Kewaunee County
Land & Water Conservation Committee

Special Meeting
August 29th, 2013

Meeting Minutes

The local USDA Natural Resources Conservation Service (NRCS) held its annual Door and Kewaunee County Local Work Group meeting at the Kewaunee County Land & Water Conservation Department on August 29th, 2013.

The Committee meeting was called to order by Brian Paplham at 9:00 a.m.

The Work Group meeting was called to order by Joe Johnson (NRCS District Conservationist) at 9:00 a.m.

Those in attendance from Kewaunee County included Land & Water Conservation Committee members Brian Paplham, Chuck Wagner, Bob Garfinkel and Ron Paider, as well as Department staff Paul Fredrich and Andy Wallander.

After introductions, Johnson presented information on the USDA's Environmental Quality Incentives Program (EQIP).

The group then reviewed and discussed the following topics

1. Local funding pools, area funding pools, and ranking process
2. Statewide practice list and payment caps
3. Identification of priority resources concerns
4. Recommendations for local ranking questions for local funding pools
5. Recommendations for area and state fund pool questions

The meeting adjourned at 11:00 a.m.

Minutes drafted by Andy Wallander.

Charles R. Wagner

Charles Wagner, LWCC Secretary

Kewaunee County
Land and Water Conservation Committee
Committee Meeting Minutes
Kewaunee County Fairgrounds
625 Third Street, Luxemburg, Wisconsin 54217

Aug 13, 2013

Committee Chairman Brian Paplham called the meeting to order at 8:00 a.m. Other committee members present for the meeting were, Ron Paider and Chuck Wagner. Bob Garfinkel and Clark Reimer were excused.
Also present for the meeting were, Andy Wallander - County Conservationist, and Joe Johnson – NRCS District Conservationist.
Paider moved to approve the meeting agenda and the minutes from the last meeting. Wagner seconded the motion. All voted in favor of the motion.
Andy started the meeting informing the committee there were no notices of non-compliance. There was no input from the public at the meeting, written or in person.
Andy informed the committee of a public meeting that will be held at the Land & Water Department on September 5, 2013. The meeting is for the explanation and public comment on the Ebert Irrigation System grant application. The meeting will start with an explanation of the system from 9-10 a.m. followed by a public comment period from 10 until all comments are received.
The Department has received its' first payment from DATCP for the staffing grant. The check was for $107,194. There is another payment from them in December. The staffing grant payment for 2014 will total $117,788. This increase is due to the increase put into the Governors new budget. The Department will also be receiving more than $100,000 in SEG and Bond funding from WDNR for this year.
Andy discussed a project from some time back where the county received funding for cost sharing on an NR 243 project for a farm. All of the funding was not used on the project. Andy contacted DATCP and they informed him we can keep the funding but it must be used for conservation purposes in the department. The funds may be used for equipment for the department as well. Andy stated that the department is in need of updating some of their computers. The committee discussed putting the funds into the 'outlay' area of his next budget and designate the funds for the computers. Andy will discuss this with the County Administrator as he does his budget for 2014.
There was one FFP approved in the last month. It was for WOLF 42 LLC.
Andy will be giving his annual report to the full board at the August meeting. The committee discussed at length Andy's document entitled "Protecting Groundwater Quality and the Public's Health in Shallow Bedrock Areas". Wagner moved to include the document with the minutes for this meeting. Paider seconded the motion. All voted in favor of the motion. The full board is strongly encouraged to carefully read through the document and be prepared to ask any questions they may have concerning this issue.
Joe was at the meeting to inform the committee about a workshop on Aug 29, 2013 at 9 a.m. at the L&W offices for the EQIP program. Andy will put out an agenda due to the interest from the entire committee.
Wagner stated that the WLWCA has hired a new office manager. She is Kimberly Warkentin. She is very talented and comes with a tremendous amount of political and conservation background. She will be a valuable asset to the association.
The committee set tentative dates and times for future meetings. They are; Sept 10th @ 8 a.m., Oct 8th @ 8 a.m., Nov 5th @ 8 a.m. and Dec 4th @ 8 a.m. All meetings will be at the office in Luxemburg.
The committee reviewed the bills. Paider moved to approve the bills. Wagner seconded the motion. All voted in favor of the motion
Paider moved to adjourn the meeting. Wagner seconded the motion. All voted in favor. The meeting was adjourned at 9:27 a.m.

Respectfully submitted;
Charles R. Wagner.
Chuck Wagner/Secretary.

