Naturally occurring radionuclides in groundwater of north central Wisconsin. [DNR-054] 1990

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Madison, Wisconsin: Wisconsin Department of Natural Resources, 1990

Wisconsin Groundwater Management Practice Monitoring Project No. 49

GROUNDWATER
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Wisconsin Department of Natural Resources

Naturally Occurring Radionuclides

In Groundwater of North Central Wisconsin

By Charles Fitzgerald

[1990 ?]

ABSTRACT

In 1985, the Water Supply Program of the Wisconsin Department of Natural Resources (WDNR), North Central District began a study of naturally occurring radioactive constituents of groundwaters in north central Wisconsin. The purpose of the study was to determine if groundwater in the area contained radioactive properties which would be of a health concern to persons utilizing the groundwater for water supplies.

Since 1985, a total of 468 water samples were analyzed for various radioactive properties. The water supplies included 48 municipal water supplies, 6 other than municipal public water supplies, 45 school water supplies, and 153 private water supplies.

The analysis performed on the water supply samples included 187 analyses for gross alpha activity, 368 for radon, 124 analyses for gross beta activity, 35 samples analyzed for uranium and 55 for radium. Each sample was not analyzed for all radioactive parameters due to the peculiarities of the funding for each phase of the project.

Funding for this study came from various sources available to the Bureau of Water Supply and from the WDNR Bureau of Water Resources Management, utilizing grants from the Wisconsin Groundwater Management Fund.

Assessment of radon in water was a prime concern for this study, both as a characterization of the aquifer and to evaluate the health aspects of breathing radon gas volatilizing from water. The US EPA has projected a maximum contaminant level (MCL) for radon of between 200 and 2,000 pCi/l (picocuries per liter). The WDNR attempted, by this study to assess the regulatory impact to public water supplies in the District.

The conclusions of the study indicate naturally occurring radioactive constituents are present in many of the groundwaters of north central Wisconsin at levels which exceed maximum contaminant levels specified or proposed by the Federal Safe Drinking Water Act (SDWA) and at levels which may be of a significant concern to suppliers and consumers of these

groundwaters. Gross alpha particle activity ranged from below detection (<1 pCi/l) to a high of 356 picocurries per liter (pCi/l). Uranium levels were detected as high as 197 pCi/l, with gross beta activity detected as high as 160 pCi/l. Radon, a specific radioactive constituent of concern was found from below detection to as high as 391,394 pCi/l. Radium values ranged from below detection to a high of 58.0 pCi/l.

Three aquifers in the area were sampled, with the Precambrian crystalline bedrock aquifer showing elevated levels of naturally occurring radioactive properties in a significant percentage of the water supplies. The Cambrian sandstone aquifer and the Pleistocene deposits showed little tendency for elevated radioactive constituents with the exception of radon in water supplies drawing water from Pleistocene deposits directly in contact with the Precambrian crystalline bedrock. Persons utilizing the crystalline Precambrian bedrock as a source of groundwater for water supplies should have the water analyzed for gross alpha and radon content to assure the safety of the water.

I. INTRODUCTION

The North Central District (NCD) of the WDNR consists of ten counties in northern and central Wisconsin (Figure 1). Water supplies, both public and private utilize groundwater as the sole source of their water. As part of the monitoring program required under the provisions of the Federal Safe Drinking Water Act (SDWA) and Chapters 160 and 162, Wisconsin Statutes, the Water Supply Program of the WDNR regularly assesses the gross alpha radioactive properties of public water supplies in the North Central District. Initial monitoring in the NCD indicated levels of radium in a few small public water supplies exceeded the combined radium maximum contaminant level (MCL) specified by the SDWA of 5 pCi/l (picocuries per liter) but also indicated elevated gross alpha radiation levels not due to radium activity. Review of the well construction of the public water supplies indicated the problem water

supplies utilized the Precambrian crystalline bedrock aquifer as their water supply source.

Information provided by the Wisconsin Geological and Natural History Survey[1] and the United States Department of Energy's National Uranium Resources Evaluation Program[2] indicated the potential for concentrations of naturally occurring radioactive constituents to be present in groundwaters associated with the Precambrian crystalline bedrock of north central Wisconsin.

In the North Central District, three types of aquifers serve as the source of the water supplies, both public and private. The major aquifer is the Pleistocene glacial deposits[3] which overlay Precambrian crystalline bedrock. These Pleistocene deposits are shallow in depth (<100 meters) and consist of fine grain sands and glacial tills. These deposits are the aquifer of choice, where available in sufficient saturated depth, due to the quantity and quality of the groundwater. The second major aquifer is the precambrian crystalline bedrock. This aquifer generally exhibits very low yields, and the water quality is often less than desirable due to iron, iron bacteria, and manganese concentration. The crystalline bedrock aquifer is the only aquifer available to many of the residents of north central Wisconsin. Large areas of Lincoln, Marathon, Portage, and Wood Counties depend upon the crystalline bedrock for their water supplies. The third aquifer in north central Wisconsin is the Cambrian sandstone formations of southern Wood, and Juneau, and Adams Counties.

Large municipal public water supplies in the North Central District are primarily located in Pleistocene deposits close to major surface waters such as the Wisconsin River. The location of these wells is often governed by the well yields available to serve large populations. Small public and most private water supplies in the District utilize the only aquifer available which, in many cases, is the Precambrian crystalline bedrock. A significant percentage of the population of the North Central District relies upon low capacity water supply wells constructed into the crystalline bedrock aquifer.

Due to the low yields of the crystalline bedrock aquifer, common construction of smaller water supply wells open to the bedrock consists of a 40-foot casing[4] with a lower unlined drillhole. The lower drillhole is commonly hundreds of feet in depth. The lower drillhole serves primarily as a reservoir for the owner to allow for sufficient recovery of groundwater between use of the well pump. Blasting and hydrofracturing are common techniques used to increase the yields of wells constructed in the crystalline bedrock. These two techniques are used to increase the fractures in the crystalline bedrock to intercept other existing water bearing fractures.

II. HEALTH ASPECTS

Four naturally occurring radioactive isotopes are of concern - radium 226, 228, uranium, and radon 222. All four of these isotopes are of concern due to their potential for causing cancer and other health problems in persons using water supplies containing these elements.

Radium has long been recognized as a potential human carcinogen. The existing federal and state MCL for Radium 226 and Radium 228 is 5 pCi/l. Radium is similar in behavior to calcium and like calcium residues in the bones when ingested. Human health data indicates a correlation between ingested radium and bone cancer.

Uranium has potentially carcinogenic properties as well as chemotoxic effects to the kidney. The Environmental Protection Agency is reported to propose shortly an MCL for uranium of between 10 and 40 pCi/l based upon studies which have indicated potential health effects in humans consuming elevated levels of uranium.

Radon-222 is a radioactive gas (a decay product of Radium 226) which has been linked to an increased risk of lung cancer. High concentrations of radon in water may result in elevated levels of radon gas in the indoor atmosphere of a building being served by the water supply due to volatilization of radon from the water during showers, clothes washing,

etc. In general, a ratio of 10,000 pCi/l of radon in a water supply may result in an increase of 1 pCi/l of radon in air in the interior atmosphere of a building[5].

The Wisconsin Division of Health has specified a maximum radon in water health advisory level of 40,000 pCi/l[6]. A level of 40,000 pCi/l of radon in water would result in an increase of 4 pCi/l in the indoor air of an average home. The US EPA has established a level of 4 pCi/l in the home air as a level at which action should be taken to reduce the radon in air concentrations[7].

The US EPA is reported to shortly propose a drinking water MCL for radon of between 200 to 2,000 pCi/l, with an expected level being discussed of 500 pCi/l[8]. The discussed MCL levels would result in an increase of between .02 and .2 pCi/l in the indoor air of an average home.

Other naturally occurring radioactive elements of concern such as Thorium and Lead 210 are not covered in this report.

III. STUDY DESIGN

In 1985, a concern was raised by WDNR North Central District Water Supply staff regarding the potential for naturally occurring radioactive contaminants to be present in the water supplies of the District. Monitoring of various public water supplies had indicated the potential for this contamination to exist in water supply wells utilizing the Precambrian crystalline bedrock aquifer as a source of water.

Concern over the safety of the groundwaters of the Precambrian aquifer was increased due to the State of Wisconsin Well Compensation Program, which provides funds to private homeowners to replace contaminated water supply wells. In many cases, the State of Wisconsin was providing funds to construct new, deeper wells into the Precambrian aquifer due to contamination in the shallow Pleistocene aquifer. Concern was expressed that the State of Wisconsin was subsidizing the exchange of one man-made contaminant for other naturally occurring contaminants which may be more hazardous.

Starting in 1986, funds were obtained from various sources, primarily the Wisconsin Groundwater Management Fund, to sample and analyze water supplies in the District for naturally occurring radioactive isotopes.

The water supplies to be analyzed were recently constructed drilled wells, primarily private water supplies, for which adequate construction data existed and public water supplies serving schools, mobile home parks, and municipalities.

The sampling locations were chosen to provide coverage of the entire District and provide information on each type of aquifer in each area of the District (see Figure 2-13).

All samples were obtained by WDNR NCD Water Supply staff. Samples were obtained from sample locations as close to the well as possible, and prior to any pressure tanks and/or water treatment devices. The sampling procedure involved locating the sampling point prior to pressure tanks and water treatment devices and running the water supply to provide for fresh groundwater from the aquifer (5-15 minutes) prior to obtaining the sample. Samples to be analyzed for gross alpha and beta radiation were collected in 750 ml polyethylene bottles obtained from the Wisconsin State Laboratory of Hygiene (SLOH) and shipped to the SLOH the same day. Samples for the analysis of radon gas were obtained in two 40 ml glass septum top vials obtained from the SLOH and shipped to the SLOH the same day.

If the analysis of the gross alpha particle activity indicated further analysis was warranted (e.g. >15 pCi/l), samples for the analysis of uranium and radium were obtained by WDNR staff in one-gallon polyethylene containers, preserved with nitric acid and shipped to the SLOH as soon as practical but no later than one week from the time of sampling. Gross alpha particle activity was used as an indicator of the need for further analysis radium and uranium.

All analyses were performed by the Radiation Protection Laboratory of the Wisconsin State Laboratory of Hygiene.

IV. RESULTS

A. General

The results of all radioactivity analyses (NCD Radioactivity Study and SDWA compliance samples) performed on water samples obtained from the North Central District from 1985 to 1989 are presented in Table 1 and Figures 3-13. These results indicate a dramatic difference in levels of naturally occurring radioactive elements in the groundwaters of the different aquifers of the District and in the specific area of each aquifer.

The data presented in Table 1 is separated by county, township name, and by water source. The wells indicated as being a water source of sandstone or crystalline bedrock are wells constructed with a steel well casing grouted into the surface of the bedrock, with open boreholes extending to various depths into the bedrock. The sandstone refers to the Cambrian sandstone aquifer while the crystalline notation refers to the Precambrian crystalline bedrock aquifer. The water supplies indicated as obtaining their water from unconsolidated (Pleistocene aquifer) formations are constructed with well casings to varying depths.

B. Cambrian Sandstone Aquifer

The Cambrian sandstone aquifer is utilized only in a limited area in the southern portion of the North Central District (Adams, Juneau, Wood, and Marathon Counties) and exhibited little tendency to contain groundwaters with elevated levels of naturally occurring radioactive elements.

Analysis for gross alpha particle activity was performed on 20 samples obtained from water supplies receiving their water from the Cambrian sandstone. The gross alpha particle activity ranged from below detection (<3.0 pCi/l) to a high of 10.1 pCi/l, with a standard deviation of 3.16 pCi/l and an arithmetic mean of 1.4 pCi/l. (Note in all calculations, values less than the detection limit were assigned a value of 0 (zero)).

Due to the relatively low values reported for the gross alpha activity, only 5 of 20 samples of water from the Cambrian sandstone were analyzed for radium content, with the high combined total radium (Radium 226 plus Radium 228) reported at 5.6 pCi/l and 2 of the 5 samples being analyzed at below the detection limit of 1.0 pCi/l. None of the samples obtained from the Cambrian sandstone aquifer were analyzed for uranium content.

Ten water samples obtained from the Cambrian sandstone were analyzed for gross beta particle activity with all but 2 being analyzed at less than detection (4.3 to 4.5 pCi/l), one value of 4.6 pCi/l and the high value of 6.5 pCi/l.

Radon activity was measured in 15 water samples obtained from the Cambrian sandstone aquifer, with values being reported from below the detection level (see note) to a high of 767 pCi/l. The arithmetic mean of the radon activity in the 15 Cambrian sandstone water samples was 289.8 pCi/l, with a sample standard deviation of 244.2 pCi/l.

Note: Radon detection levels - the detection level for radon in water ranged from a low of <65 pCi/l to a high of <520 pCi/l (see Table 1). For all calculations, values being reported as less than detection were assigned a value of zero.

C. Unconsolidated Pleistocene Aquifer

The unconsolidated Pleistocene aquifer exists over most of the North Central District. Its thickness ranges from a depth of less than 1 meter to 100 meters. This unconsolidated aquifer consists primarily of glacial drift, outwash or till materials and is the aquifer of choice, where available, with water yields usually adequate to serve a variety of purposes.

Twenty-four water supplies utilizing the Pleistocene aquifer were analyzed for gross alpha activity. Of these, only 7 exhibited activities greater than the detection limit (<3.0 pCi/l), with the

highest value being reported at 12.7 pCi/l. No water supplies in the Pleistocene aquifer were analyzed for radium or uranium activity.

Gross beta activity was determined in 18 water supplies, with 11 values being reported at less than the detection level (<2.9 - 4.9 pCi/l) and a high value of 39.6 pCi/l.

One hundred ninety-six water supplies obtaining their water from the Pleistocene aquifer were analyzed for radon activity. The arithmetic mean of the results was 944.9 pCi/l with a population standard deviation of 2,652 pCi/l. The highest value for radon activity was 30,678 pCi/l in the unconsolidated Pleistocene aquifer. Water supplies exhibiting the elevated radon activity (e.g., >1,000 pCi/l) were wells obtaining the groundwater directly adjacent to the interface between the unconsolidated Pleistocene aquifer and the underlying Precambrian crystalline bedrock aquifer.

D. Crystalline Precambrian Aquifer

The crystalline Precambrian aquifer is the only aquifer available to large portions of the population of Marathon, Portage, and Wood Counties. The lack of sufficient depth of the unconsolidated Pleistocene deposits in these areas results in a common well construction consisting of 40 feet of casing sealed into the bedrock and an open borehole in the bedrock, sometimes hundreds of feet in depth.

The crystalline Precambrian bedrock exhibited the widest range and maximum values for all parameters analyzed. The naturally occurring radioactive properties of the Precambrian crystalline bedrock are not consistent within each area. Individual wells on the same property can exhibit dramatically different values depending upon depth, yield, and water use[9].

Gross alpha activity was measured in 143 water supplies obtaining the water from the Precambrian crystalline bedrock. Values ranged from below detection (<3.0 pCi/l) to a high of 356 pCi/l, with an arithmetic mean of 15.7 pCi/l and a population standard deviation of 51.1 pCi/l.

Radium content was measured in 34 water supplies. The values ranged from below detection (<1.0 pCi/l) for each radium (Radium 226 and Radium 228) to a high of 58 pCi/l for combined radium. The arithmetic mean for the combined radium activity for the water supplies coming from the Precambrian bedrock was 6.3 pCi/l, with a standard deviation of 14.1 pCi/l.

