearance:
Start	8:45 am				8'-1"				
	9:00		23	312	29'-6"	21.41	14.6		Cloudy - Little Sand
	9:15		23	312	29'-8"	21.58	14.5		Clear - No Sand
	9:30		23	312	29'-10"	21.75	14.3	HARDNESS =	" " "
	9:45		23	312	29'-11"	21.83	14.3	FE =	" " "
	10:00		23	312	29'-11 $\frac{1}{2}$ "	21.87	14.3	pH =	" " "
	10:30		23	312	30'-0"	21.91	14.2		" " "
	11:00		23	312	30'-6"	22.50	13.9		" " "
	11:30		23	312	30'-1"	22.0	14.2		" " "
	12:00		23	312	30'-1 $\frac{1}{2}$ "	22.0	14.2		" " "
	12:30 pm		23	312	30'-1 $\frac{1}{2}$ "	22.04	14.2		" " "
	1:00		23	312	30'-2"	22.08	14.1		" " "
	1:30		23	312	30'-2"	22.08	14.1		" " "
	2:00		23	312	30'-2 $\frac{1}{2}$ "	22.12	14.1		" " "
	2:30		23	312	30'-3"	22.15	14.1		" " "
	3:00		23	312	30'-3 $\frac{1}{2}$ "	22.21	14.0		" " "
	3:30		23	312	30'-3 $\frac{1}{2}$ "	22.21	14.0		" " "
	4:00		23	312	30'-4"	22.25	14.0		" " "
	4:30		23	312	30'-4"	22.25	14.0		" " "
	5:00		23	312	30'-4 $\frac{1}{2}$ "	22.29	14.0		" " "
	5:30		23	312	30'-4 $\frac{1}{2}$ "	22.29	14.0		" " "
	6:00		23	312	30'-5"	22.33	14.0		" " "
	6:30		23	312	30'-5"	22.33	14.0		" " "
	7:00		23	312	30'-5"	22.33	14.0		" " "
	7:30		23	312	30'-5"	22.33	14.0		" " "





## PUMP TEST OF WELL

DATE July 21, 1986

WELL NO. TW-14-86 OWNER City of Rhineland LOCATION 390' south of TW-4-86 on James Ross Property - Fox Ranch Road

DIA. ORIFICE 6" X 4" STATIC LEVEL 11 FT. 7 IN. WELL DEPTH            FEET  
 DRILLED BY Rhineland Well Drilling LENGTH OF AIRLINE            FT. X            DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE 50 1/2 FT. TO TAIL PIPE            FT. TESTED BY Cliff Nahles / Ray C. Weber

Reading Number	Time	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level	Drawdown in Feet	Specific Capacity	TW-9-86	Drawdown in TW-9-86	Water Appearance:
	8:22				11'-7"			7'-9 1/2"		Murky - Sand
	8:30		23	312	33'-10 1/2"	22.29	14	8'-9"	0.96	Clear - No Sand
	9:00		23	312	34'-3 1/2"	22.71	13.7	8'-9"	0.96	" "
	9:30		23	312	34'-5"	22.85	13.7	8'-9 1/2"	1.00	" "
	10:00		23	312	34'-5"	22.85	13.7	9'-1"	1.29	" "
	10:30		23	312	34'-5 1/2"	22.88	13.7	9'-1"	1.29	" "
	11:00		23	312	34'-6 1/2"	22.96	13.6	9'-1"	1.29	" "
	11:30		23	312	34'-6 1/2"	22.96	13.6	8'-11 1/2"	1.15	" "
	12:00		23	312	34'-6 1/2"	22.96	13.6	9'-0"	1.19	" "
	12:30		23	312	34'-7"	23.00	13.6	9'-1"	1.28	" "
	1:00		23	312	34'-7 1/2"	23.04	13.5	9'-1 1/2"	1.25	" "
	1:30		23	312	34'-7 1/2"	23.04	13.5	9'-1"	1.28	" "
	2:00		23	312	34'-7 1/2"	23.04	13.5	9'-2"	1.38	" "
	2:30		23	312	34'-8"	23.08	13.5	9'-3"	1.46	" "
	3:00		23	312	34'-8"	23.08	13.5	9'-3 1/2"	1.50	" "
	3:30		23	312	34'-8 1/2"	23.12	13.5	9'-4"	1.54	" "
	4:00		23	312	34'-8 1/2"	23.12	13.5	9'-4"	1.54	" "
	4:30		23	312	34'-8 1/2"	23.12	13.5	9'-4 1/2"	1.58	" "
	5:00		23	312	34'-8 1/2"	23.12	13.5	9'-4 1/2"	1.58	" "
	5:30		23	312	34'-9"	23.15	13.5	9'-4 1/2"	1.58	" "
	6:00		23	312	34'-9"	23.15	13.5	9'-4 1/2"	1.58	" "
	6:30		23	312	34'-9"	23.15	13.5	9'-5"	1.62	" "
	7:00		23	312	34'-9"	23.15	13.5	9'-5"	1.62	" "
	7:30		23	312	34'-9 1/2"	23.19	13.5	9'-5 1/2"	1.66	" "
	8:00		23	312	34'-9 1/2"	23.19	13.5	9'-5 1/2"	1.66	" "
	8:30		23	312	34'-10"	23.25	13.4	9'-6"	1.71	" "

## PUMP TEST OF WELL

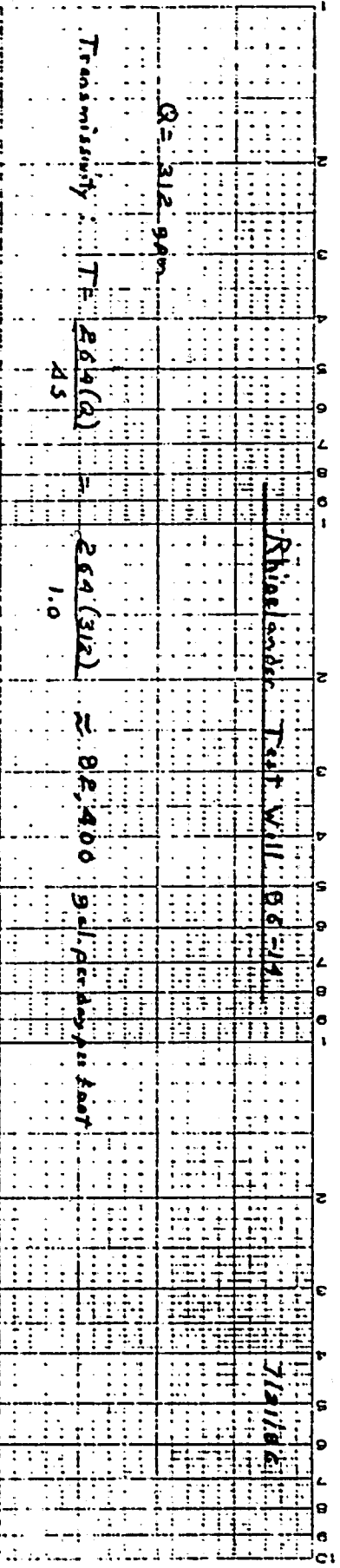
DATE July 21, 1986

WELL NO. TW-14-86 OWNER City of Rhineland LOCATION 390' south of TW-4-86 on James Ross Property - Fox Ranch Road

DIA. ORIFICE 6" X 4" STATIC LEVEL 11 FT. 7 IN. WELL DEPTH FEET  
 DRILLED BY Rhineland Well Drilling LENGTH OF AIRLINE FT. X     DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE     FT. TO TAIL PIPE     FT. TESTED BY Ray C. Weber

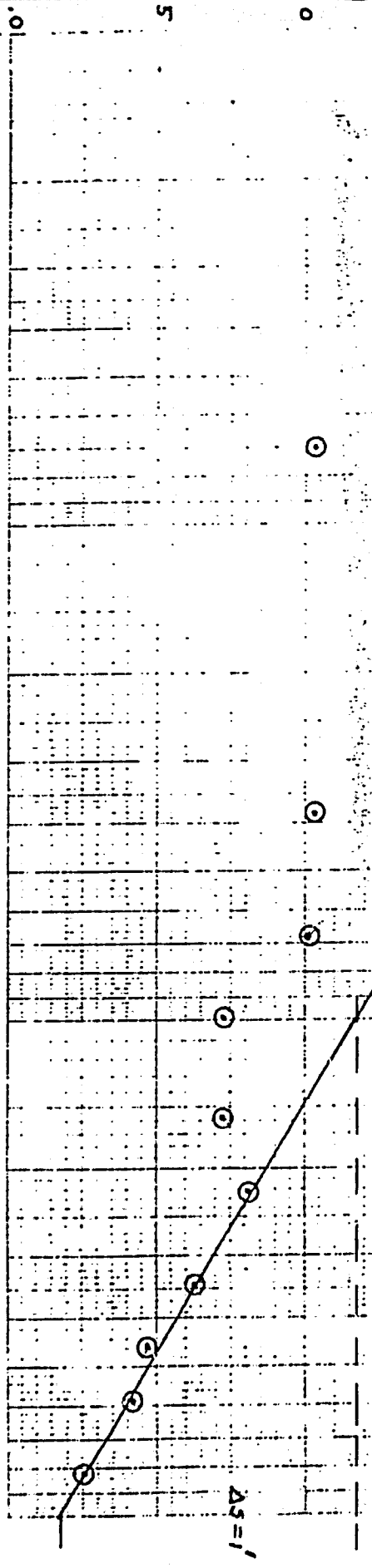
Reading Number	Time	Altitude Ga. In Feet	Inches on Orifice	G.P.M.	Pumping Level	Drawdown In Feet	Specific Capacity	TW-9-83	Drawdown	Water Appearance:
	9:00		23	312	34'-10"	23.25	13.4	9'-6"	1.71	Water Clear - No Sand
	9:30		23	312	34'-10"	23.25	13.4	9'-6 1/2"	1.75	" " " "
	10:00		23	312	34'-10"	23.25	13.4	9'-6 1/2"	1.75	" " " "
	10:30		23	312	34'-10 1/2"	23.29	13.4	9'-6 1/2"	1.75	" " " "
	11:00		23	312	34'-10 1/2"	23.29	13.4	9'-6 1/2"	1.75	" " " "
	11:30		23	312	34'-11"	23.33	13.4	9'-6 1/2"	1.75	" " " "
	12:00		23	312	34'-11"	23.33	13.4	9'-6 1/2"	1.75	" " " "
	12:30		23	312	34'-11"	23.33	13.4	9'-6"	1.71	" " " "
	1:00		23	312	34'-11"	23.33	13.4	9'-6"	1.71	" " " "
	1:30		23	312	34'-11"	23.33	13.4	9'-5"	1.62	" " " "
	2:00		23	312	34'-11"	23.33	13.4	9'-5"	1.62	" " " "
	2:30		23	312	34'-11"	23.33	13.4	9'-4 1/2"	1.58	" " " "
	3:00		23	312	34'-11"	23.33	13.4	9'-5"	1.62	" " " "
	3:30		23	312	34'-11 1/2"	23.37	13.4	9'-5"	1.62	" " " "
	4:00		23	312	34'-11 1/2"	23.37	13.4	9'-5"	1.62	" " " "
	4:30		23	312	34'-11 1/2"	23.37	13.4	9'-5 1/2"	1.66	" " " "
	5:00		23	312	34'-11 1/2"	23.37	13.4	9'-5 1/2"	1.66	" " " "
	5:30		23	312	34'-11 1/2"	23.37	13.4	9'-5 1/2"	1.66	" " " "
	6:00		23	312	35'-0"	23.41	13.4	9'-5 1/2"	1.66	" " " "
	6:30		23	312	35'-0"	23.41	13.4	9'-5 1/2"	1.66	" " " "
	7:00		23	312	35'-0"	23.41	13.4	9'-5 1/2"	1.66	" " " "
	7:30		23	312	35'-0"	23.41	13.4	9'-6"	1.71	" " " "
	8:00		23	312	35'-0"	23.41	13.4	9'-6"	1.71	" " " "
	8:30		23	312	35'-0"	23.41	13.4	9'-6"	1.71	" " " "