Kewaunee County

LAND & WATER CONSERVATION DEPARTMENT

DATE: August 20th, 2013
FROM: Andy Wallander, County Conservationist
TO: Kewaunee County Board of Supervisors
SUBJECT: Protecting Groundwater Quality and the Public's Health in Shallow Bedrock Areas

With budget discussions coming up, I am aware that the County Board has a range of important topics to address. However, I believe protecting the public's health and welfare (as it is influenced by the groundwater our local citizens consume daily) is no less important a topic for serious consideration by the Board. I appreciate the time and effort that I am asking of you to seriously consider this information and the following request. I know this is a lot to read, but it truly is very important.

I am asking the County Board to support, through its Land & Water Conservation Committee, the formation of a knowledgeable "working group", with the specific charge being 1) reviewing the Final Report of the Northeast Wisconsin Karst Task Force, and 2) working through how some of the Report's recommendations can be adopted locally, through county ordinance, in order to prevent contamination of the County's groundwater resources in areas having shallow fractured bedrock. I am asking that this workgroup begin its tasks over the upcoming winter months.

Background

Back in 1989, at the beginning of my job here in Kewaunee County, I would often have the chance to talk with farmers during field visits. In talking with many of the farmers (the "old timers", as they called themselves) there was a recurring theme. During early spring, and after heavy rains, their well water smelled or tasted different, was a little cloudy, and in some cases, ran out of the faucet as a brown stream. They told me this had been going on for many years. The "old timers" would simply send empty jugs along with their kids to bring home "cleaner" water from school. Back then, people just seemed to put up with it being almost an annual springtime event.

A great deal of rural well water testing has taken place in northeast Wisconsin since then. As a

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result, there has been corresponding efforts to come up with more effective local groundwater protection strategies, specifically in areas of shallow soil depths to fractured bedrock, or what is referred to as "Karst" topography (see attached *"Karst and shallow carbonate bedrock in Wisconsin"* for more information). I have also noticed that the rural public's perception that groundwater quality is continuing to get worse has grown through the years. During the early 2000s, as certified lab reports started coming back with more rural wells showing up with unsafe levels of bacteria and nitrate, protecting groundwater quality increasingly became one of the top environmental concerns in the County.

In March of 2004, Kewaunee County saw a highly publicized case of well water contamination, resulting in Scott and Judy Treml (along with Midwest Environmental Advocates) pursuing legal action against a local farmer and the State of Wisconsin. The Door County peninsula has remained a highly researched, and publicized area of Karst groundwater contamination concerns. Calumet County has also been in the media spotlight for its groundwater quality concerns due to shallow Karst bedrock.

After a particularly highly publicized 2006 groundwater contamination event in the Town of Morrison (Brown County), the "Northeast Wisconsin Karst Task Force" was formed. The Task Force coincided with a concerted effort undertaken by groundwater quality professionals, and land and water conservation committees and staff from the counties of Brown, Calumet, Door, Kewaunee and Manitowoc, to convince state legislators of the need for state-level rules allowing more focused, robust and effective local regulations to protect groundwater quality in the most vulnerable of Karst areas in northeastern Wisconsin. The Wisconsin League of Conservation Voters even adopted this groundwater quality protection effort as one of its four top statewide conservation priorities during its annual legislative lobby day in Madison.

Although there were some legislative "champions" for this issue down in the state capitol building, and quite a few state lawmakers at least personally agreed with the concepts and recommendations outlined in the *Final Report of the Northeast Wisconsin Karst Task Force* (**http://learningstore.uwex.edu/Final-Report-of-the-Northeast-Wisconsin-Karst-Task-Force-P1394.aspx**), in the end, state rules allowing adoption of adequately effective local regulations addressing these shallow bedrock areas were never adopted. In fact, since that time it has actually become more burdensome for local governments to adopt meaningfully effective local regulations for groundwater protection in Karst areas if they even appear any more restrictive than the current statewide, "one-size-fits-all" regulations and standards.

Well Testing in Kewaunee County

Since 2004, the Kewaunee County Land & Water Conservation Department (LWCD) has coordinated a basic, voluntary county-wide well testing program for rural private well owners through the University of Wisconsin – Stevens Point Water and Environmental Analysis Laboratory (WEAL). WEAL is a state-certified, state-of-the-art facility capable of analyzing a wide range of groundwater parameters including metals, nutrients, and pesticides. Davina Bonness, LWCD Water Quality Specialist, has been our lead staff person working very diligently on this program. Paul Fredrich, LWCD Soils Specialist, has also assisted quite a bit with the field logistics of the program. Please see the attached LWCD Well Testing Program Report for more information.

The goal of our well testing program was, and has remained, "to introduce private rural well owners to the importance of regular, periodic well testing". As a side benefit, the program has also provided data that has helped the LWCD in its ongoing effort to map areas within the County that have the greatest vulnerability to groundwater contamination.

