# PROCEEDINGS OF THE BOARD OF COUNTY COMMISSIONERS

Date: June 16, 2026 9:00 a.m.

Place: Commissioners Room, Courthouse, Caledonia, MN

Members Present: Cindy Wright, Eric Johnson, Kurt Zehnder, Robert Schuldt, and Greg Myhre

Others Present: Interim Auditor/Treasurer Polly Heberlein, Fillmore County Journal Reporter Charlene Selbee, The Caledonia Argus Associate Editor Kaita Gorsuch, Finance Director Carol Lapham, Coordinator Brent Parker, EDA Director & Coordinator Support Allison Wagner, Engineer Brian Pogodzinski, Interim Attorney Suzanne Bublitz, Assessor Luke Onstad, Environmental Services Director Amelia Meiners, Donna Buckbee, Chris Priebe, Floyd Hackman, John Haines, Robin Danielson, Eric Danielson, Cindy Crestwell-Hatleli, Scott Hatleli, Bev Hanson, Dean Mierau, Steve Hartwick, Jackie Baker, Supervisor Medicolegal Death Investigators Monica Kendall, Chief Medical Examiner Ross Reichard, and R.L. Christensen

Presiding: Chairperson Myhre

Call to order.

Pledge of Allegiance.

Motion was made by Commissioner Johnson, seconded by Commissioner Schuldt motion unanimously carried to approve the agenda.

Motion was made by Commissioner Wright, seconded by Commissioner Johnson, motion unanimously carried to approve the meeting minutes from June 2, 2026. There was one misspelled name that would need to be corrected in the minutes.

Commissioner Wright said there was one misspelled name that would need to be corrected in the Workgroup Session minutes. Motion was made by Commissioner Wright, seconded by Commissioner Zehnder, motion carried to approve the workgroup session minutes from June 9, 2026 with the correction. All Commissioners voted yes except for Commissioner Myhre who abstained due to being absent from the meeting.

Public Comment:

John Haines said he had recently suggested a mortarium on all sand mine applications. He said after the board had reinstated the half mile density rule a variance had been applied for. He said a comment had been made that sand was needed for roads, construction, and septic systems. Haines said he had done research and did not think sand was needed for roads or septic systems. He said gravel was what was needed. Haines said he thought there was some truth to sand being needed for construction.

Robin Danielson said she had come to a board meeting a year ago to ask if a Commissioner could attend a Township meeting regarding a vacated alley. She said the Township had wanted the landowner to help pay for the vacated alley. Danielson said her property line was surveyed. She said she had concerns about violations of State law. She invited the Commissioner and County Attorney to attend the next Township meeting.

Cindy Crestwell-Hatleli asked the board to please approve the rezoning request. She said she thought a precedent was already set. She said there was already a residential parcel that bordered it. She said she also had concerns about response times for data requests. She said she had requested hallway data footage and footage from the zoning department and had not yet received it.

Donna Buckbee said she supported the request of her neighbor.

Jackie Baker said she supported Bev Hanson's request. She said zoning ordinance integrity was important. She said zoning policies should be classified correctly from the start. Baker said she was a strong advocate for doing things correctly. She believed the area should be rezoned.

APPOINTMENTS

Commissioner Johnson moved, Commissioner Wright seconded, motion unanimously carried to open a public hearing to consider amending Peddler Ordinance 13 to reflect fee structure change, new requirement for Peddler/Transient Merchant to give bond to the county along with the change in the license period.

Interim Auditor/Treasurer Polly Heberlein said the proposed changes to the Peddler/Transient Merchant license would include changing the $75 monthly fee to a $150 yearly fee. The County would also require a bond. The license period would go from 30 days to a one-year timeline. Heberlein said the changes had been discussed previously and the department had done research to see what other counties in the area were doing. The proposed changes would make Houston County consistent with the rules in other counties.

There were no public comments on the matter.

Commissioner Johnson moved, Commissioner Wright seconded, motion unanimously carried to come out of the public hearing and return to the regular session.

Commissioner Zehnder moved, Commissioner Johnson seconded, motion unanimously carried to open a public hearing to consider changing the current On-Sale/Off-Sale 3.2 Beer &

Wine License to an On-Sale Liquor License/Sunday for Pine Creek Golf Course at 3815 N. Pine Creek Rd in La Crescent MN.

Interim Auditor/Treasurer Heberlein said a public hearing was required when changes were requested. She said Pine Creek Golf Course was requesting a full liquor license including Sundays.

No one came forward with a public comment.

Commissioner Johnson moved, Commissioner Zehnder seconded, motion unanimously carried to come out of the public hearing and return to the regular session.