Rhode Island Test Well 85-14

7/21/62

Drawdown  $D$  TW 85-9  
 Distance  $\pm 400'$



June 12, 1986

Foth & Van Dyke  
ATTN: Mr. Ray Webber  
2737 S. Ridge Rd.  
P.O. Box 19012  
Green Bay, WI 54307-9012

RE: GEOPHYSICAL INVESTIGATIONS FOR THE CITY OF RHINELANDER

Dear Ray:

As you know on May 7 and 8, 1986 Layne-Northwest Company conducted 7 electrical resistivity profile lines, 5 electrical resistivity depth soundings, and 2 seismic refraction soundings in and around the City of Rhinelander in an attempt to identify favorable test well locations.

Electrical resistivity was chosen since this geophysical method has the ability to determine the electric resistivity of Earth materials in place. The electrical resistivity of Earth materials is principally related to the conductivity of their pore fluid. In unsaturated sandy soils the principal pore fluid is air. For this reason unsaturated sandy soils tend to have very high electrical resistivities. In soils which are saturated with water the electrical resistivity measured tends to be that of the formation water. The electrical resistivity of natural formation fluids is principally determined by the concentrations of ions in the water. Fluids which are in clean sandy soils tend to have lower ionic concentrations, as a result saturated clean sands tend to be moderately to highly resistive. Fluids which are in soils that contain significant amount of silts or clays tend to have higher ionic concentrations due to the interaction of the natural fluids with the clay minerals present. For this reason saturated



soils with higher clay or silt content tend to be lower in electric resistivity. It was felt that electrical resistivity would be useful in identifying areas which had a higher potential for the presence of clean sand and gravels.

Since there was little well control in some of the areas to be explored it was determined that it would be necessary to collect some seismic refraction data as well. The method of seismic refraction uses the principal of the distortion of sound waves as they cross the boundary between two materials having different sound conduction velocities. In most cases the strongest sound conduction velocity contrast occurs at the interface between the unconsolidated materials and the consolidated bedrock. It was Layne-Northwest's opinion that the method of seismic refraction should be able to determine a reasonably accurate estimate of the depth to bedrock in the survey areas.

The first area to be surveyed was an area west of the city airport. The map in the appendix of this report shows the study area. The city had three existing test wells, one of which (test well TW9-86) encountered noticeably better formation than the other two. It was the purpose of this study to identify the shape of the sand body and attempt to identify areas in which similar types of formation could be encountered.

Seven electrical resistivity profile lines were run in this area using a 40' electrode separation with the Wenner array. The data are presented on the map in the appendix of this report. The data indicates that the sand body is an irregularly shaped linear feature which trends slightly west of due north. Such a pattern suggests a melt water channel depositional environment. Channel deposits can be quite prolific aquifers, however they tend to be thin and meander quite a bit around a linear trend. Since they are generally thin and somewhat irregular in nature it can be difficult to exactly pinpoint the best test well location. Two electric resistivity depth soundings were conducted in the area and a test well site was recommended at the second depth sounding location. The formation encountered by this test well and by

another test well drilled along this trend where not of the same quality as the formations encountered at test well No. TW9-86. This data suggests that the sand body is a narrow, meandering, irregular feature and additional test well locations may be difficult to find. The possibility of using some type of inexpensive soil boring technique should be considered before additional test well locations are chosen in this area. In addition an extended pumping test of test well TW9-86 should be considered to ensure that the aquifer is of sufficient lateral extent and receives sufficient recharge to sustain a high capacity water well for a prolonged period of time.

The second area to be surveyed was in a gravel pit near City of Rhinelander well No. 5. A prolific sand and gravel aquifer is known to exist at this well site. Electrical resistivity depth sounding R-3 was run near this well for comparison to other resistivity depth soundings. Resistivity depth sounding R-3 indicated a layer of approximately 10' to 15' of highly resistive dry sandy soil above a layer of saturated clean sand and gravel which extended to bedrock which was at a depth of about 70' to 80'.

The third area to be surveyed was in a remote area near Timothy Lane. Electrical resistivity depth sounding No. R-4 was run at this location. The data indicated a surface layer about 9' to 10' thick of extremely resistive dry sand. Below this layer was a layer of saturated, relatively clean formation extending to bedrock which was at a depth of approximately 40'. Seismic line S-1 was run in this area to confirm the shallow bedrock depths. The data indicated a depth to bedrock of approximately 30'. Due to the relatively thin layer of saturated material present in this area it does not appear that a test well would be warranted.

Seismic line S-2 was run in the Harmony Hills Trailer Court. The seismic data was of poor quality but indicated a shallow (approximately 30') bedrock depth. Later conversations with a local well driller indicated that the depth to rock may in fact be closer to 100'. The driller reported that the area contains

Foth & Van Dyke  
June 12, 1986  
Page 4

many extremely large boulders. It is probable that sound waves refracting off these boulders may have given a false bedrock reading. It is probably not possible to determine an accurate bedrock depth using seismic refraction in this area due to the presence of these boulders. Based on the erroneous seismic data no additional work was done in this area. It is possible that this area may be worth some further investigation using methods other than seismic refraction.

Electrical resistivity depth sounding R-5 was conducted near the Sunrise Plaza Shopping Center on Highway 8. Two wells in the immediate area indicated that the bedrock depth was greater than about 115'. Depth sounding R-5 showed a layer of approximately 40' of extremely resistive sandy material. The depth to water was probably not accurately detected by this depth sounding. Below this was an approximately 100' thick layer of less resistive material, probably indicating saturated sand. The data from R-5 indicated a depth to bedrock of approximately 120' to 140'. This area appears to have the potential for the presence of clean saturated formation. However, as you pointed out, there are some water quality concerns in the area. If a test well were to be drilled in this area it is suggested that an extended range pumping test be conducted in order to address the long term water quality considerations.

Most of the area surveyed were characterized by a surface layer of dry, very sandy soil. This layer presented problems in terms of electrode contact resistance. This high electrode contact resistance probably reduced the effective resolution of the electrical resistivity method and may have caused some anomalous readings. However, it is Layne-Northwest's opinion that the data collected is still substantially correct but should be viewed more from a qualitative rather than a quantitative frame of reference. If additional geophysical work is conducted in the Rhinelander area more attention should be given to methods to reduce the electrode contact resistance such as preparation of electrode plants with salt water. Better well control information should be used to prevent erroneous interpretation of geophysical data due to atypical

Foth & Van Dyke  
June 12, 1986  
Page 5

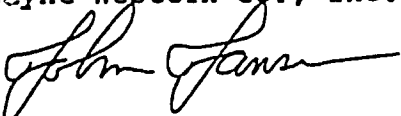
geologic conditions such as occurred in the Harmony Hills Trailer Court.

The area around the airport still appears promising but more subsurface information is necessary before any predictions of the capacity of this area can be made. Some type of boring program should be instituted to confirm the trend of the sand body. It is Layne-Northwest's opinion that it is likely that the sand body will trend substantially similar to the electrical resistivity trend shown on the enclosed map though the body of cleanest sand may be patchy and discontinuous in nature.

Layne-Northwest appreciates the opportunity to work with Foth & Van Dyke on this project. We would like to thank you for your assistance and insight as well as for the input from Roger Freund. As you know, Rhinelander is a challenging area from a water supply standpoint. Layne-Northwest feels that some difficulties in any exploration program in this area are to be expected but we feel that your objective of a new high capacity water well of 1,000 gpm or more in the Rhinelander area is an obtainable goal. Please feel free to contact me if you should require any more information pertaining to this matter.

Respectfully submitted,

LAYNE-NORTHWEST Div. of  
Layne-Western Co., Inc.