From a human health standpoint, the most important tests that a rural private well owner should perform on a regular schedule include those for bacteria and nitrate. Although the bacteria and nitrate results obtained through our LWCD well testing program were never designed to directly trace a well contamination event back to a specific source, standing at the wellhead and taking note of the surrounding landscape can often reveal the most likely land use practices that could be causing contamination of the groundwater aquifer. For a more specific determination of a pollution source, more sophisticated, rigorous and costly testing would need to be undertaken, such as, for example, microbial source tracking (MST). Currently, such testing is beyond the ability, and budget, of the LWCD.

I would like to point out that no matter how in-depth an explanation we provide to the public regarding the limits of our local LWCD program results, there continue to be many different analyses being given by members of the public-at-large as "interpretations" of the results and, more specifically, exactly who and what, are the causes for a "bacteria positive" or "elevated nitrate" test result. In actuality, once again, our well testing program was never designed to be sophisticated enough for this level of analysis. All I can truly say about a "bacteria positive" or an "elevated nitrate" well test result is that it indicates that the underlying aquifer, where the well is drawing its water from,

is being negatively impacted by surrounding land use(s).

Concerning Groundwater Quality Protection in Our Shallow Bedrock Areas

Based on the education and experience that I have, geology books and university research studies I have read about Karst, as well as many discussions with professional groundwater specialists, geologists and hydrogeologists through the years, here are what I believe are the "facts", as they pertain to groundwater quality protection in the County's shallow bedrock areas.

1. Land use practices provide contaminants (e.g. bacteria and nitrate, etc.) that "percolate" down through the soil, during the process referred to as groundwater "recharge". Groundwater recharge takes place at varying rates of speed, depending on differing soil types, precipitation amount and intensity, crop uptake, snowmelt, etc. In Karst areas, however, the depth of soil to fractured bedrock is the prime factor governing the speed of groundwater recharge.

2. The soil's depth (or thickness) to underlying bedrock matters. Especially if the bedrock is fractured, such as the fractured carbonate limestone, referred to as "Karst", that underlies Kewaunee County. Groundwater contaminant attenuation (i.e. natural cleansing, filtering), through physical, chemical and biological processes, takes place during percolation through the soil profile, with attenuation rates decreasing as the soil depth gets shallower to fractured bedrock. Once percolating contaminants reach fractured bedrock, no pollutant attenuation takes place, just quick and efficient transport down to, and within, the underlying groundwater aquifer. Depths of 20 feet or less to fractured bedrock are often considered "shallow" by hydrogeologists and groundwater specialists, as far as contaminant transport and attenuation potential are concerned.

3. In shallow fractured bedrock areas, the combination of readily available contaminants from surface and near-surface land uses, along with quick and efficient groundwater recharge rates, causes the underlying groundwater aquifer to be susceptible to contamination on a chronic basis. This is witnessed at the surface by contamination events at wells drawing from the contaminated aquifer below.

4. From conversations with many professional groundwater specialists, geologists and hydrogeologists through the years, I have come away with the belief that current federal, state and local rules, regulations, statutes and codes covering land application of wastes (especially in liquid forms) are not robust or effective enough for areas where there is underlying shallow fractured bedrock.

5. Although land application of liquid wastes other than manure, as well as percolating effluent from some rural on-site septic systems, are likely contributing an unknown percentage of overall contaminant load to the groundwater in shallow fractured bedrock areas, the percentage from septic effluent and other liquid waste is likely quite small compared to the widespread use of rural land for manure application in Kewaunee County.

6. Application of liquid manure provides quicker, more readily available quantities of contaminants (i.e. bacteria and nitrate, etc.) than solid manure application. Especially during periods when the soil's biological, chemical and physical attenuation processes are slowed down, such as when soils are frozen, snow-covered or saturated.

7. From the perspective of groundwater quality protection, this problem will never be solved looking at it as a "farm-size" issue. It must be addressed as a "waste application on shallow fractured bedrock soils" issue. Although, with agriculture being such a huge percentage of the land use in Kewaunee County's rural areas, manure application, especially in liquid form, on shallow soils will, no doubt, need to be an important part of the discussion.

8. Locally adopting, and codifying through county ordinance, any of the recommendations found in the *Northeast Wisconsin Karst Task Force's Final Report* would be a huge step toward helping to protect Kewaunee County's groundwater quality, and as such, play an important role in protecting the public's health and welfare. Actually, the Kewaunee County Board previously adopted a resolution (September 18th, 2007) in support of the Task Force's Final Report.