Uranium activity was measured in 35 Precambrian water supplies with the range from below detection (<1.0 pCi/l) to a high of 197 pCi/l, with an arithmetic mean of 40.7 pCi/l and a standard deviation of 51.2 pCi/l.

Gross beta activity for the 96 samples obtained from the Precambrian crystalline aquifer ranged from below the detection levels (3.0 - 4.6 pCi/l) to a high of 160 pCi/l. The arithmetic mean for the gross beta activity was 10.8 pCi/l with a standard deviation of 26.8 pCi/l.

Radon activity in the Precambrian aquifer was the largest set of data obtained during the course of this study; 157 water supplies utilizing the crystalline bedrock were analyzed for radon. Detection limits varied from less than 56 pCi/l to 198 pCi/l. The range of radon values went from below detection (3 samples) to a high of 391,394 pCi/l, with an arithmetic mean of 15,910.9 pCi/l and a standard deviation of 46,260 pCi/l.

V. DISCUSSION

The Federal Safe Drinking Water Act (SDWA) has regulated the maximum contaminant level (MCL) of a contaminant in a public water supply at various risk levels. The existing SDWA and NR 109 (Safe Drinking Water Act and Wisconsin Administrative Code) requirements have established an MCLs for gross alpha activity at 15 pCi/l and combined radium activity at 5 pCi/l. The State of Wisconsin DNR has primacy to enforce the SDWA in Wisconsin.

At the present time, the SDWA does not specify an MCL for uranium; however, the discussed future MCL is 40 pCi/l for the radioactive isotope activity. The level is based upon a risk due to the carcinogenic properties of uranium and also potential chemotoxic effects of the element to the kidneys.

Radon analysis was a prime concern of this study (Figures 3-13), both as an indication of the aquifer characteristics and as a result of the health aspects associated with breathing radon gas. The SDWA has proposed an MCL for radon in public water supplies between 200 and 2,000 pCi/l, with a level of 500 pCi/l reportedly being projected. The proposed MCL is based upon the risk associated with breathing radon gas which volatilizes from the water and enters the atmosphere of the building.

Assuming a level of 10,000 pCi/l of radon in the water supply will result in an increase of 1 pCi/l in the indoor atmosphere of an average home, the proposed MCL should be established at a level of 200 pCi/l or less if the level is to be regulated at a risk level equivalent to many other contaminants regulated by the SDWA. Of special concern is the laboratory detection limit for radon which, in cases, exceeds the lower recommended MCL of 200 pCi/l. Because of the relatively slow rate of volatilization of radon into the air, radon and its breakdown products, polonium-218 and lead-210, may also be an ingestion hazard.

The State of Wisconsin Department of Health and Social Services has established an advisory level for radon in water at 40,000 pCi/l, which

corresponds to a level at which the indoor atmosphere of a home may reach an action level of 4.0 pCi/l.

While the SDWA is enforceable for public water supplies, by association the federal MCLs also act as recommended health advisory levels for private water supplies. If the SDWA specifies an MCL of 500 pCi/l, the impact to the consumers of all water supplies in north central Wisconsin will be significant.

A particular concern for future research is the possibility of pressure tanks, water heaters, and water treatment devices (e.g., water softeners and, particularly, carbon filters) concentrating radioactive isotopes to a degree which poses a potential health risk to persons living with these devices[9]. These water treatment devices are very common in the study area due to the poor water quality, e.g., iron, manganese, and sulfur commonly associated with the aquifers in the North Central District.

VI. CONCLUSIONS

Two of the three aquifers studied in the North Central District indicate little potential for containing naturally occurring radioactive constituents which would be of a health concern to the consumers of groundwaters from these aquifers. The Cambrian sandstone aquifer exhibited little potential for containing natural radioactive properties. The Cambrian aquifer showed little potential for containing gross alpha or beta emitting radioactive constituents which would be of a health concern and only 4 samples exhibiting a radon activity greater than 500 pCi/l.

The Pleistocene aquifer showed little potential for containing radon at levels which would exceed the State of Wisconsin Advisory Level of 40,000 pCi/l; however, if the US EPA established an MCL at 500 pCi/l, 28.5 percent of the wells sampled in this group would exceed the MCL. These Pleistocene water supplies were located throughout the District with the exception of Adams County.

The crystalline Precambrian bedrock aquifer exhibited a strong tendency for containing groundwaters with significant levels of naturally occurring radioactive constituents. Elevated levels of all parameters, gross alpha, beta, radium, uranium, and radon were found during the course of this study, primarily in northern Portage and Wood Counties and throughout Marathon County.

In the crystalline Precambrian bedrock, 143 water supplies were analyzed for gross alpha particle activity; 30 of the samples indicated levels exceeding 15 pCi/l, the SDWA MCL action level or a rate of 20.9 percent of all the samples analyzed from the Precambrian aquifer. A total of 74 water samples obtained from the crystalline Precambrian bedrock aquifer were analyzed for combined radium. Ten of these samples exceeded the 5 pCi/l SDWA MCL or a rate of 13.5 percent of all samples analyzed; 35 water supplies, obtaining their water from the crystalline bedrock aquifer were analyzed for uranium, 5 percent (8 water supplies) of these exceeded the level of proposed SDWA MCL of 40 pCi/l or a rate of 23.5 percent.

It is important to note only 11 of 143 water supplies analyzed for gross alpha activity in the Precambrian crystalline aquifer resulted in values for combined radium and/or uranium exceeding existing or proposed MCLs, or a rate of 7.6 percent.

Of particular concern is some of the uranium and combined radium levels found, some were extremely high, indicating while these isotopes are not widespread, even adjacent wells can differ dramatically where radium and uranium concentrations do occur (e.g., Townships of Wausau and Texas in Marathon County and Stockton in Portage County), they can be very significant.

The levels of gross alpha radiation indicated does, in most cases, exceed the levels of radium and uranium combined, indicating the potential for other alpha emitting isotopes such as thorium, polonium, and lead.

Gross beta activity was measured on 96 water supplies in the crystalline bedrock. Five exceeded the SDWA MCL of 50 pCi/l, for a rate of

5.2 percent of the water supplies exceeding the recommended levels. This may indicate the presence of elements such as thorium 234, palladium 234, and lead 214 and 210 being present (Figure 14).

The most significant results obtained from the analysis of water supply samples obtained from the crystalline Precambrian bedrock were for radon. A total of 157 radon in water tests were performed on crystalline bedrock well samples, 139 of these exceed a level of 500 pCi/l or a rate of 88.5 percent greater than the projected SDWA MCL. In all, 368 radon analyses of water supplies were performed. 199 of these results exceeded the projected MCL of 500 pCi/l, or a rate of 54 percent of all wells sampled. Only 9 of the 157 water supplies exceeded the 40,000 pCi/l recommended Health Advisory Level of the Wisconsin Division of Health.

VII. RECOMMENDATIONS

Public agencies which have a regulatory and/or an advisory function in the protection of public health should establish a framework to proceed with future research and a public information campaign regarding the potential for water supplies, both public and private to contain naturally occurring radioactive constituents of a health concern. These agencies and their recommended functions should include:

1. The Wisconsin Department of Natural Resources, with the US EPA, expand the sampling program beyond the North Central District to other areas of precambrian crystalline bedrock and other significant geologic formations to determine the regulatory impact to public and private water supplies. The WDNR has already begun to require all new municipal and other than municipal wells to be analyzed for radon.

2. The Wisconsin Division of Health review the Health Advisory Levels presently established and coordinate with the US EPA and WDNR regarding the proper Health Advisory recommendations for radon.

3. The WDNR, WDOH, and Wisconsin Radiation Protection Council establish a public information campaign to notify water supply

owners in suspect areas of the need for water supply analysis. This should be done in conjunction with local public health agencies.

4. The WDNR and the Wisconsin Department of Industry, Labor and Human Relations should begin research on the possibility that common water holding or treatment devices (e.g., pressure tanks, water softeners, charcoal filters, etc.) may have the ability to concentrate radioactive materials, presenting a greatly accelerated health risk to persons coming in close contact with these devices.

5. WDOH, WDNR, and US EPA should begin research on the potential ingestion hazard presented by radon and its decay products such as Lead 210.

6. The Wisconsin Geologic and Natural History Survey should establish a program to identify areas of concern in the state and to guide the WDNR on future sampling programs.

7. Funding should be obtained to expand the ability of the Wisconsin State Laboratory of Hygiene to analyze radiation properties of water supplies.

8. Analysis of radioactivity in nearby wells or test wells should be taken into account before the construction of a replacement well for a volatile chemical or pesticide contaminated supply. An evaluation of total health risk needs to be accomplished prior to funding a replacement water supply.

References

1. Personal communication with Mike Mudrey, Geologist, with the Wisconsin Geologic and Natural History Survey (WGNHS)

2. National Uranium Resources Evaluation; Uranium and Thorium Occurrences in Precambrian Rocks, Upper Peninsula of Michigan and Northern Wisconsin; Open File Report GJBX-48(76)

3. Pleistocene Geology of Vilas County, Wisconsin, by John Attig, WGNHS, 1985, Information Circular No. 50

Pleistocene Geology of Marathon County, Wisconsin. By John Attig and Maureen Muldoon. WGNHS. 1989. Information Circular No. 65.

Pleistocene Geology of Portage County, Wisconsin. By Lee Clayton. WGNHS. 1986. Information Circular No. 56.

4. NR 112, Wisconsin Administrative Code; Well Construction and Pump Installations

5. Radon Transferred from Drinking Water into House Air, by C.T. Hess, M.A. Vietti, E. Lachapella, and J. Guillemette, University of Maine

6. Interdepartment Memorandum, Wisconsin Division of Health to Wisconsin Department of Natural Resources, 1986

7. A Citizen's Guide to Radon. US EPA and CDC, August 1986, OPA-86-004

8. U.S. Environmental Protection Agency; Office of Drinking Water, Memorandum, January 1989

9. Radionuclides in Drinking Water: By Jerry Lowry and Sylvia Lowry Journal, AWWA, July 1988

Figures and Tables

DNR FIELD DISTRICTS AND AREAS

DISTRICT OFFICES

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Fitchburg, WI 53711
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Rev. 5-88

BEDROCK GEOLOGY OF WISCONSIN

UNIVERSITY OF WISCONSIN - EXTENSION
Geological and Natural History Survey
M.E. Ostrom Director and State Geologist

APRIL 1981

LEGEND

Extent of glaciation

PHANEROZOIC

DEVONIAN FORMATIONS
- dolomite and shale

SILURIAN FORMATIONS
- dolomite

ORDOVICIAN FORMATIONS
- Om — Maquoketa Formation—shale and dolomite
- Sinnipee Group—dolomite with some limestone and shale
- St. Peter Formation—sandstone with some limestone shale and conglomerate
- Opc — Prairie du Chien Group—dolomite with some sandstone and shale

CAMBRIAN FORMATIONS
- sandstone with some dolomite and shale

PRECAMBRIAN

MIDDLE PROTEROZOIC ROCKS
- Keweenawan Rocks—
  - ss, sandstone
  - v, basaltic to rhyolitic lava flows
  - t, gabbroic, anorthositic and granitic rocks
- Wolf River Rocks—
  - g, rapakivi granite, granite and syenite
  - a, anorthosite and gabbro

LOWER PROTEROZOIC ROCKS
- quartzite
- granite, diorite and gneiss
- s, argillite, siltstone, quartzite, graywacke, and iron formation
- vo, basaltic to rhyolitic metavolcanic rocks with some metasedimentary rocks
- ga, meta-gabbro and hornblende diorite

LOWER PROTEROZOIC OR UPPER ARCHEAN ROCKS
- mv, metavolcanic rocks
- gn, granite, gneiss and amphibolite