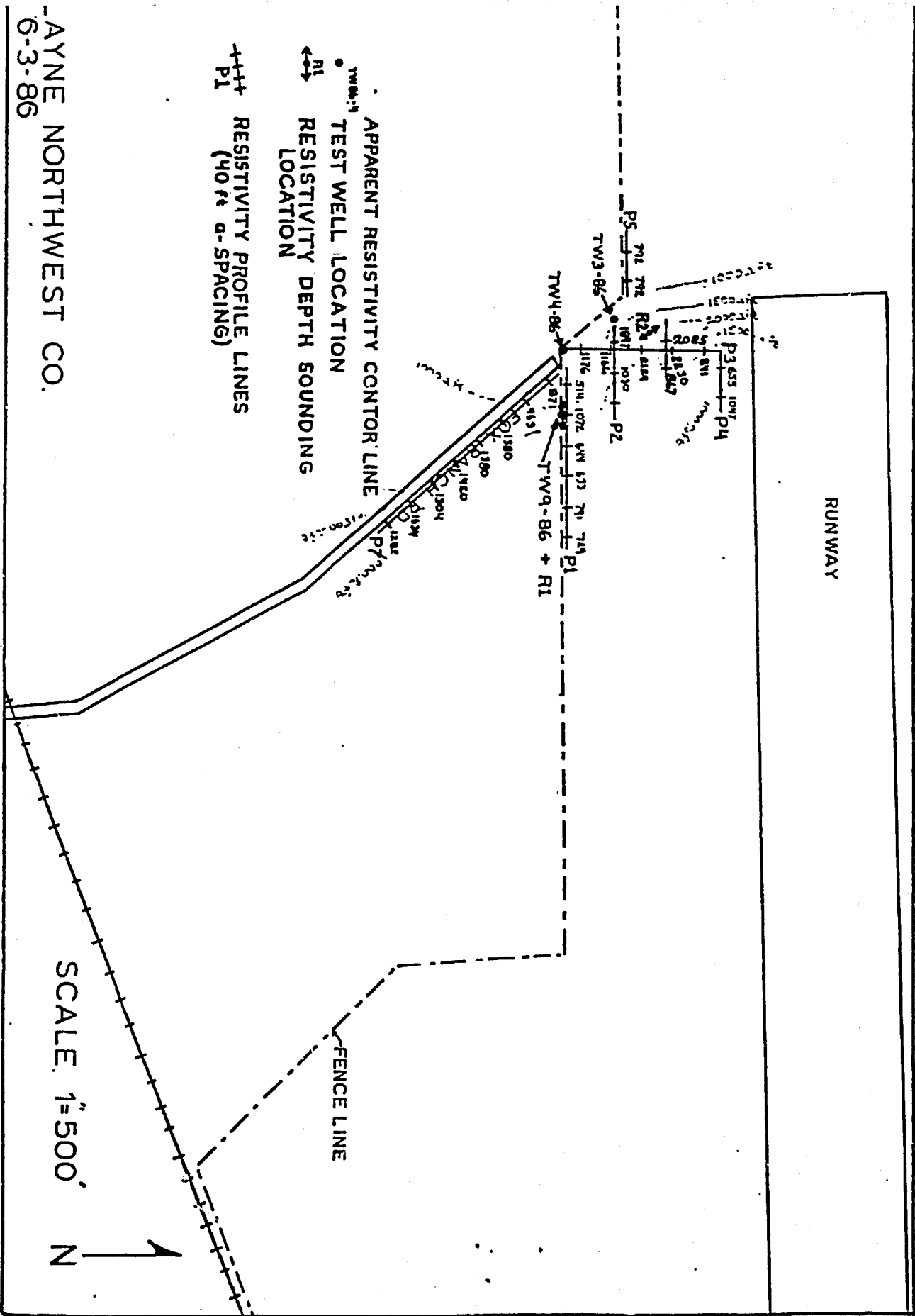
Mr. John R. Jansen  
Hydrogeophysicist

JRJ:pw

Enc.

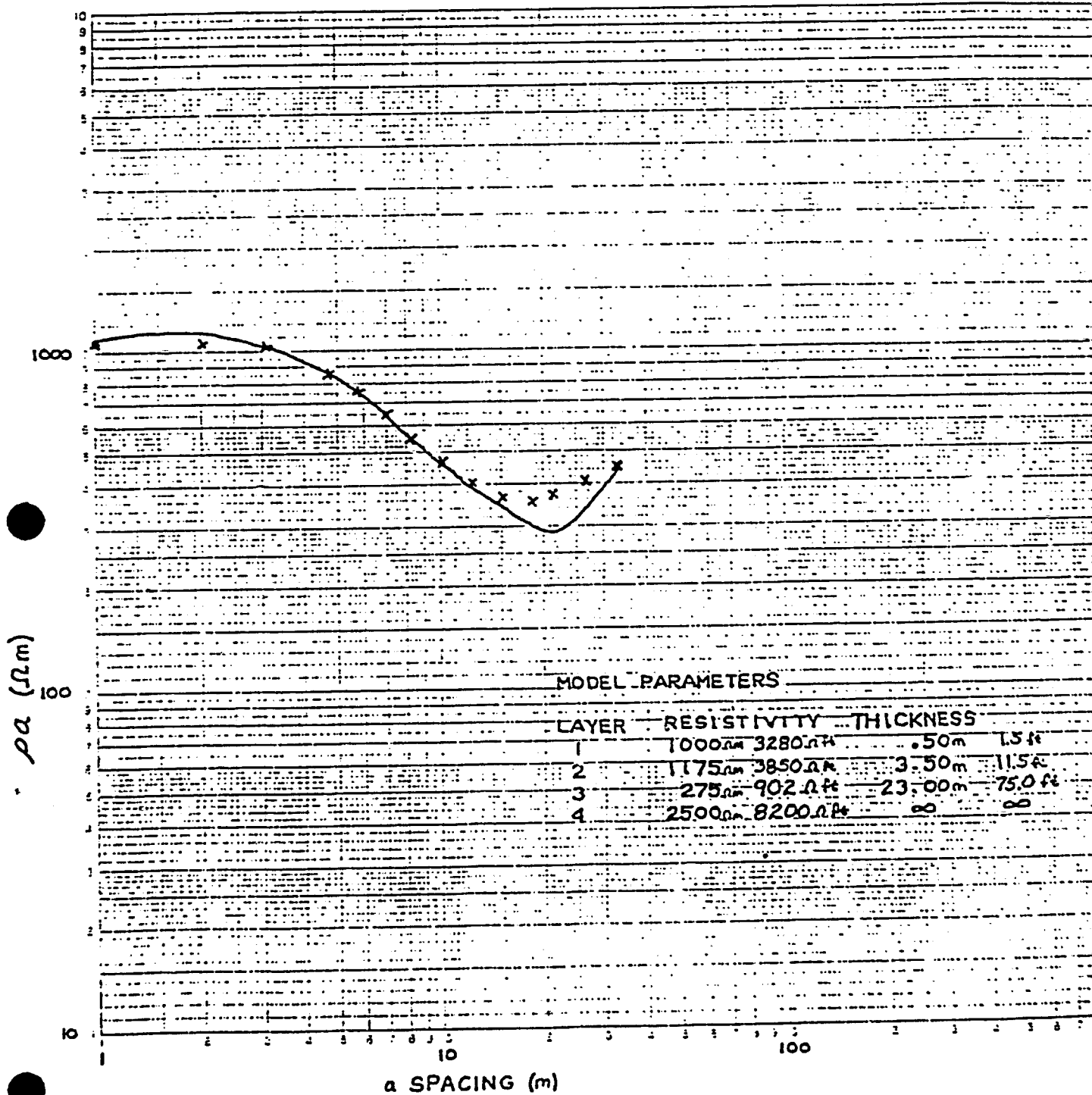


APPARENT RESISTIVITY CONTOUR MAP  
 RHINELANDER, WI AIRPORT AREA



-AYNE NORTHWEST CO.  
 6-3-86

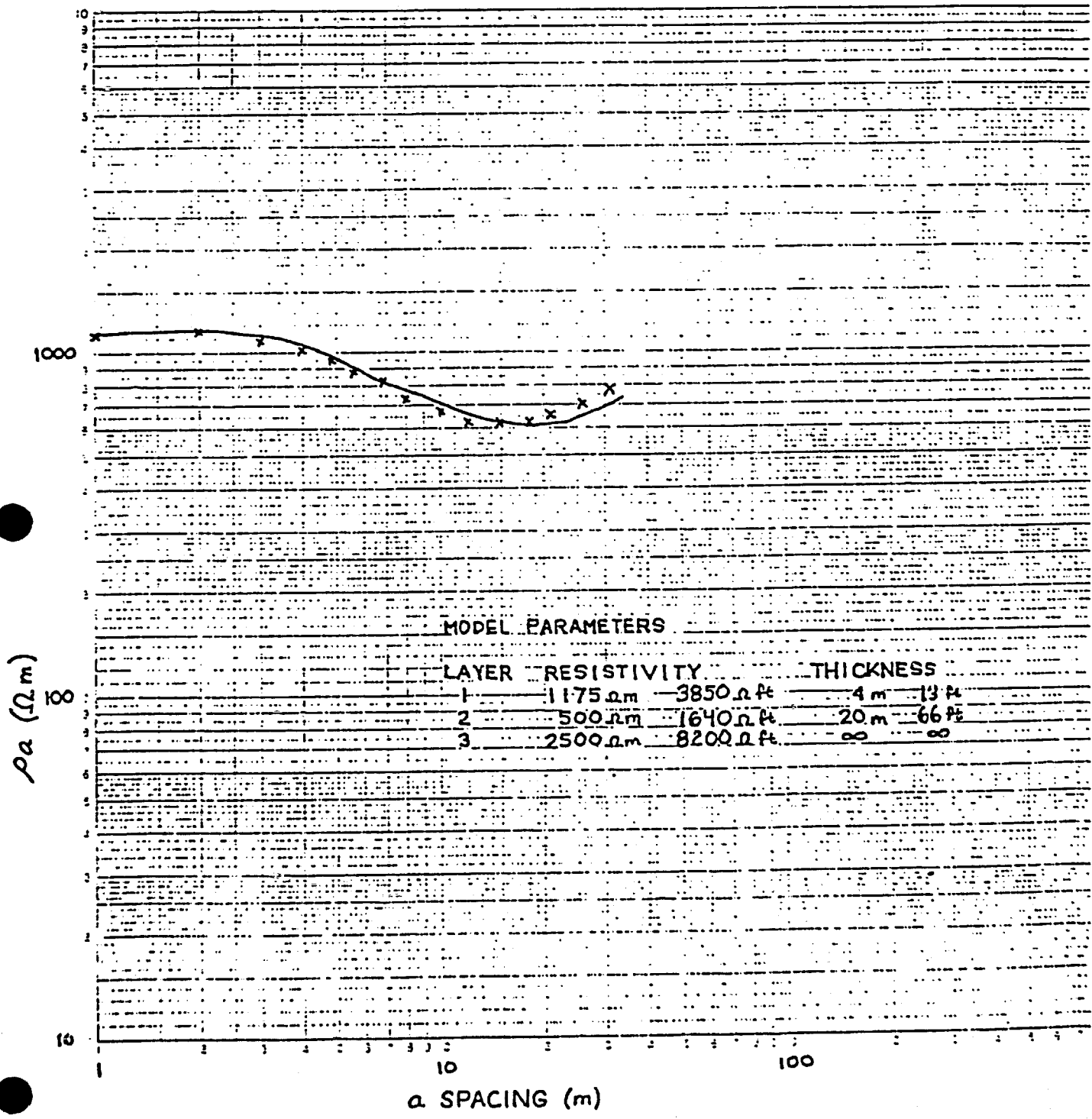
R.1



MODEL PARAMETERS

LAYER	RESISTIVITY	THICKNESS		
1	1000 $\Omega m$ 3280 $\Omega ft$	.50m	1.5ft	
2	1175 $\Omega m$ 3850 $\Omega ft$	3.50m	11.5ft	
3	275 $\Omega m$ 902 $\Omega ft$	23.00m	75.0ft	
4	2500 $\Omega m$ 8200 $\Omega ft$	$\infty$	$\infty$	