9. Without more robust and effective local regulations for waste application in Kewaunee County's shallow fractured bedrock areas, I believe the quality of the County's groundwater resource will continue to be increasingly at risk, with the number of local groundwater

contamination events growing to be a more serious problem as time goes on. It is time to do something.

So once again, I am asking the County Board to support, through its Land & Water Conservation Committee, the formation of a knowledgeable "working group", with the specific charge being 1) reviewing the Final Report of the Northeast Wisconsin Karst Task Force, and 2) working through how some of the Report's recommendations can be adopted locally, through county ordinance, in order to prevent contamination of the County's groundwater resources in areas having shallow fractured bedrock. Again, I am asking that this workgroup begin its tasks over the upcoming winter months.

What I envision, at this time, is a group comprised of people who have a working knowledge of groundwater hydrology in Karst bedrock systems, groundwater quality monitoring, public health, ordinance development, and cost-sharing programs drawn from the LWCD staff and Committee, University of Wisconsin System, local NRCS, as well as DNR groundwater specialists and DATCP. The final work product would be a draft proposed ordinance that would then go through broad public and agency review and comment (along with editing, if necessary), with a final draft county ordinance being submitted to the county board for approval and adoption.

I would welcome the opportunity to try and answer any questions you might have regarding this request and I would be happy to discuss this topic with you as best I can. For your information, I have also attached copies of depth to bedrock map for the County, as well as an example of one of many research projects done on Karst here in Northeast Wisconsin. I can provide a copy of the Task Force's Final Report if you are unable to download a copy from the internet link given above.

Thank you again for your time and serious consideration of this request.

- Andy Wallander, County Conservationist

Report to County Board on LWCD Well Testing Program

Since 2004, the Kewaunee County Land & Water Conservation Department (LWCD) has coordinated a basic level, voluntary county-wide well testing program for rural private well owners through the University of Wisconsin – Stevens Point Water and Environmental Analysis Laboratory (WEAL). WEAL is a state-certified, state-of-the-art facility capable of analyzing a wide range of groundwater parameters including metals, nutrients, and pesticides.

The goal of the well testing program has remained "to introduce private rural well owners to the importance of regular, periodic well testing". As a side benefit, the program has also provided data that has helped the LWCD in its ongoing effort to map areas that are vulnerable to groundwater contamination.

From a human health standpoint, the most important tests that a rural private well owner should perform on a regular schedule include those for bacteria and nitrate. The bacteria and nitrate results obtained through the LWCD's well testing program are not precise enough to directly trace a well contamination event back to a specific source. However, standing at the wellhead and taking note of the surrounding landscape can oftentimes reveal the most likely land use practices that could be causing contamination of the aquifer that the contaminated well is drawing from. For a more specific determination of a pollutant source, more sophisticated, rigorous and costly testing would need to be undertaken.

Once again, the LWCD program is not precise enough to indicate specifically who and what, are the causes for a "bacteria positive" or "elevated nitrate" test result. In actuality, the well testing program was never designed to be precise enough for this level of analysis. All one can truly say about a "bacteria positive" or an "elevated nitrate" well test result through this program is that it indicates that the underlying aquifer, where the well is drawing its water from, is being negatively impacted by surrounding land use(s).

Local Well Sampling Results – "The Raw Data"

The actual raw data results from the LWCD's most recent March 18th, 2013 sampling round are as follows:

- Total wells sampled – 59
- Coliform Positive Test Results – 9 wells (15.3%) ***Unsafe for human consumption***
- *E. Coli* Positive Test Results – 1 well (1.7%) ***Unsafe for human consumption***
- Elevated Nitrates of 2.1 through 9.9 parts per million – 14 wells (23.7%) ***Safe for human consumption but shows an increasing level of surrounding land use impacts (Note: 2.0 parts per million or less is considered within natural levels for northeastern Wisconsin)***
- Elevated Nitrates of 10.0 parts per million or greater – 7 wells (11.9%) ***Unsafe for consumption by pregnant mothers and infants under 6 months of age***
- Wells Testing Unsafe due to Bacteria Present and/or Nitrates above the Human Health Standard of 10.0 parts per million – 13 wells (22.0%) ***Unsafe for human consumption***

As of June 26th, 2013, since the LWCD began the testing program back in August of 2004, the actual raw total data results are as follows:

- Total individual wells sampled – 483
- Coliform Positive Test Results – 80 samples (16.6%) ***Unsafe for human consumption***
- *E. Coli* Positive Test Results – 19 samples (3.9%) ***Unsafe for human consumption***

