Development of Tools to Address Groundwater in Comprehensive Planning

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PROJECT SUMMARY

Title: Development of Tools to Address Groundwater in Comprehensive Planning

Project I.D.: WRI #: WR04R005; GCC #: 05-BMP-01

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Background/Need:

Groundwater, lakes, rivers, streams, and wetlands are among Wisconsin's greatest natural resources. Fish, wildlife, and plants depend on these water resources to give them life. In order for communities to plan for the future, it is essential that both the quantity and quality of groundwater be protected. Land use decisions can have significant and unanticipated consequences for groundwater resources. Declining water levels and reductions in water quality have already occurred in many parts of the state.

Legislation adopted in Wisconsin in 1999 requires that by January 1, 2010 all communities that make specified land use decisions base those decisions on a comprehensive plan. Despite widespread understanding among groundwater scientists and planners that groundwater needs to be addressed throughout a comprehensive plan, there have been no efforts to track how groundwater is being addressed in the plans.

Objectives:

The objectives of this project are to improve local groundwater planning efforts, and more importantly implementation efforts, by providing examples of high quality plans and real-life examples illustrating how local governments have implemented their plans.

Methods:

We reviewed comprehensive plans that were completed after 2000, submitted to the Wisconsin Department of Administration, and adopted by their respective communities. Our plan review consisted of two phases: Phase I was a preliminary review where we broadly examined how groundwater is being covered in each of the nine comprehensive planning elements. Phase II was a detailed review where we selected a small pool of plans based on the preliminary results to analyze the types of data, policies, and goals included in the plans. In each phase, templates for gathering and analyzing data from the plans were developed with guidance from the advisory group. To minimize any inconsistency between reviewers, an intercoding reliability score was calculated for each plan

Results and Discussion:

In the Phase I review, content analysis on 79 adopted plans found the word "groundwater" appeared most frequently in the agricultural, natural, and cultural resources element of plans, followed by the utilities and community facilities element. The housing and transportation elements, respectively, contain little to no mention of groundwater. Four plans did not mention groundwater in any element.

In the Phase II review, the types of groundwater-related goals, policies and data were analyzed in 29 plans. The number of groundwater-related goals mentioned in these plans was limited. The average number of groundwater goals per plan was 1.4. The average number of groundwater related policies per plan was 8.5. The most common policy category was waste management while the least common policy category was remediation. Only a few of the plans had policies that provide clear information about who will implement the policy and by when. The most common groundwater data include surface watersheds, soil types, and groundwater susceptibility. The least common groundwater data include impervious surface inventory, changes in water table depth, and estimated community groundwater pumping rate.

Our plan review yielded a number of interesting results. The importance of groundwater varies by community and those communities with moderate or high groundwater susceptibility had significantly higher groundwater goal scores than communities with low groundwater susceptibility. We also found communities in counties that have a groundwater protection plan and communities with municipal water systems included more groundwater data in their plan than communities without these resources. Finally, data scores did not correlate with goal or policy scores; nor did goal scores correlate with policy scores.

We also developed five case studies highlighting rural Wisconsin communities that have implemented groundwater protection or remediation measures:

- Municipal well remediation and water conservation: City of Waupaca
- Groundwater education about water quality of private wells and associated policy development: Iowa County and towns therein
- Payments to farmers to grow low nitrogen input crops near municipal well: City of Waupaca
- Municipal well remediation and wellhead protection ordinance: City of Chippewa Falls and Chippewa County
- Groundwater study included in comprehensive plan and groundwater ordinance addressing future development adopted: Town of Richfield, Washington County

Conclusions/Implications/Recommendations:

Based on our review of plans and development of case studies, we recommend the following actions to enhance how groundwater is addressed comprehensive plans:

- Increase citizen activism to heighten the priority of groundwater in local communities
- Hire local government staff and consultants that value groundwater
- Provide education about the costs of groundwater contamination and depletion
- Provide education to help plan writers better interpret and use groundwater information
- Improve the accessibility of groundwater data to plan writers
- Provide funding to support further groundwater studies

Related Publications:

Comprehensive Planning in Wisconsin: Are Communities Planning to Protect Their Groundwater? Part I, Land Use Tracker, Spring 2005

Comprehensive Planning in Wisconsin: Are Communities Planning to Protect Their Groundwater? Part II, Land Use Tracker, Winter 2005

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INTRODUCTION

Groundwater, lakes, rivers, streams, and wetlands are among Wisconsin's greatest natural resources. Fish, wildlife, and plants depend on these water resources to give them life. People depend on these waters for many things, including drinking water, waste assimilation, and recreation. Land use decisions play a key role in groundwater protection, as they can have significant and unanticipated consequences for groundwater resources. Declining water levels and reductions in water quality have already occurred in many parts of the state (Meine, 2003).

Legislation adopted in 1999 (s. 66.1001, *Wisconsin Statutes*) and amended in 2004 requires that by January 1, 2010 all communities that make specified land use decisions base those decisions on a comprehensive plan.

Despite widespread understanding among groundwater scientists and planners that groundwater needs to be addressed throughout a comprehensive plan, there have been no efforts to track how groundwater is being addressed in the plans, particularly since adoption of the comprehensive planning law in 1999. Gathering this information is also important because the quality of plans and resources of the planning agency have been found to drive successful plan implementation (Laurian et al., 2004).

Scope Of This Project

The Center for Land Use Education together with the U.S. Geological Survey evaluated adopted Wisconsin comprehensive plans to understand the extent of groundwater coverage and efforts to protect and manage groundwater in comprehensive plans. Our plan review consisted of two phases: Phase I was a preliminary review where we broadly examined how groundwater was being covered in each of the nine comprehensive planning elements. Phase II was a detailed review where we selected a small number of plans based on the preliminary results to analyze the types of data, policies, and goals included in them. In addition, we also conducted several case studies to document exemplary efforts to protect groundwater.

PROCEDURES AND METHODS

Preliminary Review

We used a database of in-progress and completed comprehensive plans from the Department of Administration (DOA) as of April 2004 to identify comprehensive plans that were completed after 2000 and submitted to the DOA. Only adopted plans were selected for review, which totaled 84 plans for 88 communities. We were able to obtain 79 such plans, which are listed in Appendix B.

We conducted an initial content analysis to determine the extent to which groundwater was covered in these 79 plans. The two reviewers counted the frequency appearance of the word "groundwater" or "ground water" in each element of a plan.

Detailed Review

Based on the preliminary review results and analysis we selected 32 plans with the greatest coverage of groundwater – that is, with the largest number of 'groundwater' hits - to review in more detail. Of these plans 29 were reviewed and analyzed. One consideration during the detailed review selection process was that plans from the same preparer should be avoided[1] so we limited the number of plans from any single author to five.

A plan review template was established in Excel to allow the two reviewers to compile the above parameters independently. The template included three separate spreadsheets; one for issues and goals, one for policies, and one for data. A project advisory group including planners, UW-Extension educators, local government officials and staff and other groundwater specialists was assembled and met multiple times to provide content suggestions for these spreadsheets. The items under each were developed using advisory committee feedback and *Groundwater and its Role in Comprehensive Planning: Comprehensive Planning and Groundwater Fact Sheet 1*.

The issue and goal template recorded any groundwater related goals and scored them with a one or a two based on how directly the goal was related to groundwater. This template also served as a place to simply record groundwater related issues that were identified in the plan, usually in the Issues and Opportunities element. Issues are referenced in the policy template.

Goals were scored with a one or a two; a one was for somewhat groundwater related goals and a two was for directly groundwater related goals. For example, a goal to "coordinate the municipal sewer, water, stormwater and other infrastructure development" would be scored with a one because it is indirectly related to groundwater. A goal to "limit groundwater pollution" would be scored with a two because it is directly related to groundwater.

The policy template had ten categories of policies that the two reviewers looked for: Water Supply, Wellhead Protection, Stormwater Management, Agricultural Practices, Waste Management, Land Conservation, Development Restrictions, Educational Programs, Remediation, Intergovernmental Cooperation and Mining.

See Appendix C for the specific policies under each policy category.

Besides noting the category of a policy, the policy template also scored a policy's language on how passive or active it was, with a one for passive or a two for active. For example if a policy said "encourage water conservation" it would be scored with a one. A policy that said "ensure a 20% decrease in residential water use" would be scored with a two. The policy template also recorded whether a policy addresses any issues identified in the plan, whether a policy indicates who is responsible for implementing it and whether the policy indicates a target date for implementation. The full list of data categories and types in the data template is in Appendix D. The data template also recorded whether the data was presented in text, chart, or map format and whether a reference to groundwater is made when the data is presented.

The plan review templates were revised several times based on test reviews of three plans that were then discarded from the sample, bringing our detailed review sample to 29 plans.

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[1] This is based on the assumption that plans by the same preparer are likely to be similar - in terms of the types of groundwater data included, the extent of groundwater coverage, and types of goals and policies recommended in the plans – since preparer is likely to use a cookie-cutter approach to plan writing.

Consistency Between Reviewers

In order to minimize any inconsistency between reviewers that could arise if each plan was reviewed by one person, an intercoding reliability score was calculated for each plan. Due to the fact that the variation between reviewers was considerable as a result of the wide variations in the format of these plans, we double-coded the policy section of all twenty-nine plans. As for the data section, which was much more straight forward, we randomly selected eighteen plans for double-coding (62% of plans). The intercoding reliability score for the data section is 90% (Berke, 2000).

Case Studies

The advisory group for this project identified Wisconsin communities that have taken steps to protect and/or remediate their groundwater. Based on these suggestions, initial contacts were made and case study communities were chosen based on the following factors:

- Focus on communities that are small, or not "urban." Small communities were chosen because larger communities have more staff and resources available for addressing groundwater issues.
- Describe a variety of groundwater protection/remediation tools
- Focus on tools could be used in many Wisconsin communities
- Seek case studies where there are existing resources for communities who are interested in this tool
- Tools may be broad or specific (i.e. watershed protection or well remediation). For specific tools, groundwater protection should be the main goal in implementing it.
- Achieve a balance between communities that focus on prevention and those that focus on remediation.