MILES
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0 50 100
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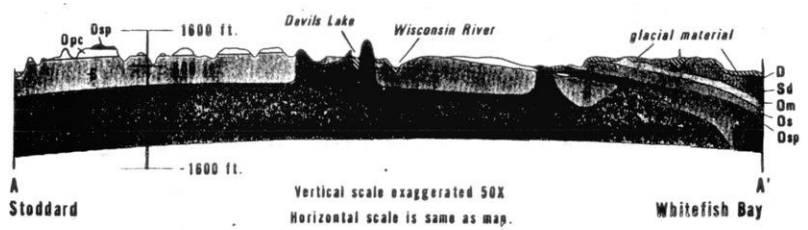
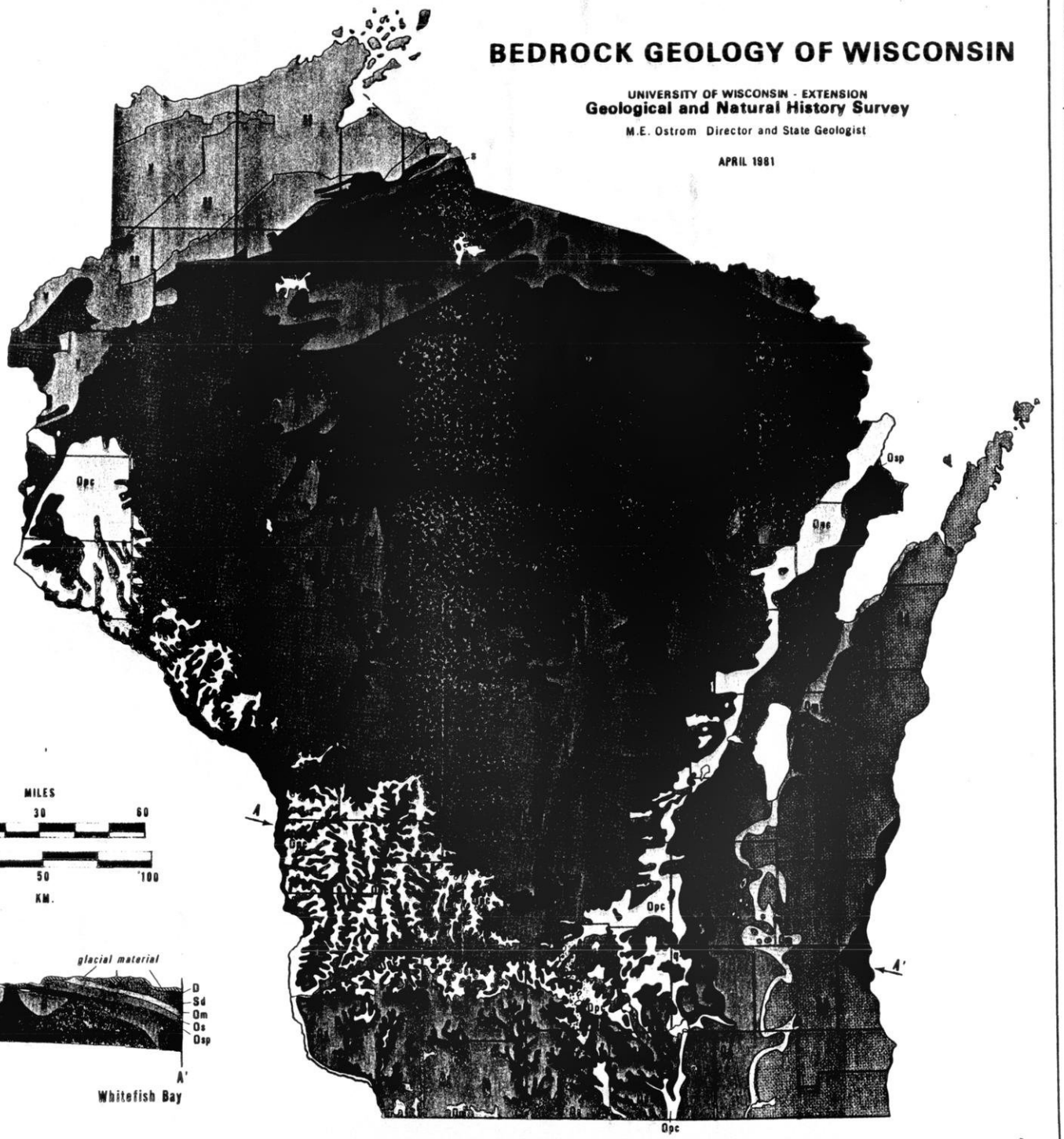
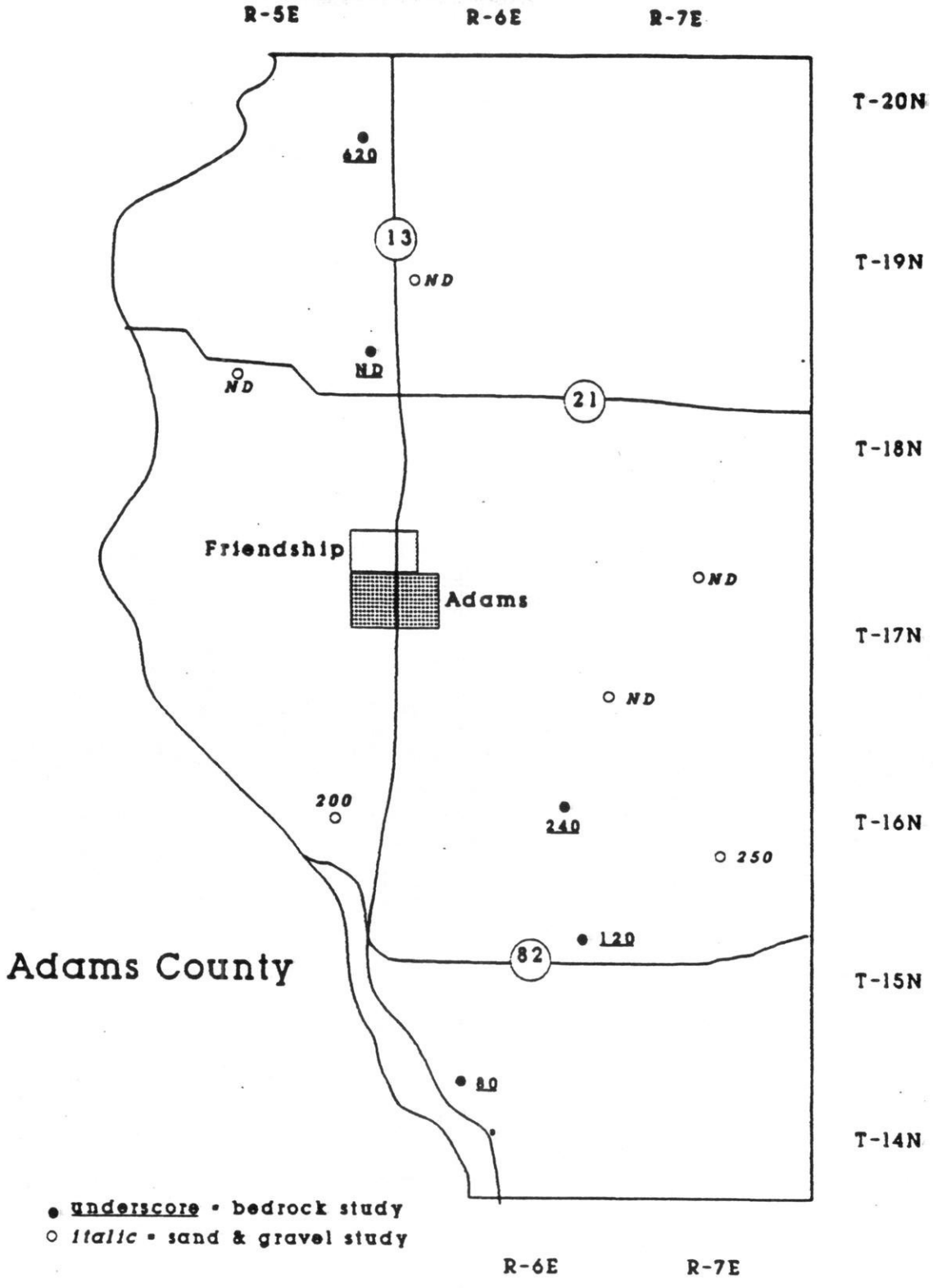
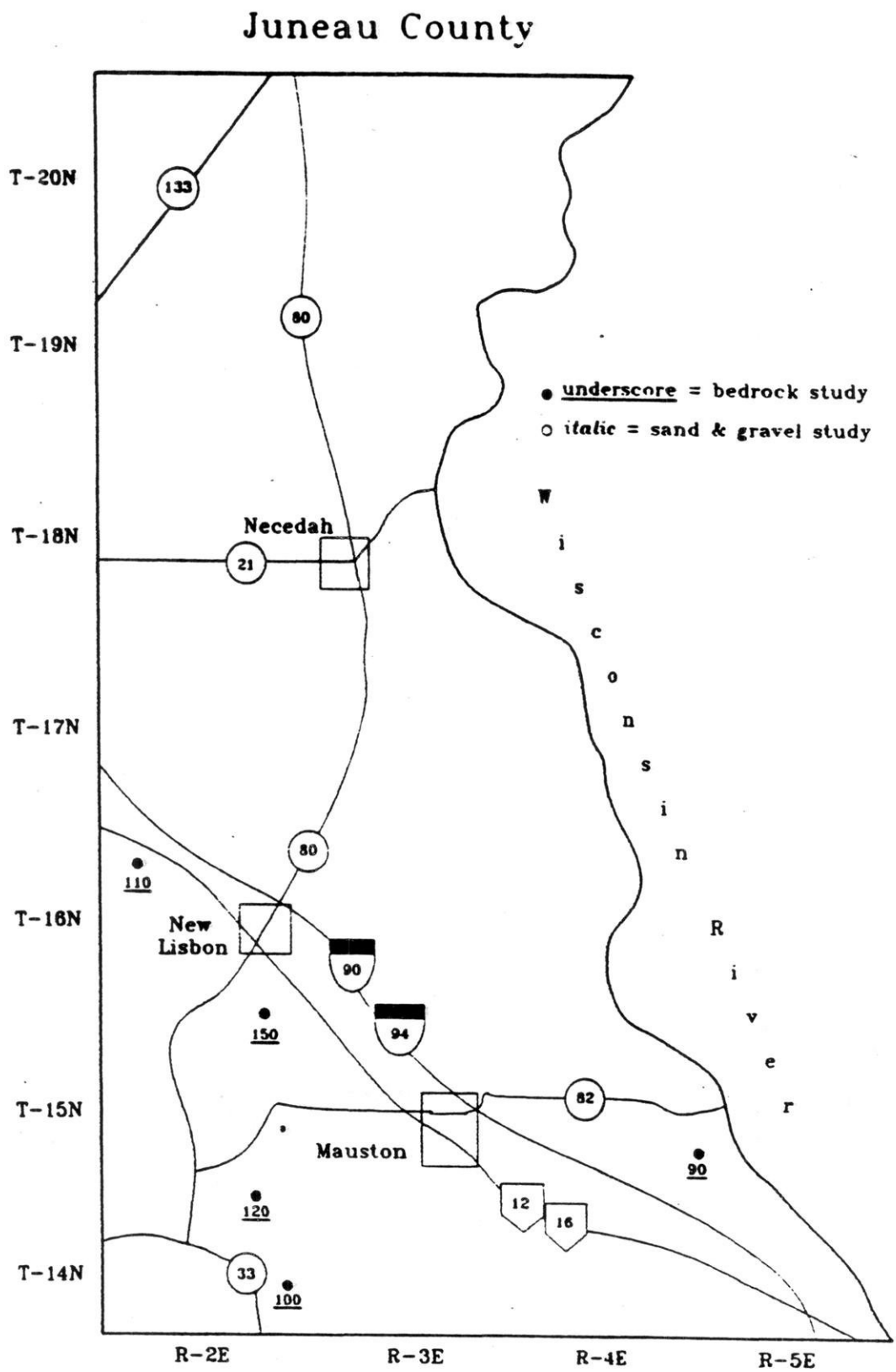




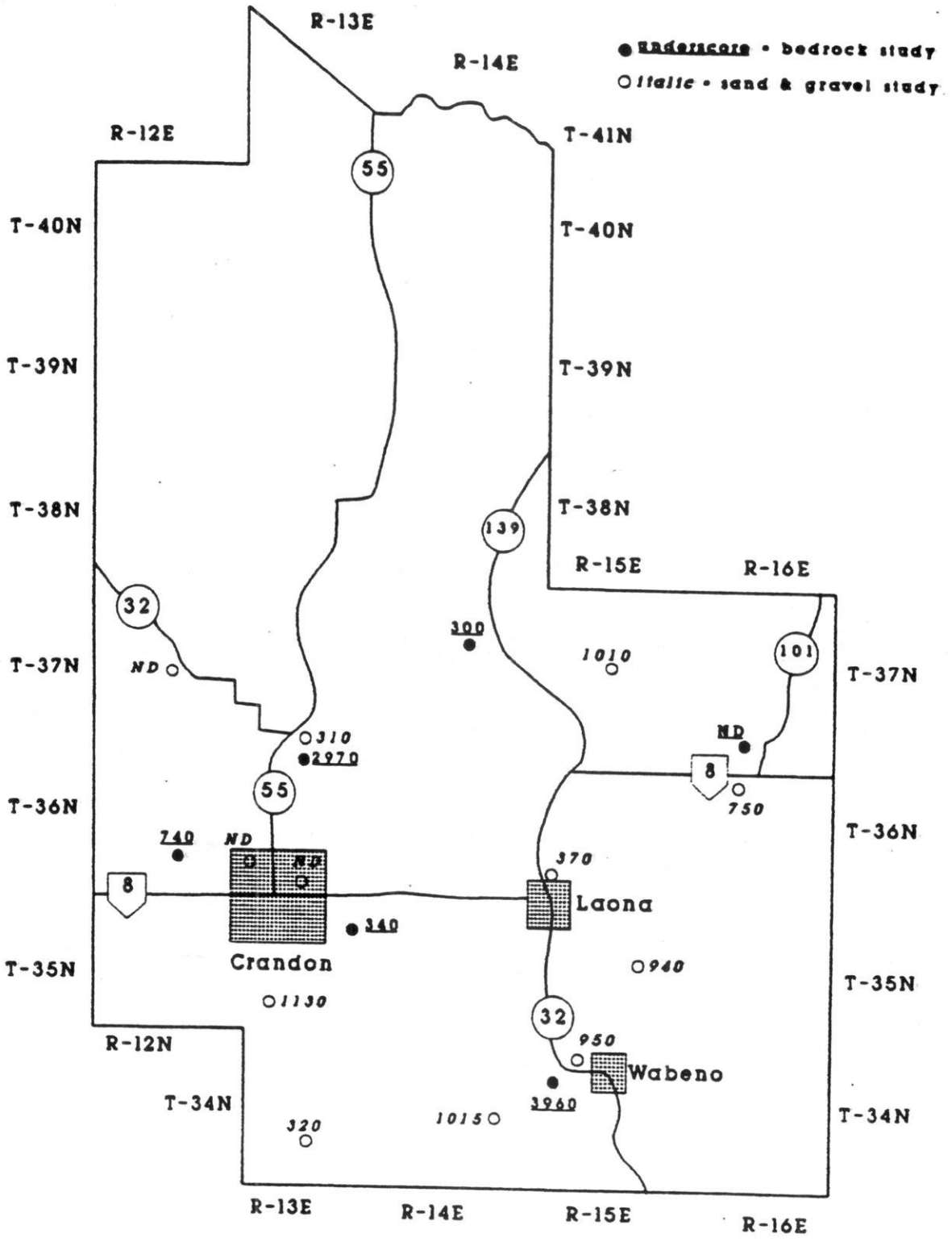
Radon-222 Values in Picocuries per Liter, (pCi/l)



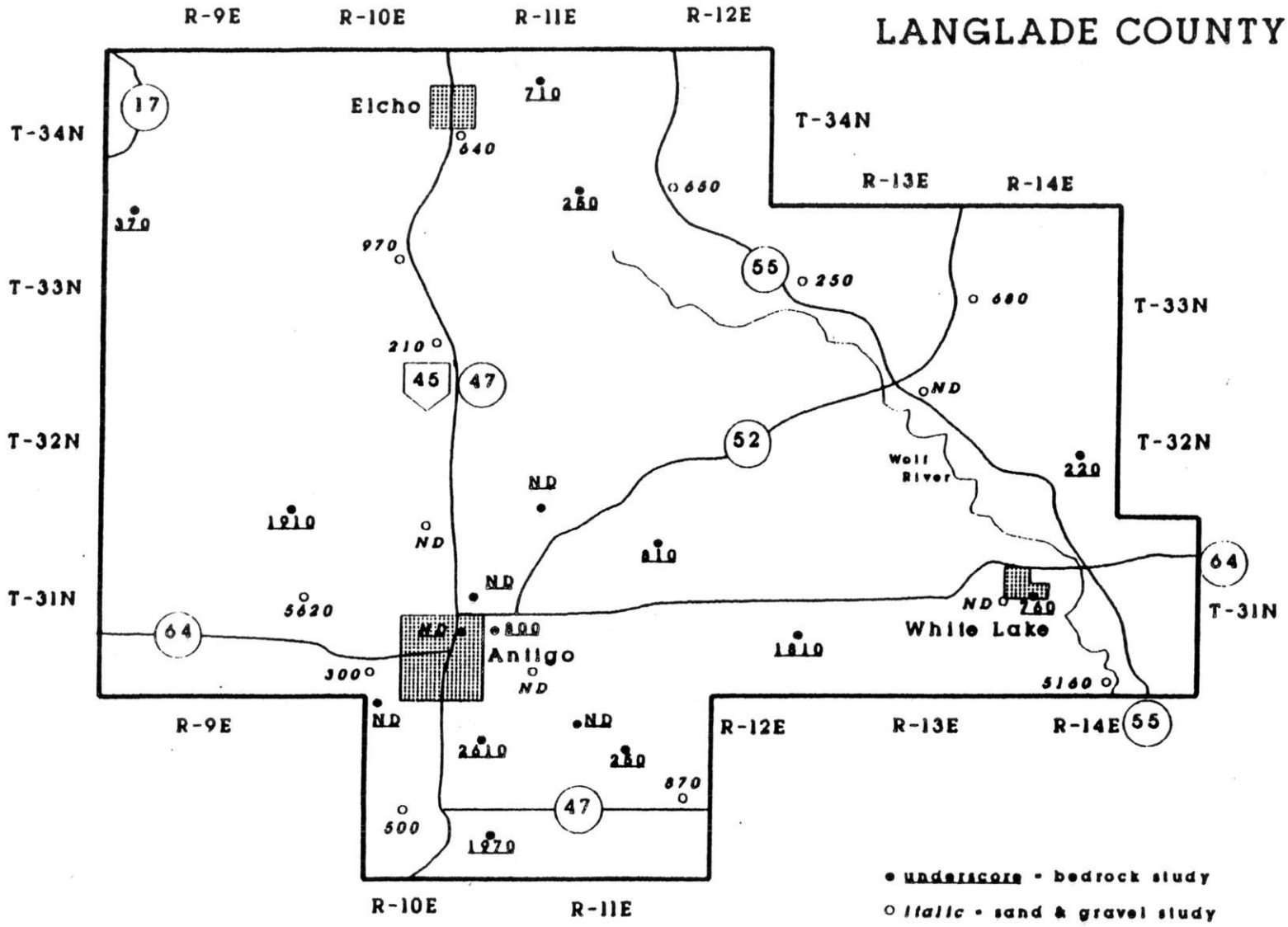


Radon-222 Values in Picocuries per Liter,(pCi/l)