- Elevated Nitrates of 2.1 through 9.9 parts per million – 69 samples (14.3%) ***Safe** for human consumption but shows an increasing level of land use impacts (Note: 2.0 parts per million or less is considered within natural levels for northeastern Wisconsin)*
- Elevated Nitrates of 10.0 parts per million or greater – 34 samples (7.0%) ***Unsafe** for consumption by pregnant mothers and infants under 6 months of age*
- Wells Testing Unsafe due to Bacteria Present and/or Nitrates above the Human Health Standard of 10.0 parts per million – 149 samples (30.8%) ***Unsafe** for human consumption*

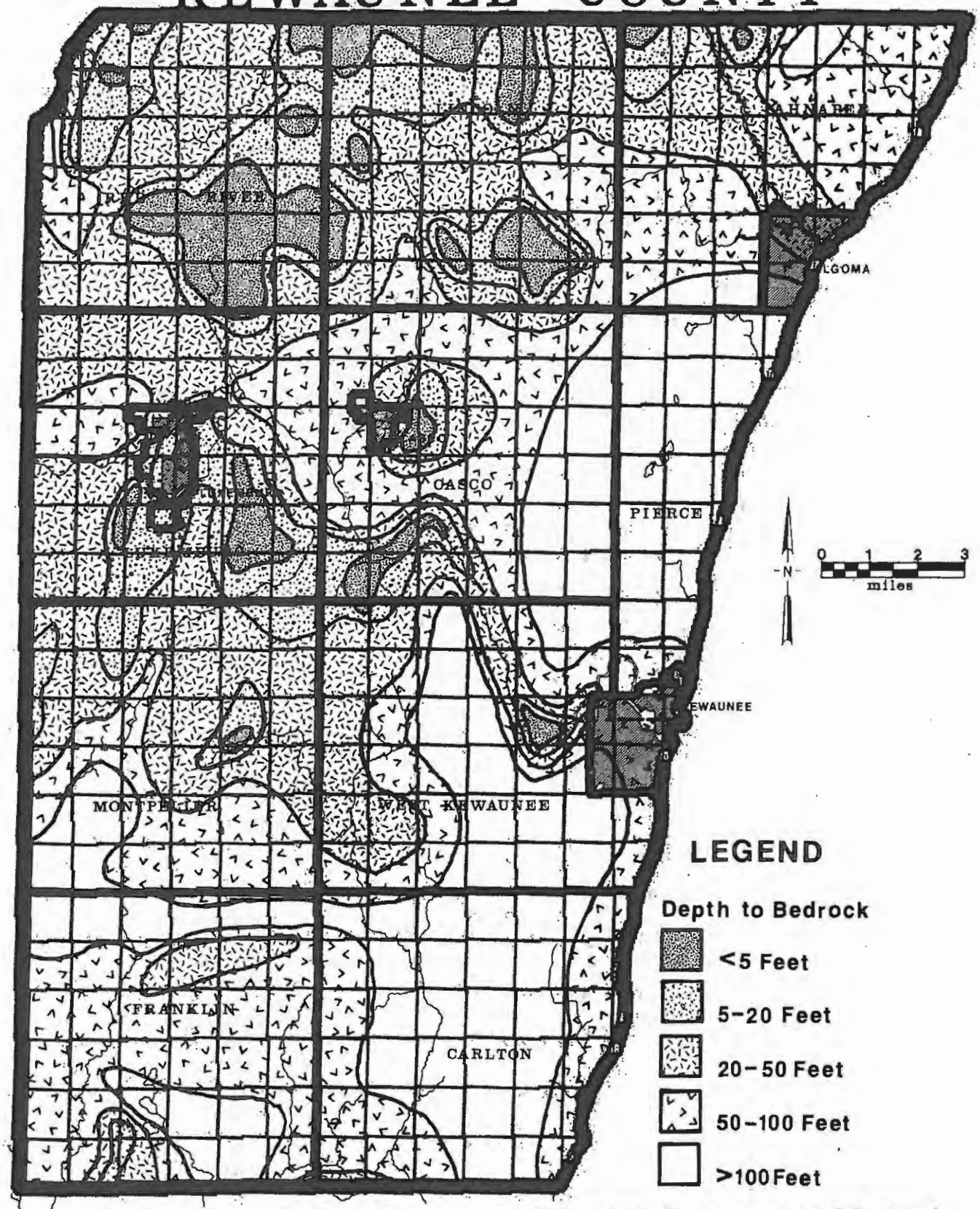
Quick Total Summary of Township Well Test Results as of June 26th, 2013