The interview questionnaire is provided as Appendix E.

Based on the criteria above and responses from initial contacts, five communities were chosen for case studies, phone interviews were conducted and taped with approval from interviewees, case studies were drafted, sent to interviewees for editing and approval and finalized.

Limitations to Review Process

Comprehensiveness
We reviewed the plans using a template we developed based on the recommendations from the advisory committee. The list of policies we included in the template is based on what the advisory committee believed to be sound policies to be included in comprehensive plans, thus there may be some policies that were overlooked.

Human error
For plans that were reviewed in hard copy form, there is a higher possibility that some coverage of groundwater could have been missed due to human error. In both hard copy and electronic versions of plans, reviewers relied on their reading of a plan, which is usually several hundred pages, thus there was a chance of missing an issue, goal, policy, or piece of data.

Plan format
The organization of a plan was another limitation. Since there is no standard format for comprehensive plans, there is substantial variation in terms of how the nine required elements are presented. Reviewers

could not use a standard review method to find the information they were looking for.

Interpretation of policy's context
Another limitation affecting the analysis of our information was that some policy statements did not fall clearly under any of the ten categories (or the sub-policies under each category) we established. Thus, reviewers had to interpret the context of the policy statement and determine to which category (or the sub-policy) to assign the statement that was under review. Based on the preliminary intercoding reliability test for policies, reviewers sometimes varied greatly in their interpretation of the policy statements that were being reviewed. As a result, to ensure consistency between the reviewers, all policy statements were double-coded (reviewed by two different people).

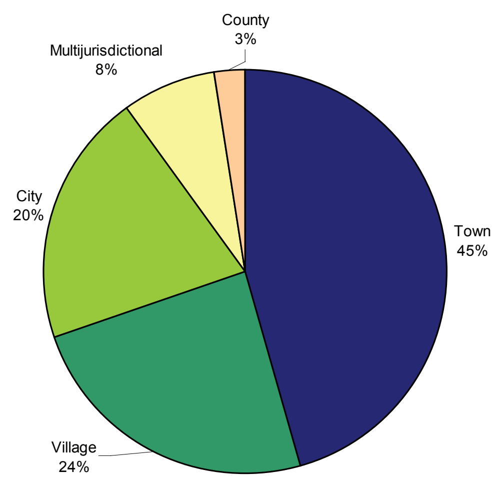
Single point of view
Most of the case studies are based on an interview with one person chosen based on their knowledge, involvement and perceived neutrality. Other people in the communities may have different viewpoints.

RESULTS AND DISCUSSION

Preliminary Plan Review Results

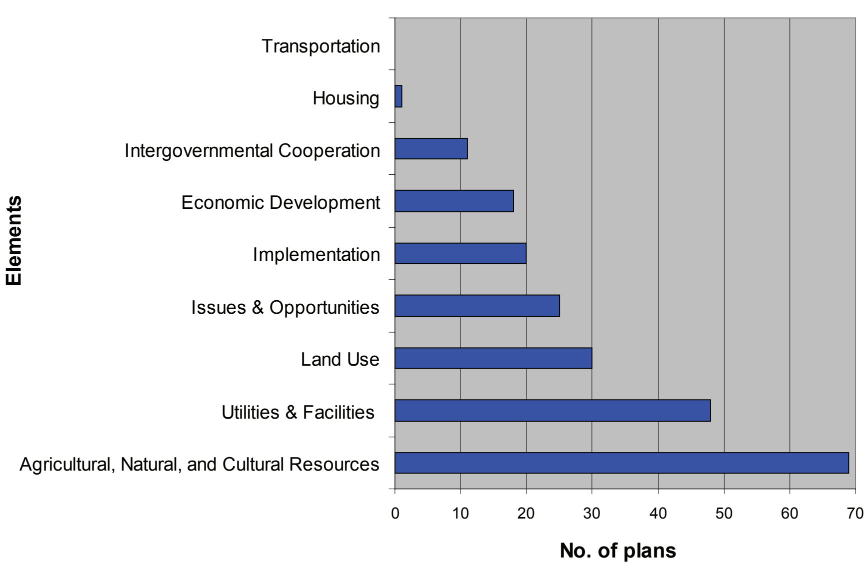
Of the 79 comprehensive plans we reviewed, the majority of plans were completed by towns, followed by villages and cities, mirroring the actual ratios of each type of municipality in Wisconsin. Figure 1 shows the breakdown of plans by community type.

Figure 1: Breakdown of plans by community type



We conducted preliminary content analysis on the 79 plans to determine the extent to which groundwater is covered in each plan. First, we counted how frequently the word "groundwater" appeared in each element of the plans. Figure 2 shows the results. As expected, the agricultural, natural, and cultural resources element contains the most extensive coverage of groundwater. Four plans did not mention groundwater at all. It is important to note that using

Figure 2: Number of comprehensive plans mentioning groundwater in each element



the word “groundwater” as the sole code word may underestimate the extent to which groundwater is covered in these plans, since alternate language could have been used. The purpose of the detailed review in Phase II is to capture these details.

Detailed Plan Review Results

From the 79 preliminary reviewed plans, we selected 29 plans that contained the greatest coverage of groundwater. All of these communities rely on groundwater for drinking water. The detailed review examined the types of goals and policies that are included in the plans, as well as the type and format of groundwater-related data and information.

Among these communities seven have low susceptibility to groundwater contamination while 22 communities have moderate to high susceptibility. Our scoring system shows that average data and policy scores are similar for both low and moderate/high susceptibility communities. However, the average goal score is evidently higher for the moderate/high susceptibility communities. Eighteen communities in the study have municipal sewer service, thirteen have municipal water service/wells, 22 have agriculture, and fourteen have mining activities.

Plan goals related to groundwater

A goal is a general statement describing a desired outcome in a community (CLUE, 2005). The number of groundwater related goals mentioned in these plans was limited. On average, each plan contained 1.4 groundwater-related goals. Twelve plans in the review sample (41%) did not contain any groundwater-related goals. Figure 3 shows the number of goals and policies per plan.

Plan policies related to groundwater

Policies describe courses of action used to ensure plan implementation and to accomplish goals (CLUE, 2005). Often one goal will have two or more policies listed under it, which would help achieve that goal. For instance, if a community goal is “protect groundwater quality,” an associated policy may be “develop a manure storage ordinance.” On average, each plan contained 8.5 groundwater-related policies. The number of policies per plan is shown in Figure 3.

Figure 3: Number of groundwater goals and policies in the 29 plans reviewed in detail

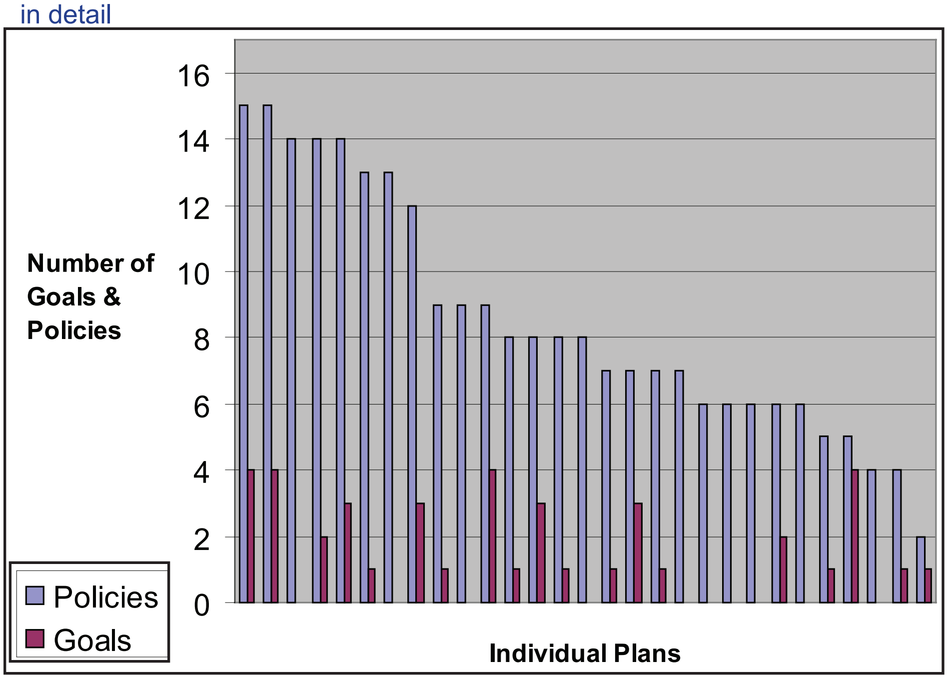


Figure 4

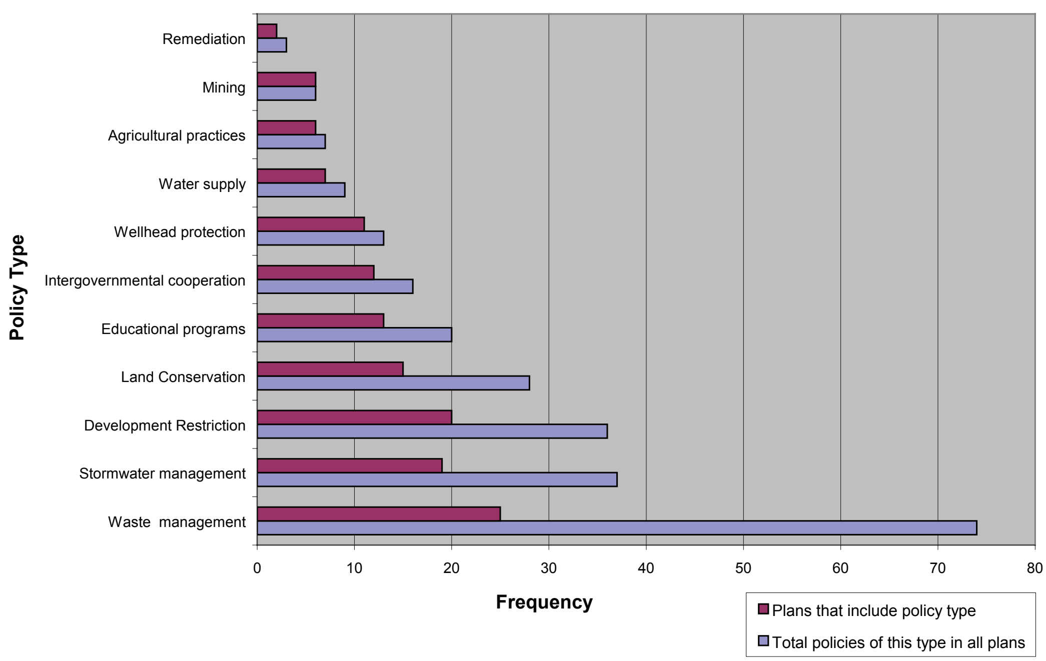


Figure 4 shows the policy categories examined and the number of plans in which they occurred. The most common policy category was *waste management*. (See Appendix C for the specific types of policies included in these categories). The average policy score was 1.43; average indicating that the policies overall were on the weak side.