Commissioner Zehnder moved, Commissioner Johnson seconded, motion unanimously carried to open a public hearing to consider an addition of an On-Sale Wine License in conjunction with the current On-Sale/Off-Sale 3.2 Beer License for La Crescent Snowmobile Club at 2485 County 6 in La Crescent MN.

There were no public comments on the matter.

Commissioner Zehnder moved, Commissioner Johnson seconded, motion unanimously carried to come out of the public hearing and return to the regular session.

Chief Medical Examiner Ross Reichard gave the Annual Medical Examiner Report (2025 data) to the Commissioners. He said death certificate information included the cause of death, manner of death, if an autopsy occurred, if the individual was pregnant, Tabacco use, if injury date, time and location and how the injury occurred, if the injury happened at work, and if transportation injury type (e.g. driver, passenger, etc.). He said the information was used by family, relatives, and the Minnesota Department of Health/CDC-Public Health. In Houston County in 2025 the total deaths were 157. Of those deaths, 144 had been reported to the medical examiner. 18 had a complete autopsy and 14 had an external examination. Reichard discussed the manner of deaths with the Commissioners. He said a majority of deaths (131) had occurred naturally. He said this was good data and what a County wanted to see. There had been 12 accidents and one suicide. There had been no homicides or accidents due to motor vehicles. He said there had been one accident that had been due to an accidental drug overdose. The drug had been meth. Reichard said meth was the drug leading overdose deaths in Southeast Minnesota. He said they had also seen alcohol death effects rise since the pandemic. The drug overdose in Houston County had been in the 45-64 age range. Reichard said this was another trend they were seeing as drug overdoses were often happening in older adults instead of younger adults and often were happening to chronic drug users. The board thanked Reichard for the annual report.

Commissioner Johnson moved, Commissioner Zehnder seconded, motion unanimously carried to go into closed session pursuant to Minnesota Statute 13D.05, Subdivision 2 (b), to discuss preliminary allegations and private personnel data related to an employee grievance. The Commissioners, Coordinator Parker, and Attorney Bublitz attended the closed session.

Commissioner Johnson moved, Commissioner Zehnder seconded, motion unanimously carried to come out of closed session and return to regular session at 10:58 a.m. Coordinator Parker gave a summary of the closed session saying they had discussed preliminary allegations and private personnel data related to an employee grievance. He said no action had been taken during the closed session.

CONSENT AGENDA

Commissioner Wright moved, Commissioner Johnson seconded, motion unanimously carried to approve the consent agenda. Approved items are below.

1) Approve the following Liquor Licenses from July 1, 2026 – June 30, 2027.

   LIQUOR LICENCES, WINE AND STRONG BEER
   Ferndale Golf, LLC dba Ferndale Golf, LLC (on sale + Sunday)
   Ma Cal Grove Country Club, Inc. dba Ma Cal Grove Country Club, Inc. (on sale Sunday) (contingent upon submission of required paperwork)
   Par 4 Golf, LLC dba Valley High Golf Club (on/off sale + Sunday)

   Shellhorn Enterprises, Inc. dba Shellhorn Bar and Grill (on/off sale + Sunday) (contingent upon submission of required paperwork)
   Gasthaus, LLC dba Little Miami (on/off sale + Sunday)
   Money Creek Haven Inc dba Money Creek Haven Campground (on/off sale + Sunday)

   ON SALE BEER LICENSES
   Lawrence Lake Marina, LLC dba Lawrence Lake Marina
   Gopher State Sportsmans Club dba Gopher State Sportsmans Club

   OFF SALE BEER LICENSE
   Lawrence Lake Marina, LLC dba Lawrence Lake Marina
   Houston Food Mart dba Houston Food Mart

2) Approve a Lower-Potency Hemp Edible Retailer Registration for River Station LLC located in Brownsville MN.
3) Approving a Lower-Potency Hemp Edible Retailer Registration for Kwik Trip located in Hokah MN.
4) Review and approve payments. Payments are below.