Township	Number of Wells Tested	Results = Safe	Results = Unsafe
Ahnapee	29	25 (86.2%)	4 (13.8%)
Carlton	26	20 (76.9%)	6 (23.1%)
Casco	64	48 (75.0%)	16 (25%)
Franklin	45	37 (82.2%)	8 (17.8%)
Lincoln	75	37 (49.3%)	38 (50.7%)
Luxemburg	68	48 (75.0%)	20 (25%)
Montpelier	31	23 (74.2%)	8 (25.8%)
Pierce	25	19 (76.0%)	6 (24.0%)
Red River	79	44 (55.7)	35 (44.3%)
West Kewaunee	41	33 (80.5%)	8 (19.5%)
TOTAL	**483**	334 (69.2%)	149 (30.8%)

Information current as of June 26th, 2013

Kewaunee County
Land & Water Conservation Department
625 Third Street
Luxemburg, WI 54217
(920)845-9742

DEPTH TO BEDROCK
KEWAUNEE COUNTY



Source: United States Geologic Survey and Wisconsin Department of Natural Resources.

Fracturing and bedding in an exposure of carbonate bedrock near Sturgeon Bay in Door County.

Karst and shallow carbonate bedrock in Wisconsin

Wisconsin Geological and Natural History Survey 2009

Carbonate bedrock, rock formations composed primarily of limestone or dolomite, underlie the southern third of Wisconsin in a V-shaped belt (see map on other side). These rocks are commonly fractured, with the fractures providing primary pathways for groundwater movement.

Carbonate rocks are soluble, and percolating surface water can enlarge fractures to form conduits, caves, and sinkholes that are the hallmarks of a **karst** system and its related karst landscape.

In Wisconsin, karst landscapes are direct evidence of underlying shallow, fractured carbonate bedrock. But the lack of classic karst features in a landscape does not mean that shallow fractured carbonate bedrock is absent, or that the groundwater is potentially any less vulnerable to contamination.

Carbonate bedrock and groundwater contamination

Carbonate formations are important aquifers in Wisconsin. These aquifers supply water for homes, farms, cities, industries, and other human uses as well as maintaining water levels in lakes and wetlands and flows in streams and springs.

Carbonate aquifers are exceptionally vulnerable to contamination for two reasons:

- Groundwater flow in fractured rocks and karst systems can be extremely rapid—tens to hundreds of feet per day.
- Carbonate rocks are poor at filtering or otherwise removing contaminants.

Some site-specific questions to ask about carbonate aquifers

Carbonate aquifers are particularly vulnerable where overlying soils are thin or absent. There are numerous examples of groundwater contamination of carbonate aquifers in such settings in Wisconsin. Consequently, land-use activities in areas of carbonate rock must be carefully managed to avoid the release of contaminants to groundwater.

Types of questions to ask:

- Is carbonate bedrock present in the subsurface?
- How deeply is it buried? In other words, what is the thickness of the overlying material?
- What is the nature of the overlying material? For example, what is its origin, composition, grain size, etc?

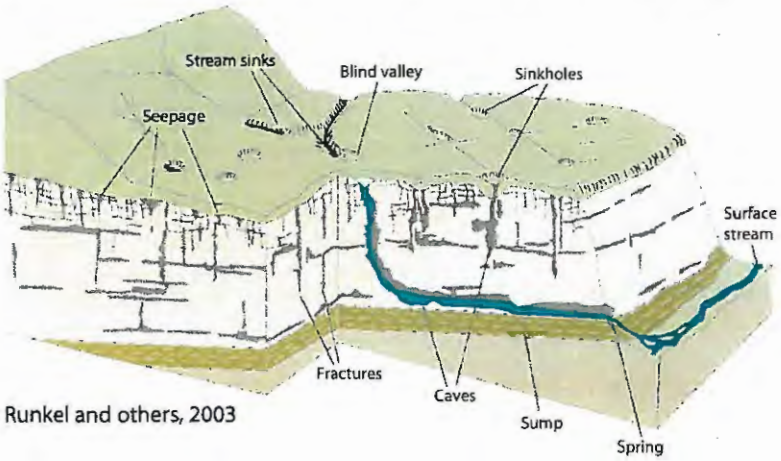
Water- and land-use management plans in areas with carbonate bedrock should always address these sorts of questions as they seek to protect groundwater quantity and quality.

For more information, contact

Kenneth R. Bradbury, Ph.D.
Wisconsin Geological and Natural History Survey
608.263.7921, krbradbu@wisc.edu

UW Extension
Cooperative Extension

Typical features of a karst sytem and landscape: Seepages, sinkholes, caves, fractures, springs, and stream sinks.