List of data reviewed

• Surface watersheds	• Existing or potential contaminant sources, such as ○ Nitrates ○ Pesticides ○ Uranium ○ Petroleum products ○ Industrial chemicals ○ Sludge and wastewater disposal ○ Manure storage and spreading ○ Whey spreading ○ Feedlots ○ Septage disposal ○ Junkyards ○ Salt piles ○ Underground tanks ○ Pipelines ○ Highway deicing salt ○ Overpumping induced pollution (arsenic) ○ POWTs (septic systems, holding tanks, etc.) ○ Abandoned wells
• Groundwater flow direction	
• Groundwater time of travel maps	
• Groundwater susceptibility (general)	
• Soils	
• Surficial deposits	
• Type of bedrock	
• Depth to bedrock	
• Depth to water table	
• Slopes greater than 12.5%	
• Municipal wells - current production	
• Municipal wells - capacity	
• Private wells	
• Estimated community GW pumping rate	
• Change in depth of water table	
• Impervious surface inventory	
• Water quality reports	

Data compiled in the plans

Though the guiding principles of a comprehensive plan are the goals, objectives, and policies, the background information provided in the plan is valuable in educating and increasing awareness among residents about their community.

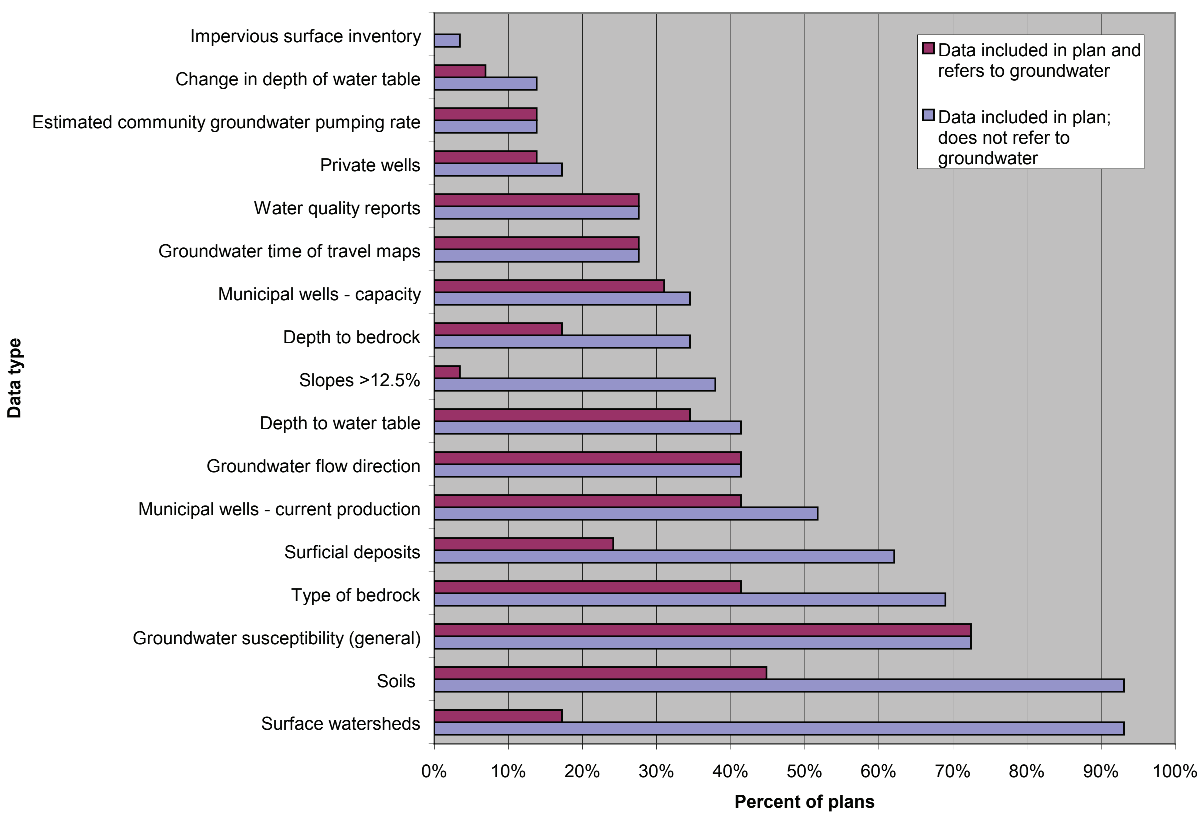
Four basic groundwater questions should be asked when preparing a comprehensive plan:

- Where does your community's groundwater come from? What land area contributes recharge to your community's well(s)?
- What geologic materials provide water for your community's well(s)? Are sensitive/susceptible areas within the recharge area identified?
- How much groundwater do your wells currently produce? Is this amount causing drawdown?
- What are the existing and potential contaminant sources that could impact your wells? (Wisconsin Department of Natural Resources, 2002b)

Based on these questions, we identified a list of data (see previous page) to look for when conducting the detailed review.

Figure 5 shows our findings. The most common groundwater data included in the plans addressed surface watersheds, soil types, and groundwater susceptibility.

Figure 5: Groundwater data in comprehensive plans



Case Study Results

The case study examples selected for this project highlight rural Wisconsin communities that have implemented groundwater protection and/or remediation measures.

Five case studies were written employing the methodology described. The case studies are in Appendix G and focus on the following topics and communities:

- Municipal well remediation and water conservation
- Groundwater education about water quality of private wells and associated policy development
- Payments to farmers to grow low nitrogen input crops near municipal well
- Municipal well remediation and wellhead protection ordinance
- Groundwater study included in comprehensive plan and groundwater ordinance addressing future development adopted

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Importance of groundwater varies by community

The extent to which groundwater is addressed in comprehensive plans varies significantly. Some plans contain extensive groundwater data and policies, while others have little. The type of data and policies in these plans are consistent across plans done by the same plan writers.

Communities with moderate or high groundwater susceptibility had significantly higher groundwater goal scores than communities with low susceptibility. However, these same communities do not have higher policy scores. This suggests that communities with moderate or high groundwater susceptibility are aware of potential groundwater problems, yet they may be unsure how to achieve their goals, may perceive barriers to achieveing their goals, or are unwilling to commit to policies in their plan.

Based on observations made while developing the case studies, nearly all communities that are engaged in groundwater protection efforts have had groundwater problems. One exception was a prevention effort led by a local citizen who was a hydrogeology professor. Because local governments often have many issues to deal with and at least the perception of limited resources, groundwater protection is often not a high priority until problems become apparent.

Availability of groundwater data and the ability to interpret it varies

The type, format, and extent of groundwater information in comprehensive plans is generally limited. When groundwater data or maps are included in plans, little or no attmpt is made to interpret the data. This may be explained in part by the fact that groundwater data is incomplete or inaccessible locally or on a state-wide level. When data is available, plan preparers may not know how to interpret it.

In those communities where groundwater data is available, communities generally made an attempt to incorporate it in local comprehensive plans. We found, for example, that communities located in counties that have produced a groundwater protection plan, incorporated more groundwater information in their comprehensive plans. In addition, communities with municipal water systems (and therefore at least one person responsible for water testing and reporting) included significantly more groundwater data in their plan than communities without municipal water systems.

Policy frequency depends on regulations and local land uses
Groundwater-related policies that are required by state or federal law appeared more frequently in local plans than other policies. Conversely, policies that are resource or issue dependent, such as those related to remediation, mining, or agriculture appear less frequently. Communities that are not facing these issues are unlikely to include them in a local plan.

Weak linkages exist between data, goals and policies
The groundwater data scores did not correlate with goal or policy scores achieved by local communities. This suggests that communities do not consistently require a minimum level of groundwater data before developing goals and policies. We also found that the groundwater goal scores do not correlate with the policy scores. Some communities are including groundwater goals, but are not taking it to the next step by developing associated policies. At the opposite end of the spectrum, some plans include multiple groundwater policies yet include no groundwater goals.

These findings may result from the very expansive nature of comprehensive planning. Communities can easily overlook groundwater or other issues when developing their comprehensive plan, particularly if there is no local champion willing to speak out about groundwater. These findings may also be related to the fact that groundwater planning is complex and new to many communities and planners.

The Wisconsin comprehensive planning law adopted in 1999 requires plans to include goals, objectives, policies, maps and programs for the conservation and effective management of groundwater. While most of the plans we reviewed contained basic groundwater-related data and a smattering of groundwater goals and policies, much remains to be done. Specifically, all plans should include data about current groundwater quality and quantity, groundwater flow direction and potential sources of contaminants. Based on this enhanced data set, local goals and policies should be developed to address local groundwater issues. Planning for groundwater is a long-term community endeavor with many valuable and indispensable benefits.

Recommendations

Based on our review of comprehensive plans, development of community case studies and discussions with key players in groundwater planning, we provide the following recommendations for improving the groundwater component of comprehensive plans.