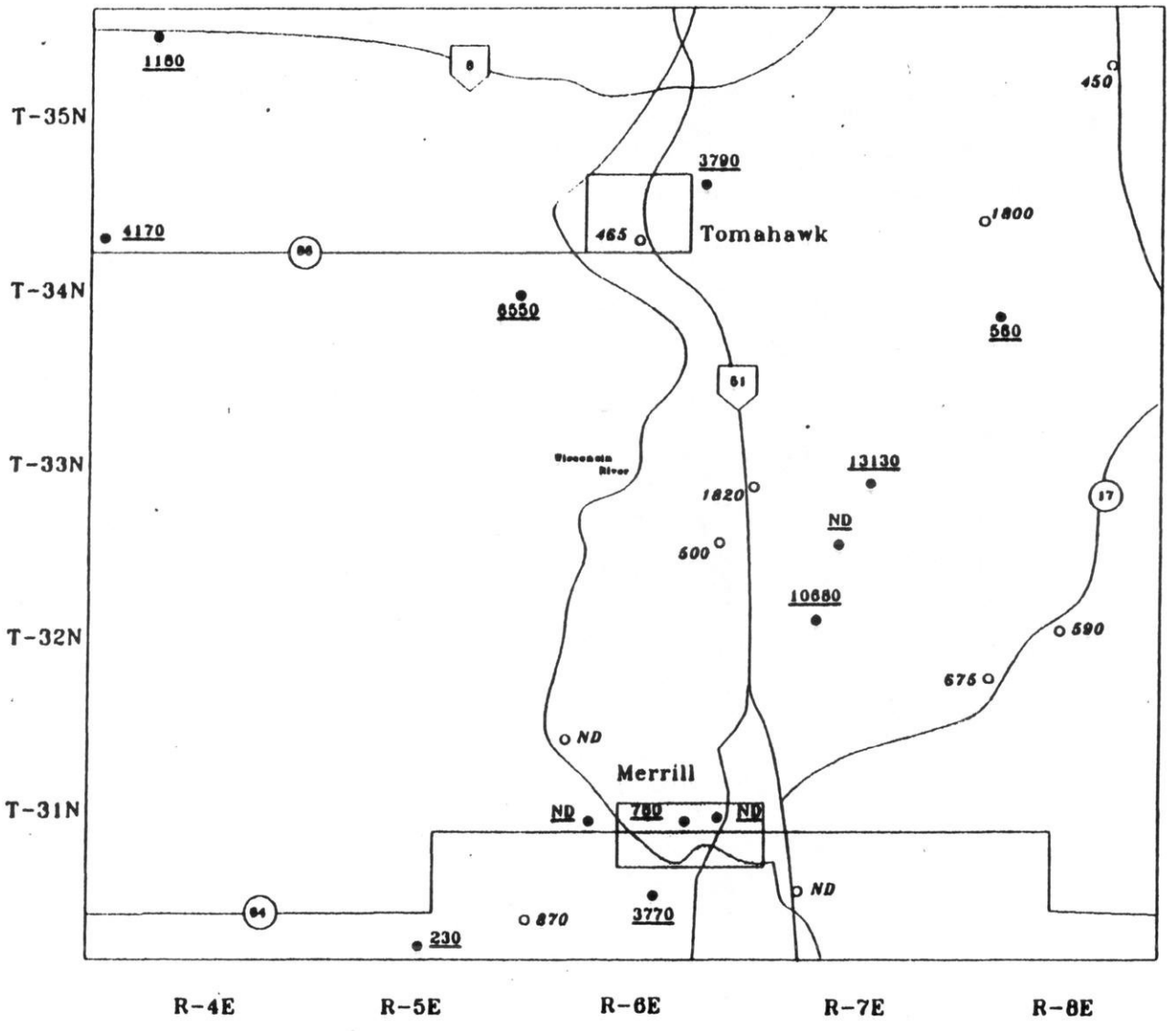
Forest County



Radon-222 Values in Picocuries per Liter, (pCi/l)



Radon-222 Values in Picocuries per Liter, (pCi/l)



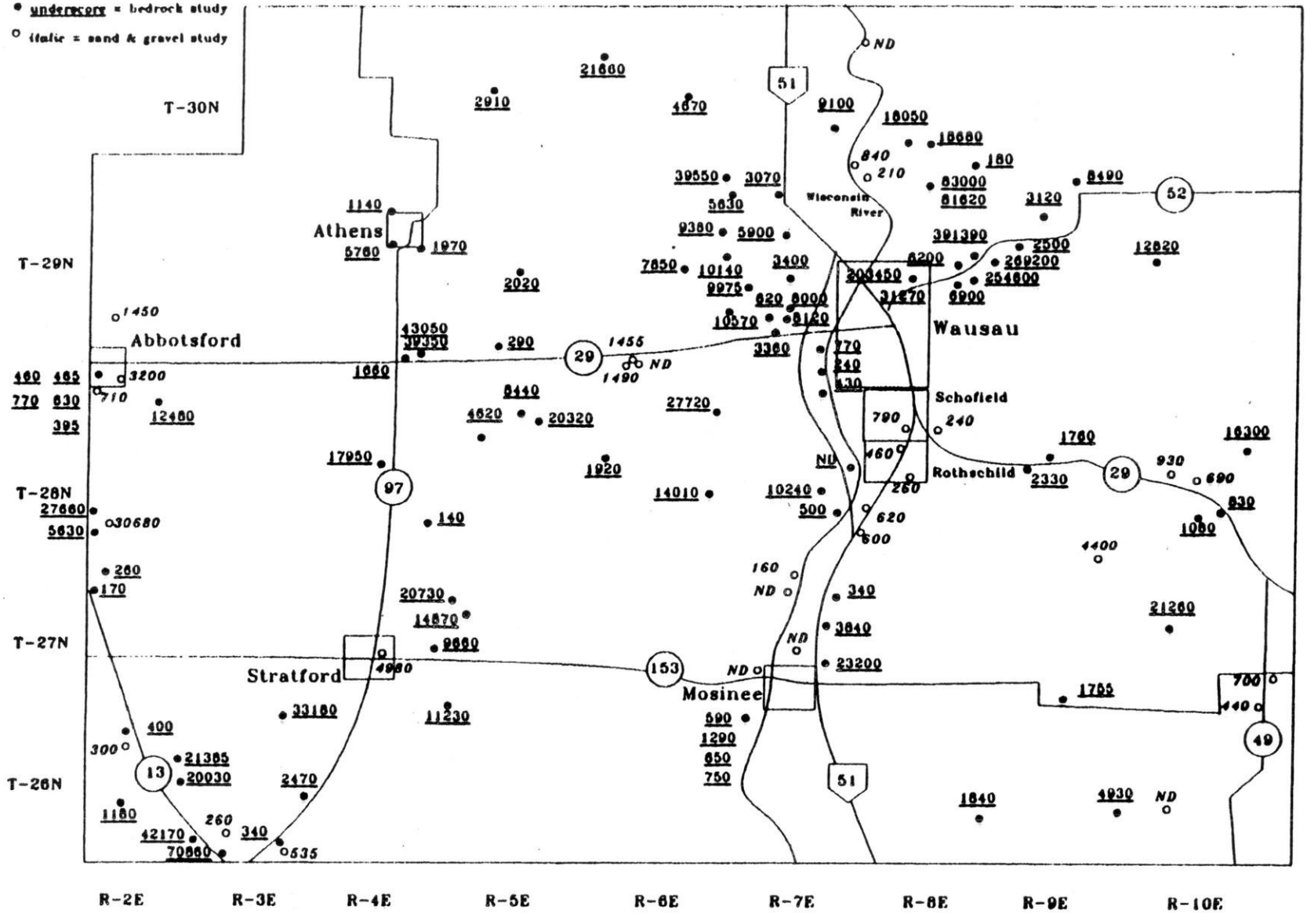
Lincoln County

• underscore = bedrock study

○ italic = sand & gravel study

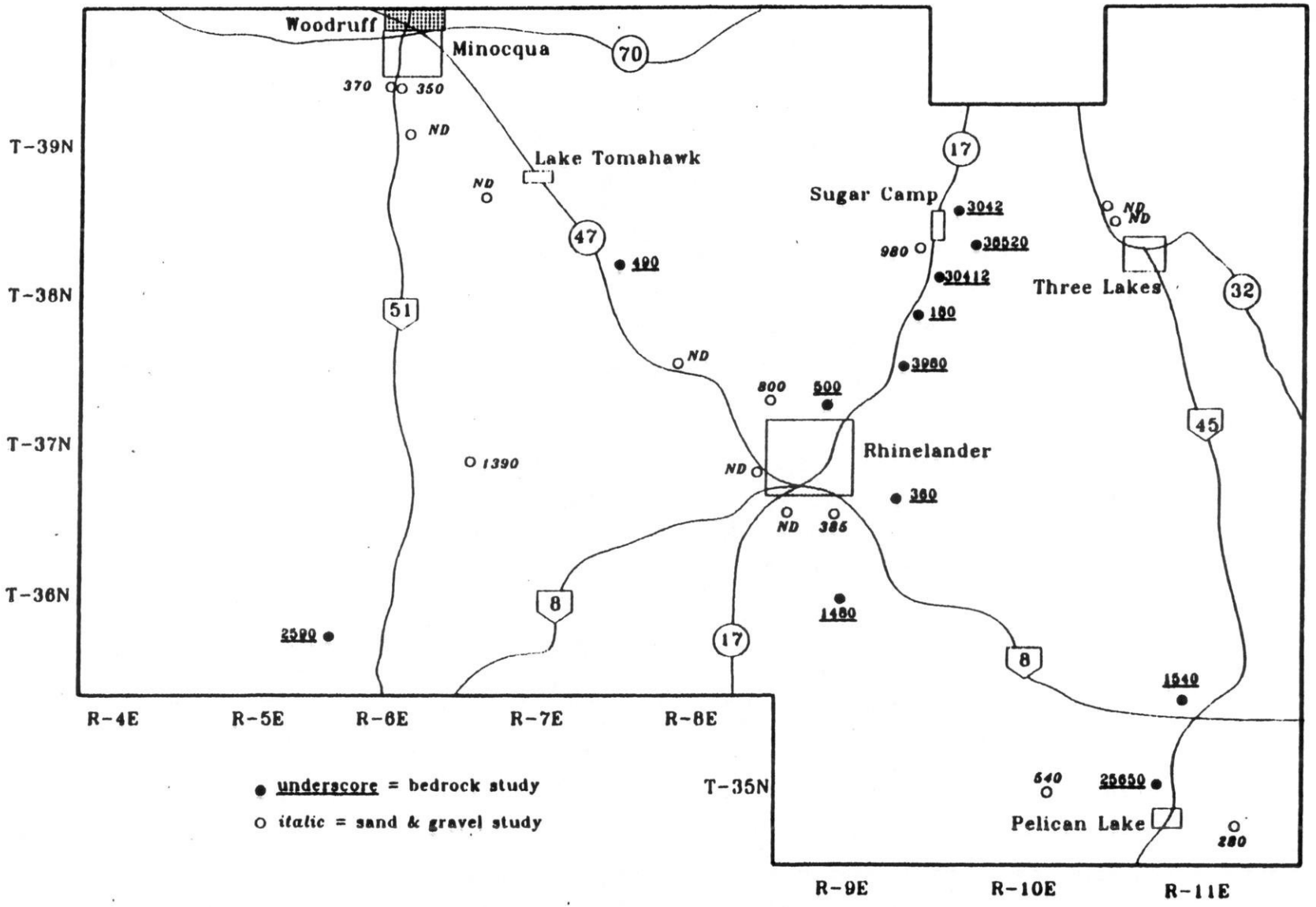
Radon-222 Values in Picocuries per Liter, (pCi/l)

Marathon County



Radon-222 Values in Picocuries per Liter, (pCi/l)

Oneida County

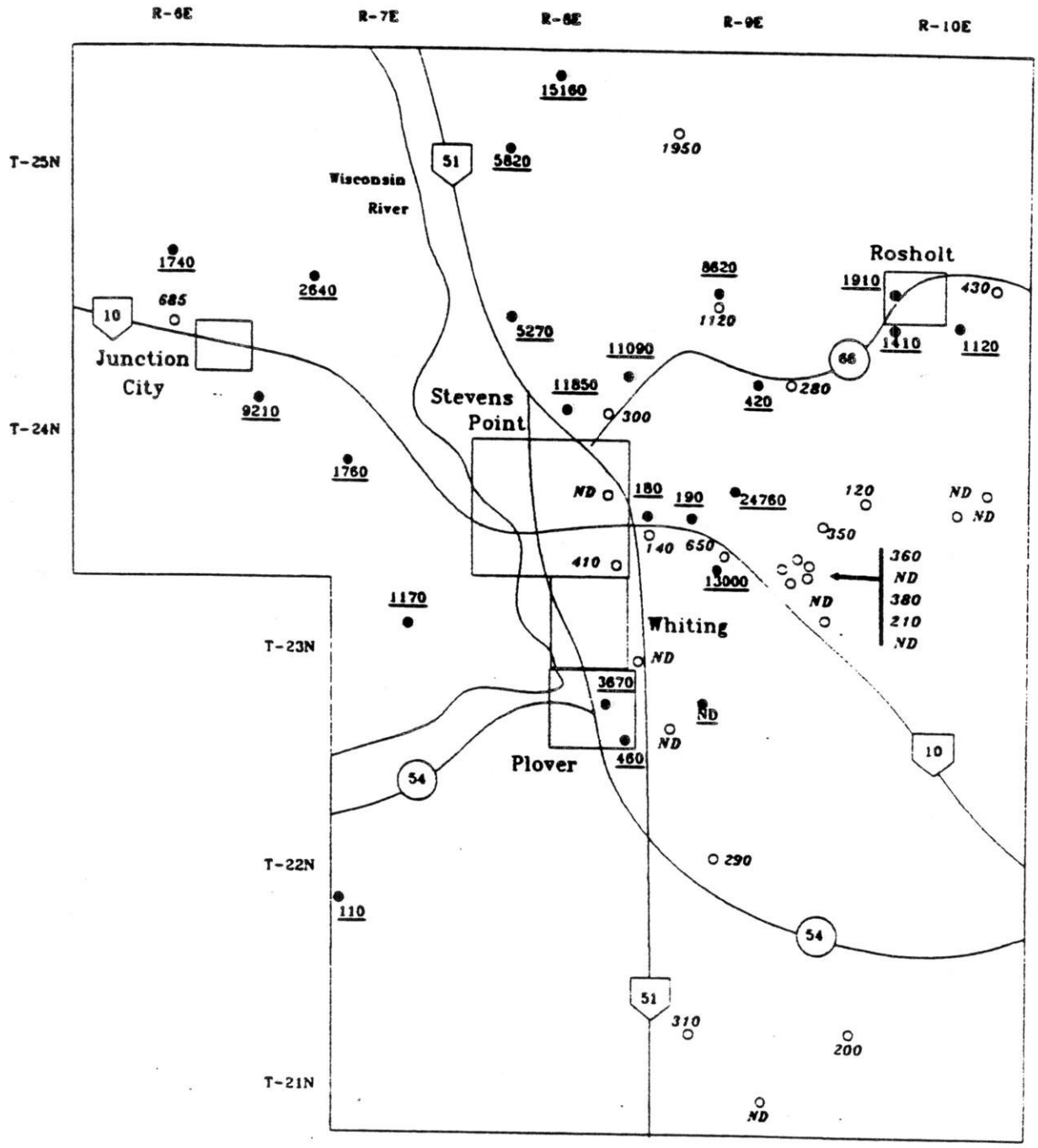


Radon-222 Values in Picocuries per Liter, (pCi/l)