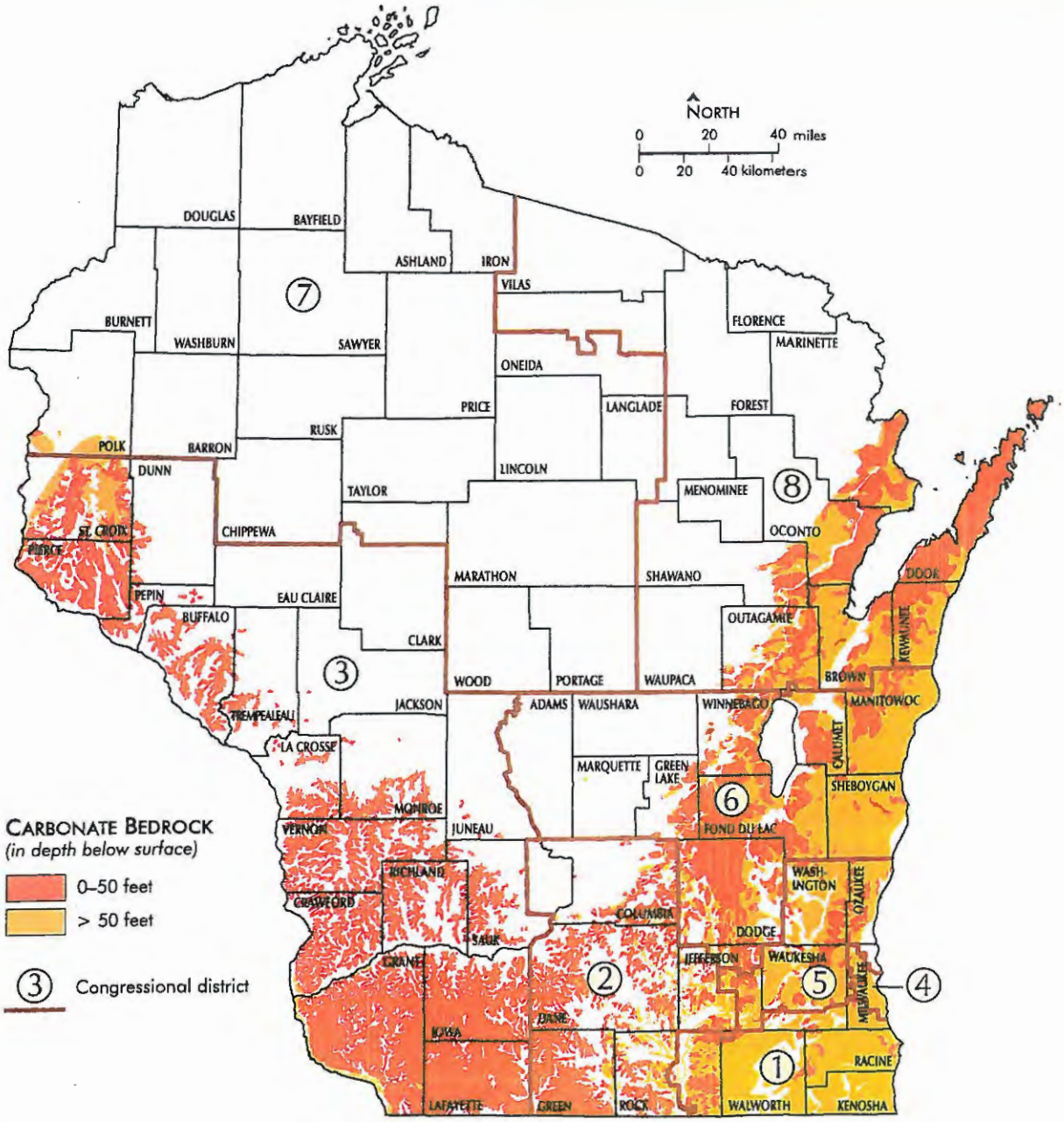


Runkel and others, 2003

Karst and shallow carbonate bedrock in Wisconsin

Wisconsin Geological and Natural History Survey 2009

Areas with carbonate bedrock within 50 feet of the land surface are particularly vulnerable to groundwater contamination.



UW Extension Cooperative Extension

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Director and State Geologist: James M. Robertson

ASSESSING SEASONAL VARIATIONS IN RECHARGE AND WATER QUALITY IN THE SILURIAN AQUIFER IN AREAS WITH THICKER SOIL COVER

Project Identification: DNR project #198

Principal Investigators: Dr. Maureen A. Muldoon, Dept of Geology, University of Wisconsin-Oshkosh; Dr. Kenneth R. Bradbury, Research Hydrogeologist/Professor, Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension

Period of Contract: 7/1/2007-8/31/2008

Objectives:

The goal of this project was to gain an understanding of seasonal variations in recharge, the timing of recharge events, and the resulting water-quality variations in the Silurian dolomite aquifer in areas with 10 feet or more of surficial sediment.