Increase citizen activism to heighten the priority of groundwater in local communities
The development of a comprehensive plan is steered heavily by local participation. One way to ensure that a comprehensive plan addresses groundwater issues is to invite residents with a strong interest in groundwater to actively participating in the process. Community activism that brings attention to groundwater can spark effective goals and policies.

Hire local government staff and consultants who value groundwater
Groundwater protection measures achieved by many of the communities featured in the case studies were spurred by the actions of a single individual that valued groundwater and persistently sought opportunities to provide education, funding and other resources. Groundwater protection and remediation efforts also depend on support from local government officials and their constituents.

Improve the accessibility of groundwater data to plan writers
Data collection during a comprehensive process may be overwhelming (imagine collecting information

on all nine elements). Data that is convenient, easily accessible and in a format that can be directly utilized in a plan will encourage plan writers and citizen planners to include groundwater data. Increasingly, scientists will need to find ways to better translate scientific information into jargon-free language understandable by the public.

Provide education to help plan writers better interpret and use groundwater information
Most professional planners and community members lack training in groundwater planning. Outreach workshops designed to educate professional and citizen/volunteer planners on how to interpret and use groundwater information would address this need.

Provide funding assistance to support further groundwater studies
Based on the detailed plan review, groundwater data related to grouindwater time of travel, impervious surfaces, and potential contaminants are lacking. These types of information require additional funding to research and investigate.

Provide education about the costs of groundwater contamination
Based on the observation from the community case studies that groundwater protection is often not a high priority until problems become apparent, it may be beneficial to provide education illustrating the costs of groundwater contamination and associated remediation. While the case studies illustrate this to a limited extent, a study of the fiscal impacts of contaminated groundwater in Wisconsin communities may be more effective to demonstrate the cost avoidance potential of groundwater protection measures.

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APPENDIX A: AWARDS, PUBLICATIONS, REPORTS, PATENTS AND PRESENTATIONS

Publications

1. Comprehensive Planning in Wisconsin: Are Communities Planning to Protect Their Groundwater? Part I, Land Use Tracker (Newsletter for the Center for Land Use Education), Spring 2005
2. Comprehensive Planning in Wisconsin: Are Communities Planning to Protect Their Groundwater? Part II, accepted by Land Use Tracker, Winter 2005
3. Comprehensive Planning in Wisconsin: Are Communities Planning to Protect Their Groundwater? submitted to Water Resources IMPACT, September 28, 2005.

Presentations

1. Comprehensive Planning in WI: Are Communities Planning to Protect Their Groundwater? American Water Resources Association Wisconsin conference in Delavan March 3, 2005.
2. Comprehensive Planning in WI: Are Communities Planning to Protect Their Groundwater? Local Government subcommittee of the Wisconsin Groundwater Coordinating Committee, Madison, April 26, 2005.
3. Comprehensive Planning in WI: Are Communities Planning to Protect Their Groundwater? tailored to the Columbia County comprehensive planning process Portage, August 24, 2005.
4. Comprehensive Planning in WI: Are Communities Planning to Protect Their Groundwater? tailored to the Town of Greenville comprehensive planning process, Greenville, September 13, 2005

APPENDIX B: COMPREHENSIVE PLANS REVIEWED

COMMUNITY	TYPE C=city T=town V=village Co = county	COUNTY	DETAILED REVIEW (X = yes)
Rice Lake	C	BARRON	
Bayfield	C	BAYFIELD	X
Clover	T	BAYFIELD	
Wrightstown	V	BROWN	X
Howard	V	BROWN	X
Ashwaubenon	V	BROWN	
Eaton	T	BROWN	X
Scott	T	BURNETT	
Stockbridge	V	CALUMET	
Brillion/Brillion	C/T	CALUMET	X
Thorp	C	CLARK	
Columbus	C	COLUMBIA	
Sun Prairie	T	DANE	X
Waunakee	V	DANE	X
Springfield	T	DANE	X
Mazomanie	T	DANE	
Berry	T	DANE	X
Cottage Grove	T	DANE	X
Dane	T	DANE	
Beaver Dam	T	DODGE	
Emmet	T	DODGE	
Sturgeon Bay	C	DOOR	
Nasewaupee	T	DOOR	X
Brussels	T	DOOR	
Tainter	T	DUNN	X
Colfax	V	DUNN	
Ludington	T	EAU CLAIRE	
North Fond du Lac	V	FOND DU LAC	
Paris	T	GRANT	
Tennyson, Potosi	V	GRANT	
Livingston	V	GRANT	
Fennimore/Fennimore	T/C	GRANT	X
Albany	T	GREEN	
Barneveld	V	IOWA	
Jefferson	Co	JEFFERSON	
Sumner	T	JEFFERSON	X

Watertown	T	JEFFERSON	X
Watertown	C	JEFFERSON	
Franklin	T	KEWAUNEE	
Algoma	C	KEWAUNEE	X
Shullsburg	C	LAFAYETTE	
Belmont	V	LAFAYETTE	
Lincoln	Co	LINCOLN	
Mishicot	V	MANITOWOC	X
Manitowoc Rapids	T	MANITOWOC	X
Kiel	C	MANITOWOC	X
Pound/Coleman	T/V	MARINETTE	
Grover	T	MARINETTE	
Oak Creek	C	MILWAUKEE	
St. Francis	C	MILWAUKEE	
Sparta/Sparta	T/C	MONROE	X
Oakdale	V	MONROE	
Wilton	T/V	MONROE	
Gillett	T	OCONTO	
How	T	OCONTO	
Little River	T	OCONTO	
Maple Valley	T	OCONTO	
Oconto	T	OCONTO	
Hortonville	V	OUTAGAMIE	
Freedom	T	OUTAGAMIE	X
Prescott	C	PIERCE	
Milltown	T	POLK	
St. Croix Falls	C	POLK	
Mount Pleasant	T	RACINE	
Lake Delton	V	SAUK	
Bass Lake	T	SAWYER	X
Plymouth	C	SHEBOYGAN	
Cedar Grove	V	SHEBOYGAN	
Roberts/Warren	V/T	ST. CROIX	X
Somerset	V	ST. CROIX	X
Trempealeau	V	TREMPEALEAU	
Hillsboro	C	VERNON	
Manitowish Waters	T	VILAS	X
Summit	T	WAUKESHA	
Sussex	V	WAUKESHA	
Marion	C	WAUPACA	
Oshkosh	T	WINNEBAGO	X
Menasha	T	WINNEBAGO	X
Nekimi	T	WINNEBAGO	X

APPENDIX C: POLICY CATEGORIES AND POLICIES

1	Water supply
1.1	**Long-term planning** to determine if enough water is available for future development
1.2	Water conservation measures
1.3	Quantity standards for new or existing high capacity wells
2	Wellhead protection
2.1	Wellhead protection plan
2.2	Identify potential contaminant sources
2.3	**Prohibit uses with the potential to contaminate groundwater** - Wellhead protection ordinances that prohibit or prescribe BMPs for these uses
2.4	Identify and/or protect areas for new municipal wells
2.5	Well construction standards (quality)
2.6	Fill abandoned wells
2.7	Limits on new development and/or uses allowed in groundwater recharge areas if recharge areas are separate from the wellhead protection zone
3	Stormwater management
3.1	Stormwater plan
3.2	**Promote infiltration** - limit impervious surfaces and/or encourage raingardens
3.3	**Treatment of stormwater runoff** to remove contaminants before discharge to ground or surface water.
4	Agricultural practices
4.1	Limits on agricultural crops allowed in designated areas
4.2	Agricultural nutrient management plans
4.3	Limitations on agricultural pesticide use
4.4	Manure storage ordinances
5	Waste management
5.1	Wastewater plan (facilities)
5.2	Group septic system standards
5.3	Locate new development or specific types of new development in areas with sewer service
5.4	**Encourage advanced wastewater treatment systems** (local communities are not allowed to require more protective standards than COMM 83, but may encourage them)
5.5	**Hazard waste collection** - Clean Sweep or other programs

5.6	**Landfill siting** - located and designed to protect surface and groundwater
5.7	Urban service or sewer service areas
6	Land Conservation
6.1	**Land acquisition** to protect groundwater
6.2	**Limit road salt use** (usually sodium chloride = NaCl) or use alternative forms of salt to decrease groundwater contamination
6.3	**Encourage/require low groundwater impact land covers** such as forest/woods, prairie, native vegetation (MFL, CRP, CREP, EQIP, local programs)
6.4	**Conservation subdivision standards** that require a portion of the land to be maintained in low groundwater impact land cover.
6.5	**Encourage conservation easements** that protect groundwater through maintaining native vegetation or other means
7	Development restriction/Land regulation
7.1	**Large lot sizes** to protect groundwater for areas with private on-site wastewater disposal systems
7.2	Limit/prevent new residential development in areas with contaminated groundwater
7.3	Encourage land uses that have the potential to pollute groundwater in areas with contaminated groundwater
7.4	Limit residential and commercial fertilizer and pesticide use (one option is through limiting lawn area)
8	Educational programs
8.1	Drinking water testing program
8.2	Other groundwater monitoring program
8.3	Groundwater Guardian program
8.4	Other groundwater education program
9	Remediation
9.1	**A contingency plan for immediate cleanup** to avoid/mitigate groundwater contamination
9.2	Long-term groundwater clean up (brownfields)
10	Intergovernmental cooperation
10.1	Coordination on any of these issues with other local governments
11	Mining
11.1	Water quality
11.2	Water quantity

APPENDIX D: DATA CATEGORIES AND TYPES

What municipal services and local land uses exist?
Municipal water service
Municipal sewer service
Agriculture
Mining
Where does your community's groundwater come from?
Surface watersheds
Groundwater flow direction
Groundwater time of travel maps
Groundwater susceptibility (general)
Soils
Surficial deposits
Type of bedrock
Depth to bedrock
Depth to water table
Are sensitive/susceptible areas within the recharge area identified?
Slopes >12.5%
How much groundwater do your wells currently produce?
Municipal wells - current production
Municipal wells - capacity
Private wells
Estimated community GW pumping rate
Change in depth of water table
Impervious surface inventory
What are the existing and potential contaminant sources that could impact your wells?
Nitrates
Pesticides
Uranium
Petroleum products
Industrial chemicals
Sludge and wastewater disposal
Manure storage and spreading
Whey spreading
Feedlots
Septage disposal
Junkyards
Salt piles
Underground tanks

Pipelines
Highway deicing salt
Overpumping induced pollution (arsenic)
POWTs (septic systems, holding tanks, etc.)
Abandoned wells
Does the quality of the groundwater from your wells meet drinking water standards?
Water quality reports

APPENDIX E: CASE STUDY QUESTIONNAIRE

Case Study Questions for Groundwater Planning Project

What questions are we trying to answer with these case studies?