Portage County

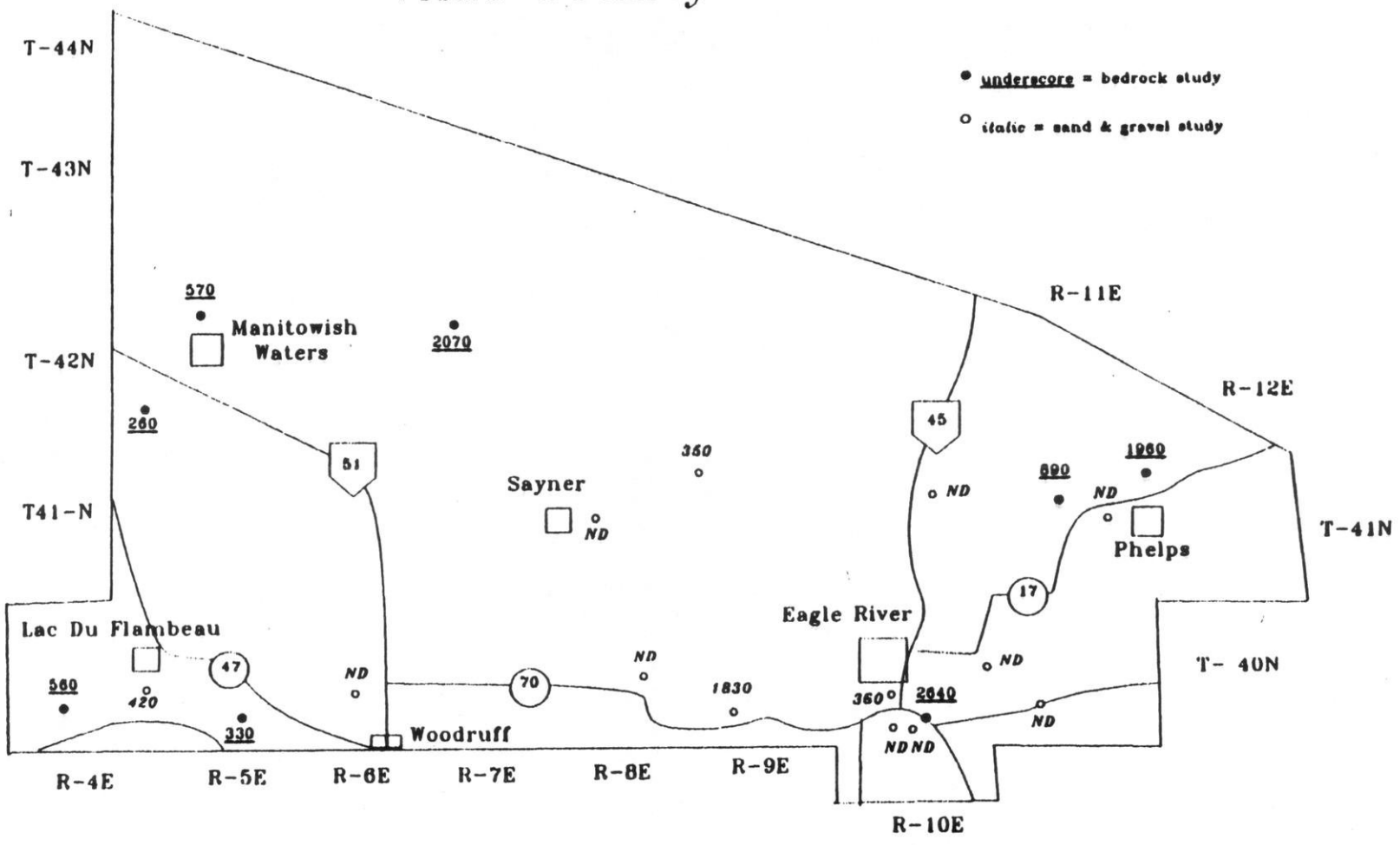
● underscore = bedrock study

○ *italic* = sand & gravel study



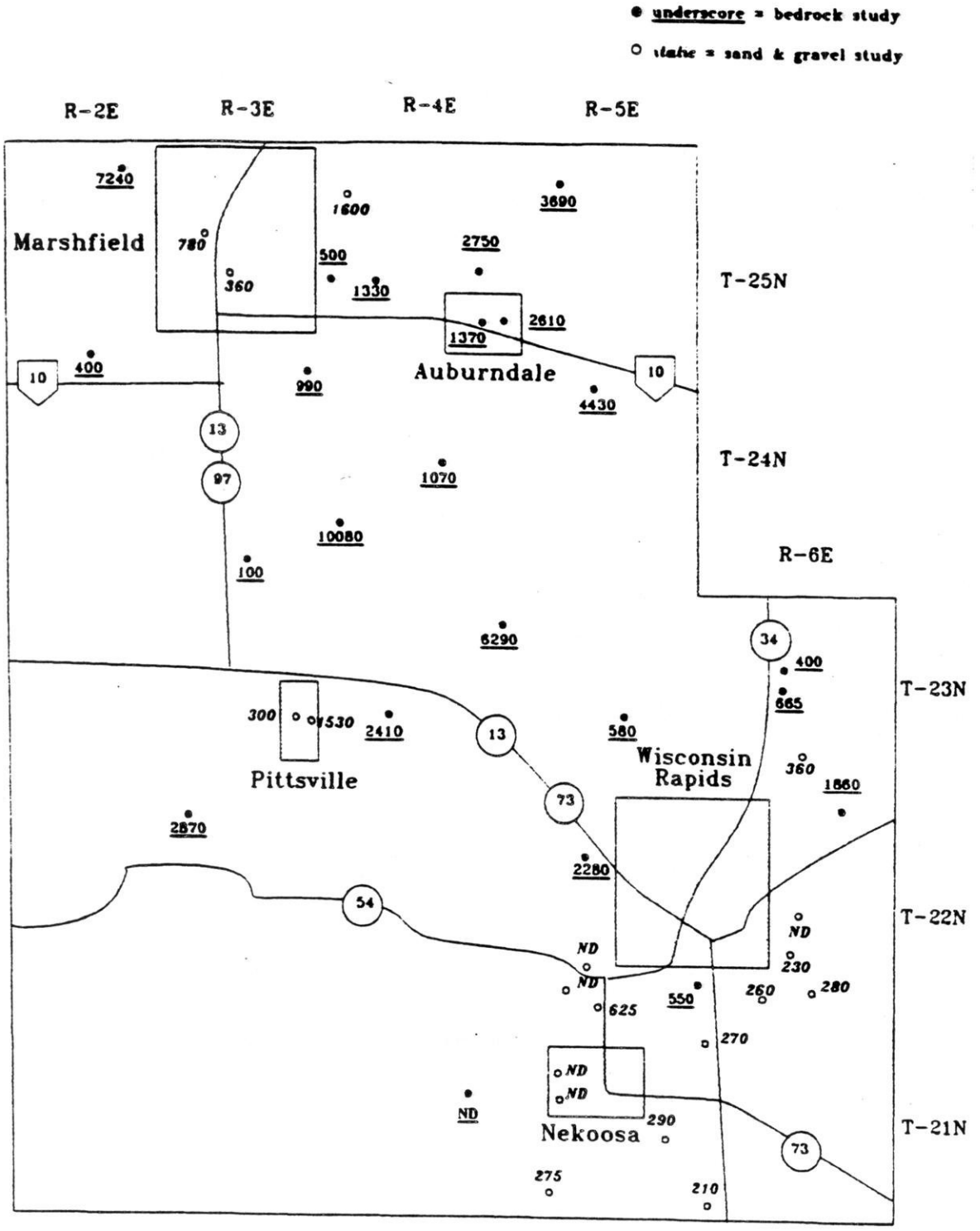
Radon-222 Values in Picocuries per Liter, (pCi/l)

Vilas County



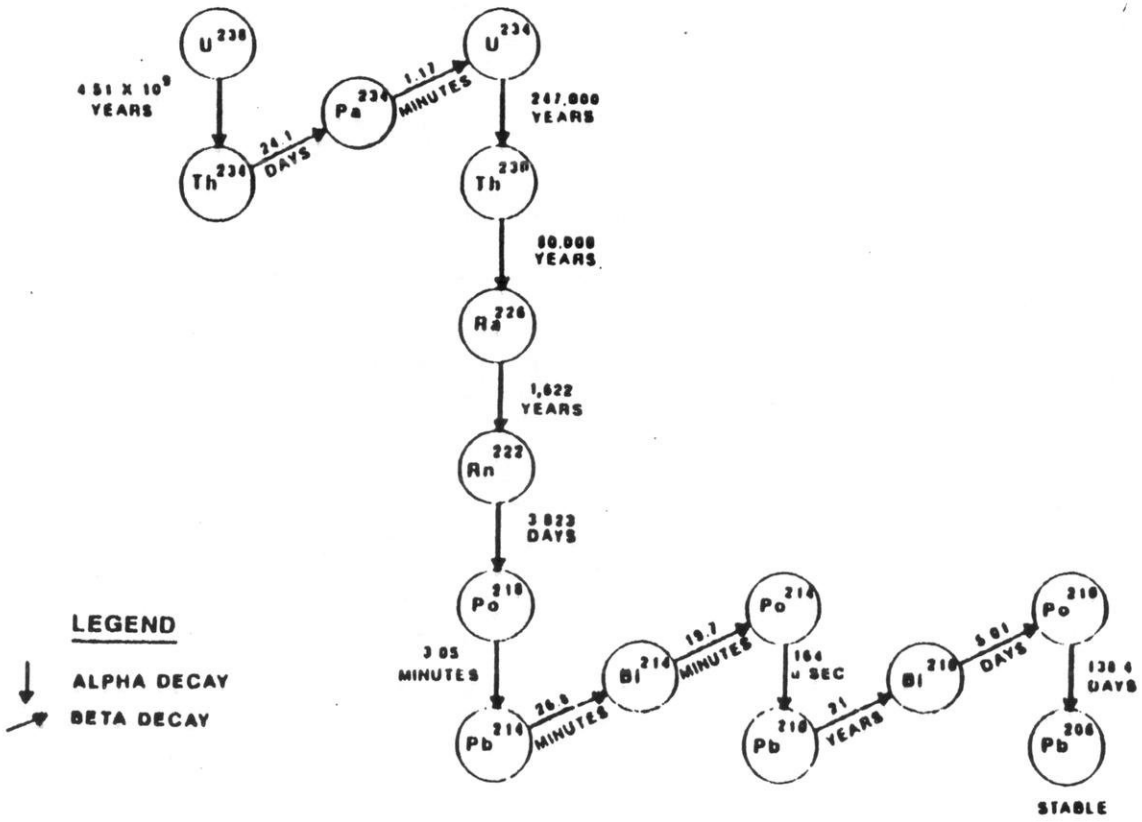
Radon-222 Values in Picocuries per Liter, (pCi/l)

Wood County



Radon-222 Values in Picocuries per Liter, (pCi/l)

URANIUM - 238 DECAY SERIES



RADIOACTIVITY IN NCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	(TOTAL RADIUM	RADIUM 226	RADIUM 228)	(GROSS ALPHA	GROSS) BETA	[URANIUM]	WATER SOURCE
** Adams								
BIG FLATS (T19 R06E)	(< 188)	(		)	(	)	[	] Unconsolidated
DELL PRAIRIE (T14 R06E)	(76)	(		)	(< 3.0	< 4.3)	[	] Sandstone
EASTON (T16 R06E)	(236)	(		)	(< 3.0	< 4.3)	[	] Sandstone
EASTON (T16 R05E)	(201)	(		)	(	)	[	] Unconsolidated
JACKSON (T15 R07E)	(121)	(		)	(< 3.0	< 4.3)	[	] Sandstone
LINCOLN (T17 R07E)	(< 184)	(		)	(	)	[	] Unconsolidated
NEW CHESTR (T16 R07E)	(248)	(		)	(	)	[	] Unconsolidated
NEW CHESTR (T16 R07E)	(< 184)	(		)	(	)	[	] Unconsolidated
PRESTON (T18 R06E)	( )	(5.6	2.6	3.0)	(10.1	)	[	] Sandstone
PRESTON (T18 R06E)	(< 65)	(		)	(< 3.0	< 4.4)	[	] Sandstone
ROME (T20 R06E)	(623)	(		)	(< 3.0	< 4.3)	[	] Sandstone
SPRINGVILLE (T15 R05E)	( )	(2.8		2.8)	(< 3.0	)	[	] Sandstone
STRONGS PRAIRIE (T18 R05E)	(< 188)	(		)	(	)	[	] Unconsolidated
** Forest								
ARGONNE (T37 R13E)	(2968)	(		)	(< 3.0	< 3.2)	[	] Crystalline
ARGONNE (T37 R13E)	(307)	(		)	(	)	[	] Unconsolidated
ARMSTRONG CREEK (T37 R16E)	(< 56)	(		)	(< 3.0	< 4.5)	[	] Crystalline
ARMSTRONG CREEK (T37 R16E)	(750)	(		)	(	)	[	] Unconsolidated
CASWELL (T37 R15E)	(1008)	(		)	(	)	[	] Unconsolidated
CRANDON (T36 R12E)	(738)	(		)	(< 3.0	< 4.4)	[	] Crystalline
FREEDOM (T34 R14E)	(1015)	(		)	(	)	[	] Unconsolidated
HILES (T37 R12E)	( )	(< 1.0	< 1.0	< 1.0)	(< 3.0	)	[	] Unknown
HILES (T37 R12E)	(< 216)	(		)	(	)	[	] Unconsolidated
LAONA (T36 R15E)	(373)	(		)	(	)	[	] Unconsolidated
LAONA (T35 R15E)	(937)	(		)	(	)	[	] Unconsolidated
LINCOLN (T36 R13E)	( )	(< 1.0	< 1.0	< 1.0)	(5.1	)	[	] Crystalline
LINCOLN (T36 R13E)	(340)	(		)	(< 3.0	< 4.4)	[	] Crystalline
LINCOLN (T36 R13E)	(< 284)	(		)	(	)	[	] Unconsolidated
LINCOLN (T36 R13E)	(< 283)	(		)	(	)	[	] Unconsolidated
LINCOLN (T35 R13E)	(1126)	(		)	(	)	[	] Unconsolidated
NASHVILLE (T34 R13E)	(316)	(		)	(	)	[	] Unconsolidated
ROSS (T38 R14E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
ROSS (T38 R14E)	(299)	(		)	(< 3.0	< 3.2)	[	] Crystalline
WABENO (T34 R15E)	( )	(		)	(15.8	)	[	9.5] Crystalline
WABENO (T34 R15E)	( )	(2.4	1.0	1.4)	(21.6	)	[	] Crystalline
WABENO (T34 R15E)	(3961)	(< 1.0	< 1.0	< 1.0)	(19.2	)	[	33.0] Crystalline
WABENO (T34 R15E)	(946)	(		)	(	)	[	] Unconsolidated
** Juneau								
KILLDARE (T15 R05E)	(93)	(		)	(5.4	6.5)	[	] Sandstone
LEMONWEIR (T16 R04E)	( )	(		)	(< 3.0	)	[	] Sandstone
LEMONWEIR (T15 R04E)	( )	(		)	(< 3.0	)	[	] Sandstone
LISBON (T16 R03E)	(151)	(		)	(3.2	4.6)	[	] Sandstone
MARION (T15 R05E)	( )	(		< 1.0)	(< 3.0	)	[	] Sandstone
NECEDAH (T18 R03E)	( )	(		< 1.0)	(< 3.0	)	[	] Sandstone
ORANGE (T17 R02E)	(109)	(		)	(< 3.0	< 4.3)	[	] Sandstone
SEVEN MILE CREEK (T14 R04E)	( )	(1.4		1.4)	(< 3.0	)	[	] Sandstone
WONEWOC (T14 R02E)	(125)	(		)	(< 3.0	< 4.4)	[	] Sandstone
WONEWOC (T14 R02E)	(102)	(		)	(< 3.0	< 4.5)	[	] Sandstone
** Langlade								
ACKLEY (T31 R10E)	( )	(1.2		1.2)	(< 3.0	)	[	] Crystalline
ACKLEY (T31 R10E)	(5619)	(		)	(	)	[	] Unconsolidated