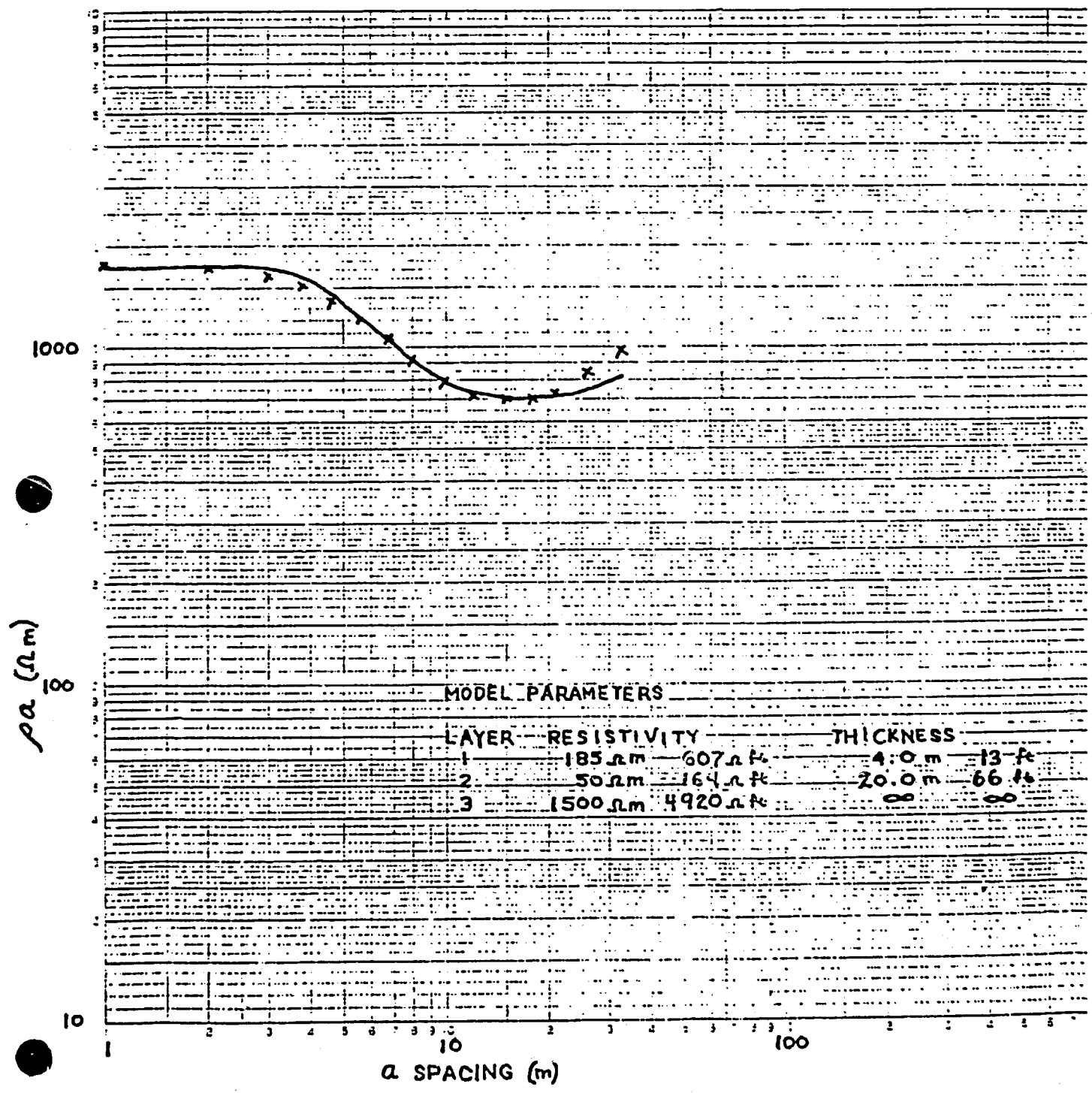
R 2



MODEL PARAMETERS

LAYER	RESISTIVITY	THICKNESS
1	1175 Ωm — 3850 Ω ft	4 m — 13 ft
2	500 Ωm — 1640 Ω ft	20 m — 66 ft
3	2500 Ωm — 8200 Ω ft	∞ — ∞

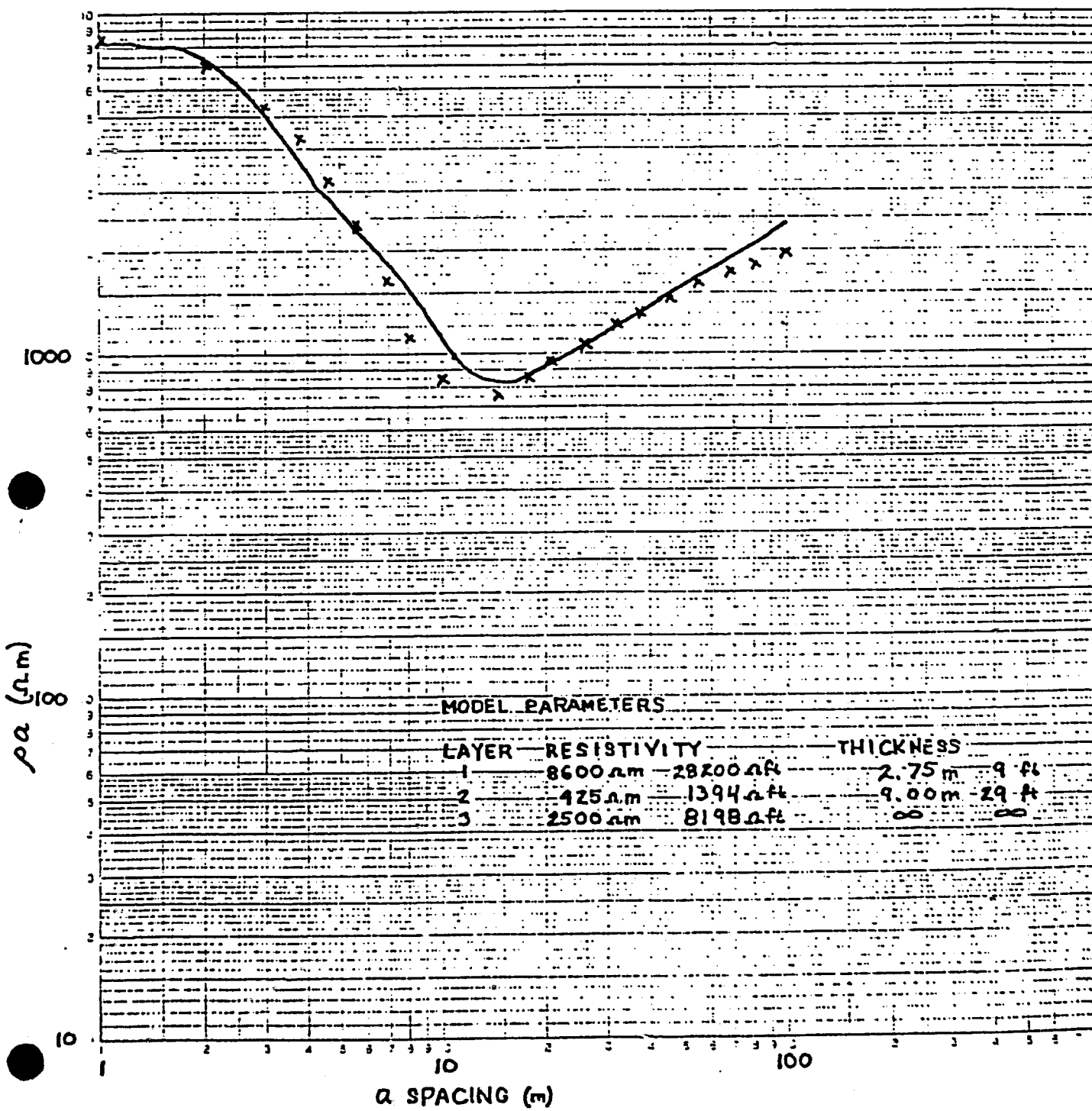
R 3



MODEL PARAMETERS

LAYER	RESISTIVITY	THICKNESS
1	185 n.m — 607 n.m	4.0 m — 13 ft
2	50 n.m — 164 n.m	20.0 m — 66 ft
3	1500 n.m — 4920 n.m	$\infty$ — $\infty$

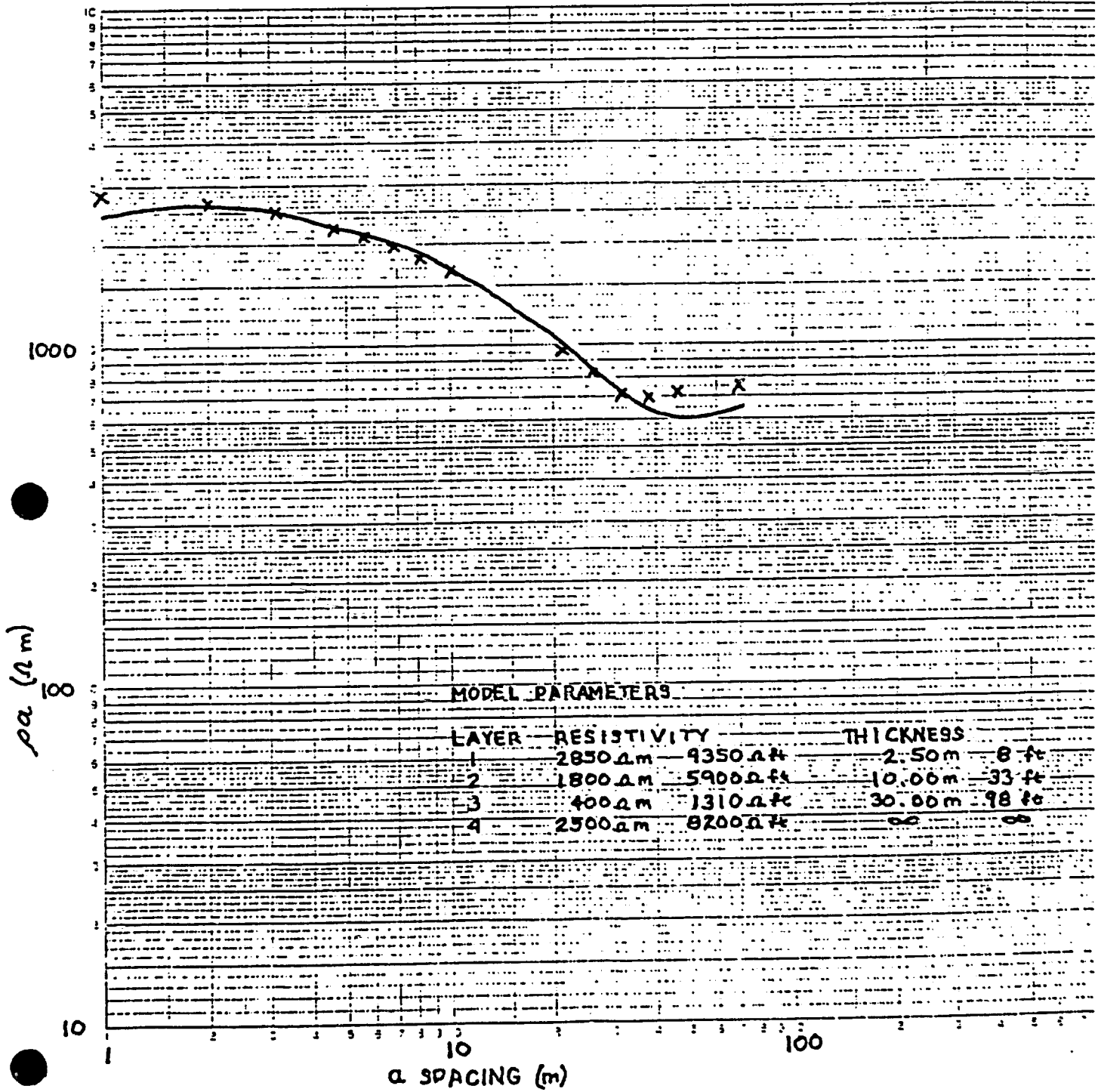
R 4



MODEL PARAMETERS

LAYER	RESISTIVITY	THICKNESS
1	8600 $\Omega m$ — 28200 $\Omega ft$	2.75 m — 9 ft
2	425 $\Omega m$ — 1394 $\Omega ft$	9.00 m — 29 ft
3	2500 $\Omega m$ — 8198 $\Omega ft$	$\infty$ $\infty$