- Does this type of groundwater protection tool work?
- What does it address?
- Why/how does it work?
- What resources are needed?
  (Check the interviewee's website before interview if possible.)

Introduction

1. Location

2. What groundwater protection strategy was implemented?
   a. Define this tool – *how does it work? Ask for more information to be sent or e-mailed – written description used in its implementation*

Overview/Analysis – People, primary issues and decisions

3. When did this take place?
   Was the tool implemented as part of a plan (e.g. comprehensive, groundwater, or land & water conservation plan)? If so, what goals/objective was it trying to achieve?

4. What was the situation at the time the groundwater protection strategy was put in place?
   Or, did any issues spark the implementation of this tool?
   a. Had there been land use changes? *Development, fragmentation, parcelization, sprawl, development pressure, annexations, new industry etc.*
   b. Any changes with groundwater quality?
   c. What was the economic and political climate like?

5. Who was involved, players?
   Who provided leadership in the change/policy development? *At all levels government, resource managers, public, citizen group, government committee or department, etc.*

6. Why did these people act? *Protect for recreation, tourism, protect economic base, water quality*

7. How did those involved decide what to do? *Public meetings, committee meetings, surveys,* etc.
    a. What other tool options did they consider? What were advantages, disadvantages of some of the options? *Cost, time, resources, interest, etc. Or, why were these tools not chosen in the end? (I suspect there won't be enough time to get into details about the advantages and disadvantages of unselected tools.)*

Decision and effects

8. What was their decision? *Probably the tool we are talking about*
    a. Who was for/against the decision? Why?
    b. How did you convince people who were against it? Or do they still disagree?

9. How much did it cost to implement this strategy? If additional money was spent where did it come from? *Grants, Allocated State money, donations,*
    a. Did you have to hire new staff? What kind of skills did the person need to have to do the work? Did they require training? How much time was spent on the project?
    b. Did you seek any external assistance to help? Was seeking for the assistance easy or difficult?

10. How did people react to the groundwater protection strategy? Did approving and implementing it change the political climate?

11. What were the results on groundwater and on the community? Was it effective? Before vs. after. How long has the change been in place?

12. What would have happened if this type of planning or management was not practiced?

Lessons Learned

13. Suggestions for others trying to do something similar? Anything you would do differently?

14. Do you think there are certain criteria for whether this arrangement would work in a community?

15. Other similar situations you know of? Similar local governments

16. Do you have any additional comments that we have not asked about?

Case study documentation

17. Photos/sketches/maps?

18. Specifics/ specific measurements/ numbers/ specifics on funding/ clarifications?

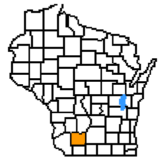
APPENDIX F: ADVISORY COMMITTEE MEMBERS

We thank the following people for serving on our project advisory committee.

Nancy Eggleston, Wood County Groundwater Specialist
Dana Jensen, Vandewalle & Associates
Sally Kefer, Land Use Team Leader, DNR
Tom Larson, Director of Regulatory and Legislative Affairs, Wisconsin Realtors Association
Pam Lazaris, Planning Service & Solutions, LLC, Private planning consultant
Dave Lindorff, Wellhead Protection Team Leader, DNR
Clarence Malick, County Board Chairman, St. Croix County, Wisconsin
Peter Manley, UW-Extension Community, Natural Resource and Economic Development (CNRED) Educator
Kevin Masarik, Groundwater Educator, Central Wisconsin Groundwater Center, UW-Stevens Point
Ed Morse, Groundwater Specialist, Wisconsin Rural Water Association
Dave Neuendorf, UW-Extension CNRED Educator
Paul Ohlrogge, UW-Extension CNRED Educator
Ray Schmidt, Portage County Groundwater Specialist
Aaron Schuette, Senior Planner, Brown County Planning Commission
Jane Silberstein, UW-Extension CNRED Educator
Gary Van Hoof, Town Chairman, Town of Freedom, Wisconsin
Jim Vanderbrook, Wisconsin Department of Agriculture, Trade and Consumer Protection

APPENDIX G: CASE STUDIES

<u>Private well testing and education program leads to comprehensive water study</u>



Iowa County is a rural county in southwestern Wisconsin. Agriculture is practiced on approximately 75% of the land. Most soils are well drained so contaminants tend to move more quickly through the soil.

Issue: Drinking water quality, health, and lack of information

In a 1999 UW-Extension Community Needs Assessment Survey, residents of Iowa County identified groundwater education as an important issue and need. [1] Several towns had also identified groundwater quality as a priority in the beginning stages of comprehensive planning processes.

At this same time the Land Conservation Department received a grant through the Environmental Quality Incentives Program (EQIP) that included money for well testing. Iowa County was eligible for this EQIP grant because of its location in the Ludden Lake watershed area, which was considered a Priority Watershed . This was the first step in developing a county wide drinking water education program.

Approach: Well testing and drinking water education program

The newly hired Community Natural Resources and Economic Development (CNRED) educator became the person responsible for implementing the well testing program. The CNRED educator did extensive outreach about the program including meeting with all 14 town boards.

The program was implemented on a town by town basis. It took two months to test and hold educational sessions for each town, and three years to do the entire county. News releases were sent out offering to test residential wells in the towns while town chairs and board members promoted well testing in their meetings. A newsletter was sent out annually to each resident of the respective towns where testing was being promoted. Towns contributed $100 each for newsletter postage.

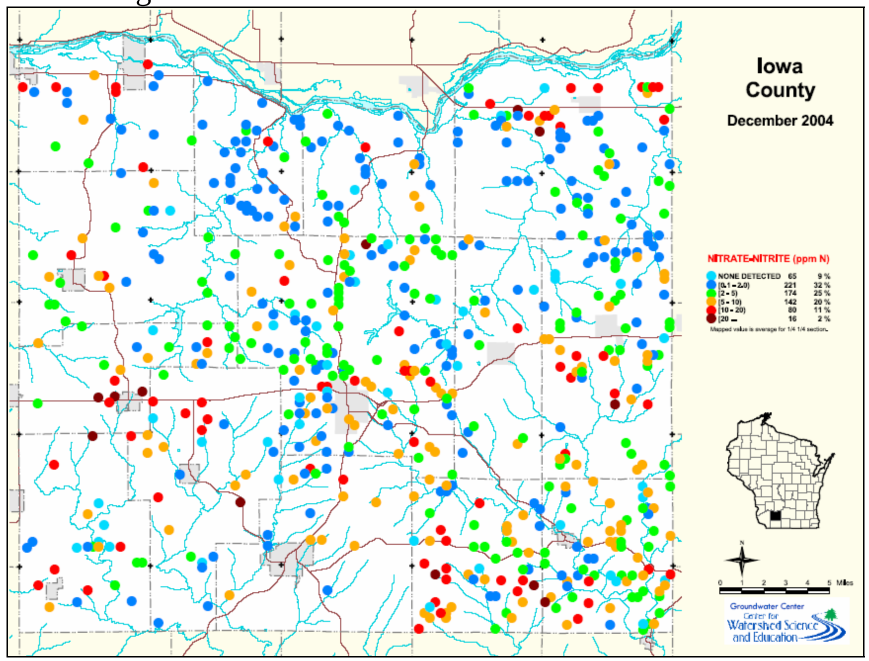
Residents registered for well testing with their town clerk, who gave them a bottle and directions for how to collect the water sample. Residents gathered their water sample in the bottle, returned it to the clerk and the sample was taken to the testing lab. Residents later attended an educational session where they received their test results.

For the first round of testing the bottles and tests were paid for by the EQIP grant. Afterwards, residents were charged $30-$40 for the bottle (depending on the test), which covered the cost of testing and postage.

This program has become very popular. All towns have been tested once and some towns have been tested twice. In 2002, three years after starting the program, 350 wells had been tested. As of 2005, over 900 wells had been tested since the beginning of the program.

Initial results

Test results showed that there were some wells higher in nitrate and coliforms than the state average. About 40% of the wells tested had some trace amounts of atrazine, a common agricultural chemical. Education is still needed; many residents did not know how deep their wells were, when their water was last tested, and whether they had a well casing.



This map shows known nitrate levels in Iowa County. The dots represent the average nitrate level of each ¼, ¼ section. Concentration increases from light blue to dark red. Red and dark red dots represent samples that exceed the health standard for nitrate.

Reflections on Well Testing and Education Program

"**Education is fairly non-threatening and can have a big impact**" – Paul Ohlrogge, Iowa County CNRED educator

Weaknesses

Since the well testing is voluntary, some households who have contaminated water may not be aware of it. Furthermore, these same households will miss out on the educational component of the testing program and may not realize why it is important to test their water.

Strengths: Educational "payoff"

The strategy of using education to improve groundwater is fairly non-threatening if done in the right way. Iowa County has many items to point to that show education can have an impact.

General awareness

- In the second round of testing, people have been asking more "sophisticated" questions, like "how can I plant native vegetation," and "what is the source of our groundwater?".

Groundwater protection and treatment

- One village and the neighboring towns have adopted a wellhead protection ordinance since this well testing program began.