RADIOACTIVITY IN MCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	(TOTAL RADIUM	RADIUM 226	RADIUM 228)	(GROSS ALPHA	GROSS BETA)	[URANIUM]	WATER SOURCE
ACKLEY (T31 R10E)	(297)	(		)	(	)	[	] Unconsolidated
AINSWORTH (T34 R12E)	(647)	(		)	(	)	[	] Unconsolidated
ANTIGO (T31 R11E)	(801)	(		)	(< 3.0	< 3.0)	[	] Unconsolidated
ANTIGO (T31 R11E)	(< 263)	(		)	(	)	[	] Unconsolidated
ANTIGO (T31 R11E)	(< 263)	(		)	(	)	[	] Unconsolidated
ANTIGO (T31 R11E)	(< 263)	(		)	(	)	[	] Unconsolidated
ANTIGO (T31 R11E)	(< 261)	(		)	(	)	[	] Unconsolidated
ANTIGO (T31 R11E)	(< 219)	(		)	(	)	[	] Unconsolidated
ELCHO (T34 R11E)	(714)	(		)	(< 3.0	)	[	] Crystalline
ELCHO (T34 R11E)	(253)	(		)	(< 3.0	< 2.9)	[	] Unconsolidated
ELCHO (T34 R10E)	(642)	(		)	(	)	[	] Unconsolidated
ELCHO (T34 R10E)	(968)	(		)	(	)	[	] Unconsolidated
EVERGREEN (T31 R13E)	(1807)	(		)	(< 3.0	< 3.1)	[	] Unconsolidated
LANGLADE (T33 R13E)	(< 282)	(		)	(	)	[	] Unconsolidated
LANGLADE (T33 R13E)	(252)	(		)	(	)	[	] Unconsolidated
LANGLADE (T33 R13E)	(678)	(		)	(	)	[	] Unconsolidated
NEVA (T32 R11E)	(< 185)	(		)	(	)	[	] Unconsolidated
NORWOOD (T30 R12E)	(246)	(		)	(< 3.0	< 3.0)	[	] Unconsolidated
NORWOOD (T30 R12E)	(< 260)	(		)	(	)	[	] Unconsolidated
NORWOOD (T30 R12E)	(873)	(		)	(	)	[	] Unconsolidated
PARRISH (T34 R09E)	(368)	(		)	(< 3.0	< 2.9)	[	] Unconsolidated
PECK (T32 R10E)	(1915)	(		)	(< 3.0	< 2.9)	[	] Crystalline
PECK (T32 R10E)	( )	(2.6		2.6)	(< 3.0	)	[	] Crystalline
POLAR (T31 R12E)	(811)	(		)	(< 3.0	)	[	] Crystalline
ROLLING (T30 R11E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
ROLLING (T30 R11E)	(2615)	(		)	(< 3.0	)	[	] Crystalline
ROLLING (T30 R11E)	(1966)	(		)	(3.0	< 3.0)	[	] Crystalline
ROLLING (T30 R11E)	(< 273)	(		)	(	)	[	] Unconsolidated
ROLLING (T30 R11E)	(501)	(		)	(	)	[	] Unconsolidated
UPHAM (T33 R11E)	(210)	(		)	(	)	[	] Unconsolidated
WOLF RIVER (T32 R14E)	( )	(< 1.0	< 1.0	< 1.0)	(3.0	)	[	] Crystalline
WOLF RIVER (T32 R14E)	(219)	(		)	(< 3.0	< 2.9)	[	] Unconsolidated
WOLF RIVER (T31 R14E)	(764)	(		)	(	)	[	] Unconsolidated
WOLF RIVER (T31 R14E)	(< 194)	(		)	(	)	[	] Unconsolidated
WOLF RIVER (T31 R14E)	(5161)	(		)	(	)	[	] Unconsolidated
** Lincoln								
BIRCH (T33 R07E)	(13130)	(		)	(< 3.0	4.4)	[	] Crystalline
BIRCH (T33 R07E)	(< 274)	(		)	(	)	[	] Unconsolidated
BIRCH (T33 R07E)	(1821)	(		)	(	)	[	] Unconsolidated
BRADLEY (T34 R06E)	(6552)	(		)	(< 3.0	< 4.4)	[	] Crystalline
BRADLEY (T35 R06E)	(3791)	(		)	(< 3.0	< 4.6)	[	] Crystalline
BRADLEY (T34 R06E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
BRADLEY (T34 R06E)	(465)	(		)	(	)	[	] Unconsolidated
CORNING (T31 R05E)	(229)	(		)	(41.9	14.6)	[	] Crystalline
HARRISON (T34 R08E)	(559)	(		)	(< 3.0	5.2)	[	] Crystalline
HARRISON (T35 R08E)	(450)	(		)	(	)	[	] Unconsolidated
HARRISON (T35 R08E)	(1804)	(		)	(	)	[	] Unconsolidated
KING (T35 R07E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
MERRILL (T32 R07E)	(10685)	(		)	(< 3.0	5.6)	[	] Crystalline
MERRILL (T31 R07E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
MERRILL (T32 R06E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
MERRILL (T31 R06E)	(< 272)	(		)	(	)	[	] Unconsolidated
MERRILL (T31 R06E)	(785)	(		)	(	)	[	] Unconsolidated
MERRILL (T31 R06E)	(< 307)	(		)	(	)	[	] Unconsolidated

RADIOACTIVITY IN NCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	(TOTAL RADIUM	RADIUM 226	RADIUM 228)	(GROSS ALPHA	GROSS BETA)	[URANIUM]	WATER SOURCE
MERRILL (T32 R06E)	(196)	(		)	(	)	[	] Unconsolidated
PINE RIVER (T31 R07E)	(< 226)	(		)	(	)	[	] Unconsolidated
ROCK FALLS (T32 R05E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
ROCK FALLS (T33 R06E)	(497)	(		)	(	)	[	] Unconsolidated
ROCK FALLS (T32 R06E)	(< 213)	(		)	(	)	[	] Unconsolidated
RUSSELL (T33 R08E)	(587)	(		)	(	)	[	] Unconsolidated
SCHLEY (T32 R08E)	(674)	(		)	(	)	[	] Unconsolidated
SCOTT (T31 R06E)	(3775)	(		)	(< 3.0	< 4.4)	[	] Crystalline
SCOTT (T31 R06E)	(872)	(		)	(	)	[	] Unconsolidated
SOMO (T35 R04E)	(1176)	(		)	(	)	[	] Crystalline
TOMAHAWK (T34 R04E)	(4174)	(		)	(< 3.0	< 4.4)	[	] Crystalline
** Marathon								
BERLIN (T30 R06E)	(4673)	(		)	(	)	[	] Crystalline
BERN (T30 R03E)	(1143)	(		)	(	)	[	] Crystalline
BEVENT (T26 R09E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
BEVENT (T26 R09E)	(4934)	(		)	(< 3.0	4.6)	[	] Crystalline
BEVENT (T26 R09E)	(< 304)	(		)	(	)	[	] Unconsolidated
BRIGHTON (T27 R02E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
BRIGHTON (T27 R02E)	(166)	(		)	(	)	[	] Unconsolidated
BRIGHTON (T27 R02E)	(264)	(		)	(	)	[	] Unconsolidated
CASSEL (T28 R05E)	(1916)	(		)	(< 3.3	< 4.8)	[	] Crystalline
CLARK CO 5TH/HEMLOCK (T29 R01E)	(632)	(		)	(	)	[	] Sandstone
CLARK CO BTRNT & 5TH (T29 R01E)	(395)	(		)	(	)	[	] Sandstone
CLARK CO BY RR TRACK (T29 R01E)	(709)	(		)	(	)	[	] Unconsolidated
CLARK CO HEMLOCK ST (T29 R01E)	(767)	(		)	(	)	[	] Sandstone
CLARK CO PINE & 4TH (T29 R01E)	(465)	(		)	(	)	[	] Sandstone
CLARK CO SYCMR & 2ND (T29 R01E)	(461)	(		)	(	)	[	] Sandstone
CLARK COUNTY (T 0 R)	(27662)	(		)	(	)	[	] Crystalline
CLARK COUNTY (T 0 R)	(5632)	(		)	(	)	[	] Crystalline
CLEVELAND (T27 R04E)	(14874)	(		)	(< 3.0	5.0)	[	] Crystalline
CLEVELAND (T27 R04E)	( )	(		)	(< 3.0	)	[	] Unconsolidated
CLEVELAND (T27 R04E)	( )	(		)	(4.6	)	[	] Unconsolidated
CLEVELAND (T27 R04E)	(143)	(		< 1.0)	(3.6	39.6)	[	] Unconsolidated
CLEVELAND (T27 R04E)	(20730)	(		)	(12.6	7.7)	[	] Crystalline
CLEVELAND (T27 R04E)	(11228)	(		)	(6.2	< 4.5)	[	] Crystalline
CLEVELAND (T27 R04E)	(4977)	(		)	(	)	[	] Unconsolidated
CLEVELAND (T27 R04E)	(9656)	(		)	(	)	[	] Crystalline
EASTON (T29 R09E)	(12819)	(		)	(	)	[	] Crystalline
EAU PLEINE (T27 R03E)	(33181)	(2.2	2.2	< 1.0)	(10.1	14.4)	[	3.6] Crystalline
ELDERON (T27 R10E)	(699)	(		)	(	)	[	] Unconsolidated
ELDERON (T27 R10E)	(436)	(		)	(	)	[	] Unconsolidated
EMMET (T27 R06E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
EMMET (T27 R05E)	( )	(		)	(< 3.0	)	[	] Crystalline
FRANKFORT (T28 R03E)	(17952)	(		)	(22.6	18.7)	[	] Crystalline
FRANKFORT (T28 R03E)	( )	(8.7	6.4	2.3)	(43.2	)	[	19.0] Crystalline
GUENTHER (T26 R08E)	(1839)	(		)	(< 3.0	< 3.4)	[	] Crystalline
HALSEY (T30 R04E)	(2911)	(		)	(< 3.0	< 4.6)	[	] Crystalline
HAMBURG (T30 R05E)	(21663)	(		)	(	)	[	] Crystalline

RADIOACTIVITY IN NCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	TOTAL RADIUM	RADIUM 226	RADIUM 228	GROSS ALPHA	GROSS BETA	[URANIUM]	WATER SOURCE
HEWITT (T30 R09E)	( )	( )			(23.8)	( )	[9.0]	Crystalline
HEWITT (T30 R09E)	( )	(< 1.0	< 1.0	< 1.0)	(19.1)	( )	[ ]	Crystalline
HOLTON (T29 R02E)	(1452)	( )			( )	( )	[ ]	Unconsolidated
HULL (T28 R02E)	(12480)	( )			(23.7)	11.1)	[ ]	Crystalline
HULL (T28 R02E)	( )	(< 1.0	< 1.0	< 1.0)	( )	( )	[14.0]	Crystalline
HULL (T28 R02E)	(3197)	( )			( )	( )	[ ]	Unconsolidated
HULL (T28 R02E)	(30678)	( )			( )	( )	[ ]	Unconsolidated
JOHNSON (T29 R03E)	(5763)	( )			( )	( )	[ ]	Crystalline
KRONENWETTER (T27 R07E)	(23196)	( )			(7.8)	10.3)	[ ]	Crystalline
KRONENWETTER (T27 R07E)	(3844)	( )			( )	( )	[ ]	Unconsolidated
KRONENWETTER (T27 R07E)	(336)	( )			( )	( )	[ ]	Unconsolidated
MAINE (T29 R07E)	(5900)	( )			(< 3.0	< 3.3)	[ ]	Crystalline
MAINE (T29 R07E)	(3400)	(5.6	2.3	3.3)	(13.0	10.2)	[< 1.0]	Crystalline
MAINE (T29 R07E)	(5632)	( )			(6.3)	( )	[ ]	Crystalline
MARATHON (T28 R06E)	(14014)	( )			(< 3.0	4.2)	[ ]	Crystalline
MARATHON (T28 R06E)	( )	( )		< 1.0)	(< 3.0	( )	[ ]	Crystalline
MARATHON (T28 R06E)	(1490)	( )			( )	( )	[ ]	Unconsolidated
MARATHON (T28 R06E)	(1455)	( )			( )	( )	[ ]	Unconsolidated
MARATHON (T28 R06E)	(< 325)	( )			( )	( )	[ ]	Unconsolidated
MARATHON (T28 R06E)	(< 325)	( )			( )	( )	[ ]	Unconsolidated
MCMILLAN (T26 R03E)	(2473)	( )			(7.8)	14.7)	[ ]	Crystalline
MCMILLAN (T26 R03E)	(343)	( )			( )	( )	[ ]	Unconsolidated
MOSINEE (T27 R06E)	( )	( )		< 1.0)	(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R07E)	( )	(< 1.0	< 1.0	< 1.0)	(3.3	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	( )	( )			(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	(590)	( )			(< 3.0	< 4,6)	[ ]	Crystalline
MOSINEE (T27 R06E)	( )	( )			(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	( )	( )			(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	( )	( )			(5.5	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	( )	( )			(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	( )	( )			(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	( )	( )			(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R05E)	( )	( )			(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	( )	( )			(< 3.0	( )	[ ]	Crystalline
MOSINEE (T27 R07E)	( )	( )			(8.1	( )	[ ]	Crystalline
MOSINEE (T27 R06E)	(647)	(< 1.0	< 1.0	< 1.0)	(< 3.0	< 4.6)	[1.0]	Crystalline
MOSINEE (T27 R06E)	(1283)	(< 1.0	< 1.0	< 1.0)	(< 3.0	< 4.6)	[1.0]	Crystalline
MOSINEE (T27 R06E)	(750)	(< 1.0	< 1.0	< 1.0)	(< 3.0	< 4.6)	[2.0]	Crystalline
MOSINEE (T27 R07E)	(< 93)	( )			( )	( )	[ ]	Unconsolidated
MOSINEE (T27 R07E)	(157)	( )			( )	( )	[ ]	Unconsolidated
MOSINEE (T R)	(< 325)	( )			( )	( )	[ ]	Unconsolidated
MOSINEE (T27 R07E)	(< 342)	( )			( )	( )	[ ]	Unconsolidated
NORRIE (T28 R10E)	(16294)	(< 1.0	< 1.0	< 1.0)	(20.4	11.1)	[29.2]	Crystalline
NORRIE (T28 R10E)	( )	(< 1.0	< 1.0	< 1.0)	(5.3	( )	[ ]	Crystalline
NORRIE (T28 R10E)	(828)	( )			( )	( )	[ ]	Unconsolidated
NORRIE (T28 R10E)	(1086)	(< 1.0	< 1.0	< 1.0)	(< 3.0	< 4.8)	[ ]	Crystalline
REID (T27 R09E)	(21259)	( )			(6.6	15.6)	[ ]	Crystalline
REID (T27 R09E)	(1755)	( )			(< 3.0	( )	[ ]	Crystalline
REID (T27 R09E)	(4398)	( )			( )	( )	[ ]	Unconsolidated
RIB MOUNTAIN (T28 R07E)	( )	(4.0	4.0	< 1.0)	(12.7	( )	[ ]	Unconsolidated
RIB MOUNTAIN (T28 R07E)	( )	( )		< 1.0)	(< 3.0	( )	[ ]	Unknown
RIB MOUNTAIN (T28 R07E)	(10238)	( )			(< 3.0	6.5)	[ ]	Crystalline
RIB MOUNTAIN (T28 R07E)	(27724)	( )			(8.6	8.1)	[ ]	Crystalline
RIB MOUNTAIN (T28 R07E)	( )	(< 1.0	< 1.0	< 1.0)	(4.8	( )	[ ]	Crystalline
RIB MOUNTAIN (T28 R07E)	( )	( )		< 1.0)	(< 3.0	( )	[ ]	Crystalline