R 5



MODEL PARAMETERS

LAYER	RESISTIVITY	THICKNESS
1	2850 $\Omega m$ — 9350 $\Omega ft$	2.50m — 8 ft
2	1800 $\Omega m$ — 5900 $\Omega ft$	10.00m — 33 ft
3	400 $\Omega m$ — 1310 $\Omega ft$	30.00m — 98 ft
4	2500 $\Omega m$ — 8200 $\Omega ft$	$\infty$ — $\infty$

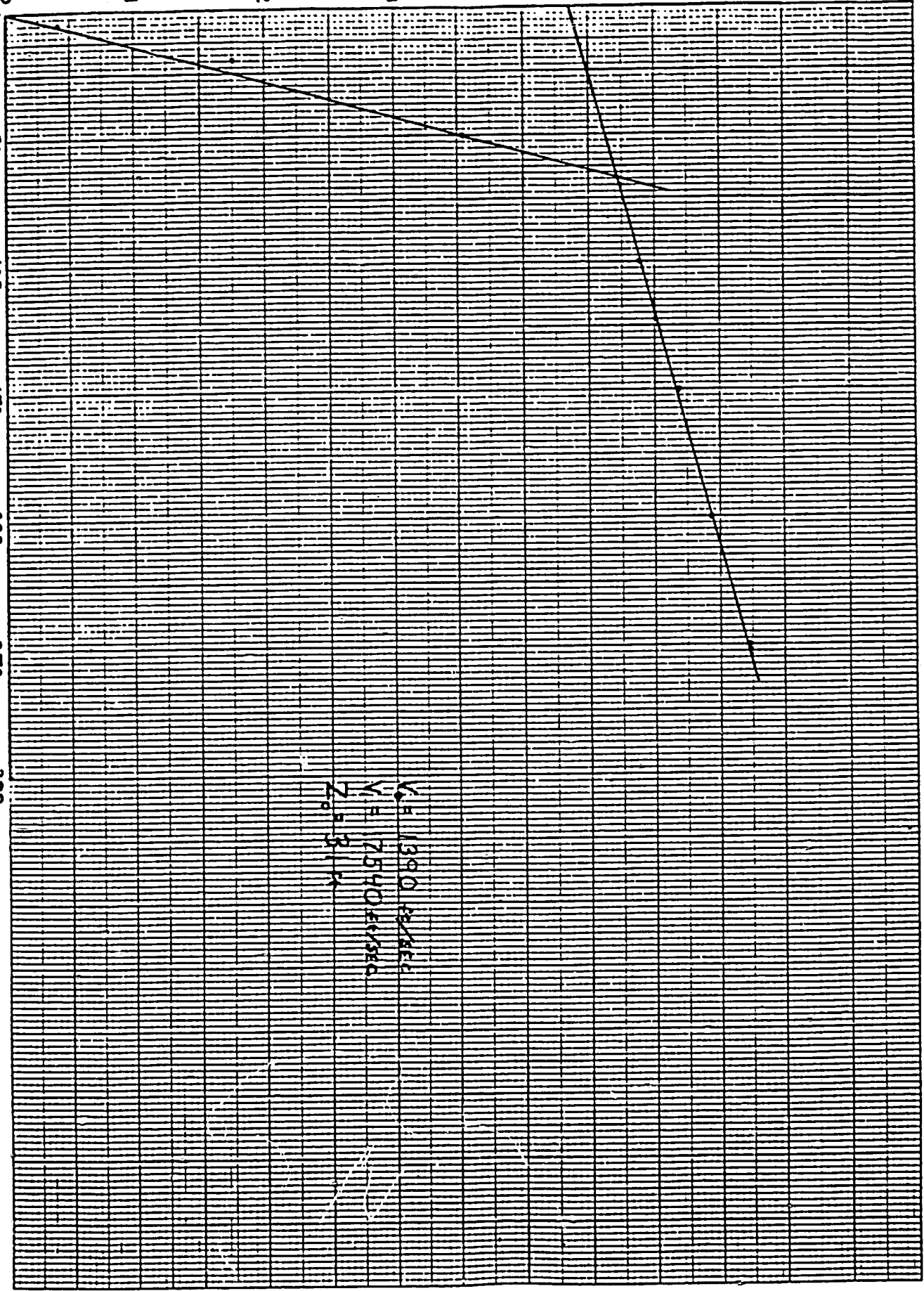
**Layne-Western**

Division of LAYNE-WESTERN COMPANY, INC.

W229 N5005 DuPlainville Road • Pewaukee, Wisconsin 53072 • 414/218-4648

**S1** PHONE 300 ft WEST OF R-4 CENTER

V = 1390 8/2/82  
M = 7540 8/1/82  
Z = 511 ft

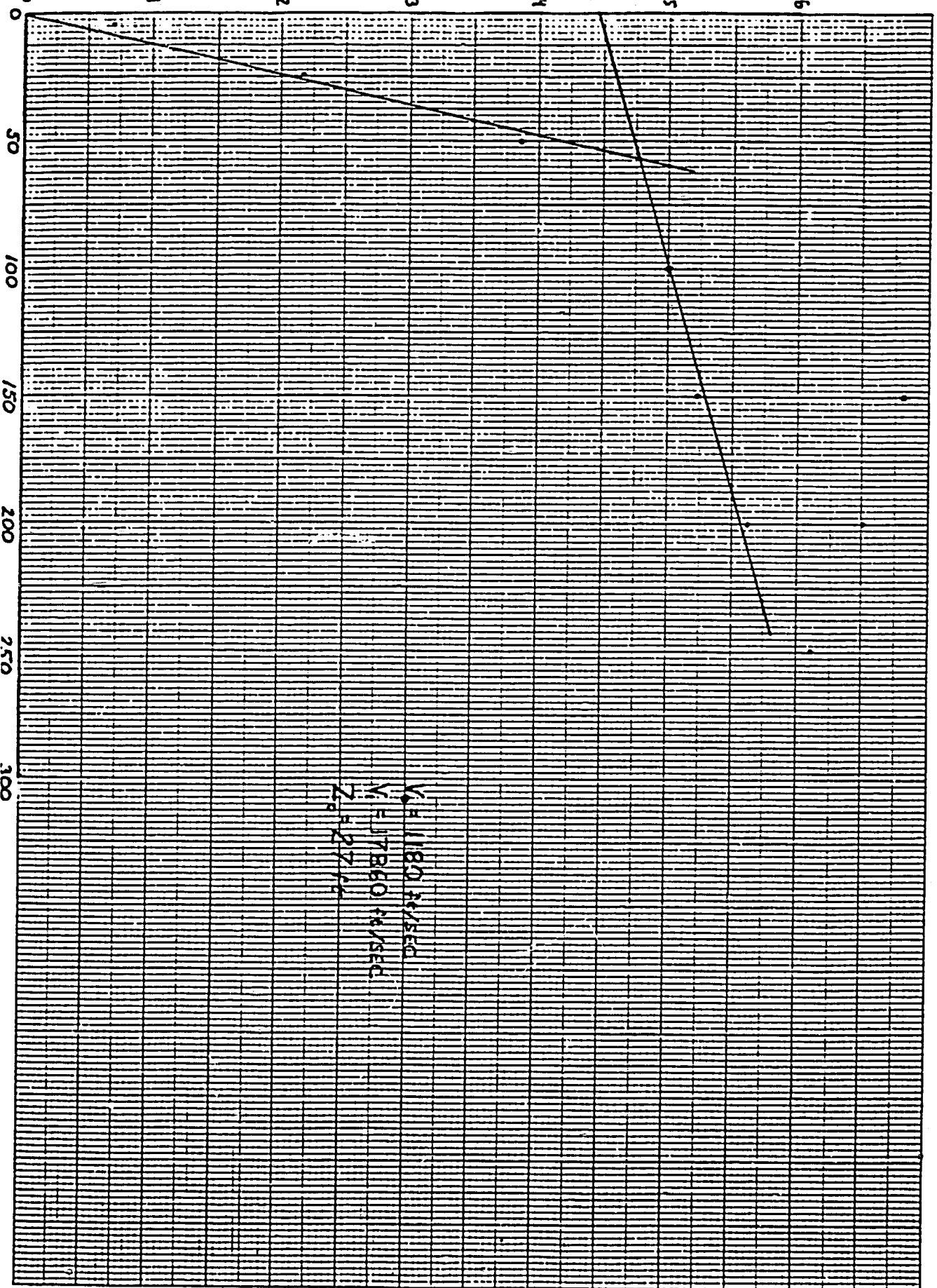


**Layne-Vorhies**

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# S 2 TRAILER COURT AREA





OFFSET WENNER SOUNDING R-1  
 JOB RHINELANDER  
 DATE 5/7/86  
 NUMBER OF SPACINGS USED 6

SPACING	PA	PC	PD1	PD2	PB
.5000	467.0	450.0	284.0	311.0	17.59
1.000	235.0	235.0	176.1	173.1	15.35
2.000	125.5	118.4	84.50	100.7	7.020
4.000	47.40	45.10	36.60	39.10	2.360
8.000	13.32	12.63	10.24	11.74	.6950
16.00	4.650	4.390	3.240	3.330	.2950