- As a result of testing, some residents have installed anion exchange filters to reduce nitrate levels in areas where it was necessary. Other residents have put well casings further down on existing wells. And people who are installing new wells have requested information and put well casings down further than required. Well casings are steel or plastic pipe installed while drilling a well, to prevent collapse of the well bore hole and the entrance of contaminants.[2]

- The county's well abandonment program has also become more popular since the testing program began. The cost sharing available for abandoning a well has been fully used during 2002 – 2005.

Incorporation into comprehensive planning

Groundwater has been a very conspicuous issue and topic in the comprehensive planning process that Iowa County is undertaking. Town Plan Commissions began asking to use groundwater data as criteria for citing development such as feedlots, automobile shops, subdivisions, etc. They wanted to know if they could make assumptions based on well test results. While it was determined that this was not the most reliable criteria, overall town plan commissions feel like they have learned a lot from the well testing program.

Participation in comprehensive groundwater study

Iowa County decided to apply for a Wisconsin Geological and Natural History Survey (WGNHS) grant to conduct an in depth water study. The grant would fund the development and collection of detailed groundwater data including: a water study and map, and geology map showing aquifers and bedrock, aquifer thickness, aquifer vulnerability, and residential and high capacity well construction. Information from this study *could* be used for criteria in siting new development.

As of spring 2005, residents are interested in the WGNHS project and are asking when the information will be available. A new Iowa County Groundwater Committee made up of local citizens and elected officials was formed in early 2005. This committee is working closely with WGNHS on the groundwater study.

Conclusion

The well testing and education program has brought many benefits. It has been effective at spurring proactive groundwater protection efforts including the current discussion about planning for future groundwater protection.

This case study was written by Bobbie Webster, Lynn Markham and Paul Ohlrogge

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Sources:
1. Ohlrogge, Paul. Drinking Water Quality in Iowa County. September 2002
2. EPA. http://www.epa.gov/seahome/well/src/construc1.htm

Drinking Water Pollution Leads to Water Conservation

Map copyright
Wisconsin Online®

Waupaca County is a rural county in central Wisconsin. 100 percent of is drinking water is from groundwater. The dominant soil type is well drained to excessively drained sand, which allows contaminants to move quickly through the soil into groundwater.[1]

Issue: Decrease of water quantity and quality

The city of Waupaca experienced water quality and quantity issues during the late 1980s and early 1990s. It has since implemented a variety of strategies to protect and conserve groundwater including well remediation and water conservation, which are discussed here, as well as cropping agreements (see separate case study).

Approach: Water Quality

Well remediation

City well number four is down gradient from the former site of a dry cleaning business. A chemical called tetrachloroethylene (PCE) leaked from an underground tank at the cleaners and was found in the drinking water pumped from the well in the mid 1980s. The Department of Natural Resources (DNR) and dry cleaner settled the case, which designated the DNR responsible for cleanup. Residents were still using backyard wells in the area to water lawns at this time.

The contaminated water was pumped out of the well number four and discharged over a rock channel so the PCE could volatilize. The water then ran into the Waupaca River. This did not reduce the amount of PCE in the drinking water and it was costly to pump continually, burning up motors in the process.

The city considered putting in a treatment facility to remove PCE, but it would have cost too much. The Waupaca Public Works director wrote a letter to the secretary of DNR who finally arranged for an extraction well to be placed over the plume of PCE. Within two weeks, the level of PCE in the water coming from the extraction well fell. They continued pumping the extraction well for a couple of months.

The present level of PCE is one to two parts per billion (ppb) compared to a Maximum Contaminant Level (MCL) to protect human health of ten ppb. The well now provides 10-15% of the city of Waupaca's water.

The city adopted a wellhead protection ordinance in 1992. As with other Wisconsin communities, the ordinance was adopted after they experienced drinking water contamination (see Chippewa Falls case study for more on wellhead protection).

"*Conserving water is the right thing to do*" - John Edlebeck,
Waupaca Public Works

Approach: Water quantity

While well number four was off line, the city realized that if any other city well went off line they would not be able to meet the average daily demand for water. They decided to drill two new wells, but also try reducing water consumption.

Industrial water use

The city first worked with the local foundry, which used approximately sixty percent of the city's water. The foundry reduced their water use by about thirty five percent by developing a way to recycle their cupola's cooling water. A cupola is used for molten metal and was the foundry's largest water use. The capital costs for recycling the water were not recovered quickly, but the foundry wanted to be a good neighbor to the city and set an example for residential water users.

Residential water use

Residential watering restrictions were also implemented as a way to reduce water consumption. This was partly at the suggestion of farmers who were not too enthusiastic about having city wells in their backyard that they did not receive water from. Furthermore, the city felt that residents should not take water for granted; conserving water is the right thing to do and they should not depend solely on industry to conserve water. The city persisted with this view even after the two new wells were in use.

The watering restrictions state that every day between noon and seven p.m. there cannot be unattended watering. The city does a small amount of policing, but focuses on educational outreach. They have not issued any ordinance violations, which would impose a $200 fine.

The city also tried to reduce water consumption by tracking high residential water users and offering the 25 highest users a free water use audit of their homes. The audits identified leaks and other areas where water could be conserved and homeowners were given free low flow showerheads, toilet tank bags and low flow aerators to help them reduce their water use. This program is ongoing.

Reflections on water quality and quantity strategies

Weaknesses

Time and money were not utilized effectively in the beginning stages of well remediation, but this was not because of decisions made by the city.

Groundwater is dynamic, so it is difficult to say that groundwater levels have risen directly because of water use restrictions or industrial water conservation.

Strengths

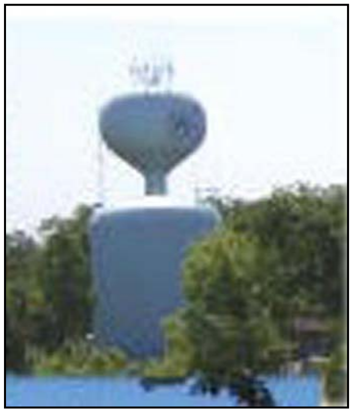
The PCE from the dry cleaners was reduced to below the drinking water standard in a time and cost efficient manner once the extraction well was installed.

The water conservation measures were implemented community wide including both industry and residential customers. Water consumption has decreased and groundwater levels have increased. Water levels in two wells have come up; originally well five was sucking air because the water table was so low. **The city has decreased water consumption overall by twenty five percent since 1994.** All of these efforts took foresight by the Public Works Department and collaboration with adjacent towns and the county.

Conclusion

Waupaca will continue their groundwater protection efforts discussed above and several other strategies including future land acquisition, replacing fuel tanks, reclaimed water recycling and more. Now that well number four has been cleaned up the city is more cautious about locations of certain industries. The water conservation activities are ongoing and do not take much time to monitor now that they have been implemented.

The city of Waupaca has taken some important measures, many of them proactive, to protect its groundwater. These can serve as a model for all Wisconsin communities that do not want to take their groundwater for granted.



City of Waupaca water tower

This case study was written by Bobbie Webster

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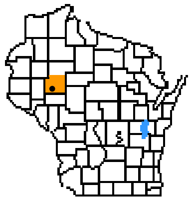
Source
1. Albert, Dennis A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. Gen. Tech. Rep. NC-178. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Jamestown, ND: Northern Prairie Wildlife Research Center Online. <http://www.npwrc.usgs.gov/resource/habitat/rlandscp/s5-1-4.htm> Accessed 2005 May.

Wellhead Protection Plan and Remediation



The City of Chippewa Falls, which is located in rural northwestern Chippewa County, receives 100 percent of its drinking water from groundwater. City soils are deep outwash deposits, which are fairly permeable and allow contaminants to reach groundwater easily.

Issue: High nitrates in City well

In 1985 the City of Chippewa Falls began to see elevated nitrate levels in the groundwater supplying its east wellfield, which provides the City with approximately 60 percent of its water (see map below).

By 1994, nitrate levels began to persistently exceed the federal drinking water standard of ten parts per million.[1] The city looked at options to improve water quality, including installing barrier wells to pump high nitrate water out and taking drinking water from the Chippewa River. The city had been working on a Groundwater Protection Plan since the late 1980s but had not adopted a plan or ordinance.

The city began groundwater monitoring studies in 1985 to try to identify the source of nitrate contamination. Shortly after, they began work on a proactive wellhead protection plan. Later, the city reacted directly to the source of nitrate contamination.

First Approach: Chippewa Falls Wellhead Protection Plan established

In 1990 the county together with the city and some neighboring townships began work on the Duncan Creek Priority Watershed (DCPW) project. An outcome of this project was a management plan for the watershed which recommended a wellhead protection(WHP) program for the county.

The county received funding to prepare a wellhead protection plan in 1993; $40,000 was in grants through WDNR and $8,000 was from the City of Chippewa Falls. The cost for ongoing groundwater monitoring studies conducted between 1985 and 1995 funded by the City totaled $160,700.[3] A consultant had previously delineated and mapped recharge areas, and time of travel zones for city wells; this information was used as the basis for two wellhead protection zones around each wellfield; a more restrictive zone closest to the well and a less restrictive zone around this zone (see table below).

By 1996 when the funding for the DCPW project ended, a model wellhead protection plan and ordinance describing the two wellhead protection zones had been written for the county. This ordinance can be used in any town, village or city in the county, as well as any community in the state. The City of Chippewa Falls and Chippewa County collaborated on and adopted this ordinance knowing it would help ensure the protection of their groundwater.

Why worry about Nitrates?

- Nitrates form in groundwater because of nearby fertilizer use, barnyard runoff, and septic systems.
- Nitrates are especially harmful to infants who can develop "blue baby syndrome" after drinking water high in nitrates.
- Pregnant women who drink nitrate-contaminated water during pregnancy are more likely to have babies with birth defects.[5]
- A high nitrate level may mean that your water also has bacteria or farm chemicals.[6]

Additional Measures

A newsletter was also published and distributed annually to all residents within the five year zone of contribution to the city's wells between 1996 and 1999. The newsletter explains ground water movement, present problems and future concerns, and explains how activities on individuals' property can impact ground water quality.[2]

The city also conducted a Contaminant Source Inventory in 1995 for each wellfield to identify potential sources of groundwater contamination. Between 1962 and 1995 about 285 acres of land were purchased by the city to protect the west wellfield from contamination. This land, which makes up most of the 30-day time of travel in the west wellfield, is left forested or open so that the land is not used for practices that could contaminate the wells.