Background/Need:

The fractured Silurian dolomite aquifer is an important, but vulnerable, source of drinking water in northeast Wisconsin. Well contamination events in the Town of Morrison in Brown County (Green Bay Press Gazette, Feb 8, 2006) and Cooperstown in Manitowoc County (Green Bay Press Gazette, May 12, 2008) refocused public attention on the aquifer's susceptibility to contamination. In both events, it appears that manure-contaminated recharge impacted several domestic wells completed in the underlying dolomite aquifer. While these events generated media attention, they are not isolated incidents. Historically, "brown-water" events during spring have been noted in several other counties underlain by the Silurian aquifer – specifically in Door, Calumet, Kewaunee and Manitowoc Counties. In response to these events, Kevin Erb of UW-Extension organized a Northeast Wisconsin Karst Task Force that was charged with developing recommendations for best management practices (BMPs) that would help minimize groundwater contamination in areas underlain by shallow carbonate aquifers with specific attention to BMPs relating to the storage and application of animal wastes.

Previous work in Door County, where soils are typically less than five feet thick, has demonstrated that recharge to the dolomite aquifer can be exceedingly rapid and there was general agreement that the aquifer underlying the Door Peninsula is vulnerable to contamination. Deliberations of the Karst Task Force revealed that there was less consensus on the relative vulnerability of the aquifer in places where the soils were thicker (greater than 5 feet, but less than 50 feet). In reviewing the literature, we were able to locate few field studies of recharge variability in areas where these thicker soils occur over the dolomite aquifer. The need for field data in such settings motivated this study.

Methods:

We installed shallow bedrock wells using air-rotary methods at sites in four counties (Brown, Calumet, Kewaunee, and Manitowoc) where the Silurian aquifer was the uppermost bedrock aquifer and soil was greater than 10 feet thick. All wells were located at the edge of agricultural fields where manure or sewage sludge was being applied. Wells were sited to avoid interference

from septic systems. Geophysical logs were used to identify high-permeability bedding-plane fractures. Water levels and water temperature were recorded every 30 minutes using Solinst Leveloggers™. Each of the wells was also instrumented with a downhole temperature/conductivity probe placed adjacent to a major horizontal fracture. Probes were connected to a surface datalogger that was programmed to record hourly average values. All wells were sampled approximately monthly for nitrate-nitrogen, chloride, and dissolved phosphorus during the period September 2007 to August 2008. Samples were collected by lowering a submersible Grundfos sampling pump into the well to a point opposite the major bedding-plane-parallel fracture penetrated by that well.

Results & Conclusions:

This study documented variations in water levels, fluid temperature and electrical conductivity, and selected water-quality parameters in four wells completed in the Silurian dolomite aquifer. The data collected provide a better understanding of seasonal variations in recharge and the resulting water-quality variations in the aquifer in areas with ~10 to 20 feet of surficial sediment.

Water levels in all four monitoring wells show rapid responses to episodic recharge events throughout the year. Most recharge occurred following snow melt and large rainfall events in the early spring. However, significant recharge also occurred in autumn, winter, and summer. The response to recharge seems to be a function of the thickness and texture of the unconsolidated material. Water-table depth does not seem to be an important control on the response to recharge.

In all wells, rapid drops in fluid conductivity in response to recharge indicate that low-conductivity recharge water penetrated into the saturated zone within a day or two of the recharge event. Water from all four wells contained elevated nitrate-nitrogen and chloride. Average nitrate-nitrogen values in three of the wells exceed the drinking water standard of 10 mg/L and all wells exceeded nitrate standard at some time during year. Chloride values are elevated in all wells. Phosphorus values are elevated in the two shallow wells, but not in the deeper wells. Elevated nitrate and chloride values suggest that land-use activities are affecting water quality in all wells.

Recommendations/Implications:

This study indicates that, even in areas with 10 to 20 feet of soil cover, the Silurian dolomite aquifer is exceedingly vulnerable to contamination from activities at the land surface. Resource mangers should consider the timing of recharge events when developing best management practices for the application of animal wastes and sewage sludge. The fact that recharge water reaches the saturated zone very rapidly and that significant recharge occurs from December to April suggests that manure and sewerage sludge applied during the winter months has the potential to carry pathogens to the aquifer very rapidly.

Availability of report

WDNR, WGNHS

Key Words:

Recharge, fractured carbonates, water-quality