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	467.2	17.57	449.7	284.0	311.0	297.5	934.6
1.000	242.4	14.86	227.5	176.1	173.1	174.6	1097.
1.500							1233.
2.000	125.4	7.022	118.4	84.50	100.7	92.60	1163.
3.000							1081.
4.000	47.42	2.358	45.07	36.60	39.10	37.85	951.2
6.000							744.7
8.000	13.32	.6948	12.62	10.24	11.74	10.99	552.4
12.00							412.7
16.00	4.667	.2938	4.373	3.240	3.330	3.285	330.2
24.00							351.3
32.00							437.7

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	-.1262	-9.075	
1.000	-6.331	1.718	-74.68
2.000	6.376	-17.49	-30.45
4.000	-.1264	-6.605	-36.32
8.000	-3.753	-13.64	-31.93
16.00	-.7498	-2.739	.1521

R.M.S. OBSERVATIONAL ERROR = 2.604  
 R.M.S. OFFSET WENNER DIFFERENCE = 10.23  
 R.M.S. LATERAL DIFFERENCE = 38.39

OFFSET WENNER SOUNDING R-2  
 JOB RHINELANDER  
 DATE 5/7/86  
 NUMBER OF SPACINGS USED 7

SPACING	PA	PC	PD1	PD2	PB
.5000	508.0	483.0	388.0	339.0	25.30
1.000	258.0	245.0	187.2	183.5	13.93
2.000	115.6	108.5	99.50	84.10	7.850
4.000	53.90	51.90	46.50	37.50	2.020
8.000	19.26	18.46	16.18	15.28	.8110
16.00	8.890	8.609	6.640	5.610	.2800
32.00	5.260	4.900	3.480	3.610	.3700

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	508.1	25.29	482.8	388.0	339.0	363.5	1141.
1.000	258.4	13.90	244.5	187.2	183.5	185.3	1164.
1.500							1198.
2.000	115.9	7.824	108.1	99.50	84.10	91.80	1153.
3.000							1146.
4.000	53.91	2.019	51.89	46.50	37.50	42.00	1055.
6.000							869.3
8.000	19.26	.8107	18.45	16.18	15.28	15.73	790.6
12.00							732.7
16.00	8.889	.2800	8.609	6.640	5.610	6.125	615.7
24.00							649.0
32.00	5.264	.3696	4.895	3.480	3.610	3.545	712.7
48.00							968.8
64.00							1086.

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	-5.903	13.48	
1.000	-.3598	1.996	-28.94
2.000	-.6466	16.77	-29.95
4.000	-3.709	21.42	20.47
8.000	-5.709	5.721	-25.87
16.00	1.125	16.81	10.85
32.00	-.1899	-3.667	-40.14

R.M.S. OBSERVATIONAL ERROR = .2908  
 R.M.S. OFFSET WENNER DIFFERANCE = 13.39  
 R.M.S. LATERAL DIFFERANCE = 25.50

OFFSET WENNER SOUNDING R-3  
 JOB RHINELANDER  
 DATE 5/8/86  
 NUMBER OF SPACINGS USED 6

SPACING	PA	PC	PD1	PD2	PB
.5000	635.0	583.0	435.0	614.0	53.50
1.000	388.0	374.0	261.0	290.0	13.49
2.000	20.10	192.8	135.0	143.0	9.000
4.000	81.80	77.80	65.30	62.90	4.110
8.000	19.68	18.41	13.70	23.20	1.356
16.00	9.950	9.149	6.640	7.760	.6910

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	635.7	53.43	582.3	435.0	614.0	524.5	1647.
1.000	387.7	13.49	374.2	261.0	290.0	275.5	1731.
1.500							1576.
2.000	36.55	1.630	34.92	135.0	143.0	139.0	1746.
3.000							1690.
4.000	81.85	4.107	77.74	65.30	62.90	64.10	1611.
6.000							1649.
8.000	19.72	1.353	18.36	13.70	23.20	18.45	927.3
12.00							759.3
16.00	9.895	.6948	9.200	6.640	7.760	7.200	723.8
24.00							745.2
32.00							804.4

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	-.2359	-34.12	
1.000	.1315	-10.52	57.53
2.000	-497.0	-5.755	-41.72
4.000	-.1343	3.744	-67.86
8.000	-.4360	-51.49	-48.50
16.00	1.101	-15.55	101.1

R.M.S. OBSERVATIONAL ERROR = 202.9  
 R.M.S. OFFSET WENNER DIFFERENCE = 26.50  
 R.M.S. LATERAL DIFFERENCE = 60.87

BISON INSTRUMENTS INC.

OFFSET WENNER SOUNDING R-4  
 JOB RHINELANDER  
 DATE 5/8/86  
 NUMBER OF SPACINGS USED 8

SPACING	PA	PC	PD1	PD2	PB
.5000	3110.	2900.	2560.	1857.	207.0
1.000	1700.	1572.	1327.	1342.	129.1
2.000	692.0	657.0	597.0	590.0	37.10
4.000	143.4	137.3	128.1	142.5	5.920
8.000	40.20	38.90	33.90	29.70	1.270
16.00	10.92	9.990	8.070	8.689	.9680
32.00	9.370	8.890	5.560	6.600	.4800
64.00	6.930	6.420	4.250	5.070	.4350

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	3108.	207.0	2901.	2560.	1857.	2208.	6938.
1.000	1700.	129.0	1571.	1327.	1342.	1334.	8384.
1.500							8349.
2.000	693.0	37.04	656.0	597.0	590.0	593.5	7458.
3.000							5134.
4.000	143.3	5.923	137.3	128.1	142.5	135.3	3400.
6.000							1976.
8.000	40.18	1.270	38.91	33.90	29.70	31.80	1598.
12.00							1163.
16.00	10.93	.9663	9.972	8.070	8.689	8.379	842.3
24.00							1044.
32.00	9.370	.4800	8.890	5.560	6.600	6.080	1222.
48.00							1472.
64.00	6.892	.4373	6.454	4.250	5.070	4.660	1873.
96.00							2462.
128.0							2887.

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	9.650	31.83	
1.000	-6.468	-1.124	-3.634
2.000	-.3030	1.179	19.96
4.000	.1255	-10.64	6.134
8.000	7.465	13.20	87.42
16.00	-3.473	-7.387	-69.46
32.00	0.000	-17.10	47.02
64.00	1.088	-17.59	-20.60

R.M.S. OBSERVATIONAL ERROR = .4230  
 R.M.S. OFFSET WENNER DIFFERENCE = 15.65  
 R.M.S. LATERAL DIFFERENCE = 44.09

LAYNE WESTERN COMPANY, INC.

OFFSET WENNER SOUNDING R-5  
 JOB RHINELANDER  
 DATE 5/8/86  
 NUMBER OF SPACINGS USED 7

SPACING	PA	PC	PD1	PD2	PB
.5000	621.0	592.0	415.0	332.0	26.00
1.000	522.0	489.0	392.0	395.0	25.00
2.000	258.0	234.0	221.0	202.0	24.00
4.000	114.1	106.0	97.90	88.20	8.630
8.000	47.60	44.70	36.00	41.70	3.200
16.00	13.18	12.45	12.99	11.88	.9610
32.00	4.460	4.290	3.170	3.800	.1825

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	619.4	26.06	593.4	415.0	332.0	373.5	1173.
1.000	517.9	25.19	492.7	392.0	395.0	393.5	2472.
1.500							2842.
2.000	258.0	24.00	234.0	221.0	202.0	211.5	2657.
3.000							2847.
4.000	114.3	8.610	103.7	97.90	88.20	93.05	2338.
6.000							1906.
8.000	47.74	3.189	44.55	36.00	41.70	38.85	1952.
12.00							1524.
16.00	13.29	.9526	12.34	12.99	11.88	12.43	1250.
24.00							862.9
32.00	4.466	.1822	4.283	3.170	3.800	3.485	700.7
48.00							534.1
64.00							642.5

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	.4842	22.22	
1.000	1.544	-.7623	-11.05
2.000	0.000	8.983	9.692
4.000	-.4634	10.42	51.63
8.000	-.6282	-14.67	33.33
16.00	-1.737	8.926	5.910
32.00	-.2798	-18.07	99.13

R.M.S. OBSERVATIONAL ERROR = .9507  
 R.M.S. OFFSET WENNER DIFFERENCE = 13.65  
 R.M.S. LATERAL DIFFERENCE = 44.49

**Excerpts from April 14, 1987**

**Update of Groundwater  
Investigation**

**Foth & Van Dyke**

Test Well No. 17

Later in December of 1986 the next step was initiated. This was to obtain bids from contractors for drilling one or more larger diameter test wells in the vicinity of test wells No. 9 and No. 14 at the west edge of the airport. These were the only two of the eight test wells in this area that appeared to be favorable for well development. Specifications were prepared and bids received on January 26, 1987. Layne-Northwest Company of Schofield, Wisconsin was the low bidder.

The purpose of this phase of the investigation was to construct a larger test well (10 inch) that would be pumped at a higher rate than the smaller test wells. Observation wells (sand points) were also constructed at varying distances from the test well that could be used to measure the lowering of the water table during pumping.

Test well No. 17 was constructed to a depth of 80 feet with a 10 inch screen set between the depths of 55 feet and 80 feet. It was located five feet from test well No. 9 just inside of the airport fence. Construction of the test well and the three observation wells was completed the first week of March 1987. The attached pages from Layne-Northwest Company show the formations which were encountered. A general observation regarding the formations

encountered is that the coarser formations were higher up and that the material became finer with depth. At two of the observation wells the bottom formation was quite tight.

#### Test Pumping

On March 9, 1987 the test well was pumped. Personnel from the Rhinelander Water Utility, Foth & Van Dyke and Layne-Northwest were involved in taking water level measurements. The maximum output of the well was 550 gallons per minute which was somewhat less than was hoped for. The attached pump test data and sketch show the drawdown data at the test well and the observation points. The pump test was terminated after 24 hours because the drawdowns had very nearly stabilized. The drawdown data was used to graph and make calculations to determine the transmissivity and the storage coefficient which can assist in well analysis and design. Transmissivity is the thickness of an aquifer multiplied by the permeability and gives an indication of how productive an aquifer may be.

Water samples were taken during the test pumping and analyzed at the Foth & Van Dyke laboratory. A data sheet is attached.

#### Observations Regarding Test Well No. 17

Based on the data obtained during drilling and test pumping plus office analysis the following observations can be made:



1. The geologic formations which were penetrated at the four drill hole locations contained considerable fine to medium sand and not a great amount of coarse sand or gravel. Sieve analyses and sand curves were prepared by Layne-Northwest.
2. The calculated transmissivity value based on the distance-draw down method was from 50,000 to 60,000 gallons per day per foot. This is less than half the value for the aquifer in which wells No. 4 and No. 5 are developed.
3. The chemical water quality is good, but as is typical for groundwater in this area, the water is very soft and corrosive in nature.
4. It appears that a properly designed and constructed well at this location could produce approximately 800 gallons per minute. This is considerably less than the 1500 gallons per minute which was selected as the preliminary design criteria for the layouts in the September 1986 report.
5. Based on the drilling done in 1986 and in conjunction with test well No. 17, it does not look too favorable for the construction of more than two wells in the area at the west end of the airport. The sand formation found in test well No. 17 does not extend for a great distance according to the drill hole sampling data.