Reflections on Wellhead Protection Program

Weaknesses

The WHP ordinance does not address pre-existing land uses that are still contaminating the groundwater in the recharge area. One of these uses is a fertilizer plant (see below). Even today, some practices of the existing industries are not sound engineering. These land uses would not have been allowed if the wellhead protection ordinance was in effect before these industries were located in the recharge area.

There are some farms operating in the five to ten year time of travel area that are unregulated by the ordinance and their cropping practices have the potential to contaminate groundwater. Monitoring wells and private wells in the area have shown there is high nitrate in the five to ten year time of travel zone from the wellfields.

The wellhead protection ordinance does not address quantity of water. This could leave the recharge area open to uses that consume large quantities of water that may result in drawdown of the aquifer.

Strengths

By 2001 the city met safe drinking water standards and nitrate was near 6.7 parts per million after treatment and blending.[3] The city and county worked together to protect groundwater. Because some of the recharge area of the municipal wells is not in the city limits, that area is still protected under the county ordinance. In the well recharge area, land uses are now regulated to prevent potentially damaging practices from contaminating drinking water. Some land uses are prohibited. When a conditional use is allowed, the operation must follow Best Management Practices.

As of 1996, all municipal wells in Wisconsin are required to have Wellhead Protection Plans including delineation of well recharge areas. Chippewa Falls' WHP plan exceeds this requirement in two ways: it has an ordinance to help implement its plan, and the recharge areas are based on time travel to the well, rather than a fixed radius around the well, which is less accurate.

Definition: "Time of travel"
(Also known as "zone of concentration" or "zone of contribution")

A specific area of land, that contributes to a well recharge area and where water entering the surface reaches the well after a specific period of time. For example, a drop of water entering the ground in an area defined as a five year time of travel would take five years to reach the well.

Chippewa Falls and Chippewa County Wellhead Protection District

	Time of Travel	Permitted Uses	Conditional Uses	Prohibited Uses
Zone one	30 day time of travel	✓ Parks, playgrounds, beaches, with no on-site wastewater disposal systems or holding tanks; ✓ Wildlife and woodland areas; ✓ Biking, hunting, skiing, nature equestrian and fitness trails; ✓ Municipally sewered residential development; ✓ Agricultural crop production with nutrient management		**Applies to Zones one and two:** Buried hydrocarbon, petroleum or hazardous chemical storage tanks, cemeteries, chemical manufacturers, coal storage, dry cleaners, industrial lagoons and pits, etc.
Zone two	5 year time of travel	✓ All uses in zone one ✓ Parks, playgrounds, beaches with onsite wastewater discharged to a holding tank or municipal sewer ✓ Single family residences on minimum lot size with less than 8,000 gallons per day of sewage ✓ Residential use of above ground LP gas tanks less than 1,000 gallons for heating ✓ Municipally sewered commercial and industrial establishments with less than 20 gallons or 160 pounds of regulated substances in use, storage or production at a time	May request a permit for any use not explicitly prohibited	

Second Approach: Lawsuit Following New Well & Nitrate Removal System

In 1995, the city needed to add another well, which cost $115,000 to install. Nitrate levels were highest in well number one and lowest in well number five. The city could have used water from well five to blend with other water to get the overall nitrate level below the Maximum Contaminant Level (MCL) for human health. However as nitrate levels began trending up, blending would only have been a stopgap measure.

In January 1997 the water utility still needed to install a $2.2 million dollar, $170 per person, nitrate removal system in the east well-field after nitrate levels failed to decrease. [1,3] There are annual costs for chemicals, labor, and maintenance.

Through testing and collaboration with DATCP the city later found that nitrates were coming from a nearby agricultural fertilizer distributor and a possibly from a rendering plant with on-site lagoon. These industries were located near the wellfield. The Department of Agriculture Trade and Consumer Protection (DATCP) had been monitoring spills from the fertilizer cooperative for a couple of years when the city learned that it was a major source of nitrate in the drinking water. Chippewa Falls filed a lawsuit against the local fertilizer cooperative in 2000 after the coop refused to admit liability and participate in remediation efforts.

The lawsuit was settled out of court after multiple years of litigation; continuing with the case would have cost the city too much and was unlikely to recover the entire costs of cleanup, monitoring and new well construction much less result in additional compensation. The city opted for a monetary settlement and continued monitoring of the fertilizer plant by DATCP.

Reflections on Lawsuit and Remediation

Strengths

The fertilizer cooperative was required to pay the city a sum of $525,000. 'The City of Chippewa Falls benefited from the settlement in two ways. The settlement award of $525,000 partially reimbursed the City for the cost of the nitrate removal system. In addition, the City succeeded in increasing the attention to the potential for continued nitrate contamination from the cooperative site.' [1]

DATCP has also forced the original owners of the fertilizer cooperative to continue pay for ongoing investigation and monitoring at the site, as well as sampling of city wells.

The fertilizer cooperative is now under new ownership and management and required to file reports with Department of Agriculture Trade and Consumer Protection (DATCP) on the amount and type of fertilizer and agricultural chemicals handled and applied.

Weaknesses

The settlement did not include discussion to relocate the fertilizer plant and there have still been spills under the new managers. The plant has stopped using rail cars to transport fertilizer and now uses trucks, but still has spill issues. They are also doing more loading and unloading on concrete but dust flies, builds up on the ground and then soaks into the ground. Equipment is parked outdoors where and rain falls on it and carries fertilizer and other agricultural chemical residue off it. There are similar concerns with liquid fertilizer because of leaking tanks and disposal of contaminated rainwater from containment areas. This industry has inherent problems for groundwater contamination.

Future

Through the well testing there have been detections of other agricultural chemicals and breakdown products of agricultural chemicals such atrazine, metalochor, acetochlor but not over the MCL. This is not surprising since the presence of nitrate is often a precursor to other chemicals due to its relatively rapid infiltration into groundwater. City well testing will continue with frequency determined by contaminant levels and trends.

The WHP ordinance will prevent future contamination and future worsening of the groundwater quality. This WHP ordinance will result in the possible reduction of nitrates, storage of fewer hazardous substances in the wellhead protection area, possibly open space and habitat improvement, and improved intergovernmental cooperation. Chippewa Falls has not noticed a significant improvement in groundwater quality since the ordinance was enacted, but it often takes decades for soils and groundwater to be cleansed of contaminants.

Portage County in central Wisconsin implemented a similar WHP ordinance before Chippewa County did. Their program has been successful in deterring groundwater unfriendly businesses. This is part of why Chippewa Falls expects to prevent future contamination; new land uses that could contribute will not be allowed in the recharge area.

Chippewa Falls' experience shows that a WHP ordinance is more effective if implemented before contamination is a problem. However most Wisconsin communities do not have WHP ordinances and will likely only implement them if they experience drinking water contamination first.

This case studv was written bv Bobbie 2:20 and Lvnn Markham

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Timeline of Wellhead Protection plan, remediation efforts, and lawsuit in Chippewa Falls

1985

1993

1995

1996

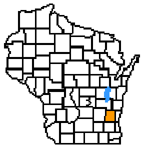
1997

2001

2003

2005

Groundwater study leads to quality town plan



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Washington County is an urban county in south eastern Wisconsin. 100 percent of the county's drinking water is from groundwater. The soil has sand and gravel deposits interspersed in clay, which causes variation in groundwater recharge.

Issue: Lack of groundwater information during comprehensive planning

The Town of Richfield in Washington County, population 11,000 experienced rapid population growth during the early 2000s. The town has a large number of private wells and private on site septic systems.

The town was interested in obtaining better groundwater information to include in its comprehensive planning process. They were seeking information about the location of important recharge areas, water table elevation, groundwater recharge rates, water use and more. This information would be important for making land use decisions in the town.

Also in the early 2000s, the Department of Geosciences at the University of Wisconsin-Milwaukee (UWM) was seeking ways to apply its groundwater expertise to local issues.

Approach: Groundwater study in combination with comprehensive planning process

UWM proposed to conduct a groundwater sustainability study for the town if it would use the information in its plan. UWM had obtained a $60,000 grant from the UW Groundwater Research and Monitoring Program and was looking for a municipality in need of groundwater information. Originally the study had been proposed in 1996 but the town had not been interested. However by 2003 when the study was proposed again, the town had experienced development pressures and was interested in obtaining more information about its groundwater resource.

If successful, the groundwater study protocol could be applied to other municipalities in need of similar information. The study conveniently coincided with the town's comprehensive planning process. The town decided to put a 12-month moratorium on new development while the study was being conducted. They wanted all future development decisions to consider groundwater as well as their usual criteria for siting development.

The groundwater study designed by UWM consisted of:

- determining the hydrogeology of the town
- developing a water budget including:
  - developing water table maps using residential wells
  - measuring stream baseflows
  - estimating recharge rates and pumping rates
- calibrating a ground water flow model to test potential new development approaches
- interacting with leaders and citizens at every step[1]

Hydrogeology

Interaction and effect of: soil types and distribution, bedrock material and depth, water table depth, and topography on groundwater infiltration, movement, availability, and susceptibility to contamination. Or, "determine the plumbing of the groundwater system".[2]

A UWM professor and three students gathered and analyzed the above information for the town. This work cost $60,000 and took two years to complete. The groundwater information was incorporated in the comprehensive plan and influenced the town's goals and objectives.

View of a typical Town of Richfield neighborhood

Reflections on groundwater study

Strengths

The town did not have to pay for the study because it was funded by a grant. This probably helped with acceptability as well.