RADIOACTIVITY IN NCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	TOTAL RADIUM	RADIUM 226	RADIUM 228	GROSS ALPHA	GROSS BETA	[URANIUM]	WATER SOURCE
RIB MOUNTAIN (T28 R07E)	( )	( )			(11.5)	( )	[6.0]	Crystalline
RIB MOUNTAIN (T28 R07E)	( )	(< 1.0	< 1.0	< 1.0)	(11.0)	( )	[ ]	Crystalline
RIB MOUNTAIN (T28 R07E)	(< 195)	( )			( )	( )	[ ]	Unconsolidated
RIETBROCK (T29 R04E)	(39355)	( )			(57.3)	36.8)	[ ]	Crystalline
RIETBROCK (T29 R04E)	(2020)	( )			(3.5)	< 4.8)	[ ]	Crystalline
RIETBROCK (T29 R04E)	(288)	( )			(< 3.0)	< 4.8)	[ ]	Crystalline
RIETBROCK (T29 R04E)	(1661)	( )			(< 3.0)	< 4.8)	[ ]	Crystalline
RIETBROCK (T29 R04E)	(1967)	( )			(< 3.0)	< 4.8)	[ ]	Crystalline
RIETBROCK (T29 R04E)	(43046)	( )			( )	( )	[ ]	Crystalline
RIETBROCK (T29 R04E)	( )	(1.5	1.5	< 1.0)	( )	( )	[35.0]	Crystalline
RINGLE (T28 R09E)	(1760)	( )			( )	( )	[ ]	Crystalline
RINGLE (T28 R09E)	(929)	( )			( )	( )	[ ]	Unconsolidated
RINGLE (T28 R09E)	(687)	( )			( )	( )	[ ]	Unconsolidated
SPENCER (T26 R02E)	( )	( )		< 1.0)	(< 3.0)	( )	[ ]	Crystalline
SPENCER (T26 R02E)	(21385)	( )			( )	( )	[ ]	Crystalline
SPENCER (T26 R02E)	(20026)	( )			( )	( )	[ ]	Crystalline
SPENCER (T26 R02E)	( )	(3.2	1.7	1.5)	(6.3)	( )	[ ]	Crystalline
SPENCER (T26 R02E)	(301)	( )			( )	( )	[ ]	Unconsolidated
SPENCER (T26 R02E)	(70864)	( )			( )	( )	[ ]	Crystalline
SPENCER (T26 R02E)	(42166)	( )			( )	( )	[ ]	Crystalline
SPENCER (T26 R02E)	( )	(2.1	2.1	< 1.0)	(27.5	20.4)	[16.0]	Crystalline
SPENCER (T26 R02E)	(1176)	( )			( )	( )	[ ]	Crystalline
SPENCER (T26 R02E)	(399)	( )			( )	( )	[ ]	Unconsolidated
STETTIN (T29 R06E)	( )	( )		< 1.0)	(< 3.0)	( )	[ ]	Crystalline
STETTIN (T29 R06E)	(10569)	( )			(< 3.0)	3.6)	[ ]	Crystalline
STETTIN (T29 R06E)	(619)	( )			(< 3.0)	< 3.2)	[ ]	Crystalline
STETTIN (T29 R07E)	(3357)	( )			( )	( )	[ ]	Unconsolidated
STETTIN (T29 R07E)	(8122)	( )			( )	( )	[ ]	Unconsolidated
STETTIN (T29 R07E)	(7984)	( )			( )	( )	[ ]	Unconsolidated
STETTIN (T29 R06E)	(10142)	( )			(8.2)	( )	[ ]	Crystalline
STETTIN (T29 R06E)	(9975)	( )			(5.2)	( )	[ ]	Crystalline
STETTIN (T29 R07E)	( )	( )		< 1.0)	(< 3.0)	( )	[ ]	Unconsolidated
STETTIN (T29 R06E)	( )	( )			(< 3.0)	( )	[ ]	Crystalline
STETTIN (T29 R06E)	(9380)	( )			(< 3.0)	< 4.6)	[ ]	Crystalline
STETTIN (T29 R07E)	(240)	( )			(4.1)	6.7)	[ ]	Unconsolidated
STETTIN (T29 R07E)	(433)	( )			(< 3.1)	< 4.7)	[ ]	Unconsolidated
STETTIN (T29 R07E)	(767)	( )			(4.8)	7.4)	[ ]	Unconsolidated
STETTIN (T29 R06E)	(39548)	(< 1.0	< 1.0	< 1.0)	(< 3.0)	5.7)	[ ]	Crystalline
STETTIN (T29 R06E)	(7854)	(< 1.0	< 1.0	< 1.1)	(< 3.0)	< 4.7)	[ ]	Crystalline
STETTIN (T29 R07E)	( )	(< 1.0	< 1.0	< 1.0)	(4.8)	( )	[ ]	Crystalline
TEXAS (T29 R07E)	( )	( )		< 1.0)	(< 3.0)	( )	[ ]	Crystalline
TEXAS (T30 R08E)	( )	( )			(356.6)	( )	[197.0]	Crystalline
TEXAS (T30 R08E)	(81617)	( )			( )	( )	[ ]	Crystalline
TEXAS (T30 R08E)	(82996)	( )			( )	( )	[ ]	Crystalline
TEXAS (T30 R08E)	( )	(10.5	4.6	5.9)	(350.5)	( )	[129.0]	Crystalline
TEXAS (T30 R07E)	(18047)	( )			(3.6)	7.1)	[ ]	Crystalline
TEXAS (T30 R08E)	(18676)	( )			(3.5)	7.7)	[ ]	Crystalline
TEXAS (T30 R07E)	(9100)	(< 1.0	< 1.0	< 1.0)	(47.4)	13.2)	[64.3]	Crystalline
TEXAS (T30 R08E)	(8490)	( )			(< 3.0)	< 3.2)	[ ]	Crystalline
TEXAS (T29 R07E)	(3071)	( )			(4.7)	( )	[ ]	Crystalline
TEXAS (T30 R08E)	(178)	( )			(35.9)	8.3)	[ ]	Crystalline
TEXAS (T30 R08E)	( )	(< 1.0	< 1.0	< 1.0)	( )	( )	[35.0]	Unknown
TEXAS (T29 R07E)	(836)	( )			( )	( )	[ ]	Unconsolidated
TEXAS (T29 R07E)	(212)	( )			( )	( )	[ ]	Unconsolidated
TEXAS (T30 R07E)	(< 326)	( )			( )	( )	[ ]	Unconsolidated

RADIOACTIVITY IN NCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	(TOTAL RADIUM	RADIUM 226	RADIUM 228)	(GROSS ALPHA	GROSS BETA)	[URANIUM]	WATER SOURCE
WAUSAU (T29 R08E)	( )	(			(138.2	)	[25.0]	Crystalline
WAUSAU (T29 R08E)	(254647)	(			(	)	[ ]	Crystalline
WAUSAU (T29 R08E)	( )	(31.1	28.3	2.8)	(150.7	)	[31.0]	Crystalline
WAUSAU (T29 R08E)	(269172)	(			(	)	[31.0]	Crystalline
WAUSAU (T29 R08E)	(6906)	(57.1	46.5	10.6)	(251.2	160.9)	[24.7]	Crystalline
WAUSAU (T29 R08E)	( )	(			(170.6	)	[ ]	Crystalline
WAUSAU (T29 R08E)	(3119)	(			(	)	[ ]	Unknown
WAUSAU (T29 R08E)	(2525)	(			(	)	[ ]	Crystalline
WAUSAU (T29 R08E)	(6165)	(			(	)	[ ]	Crystalline
WAUSAU (T29 R08E)	( )	(		< 1.0)	(< 3.0	)	[ ]	Crystalline
WAUSAU (T29 R08E)	(391394)	(58.0	55.1	2.9)	(283.6	160.2)	[162]	Crystalline
WAUSAU (T29 R08E)	(31274)	(33.8	31.3	2.5)	(117.8	63.9)	[88]	Crystalline
WAUSAU (T29 R08E)	(203455)	(37.9	35.5	2.4)	(154.8	115.9)	[105]	Crystalline
WESTON (T28 R07E)	(505)	(			(	)	[ ]	Unknown
WESTON (T28 R07E)	(621)	(			(	)	[ ]	Unconsolidated
WESTON (T28 R08E)	(461)	(			(	)	[ ]	Unconsolidated
WESTON (T28 R08E)	(242)	(			(	)	[ ]	Unconsolidated
WESTON (T28 R07E)	(791)	(			(	)	[ ]	Unconsolidated
WESTON (T28 R08E)	(259)	(			(	)	[ ]	Unconsolidated
WESTON (T28 R07E)	(602)	(			(	)	[ ]	Unconsolidated
WESTON (T28 R08E)	(2327)	(			(	)	[ ]	Unconsolidated
WIEN (T28 R04E)	(4624)	(			(3.6	< 4.8)	[ ]	Crystalline
WIEN (T28 R04E)	(3276)	(			(	)	[ ]	Crystalline
WIEN (T28 R04E)	(8442)	(			(	)	[ ]	Crystalline
WIEN (T28 R04E)	(20322)	(			(7.7	)	[ ]	Crystalline
WIEN (T28 R04E)	(21760)	(			(	)	[ ]	Crystalline
WIEN (T28 R04E)	(21547)	(			(	)	[ ]	Crystalline
WIEN (T28 R04E)	(7757)	(			(	)	[ ]	Crystalline
** Oneida								
CASSIAN (T37 R07E)	(1390)	(			(	)	[ ]	Unconsolidated
CRESCENT (T36 R08E)	(< 520)	(			(	)	[ ]	Unconsolidated
LAKE TOMAHAWK (T38 R07E)	(< 520)	(			(	)	[ ]	Unconsolidated
LITTLE RICE (T36 R05E)	(2587)	(			(< 3.0	< 4.6)	[ ]	Crystalline
MINOCQUA (T39 R05E)	( )	(		< 1.0)	(< 3.0	)	[ ]	Crystalline
MINOCQUA (T39 R06E)	(< 198)	(			(	)	[ ]	Crystalline
MINOCQUA (T39 R06E)	(351)	(			(	)	[ ]	Unconsolidated
MINOCQUA (T39 R06E)	(371)	(			(	)	[ ]	Unconsolidated
MONICO (T36 R11E)	(1537)	(			(< 3.0	)	[ ]	Crystalline
NEWBOLD (T38 R08E)	(493)	(			(< 3.0	< 3.3)	[ ]	Crystalline
PELICAN (T36 R09E)	(1481)	(			(< 3.0	< 3.1)	[ ]	Crystalline
PELICAN (T3N R09E)	(363)	(			(< 2.2	< 3.3)	[ ]	Crystalline
PELICAN (T36 R09E)	(386)	(			(	)	[ ]	Crystalline
PELICAN (T36 R09E)	(< 520)	(			(	)	[ ]	Unconsolidated
PIEHL (T37 R11E)	( )	(		< 1.0)	(< 3.0	)	[ ]	Crystalline
PINE LAKE (T37 R09E)	(3979)	(			(< 3.0	)	[ ]	Crystalline
PINE LAKE (T37 R09E)	(503)	(			(< 3.0	< 3.3)	[ ]	Crystalline
PINE LAKE (T37 R09E)	(798)	(			(	)	[ ]	Unconsolidated
PINE LAKE (T37 R08E)	(< 221)	(			(	)	[ ]	Unconsolidated
SCHOEPKE (T35 R10E)	( )	(		< 1.0)	(< 3.0	)	[ ]	Crystalline
SCHOEPKE (T35 R11E)	(25649)	(			(26.5	19.6)	[ ]	Crystalline
SCHOEPKE (T35 R11E)	( )	(< 1.0	< 1.0	< 1.0)	(	)	[22]	Crystalline
SCHOEPKE (T35 R11E)	(278)	(			(	)	[ ]	Unconsolidated
SCHOEPKE (T35 R10E)	(544)	(			(	)	[ ]	Unconsolidated
SUGAR CAMP (T38 R09E)	(30412)	(			(	)	[ ]	Crystalline