## Conclusions

The data obtained from the testing and analysis of test well No. 17 indicates that this area does not appear to be suitable for the construction of wells that could replace the existing wells No. 4 and No. 5. One or two wells with a capacity of 800 gallons per minute each possibly could be developed, but in excess of two miles of watermain would be required to transmit the water into the City. The expense of this much watermain does not appear to be warranted for this volume of water unless there is the potential for development along Highway 8 and in the airport area.

# Layne-Northwest

Division of LAYNE-WESTERN COMPANY, INC.

3200 Schofield Avenue • Schofield, WI 54476 • 715/359-4211

March 30, 1987

Foth & VanDyke  
2737 South Ridge Road  
Green Bay, WI 54307-9012

ATTENTION: Lowell Johnson, P.E.

SUBJECT: Test Drilling - City of Rhinelander

Dear Mr. Johnson:

To follow up our conversation we had on Friday, March 27, 1987, we wish to submit the following recommendations:

The average 50% size as determined from the sieve analyses from 50 to 80' shows 0.0156". The 50% size of #30 American Materials gravel pack is 0.056". This is slightly below the average of the actual formation samples. The 50% size of #20 gravel is 0.095". The #20 gravel pack seems to be too coarse to match the existing formation at the test well site.

We then recommend that #30 gravel pack from American Materials Corporation, Eau Claire, should be used for this particular location. The screen slot size would be 0.040".

We suggest that a large diameter drill hole be drilled at the site since the sand is slightly on the finer side. A large gravel envelope would help reduce the entrance velocity of the water through the screen and prevent unnecessary silting and plugging on the outside perimeter of the gravel pack or between the interface of the natural formation in the gravel pack. The attempt should be made to collect all the available groundwater possible by the pumping well with the least amount of drawdown. In our opinion, the formation sands at the test well site would merit a permanent well. The long range planning and the demand is something we are not familiar with and you will probably evaluate the economics of laying water mains out to this site.

A large diameter drill hole of at least 36" or more would certainly help in collecting the available groundwater in the area. In our opinion, a well of this size should be able to have an initial potential of around 700 to 800 gpm. However, for long range pumping periods and sustainable yields on a perennial basis, the well would probably level off around 600 to 700 gpm. We do not recommend that over 1 million gallons per day should be pumped from this particular area or within close proximity.




WATER SUPPLY SERVICES

March 30, 1987  
Lowell Johnson, P.E.  
Page 2

Please be advised that we stand ready to assist you in the event you decide to install a permanent well at the test well location, and we appreciate the cooperation that the City and Foth and VanDyke have provided for us in the test drilling of the test hole location.

Very truly yours,

LAYNE-NORTHWEST, Div. of  
Layne-Western Co., Inc.

  
Harvey M. Stricker

Branch Manager - Hydrogeologist

HMS:kan

**LAYNE - NORTHWEST COMPANY**

*"World's Largest Water Developers"*

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CITY OF RHINELANDER  
TEST DRILLING TW-17

LOCATION: Southwest Corner of Rhineland City Airport (Close to Fence)

<u>Depth From-To</u>	<u>Formation Description</u>
0-15'	Fine to Medium Sand, Muddy, Gravel, With Large Cobbles
15-51'	Fine to Course Sand, Heavy Gravel, and Some Boulders, Formation was Tight, Had to Drill Because Formation Would Not Bail
51-77'	Medium to Brown Sand, Loose, Bailed Easy
77-79'	Fine to Brown Silty Sand, Quite Tight
79-80'	Fine to Medium Sand, Silty, Broken Granite

80' Total Depth.

NOTE: Had to drill last foot because of broken granite and small  
boulders.

Set 25' of 10" nominal well screen as follows:

15' X .030" slot  
10' X .025" slot

**LAYNE - NORTHWEST COMPANY**

*"World's Largest Water Developers"*

---

CITY OF RHINELANDER  
MONITORING POINTS

Monitoring Point 50' South of Test Well.# 17

<u>Depth From-To</u>	<u>Formation Description</u>
0-55'	Fine to Course Sand, Gravel and Some Boulders
55-70'	Fine Silty Sand, Quite Muddy, Tight
70-80'	Fine Silty Muddy Sand, Very Tight

Set 5' X 1½" Sand Point to 80', Formation Too Tight - Would Not Take Water, Pulled Sand Point Back Up to 65' Where It Took Water.

Monitoring Point 150' South of Test Well.

0-55'	Fine To Medium With Some Course Sand
55-80'	Fine, Slightly Muddy To Course Sand

Set 1½" X 5' Sand Point to 80', Formation Too Tight - Pulled Point Back to 70' Where It Took Water.

Monitoring Point 50' East of Test Well.

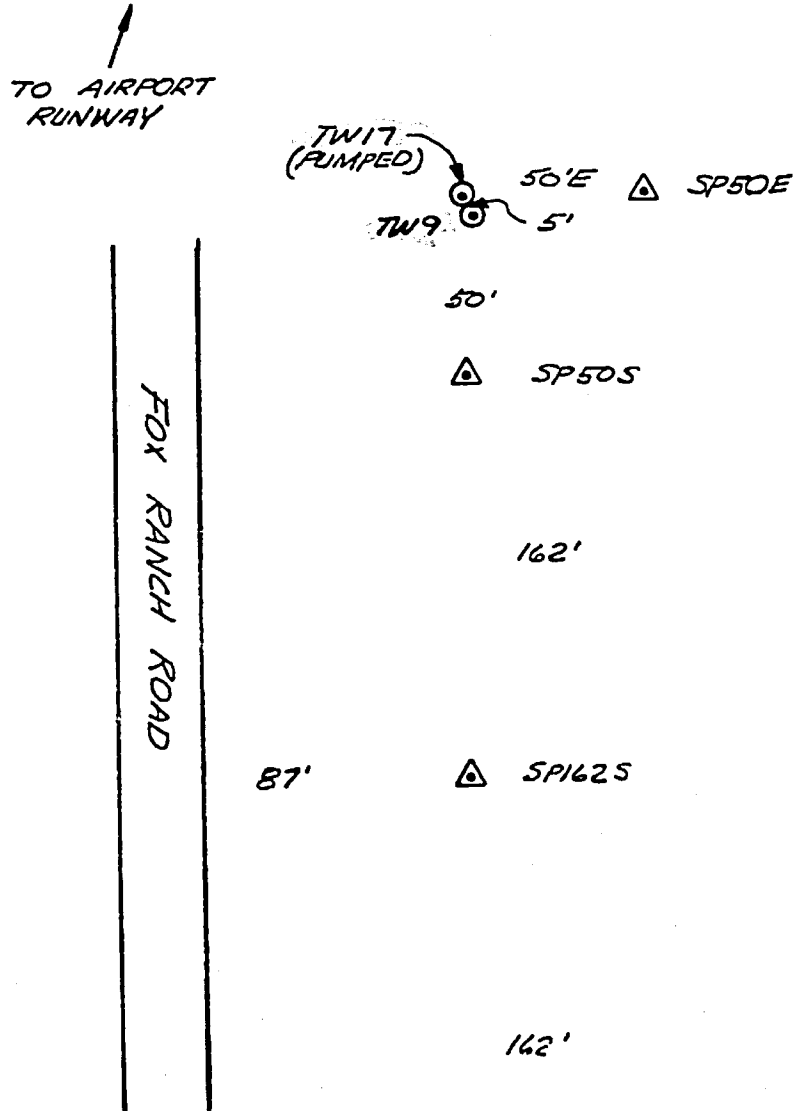
0-35'	Fine to Course Sand
35-55'	Fine to Course Sand and Some Gravel
55-80'	Fine to Course Sand, Gravel, Boulder

Set 5' Sand Point to 78'.

NOTE: Based on the formation sampling of the three monitoring holes, this monitoring hole showed the best formation compared to the other two. The best formation that was encountered in the area was at the test well site.

# TEST WELL 17 AND OBSERVATION WELL LOCATIONS

SCALE : 1" = 50'



## LEGEND

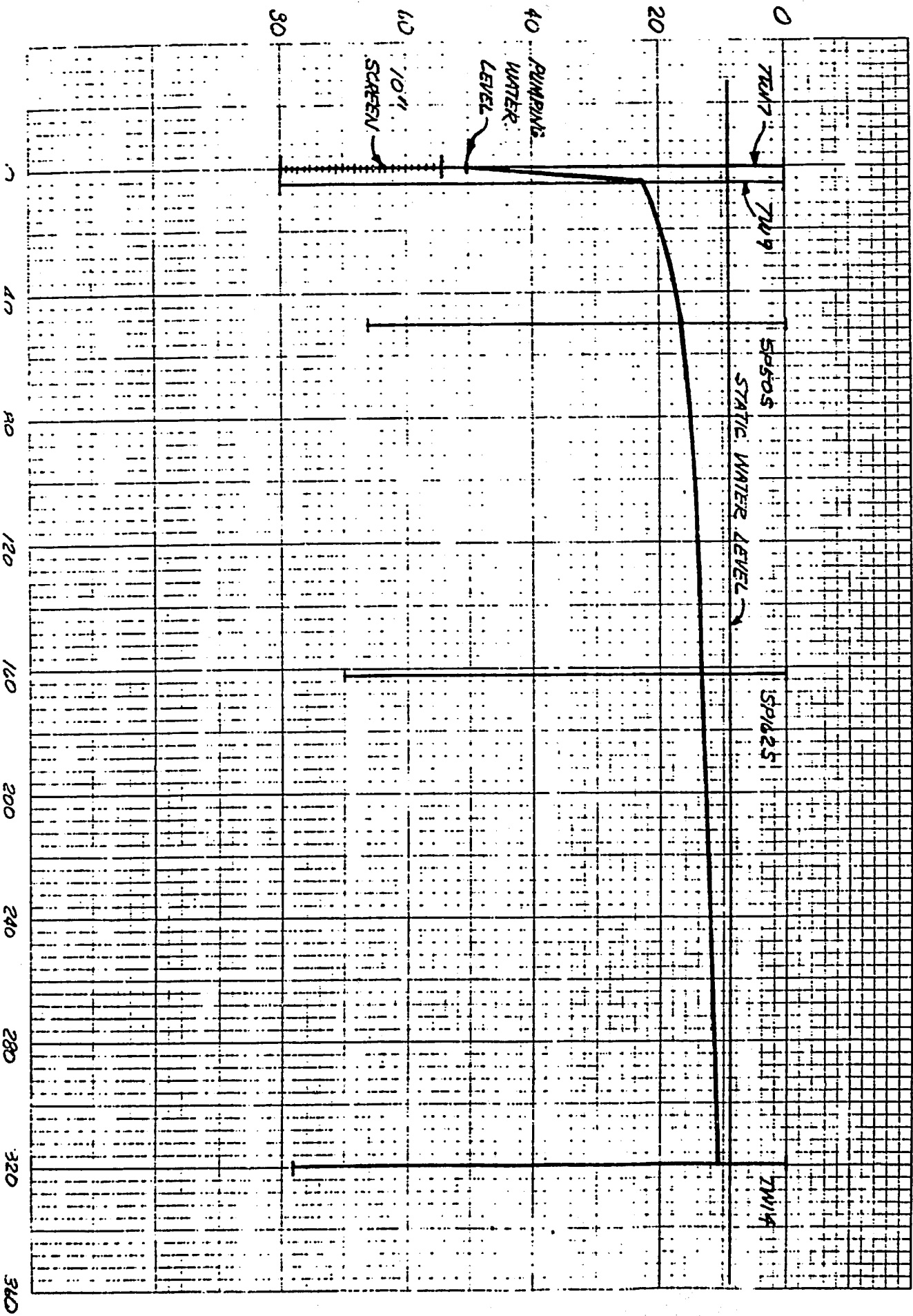
- ⊙ TEST WELL (TW)
- △ SAND POINT (SP)