As a result of the information, Richfield is now planning to keep the density of development below what recharge can support and to protect sensitive areas like wetlands, lakes and recharge areas.[1] Knowing where sensitive areas are located has caused the town to rethink where commercial areas should be. The town also wants to maintain baseflow of its streams and now knows how much groundwater can be used without compromising streams.

Richfield has committed to continued groundwater monitoring and has adopted "conservation development" standards which reduce stormwater runoff and water use.

The town has adopted a Groundwater Protection Ordinance to:

- require developers to quantify water needs and impacts, which will be tested with the model;
- require developers to install permanent monitoring wells on new developments which will be ceded to Town.

Richfield has already used their new groundwater information in deciding on whether to allow a golf course expansion.

Weaknesses

This study did not address water quality in the town. Possible contamination is a factor that the town should know about when making land use decisions.

Applying the protocol

For communities that need to conduct a similar study, it would probably cost about $60,000 but most communities could get by with a less in-depth study than Richfield. The most important information is the most basic and least costly. For instance, a community could use an existing water table map to assess present groundwater resources. Basic water table reports and maps of the entire state dated 1970s to 1990s are available from the WDNR. These maps may be questionable depending on how recent they are and how the community's wastewater is treated. If a community has private wells and waste treatment, the existing maps are probably accurate. Using existing water table maps would save around $8,000 on the study.

If a community is only interested in a snapshot of the present there is no need to build a groundwater model or to monitor homeowners' wells; this approach can reduce the cost of the study by at least 50 percent.

However, to predict effects of future development a community needs a groundwater model. If they want to know what will happen in future and how they can protect their groundwater quantity, they need to know what land uses to avoid and in what areas. This is especially the case when dealing with planning boards and developers where information is needed to address individual projects. For this, a community needs to determine the underlying hydrogeology and this has not been done on a community level in most areas of the state. Determining hydrogeology at a local level is a major time sink, taking more than six months in Richfield, but once completed will serve the community well in perpetuity.

Conclusion

Richfield residents and officials are pleased with how the study provided them with important information that can guide land use decisions. Temporarily, there was some inconvenience but the town can now be proactive with regard to decisions that affect its groundwater, rather than reactive, which is likely to occur when a municipality does not have the information that Richfield does.

This case study was written by Bobbie Webster

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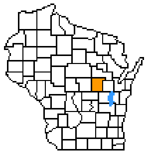
Cropping Agreements to Reduce Nitrates in Drinking Water



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Waupaca County is a rural county in central Wisconsin. 100 percent of is drinking water is from groundwater. The dominant soil type is well drained to excessively drained sand, which allows contaminants to move quickly through the soil into groundwater.

Issue: Decrease of water quality

The City of Waupaca experienced water quality and quantity issues during the late 1980s and early 1990s. It has since implemented a variety of strategies to protect and conserve groundwater including cropping agreements which are discussed here, and well remediation and water conservation (see separate case study).

Since approximately 55% of Waupaca County is agricultural land, which often uses nitrogen based fertilizers, the presence of nitrate has been an issue in city wells. Furthermore, some of the City of Waupaca's wells are located in rural areas outside of the city near agricultural land. In some wells the city was still struggling with nitrate levels close to ten parts per million (ppm) during the early to mid 1990s. Ten ppm is the Maximum Contaminant Level for human health.

The city adopted a wellhead protection ordinance in 1992 and at the advice of the wellhead protection commission, 24 monitoring wells were installed around wells five and six, the two most productive wells.

Why worry about Nitrates?

- Nitrates form in groundwater because of nearby fertilizer use, barnyard runoff, and septic systems.
- Nitrates are especially harmful to infants who can develop "blue baby syndrome" after drinking water high in nitrates.
- Pregnant women who drink nitrate-contaminated water during pregnancy are more likely to have babies with birth defects.[1]
- A high nitrate level can indicate that your water also contains bacteria or farm chemicals.[2]

Approach: Cropping Agreements

The city needed to go beyond monitoring and try to alleviate the nitrate contamination. One way they decided to do this was to reward farmers for growing crops that require less nitrogen fertilizer.

"***The less nitrogen fertilizer put on the ground, the less nitrate will form***" – John Edlebeck, Waupaca Public Works

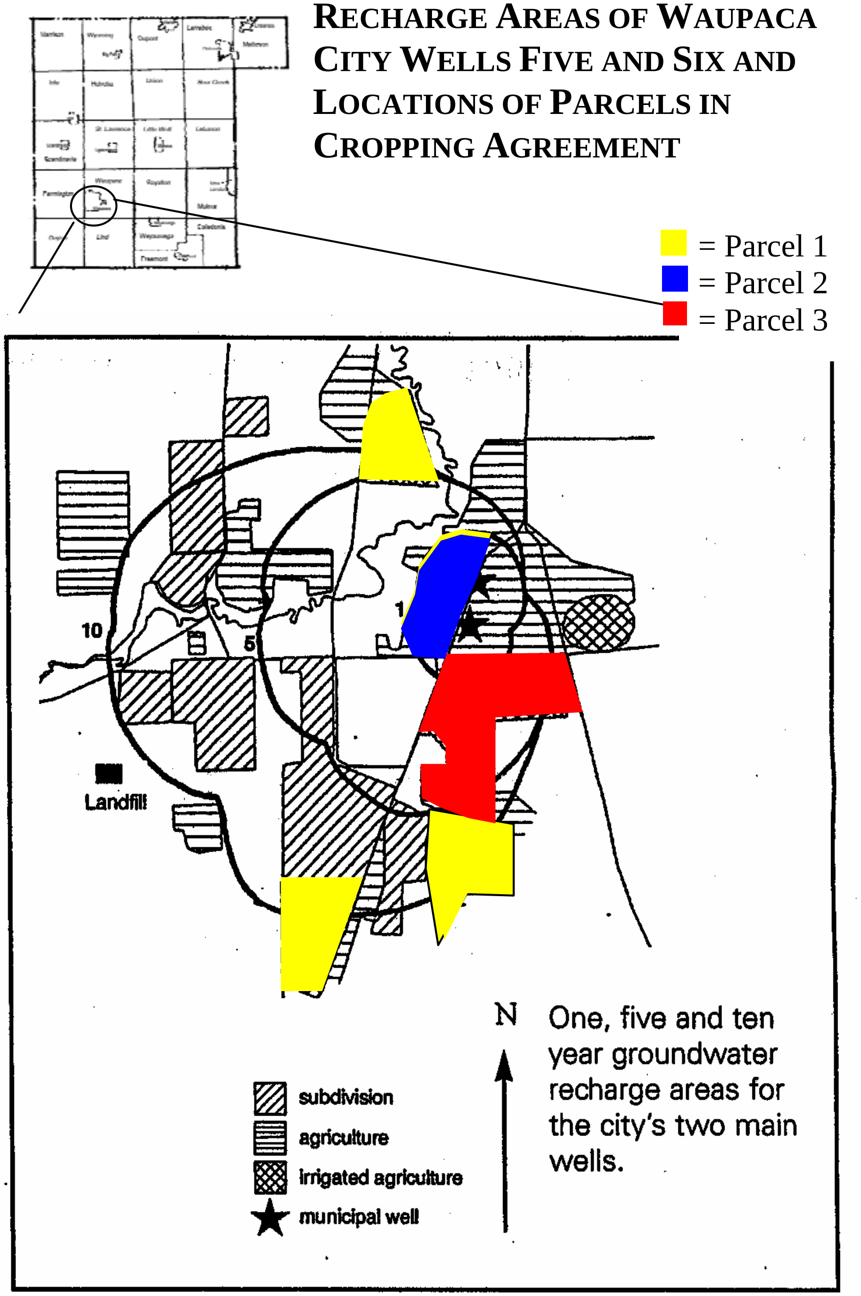
Agricultural properties, notably irrigated cornfields, in the recharge areas of wells five and six were identified (see map below). A cropping agreement with a farmer who owns 208 acres in the recharge area began in 1997. This farmer was paid to switch for one year from irrigated corn to any crop requiring low amounts of nitrogen. The city reimbursed this farmer $20 dollars per acre for harvesting soybeans, which require about three to four times less nitrogen fertilizer than corn. This agreement cost the city $4,160 the first year; the farmer has been rotating corn and soybeans each year since. This farmer currently receives $22.50 per acre. Additional parcels have been enrolled in cropping agreements and there are now three agricultural parcels totaling over 550 acres being rotated with less nitrogen-demanding crops.

Waupaca County cropping agreements

Parcel	Acres	Payment
Parcel 1	208 acres	$4680
Parcel 2	230 acres	$5175
Parcel 3	114 acres	$2565

Parcels 1 and 2 are rotated every year. A portion of parcel 3 is included every year. Parcel 3 is also paid $25 per load per year of manure hauled out of the recharge area.

RECHARGE AREAS OF WAUPACA CITY WELLS FIVE AND SIX AND LOCATIONS OF PARCELS IN CROPPING AGREEMENT



Reflections on Cropping Agreement

The City of Waupaca still struggles with nitrates, which is normal considering the prominence of agriculture and the sandy soils in the county. Well number six was taken off-line for one year because of high nitrates in 2003.

The cropping agreements are voluntary agreements that do have a positive affect on groundwater while allowing farmers to continue their livelihood. They may not be as aggressive as a regulatory program, but overall less nitrogen on the ground equals fewer nitrates in groundwater. Even though nitrates are still a concern, the city is well within compliance of standards now. They take nitrates seriously and are working to keep the level of nitrate low.

The cropping agreements are ongoing and take less time to monitor now that they have been implemented. More farmers have become interested in cropping agreements as they see their neighbors participating; some of these farmers will likely enroll in cropping agreements in the future.

Waupaca's cropping agreements show respect for an important local industry and creativeness in approaching a public health issue. These agreements demonstrate a compromise as well; cities and towns can work together to fulfill economic and ecological needs. Cropping agreements could be applicable to any community that depends on groundwater for drinking, and farming for its local economy.

This case study was written by Bobbie Webster and Lynn Markham

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