RADIOACTIVITY IN NCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	TOTAL RADIUM	RADIUM 226	RADIUM 228	GROSS ALPHA	GROSS BETA	[URANIUM]	WATER SOURCE
SUGAR CAMP (T38 R09E)	(38519)	(		)	(6.2	14.8)	[	] Crystalline
SUGAR CAMP (T38 R09E)	(180)	(		)	(< 3.0	< 4.8)	[	] Unconsolidated
SUGAR CAMP (T38 R09E)	(3024)	(		)	(< 3.0	< 4.8)	[	] Crystalline
SUGAR CAMP (T38 R09E)	(977)	(		)	(	)	[	] Crystalline
THREE LAKES (T38 R11E)	(< 225)	(		)	(	)	[	] Unconsolidated
THREE LAKES (T38 R11E)	(< 254)	(		)	(	)	[	] Unconsolidated
** Portage								
ALBAN (T25 R10E)	( )	(		)	(4.6	)	[	] Crystalline
ALBAN (T25 R10E)	(1118)	(< 1.0	< 1.0	< 1.0)	(12.5	)	[	5.2] Crystalline
ALBAN (T25 R10E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
ALBAN (T25 R10E)	( )	(		)	(< 3.0	)	[	] Crystalline
ALBAN (T25 R10E)	(1909)	(		)	(	)	[	] Crystalline
ALBAN (T25 R10E)	(1411)	(		)	(	)	[	] Crystalline
ALBAN (T25 R10E)	(429)	(		)	(	)	[	] Unconsolidated
ALMOND (T21 R09E)	(196)	(		)	(	)	[	] Unconsolidated
ALMOND (T21 R09E)	( )	(		)	(< 3.0	< 3.1)	[	] Unconsolidated
ALMOND (T21 R09E)	(< 230)	(		)	(	)	[	] Unconsolidated
AMHERST (T23 R10E)	(588)	(		)	(< 3.0	3.4)	[	] Unconsolidated
AMHERST (T23 R10E)	(439)	(		)	(	)	[	] Unconsolidated
AMHERST (T23 R10S)	(< 220)	(		)	(	)	[	] Unconsolidated
CARSON (T24 R06E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
CARSON (T24 R06E)	(9212)	(		)	(5.1	)	[	] Crystalline
CARSON (T24 R07E)	(1758)	(		)	(< 3.0	3.1)	[	] Crystalline
CARSON (T24 R06E)	(685)	(		)	(	)	[	] Unconsolidated
DEWEY (T25 R07E)	(5818)	(< 1.0	< 1.0	< 1.0)	(20.8	)	[	24.7] Crystalline
DEWEY (T25 R08E)	(15158)	(		)	(3.6	)	[	] Crystalline
EAU PLAINE (T25 R07E)	( )	(		)	(< 3.0	< 3.1)	[	] Crystalline
EAU PLAINE (T25 R07E)	(2643)	(		)	(	)	[	] Crystalline
EAU PLEINE (T25 R06E)	(1739)	(		)	(5.6	)	[	] Crystalline
GRANT (T22 R07E)	(115)	(		)	(	)	[	] Crystalline
GRANT (T22 R07E)	( )	(		)	(< 3.0	< 3.0)	[	] Crystalline
HULL (T24 R08E)	( )	(		< 1.0)	(< 3.0	)	[	] Crystalline
HULL (T24 R08E)	(183)	(		)	(< 3.0	< 3.3)	[	] Crystalline
HULL (T24 R08E)	(11854)	(1.6	1.6	< 1.0)	(12.1	)	[	6.0] Crystalline
HULL (T24 R08E)	(140)	(		)	(3.4	)	[	] Unconsolidated
HULL (T24 R08E)	(5271)	(		)	(	)	[	] Crystalline
HULL (T24 R08E)	( )	(		)	(26.7	10.4)	[	] Crystalline
HULL (T24 R08E)	( )	(1.9	1.9	< 1.0)	(	)	[	20] Crystalline
HULL (T24 R08E)	(11090)	(		)	(	)	[	] Crystalline
HULL (T24 R08E)	(< 213)	(		)	(	)	[	] Unconsolidated
HULL (T24 R08E)	(766)	(		)	(	)	[	] Unconsolidated
HULL (T24 R08E)	(186)	(		)	(	)	[	] Crystalline
HULL (T24 R08E)	( )	(		)	(28.4	)	[	] Crystalline
HULL (T24 R08E)	( )	(4.0	1.8	2.2)	(	17)	[	] Crystalline
HULL (T24 R08E)	(300)	(		)	(	)	[	] Unconsolidated
LINWOOD (T23 R07E)	(1171)	(		)	(	)	[	] Crystalline
LINWOOD (T23 R07E)	( )	(		)	(7.4	5.6)	[	] Crystalline
NEW HOPE (T24 R10E)	(123)	(		)	(< 3.0	< 4.9)	[	] Unconsolidated
NEW HOPE (T24 R10E)	(< 49)	(		)	(< 3.0	< 4.8)	[	] Unconsolidated
NEW HOPE (T24 R10E)	(< 49)	(		)	(< 3.0	< 4.9)	[	] Unconsolidated
PINE GROVE (T21 R08E)	(310)	(		)	(	)	[	] Unconsolidated
PLOVER (T23 R08E)	(459)	(		)	(< 3.0	< 3.2)	[	] Unconsolidated
PLOVER (T23 R08E)	( )	(		)	(< 3.0	)	[	] Crystalline
PLOVER (T23 R08E)	(3672)	(		)	(< 3.0	)	[	] Crystalline

RADIOACTIVITY IN NCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	(TOTAL RADIUM	RADIUM 226	RADIUM 228)	(GROSS ALPHA	GROSS BETA)	[URANIUM]	WATER SOURCE
PLOVER (T23 R08E)	(411)	(		)	(	)	[ ]	Unconsolidated
PLOVER (T23 R08E)	(< 291)	(		)	(	)	[ ]	Unconsolidated
PLOVER (T23 R08E)	(< 220)	(		)	(	)	[ ]	Unconsolidated
PLOVER (T22 R09E)	(291)	(		)	(	)	[ ]	Unconsolidated
SHARON (T25 R09E)	(8625)	(		)	(< 3.0	3.4)	[ ]	Crystalline
SHARON (T24 R09E)	(423)	(		)	(	)	[ ]	Crystalline
SHARON (T25 R09E)	(1118)	(		)	(	)	[ ]	Unconsolidated
SHARON (T24 R09E)	(280)	(		)	(	)	[ ]	Unconsolidated
SHARON (T25 R09E)	(1951)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T24 R09E)	( )	(		)	(9.4	)	[ ]	Sandstone
STOCKTON (T24 R09E)	(24756)	(		)	(	)	[ ]	Crystalline
STOCKTON (T23 R09E)	(< 75)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T24 R09E)	( )	(		< 1.0)	(< 3.0	)	[ ]	Crystalline
STOCKTON (T24 R09E)	(12998)	(< 1.0	< 1.0	< 1.0)	(	)	[156.8]	Crystalline
STOCKTON (T24 R09E)	( )	(< 1.0	< 1.0	< 1.0)	(93.2	52.1)	[88.0]	Crystalline
STOCKTON (T24 R09E)	(653)	(		)	(	)	[ ]	Crystalline
STOCKTON (T24 R09E)	( )	(< 1.0	< 1.0	< 1.8)	(11.2	)	[14]	Crystalline
STOCKTON (T24 R09E)	( )	(		)	(8.7	5.9)	[ ]	Crystalline
STOCKTON (T24 R09E)	(351)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T23 R09E)	(335)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T24 R09E)	(< 220)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T24 R09E)	(< 194)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T24 R09E)	(210)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T24 R09E)	(< 195)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T24 R09E)	(360)	(		)	(	)	[ ]	Unconsolidated
STOCKTON (T24 R09E)	(381)	(		)	(	)	[ ]	Unconsolidated
** Vilas								
ARBOR VITAE (T40 R07E)	( )	(		< 1.0)	(< 3.0	)	[ ]	Unknown
ARBOR VITAE (T40 R06E)	(< 208)	(		)	(	)	[ ]	Unconsolidated
BOULDER JUNCTION (T42 R07E)	(2071)	(		)	(< 3.0	< 3.0)	[ ]	Crystalline
BOULDER JUNCTION (T41 R06E)	(620)	(		)	(	)	[ ]	Unconsolidated
CLOVERLAND (T40 R09E)	(1828)	(		)	(	)	[ ]	Unconsolidated
CONOVER (T41 R11E)	(888)	(		)	(< 3.0	< 4.0)	[ ]	Crystalline
CONOVER (T41 R10E)	(< 198)	(		)	(	)	[ ]	Crystalline
LAC DU FLAMBEAU (T40 R04E)	(327)	(		)	(< 3.0	< 4.0)	[ ]	Crystalline
LAC DU FLAMBEAU (T40 R05E)	(563)	(		)	(< 3.0	< 4.0)	[ ]	Crystalline
LAC DU FLAMBEAU (T40 R04E)	( )	(		< 1.0)	(< 3.0	)	[ ]	Crystalline
LAC DU FLAMBEAU (T40 R05E)	(418)	(		)	(	)	[ ]	Unconsolidated
LAND O' LAKES (T43 R08E)	(535)	(		)	(	)	[ ]	Unconsolidated
LINCOLN (T40 R10E)	(2644)	(		)	(16.0	9.0)	[ ]	Crystalline
LINCOLN (T40 R10E)	( )	(< 1.0	< 1.0	< 1.0)	(	)	[ ]	Crystalline
LINCOLN (T40 R10E)	(< 254)	(		)	(	)	[ ]	Unconsolidated
LINCOLN (T40 R10E)	(362)	(		)	(	)	[ ]	Unconsolidated
LINCOLN (T40 R10E)	(< 258)	(		)	(	)	[ ]	Unconsolidated
LINCOLN (T40 R10E)	(< 218)	(		)	(	)	[ ]	Unconsolidated
MANITOWISH WATERS (T42 R05E)	(265)	(		)	(< 3.0	< 4.0)	[ ]	Unconsolidated
MANITOWISH WATERS (T42 R05E)	(568)	(< 1.0	< 1.0	< 1.0)	(< 3.0	< 4.6)	[ ]	Unconsolidated
PHELPS (T42 R12E)	(1960)	(		)	(< 3.0	< 4.6)	[ ]	Crystalline
PHELPS (T41 R11E)	(< 256)	(		)	(	)	[ ]	Unconsolidated
PLUM LAKE (T41 R09E)	(353)	(		)	(	)	[ ]	Unconsolidated
PLUM LAKE (T41 R08E)	(< 218)	(		)	(	)	[ ]	Unconsolidated
PRESQUE ISLE (T43 R06E)	(293)	(		)	(	)	[ ]	Unconsolidated
PRESQUE ISLE (T44 R06E)	(970)	(		)	(	)	[ ]	Unconsolidated
ST GERMAIN (T40 R08E)	(< 197)	(		)	(	)	[ ]	Unconsolidated

RADIOACTIVITY IN NCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	(TOTAL RADIUM	RADIUM 226	RADIUM 228)	(GROSS ALPHA	GROSS BETA)	[URANIUM]	WATER SOURCE
WASHINGTON (T40 R11E)	(< 215)	(		)	(	)	[ ]	Unconsolidated
** Wood								
(T R)	(6801)	(		)	(	)	[ ]	Unconsolidated
ARPIN (T24 R04E)	(1075)	(		)	(< 3.0	)	[ ]	Crystalline
AUBURNDALE (T25 R04E)	(2752)	(		)	(< 3.0	)	[ ]	Crystalline
AUBURNDALE (T25 R04E)	(1368)	(		)	(< 3.0	)	[ ]	Crystalline
AUBURNDALE (T25 R04E)	(2611)	(		)	(4.9	)	[ ]	Unconsolidated
CAMERON (T25 R03E)	(365)	(		)	(	)	[ ]	Unconsolidated
DEXTER (T22 R03E)	(2868)	(		)	(4.4	< 3.2)	[ ]	Crystalline
GRAND RAPIDS (T22 R05E)	( )	(6.8	1.6	5.2)	(7.2	)	[ ]	Crystalline
GRAND RAPIDS (T22 R05E)	(2284)	(		)	(< 3.0	)	[ ]	Crystalline
GRAND RAPIDS (T22 R06E)	(551)	(		)	(< 3.0	< 3.2)	[ ]	Crystalline
GRAND RAPIDS (T22 R06E)	(257)	(		)	(	)	[ ]	Unconsolidated
GRAND RAPIDS (T22 R06E)	(227)	(		)	(	)	[ ]	Unconsolidated
GRAND RAPIDS (T22 R06E)	(< 250)	(		)	(	)	[ ]	Unconsolidated
GRAND RAPIDS (T23 R06E)	(359)	(		)	(	)	[ ]	Unconsolidated
GRAND RAPIDS (T22 R06E)	(280)	(		)	(	)	[ ]	Unconsolidated
HANSEN (T23 R04E)	(2407)	(		)	(37.4	26.6)	[ ]	Crystalline
HANSEN (T23 R04E)	( )	(13.4	8.3	5.1)	(	)	[10]	Crystalline
HANSEN (T23 R04E)	( )	(< 1.0	< 1.0	< 1.0)	(8.4	)	[ ]	Crystalline
HANSEN (T23 R04E)	(6294)	(1.2	1.2	< 1.0)	(11.5	)	[10.2]	Crystalline
HANSEN (T23 R04E)	(5513)	(		)	(	)	[ ]	Unconsolidated
HANSEN (T23 R04E)	(6601)	(		)	(	)	[ ]	Unconsolidated
HANSEN (T23 R04E)	(6966)	(		)	(	)	[ ]	Unconsolidated
HILES (T22 R02E)	( )	(1.2		1.2)	(< 3.0	)	[ ]	Crystalline
LINCOLN (T25 R02E)	(7243)	(		)	(< 3.0	< 3.2)	[ ]	Crystalline
LINCOLN (T25 R02E)	(403)	(		)	(	)	[ ]	Unconsolidated
MARSHFIELD (T25 R03E)	(503)	(		)	(< 3.0	)	[ ]	Sandstone
MARSHFIELD (T25 R03E)	(1334)	(		)	(6.7	)	[ ]	Crystalline
MARSHFIELD (T25 R03E)	(991)	(		)	(< 3.0	< 3.0)	[ ]	Crystalline
MARSHFIELD (T25 R03E)	(783)	(		)	(	)	[ ]	Unconsolidated
MARSHFIELD (T25 R03E)	(1604)	(		)	(	)	[ ]	Unconsolidated
MCMILLAN (T26 R03E)	(260)	(		)	(	)	[ ]	Unconsolidated
MCMILLAN (T26 R03E)	(530)	(		)	(	)	[ ]	Unconsolidated
MILLADORE (T25 R05E)	( )	(		< 1.0)	(< 3.0	)	[ ]	Unknown
MILLADORE (T25 R05E)	(3689)	(		)	(< 3.0	)	[ ]	Crystalline
MILLADORE (T25 R05E)	(4431)	(		)	(< 3.0	)	[ ]	Crystalline
PORT EDWARDS (T21 R05E)	(< 74)	(		)	(< 3.0	< 3.2)	[ ]	Sandstone
PORT EDWARDS (T21 R05E)	(< 198)	(		)	(	)	[ ]	Unconsolidated
PORT EDWARDS (T R)	(< 200)	(		)	(	)	[ ]	Unconsolidated
PORT EDWARDS (T22 R05E)	(< 270)	(		)	(	)	[ ]	Unconsolidated
PORT EDWARDS (T21 R05E)	(275)	(		)	(	)	[ ]	Unconsolidated
RICHFIELD (T24 R03E)	(104)	(		)	(< 3.0	< 3.1)	[ ]	Crystalline
RICHFIELD (T24 R03E)	(10080)	(		)	(	)	[ ]	Unconsolidated
RUDOLPH (T23 R06E)	(665)	(		)	(< 3.0	)	[ ]	Crystalline
RUDOLPH (T23 R06E)	(1856)	(		)	(< 3.0	< 4.4)	[ ]	Crystalline
RUDOLPH (T23 R06E)	(400)	(		)	(< 3.0	)	[ ]	Crystalline
SARATOGA (T R)	(625)	(		)	(	)	[ ]	Unconsolidated
SARATOGA (T21 R06E)	(209)	(		)	(	)	[ ]	Unconsolidated
SARATOGA (T21 R06E)	(266)	(		)	(	)	[ ]	Unconsolidated
SARATOGA (T21 R05E)	(288)	(		)	(	)	[ ]	Unconsolidated
SENECA (T22 R05E)	(< 173)	(		)	(	)	[ ]	Unconsolidated
SIGEL (T23 R05E)	(577)	(		)	(< 3.0	< 3.3)	[ ]	Crystalline
WOOD (T23 R03E)	(1531)	(		)	(	)	[ ]	Unconsolidated

RADIOACTIVITY IN MCD WATER SUPPLIES
(all results in pico curies / liter)
(pCi/l)

TOWNSHIP NAME	RADON	(TOTAL RADIUM	RADIUM 226	RADIUM 228)	(GROSS ALPHA	GROSS BETA)	[URANIUM]	WATER SOURCE
WOOD (T23 R03E)	(297)	(		)	(	)	[ ]	Unconsolidated

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