⊙ TW14

320'

# DRAWDOWN AFTER 1200 MINUTES OF PUMPING

RAMBLANDER  
MARCH 1957





FOTH AND VAN DYKE  
Engineers/Architects  
2737 S. Ridge Road  
P.O. Box 19012  
Green Bay, Wisc. 54307-9012

LABORATORY ANALYSIS RESULTS  
W.D.N.R. LAB CERT. NO. 405051240

-----  
Client City of Rhinelander Sampled By Ray Weber  
Address P.O. Box 658 Scope I.D. 87R7  
Rhinelander, WI 54501 Billing Line No. 2  
Liaison L. Johnson  
Name of Rep. Supply Order No.  
Telephone No. (000) 000-0000 Result Sheet No. 35742.00  
-----

Sample I.D. Test Well  
Date Collected 317 (TW17)  
Date Received 3/10/87  
3/17/87

Parameters, units ----- Results -----  
  
T. Alkalinity, mg/l 50  
Calcium, mg/l 12 Langelier Index at 50°F = (-)3.05  
Chloride, mg/l 1  
T. Hardness, mg/l 40  
Manganese, mg/l < 0.05  
Nitrate, mg/l 0.30  
pH, std. units 5.9  
Sodium, mg/l 3.5  
TDS, mg/l 64  
Sulfate, mg/l 9  
Iron, mg/l < 0.10

2000  
As in wells 4, 5 & 6 was non-detect

comments: Due to date received Nitrate, pH, and TDS holding times were exceeded.

Signed: Samuel J. Berg Date: 4/6/87

# Foth & V Dyke

Engineers/Architects

2737 S. Ridge Road P. O. Box 19012 Green Bay, Wisconsin 54307-9012 414/497-2500

## PUMP TEST OF WELL

DATE March 10, 1987

WELL NO. TW17 OWNER City of Rhinelander 87R6 LOCATION Airport - Fox Ranch Road

DIA. ORIFICE 6 " X 4 7/8" STATIC LEVEL 8 FT. 101/2 IN. WELL DEPTH 80 ft. - Screen: 55-80 FEET

DRILLED BY Layne-Northwest LENGTH OF AIRLINE N/A FT. N/A DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE - FT. TO TAIL PIPE 64 FT. TESTED BY D. Hornung, R. Weber

Time	Elapsed Time Min.	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level Feet	Drawdown in Feet	Specific Capacity GPM/ft.	Water Appearance:
11:27 A.M.	1			410	37.33	28.45	14.41	
	5		13.5					
	30							
	60		14.0	420	38.62	29.74	14.12	
	90							
1:20 P.M.	120		14.0	420	38.75	29.87	14.06	Increase pumpage
	130							Decrease pumpage
	135							
	150		25.5	560	48.00	39.12	14.31	
2:23	183		25.5	560	48.54	39.66	14.12	
	213		25.5	560	49.79	40.91	13.69	
3:20	243		25.5	560	49.75	40.87	13.70	
	273		25.5	560	49.75	40.87	13.70	
4:20	303		25.5	560	49.88	41.00	13.66	
	333		25.5	560	49.88	41.00	13.66	
5:20	363		25.5	560	49.92	41.04	13.64	
	393		25.5	560	49.92	41.04	13.64	
6:20	423		25.5	560	50.00	41.12	13.62	
	453		25.5	560	50.04	41.16	13.60	
7:20	483		25.5	560	-	-	-	
	513		25.5	560	50.04	-	-	
8:20	543		25.5	560	50.04	-	-	
	573		25.5	560	50.08	41.20	13.59	
9:20	603		25.5	560	50.08	41.20	13.59	
	633		25.5	560	50.08	41.20	13.59	
10:20	663		25.5	560	50.08	41.20	13.59	





2737 S. Ridge Road P. O. Box 19012 Green Bay, Wisconsin 54307-9012 414/497-2500

**PUMP TEST OF WELL**

DATE March 10, 1987

WELL NO. TW17 OWNER \_\_\_\_\_ City of Rhinelander LOCATION \_\_\_\_\_

DIA. ORIFICE \_\_\_\_\_ " X \_\_\_\_\_ " STATIC LEVEL 8 FT. 10 1/2 IN. WELL DEPTH \_\_\_\_\_ FEET

DRILLED BY \_\_\_\_\_ LENGTH OF AIRLINE \_\_\_\_\_ FT. DIRECT READING LEVEL INDICATOR \_\_\_\_\_

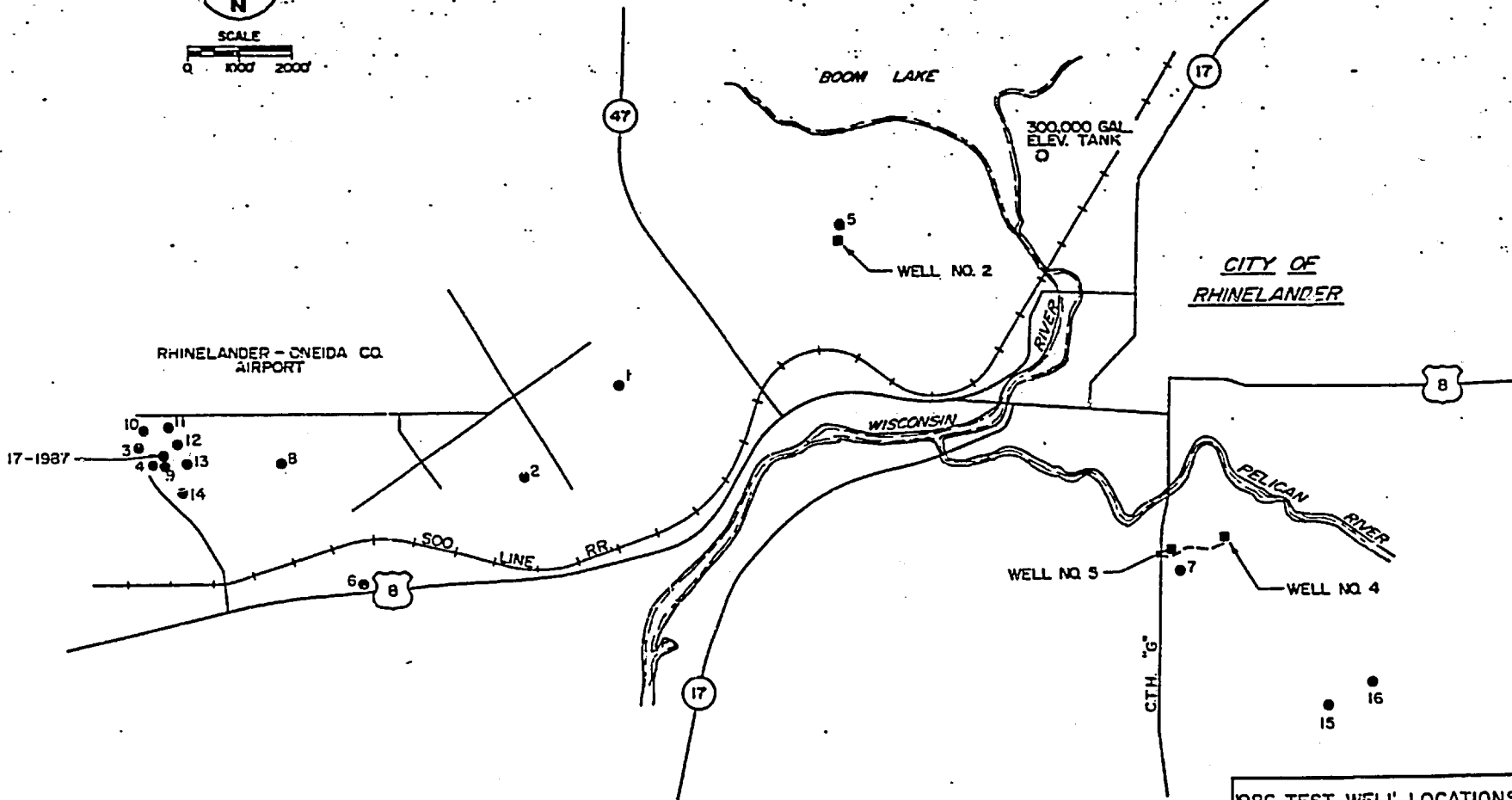
PUMP SETTING TO DISCHARGE NOZZLE \_\_\_\_\_ FT. TO TAIL PIPE \_\_\_\_\_ FT. TESTED BY \_\_\_\_\_

Recovery Reading Number	Elapsed Time	Altitude GA. in Feet	Inches on Orifice	G.P.M.	BREAKING Level Feet	Drawdown in Feet	Specific Capacity	Water Appearance:
	5 Sec	-	-	0	20.42	-	-	Clear, Cloudy, Murky, Muddy, Sandy, Temp., Odor
	15 Sec				15.67			
	30 Sec				13.25			
	1 Min				12.08			
	5 Min				11.00			
	15 Min				10.42			
	30 Min				10.25			
	60 Min				10.08			
	90 Min				10.00			
	120 Min				9.92			



SCALE  
0 1000 2000

500,000 GAL.  
ELEV. TANK



1986 TEST WELL LOCATIONS

**Foth & Van Dyke**

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FIGURE NO. 6