**REQUEST APPROVAL FOR PAYMENTS**

**2026/06/16 COMMISSIONER WARRANTS:**

| VENDOR NAME | AMOUNT |
|---|---|
| ACENTEK | 5,997.17 |

| | |
|---|---|
| ADVANCED CORRECTIONAL HEALTHCAR | 8,112.33 |
| BOLTON & MENK INC | 6,000.00 |
| BRUENING ROCK PRODUCTS INC | 19,057.17 |
| CALEDONIA SNO GOPHERS CLUB | 2,269.08 |
| CALEDONIA/CITY OF | 15,054.92 |
| ENTERPRISE FM | 10,462.64 |
| HILLER COMMERCIAL FLOORS | 8,000.00 |
| HOUSTON COUNTY TREASURER | 21,309.13 |
| HOUSTON COUNTY TREASURER | 61,861.89 |
| JC SMITH INC | 5,648.00 |
| KNOW INK | 4,125.00 |
| LIBERTY TIRE RECYCLING LLC | 3,750.65 |
| MEYERS LAWN SERVICE LLC | 2,000.00 |
| MIENERGY COOPERATIVE | 4,141.61 |
| MN STATE AUDITOR | 16,306.50 |
| MN STATE TREASURER | 4,424.00 |
| OVERHEAD DOOR COMPANY | 3,935.20 |
| PHILLIPS OUTDOOR SERVICES | 29,805.59 |
| QUALITY POWER SOLUTIONS | 5,565.00 |
| RICHARD'S SANITATION LLC | 26,993.41 |
| TRIMIN SYSTEMS INC | 2,250.00 |
| VISA | 14,809.49 |
| WEX BANK | 2,575.89 |
| WEX BANK | 2,617.82 |
| WIEBKE TIRE CO | 14,001.55 |
| ZIEGLER INC | 49,920.00 |
| | 350,994.04 |
| 60 VENDORS PAID LESS THAN $2000.00 | 29,321.91 |
| | 380,315.95 |
| PUBLIC HEALTH & HUMAN SERVICES | 203,834.55 |
| | 584,150.50 |

ACTION ITEMS

File No. 1 – Motion was made by Commissioner Zehnder, seconded by Commissioner Wright, motion unanimously carried to approve the amendment to Peddler Ordinance #13.

File No. 2 –Motion was made by Commissioner Schuldt, seconded by Commissioner Zehnder, motion unanimously carried to approve the change in Liquor License for Pine Creek Golf Course in La Crescent.

File No. 3 –Motion was made by Commissioner Wright, seconded by Commissioner Johnson, motion unanimously carried to approve the change in Liquor License for La Crescent Snowmobile Club.

File No. 4 –Motion was made by Commissioner Zehnder, seconded by Commissioner Johnson, motion unanimously carried to approve a renewal of a 5-Year Lease with the Dept. of Public Safety, Driver and Vehicle Services for the rental of approximately 360 sq. feet of space in the lower level of the Historic Courthouse which was used for a Driver Exam station. The updated rental amount would total $1,260.00 per year which would be paid quarterly. The lease would commence on October 1, 2026 and continue through September 30, 2031.

File No. 5 –Motion was made by Commissioner Zehnder, seconded by Commissioner Wright, motion unanimously carried to approve an Interim Use Permit (IUP) for MNRE 1570 61-US 14, LLC to operate a cannabis business with a medical cannabis endorsement in the Highway Business District in La Crescent Township.

File No. 6 – Commissioners discussed approving or denying a Zoning Amendment for Beverly Hanson to rezone an area from Agriculture Protection District to Residential Yucatan Township with County staff. The Planning Commission had recommended denial of the request. Environmental Services Director Amelia Meiners said there seemed to be some confusion around the request. Meiners said the property itself was in compliance and had been since it was permitted as a CUP many years prior. She said the surrounding acreage was primarily ag. The zoning department had received comments against the change. Commissioner Myhre asked questions about how the property was taxed. Assessor Luke Onstad explained that the property was taxed as residential. He said tax classification was different than zoning district. Tax classification went by the use and this was different from zoning. Commissioner Wright asked why the matter had come up now. The Commissioners discussed concerns about spot zoning. Motion was made by Commissioner Johnson, seconded by Commissioner Wright, motion carried three to two, to deny a Zoning Amendment for Beverly Hanson to rezone an area from Agriculture Protection District to Residential Yucatan Township. The Commissioners voted by roll. Commissioners Wright, Johnson, and Zehnder voted yes to deny the request. Commissioners Schuldt and Myhre voted no.

File No. 7 –Motion was made by Commissioner Johnson, seconded by Commissioner Wright, motion unanimously carried to approve a Conditional Use Permit (CUP) for Skyline Materials LTD to expand a quarry for mineral extraction in the Agriculture Protection District in Brownsville Township. Commissioner Wright noted that there were no objections submitted to the zoning office regarding the request.

File No. 8 – Motion was made by Commissioner Wright, seconded by Commissioner Schuldt, motion unanimously carried to adopt an MS4 (Municipal Separate Storm Sewer System) ordinance regulating illicit discharge, pet waste, and construction stormwater within the MS4 boundary that consists of County right of way within the City of La Crescent and a small portion of La Crescent Township.

File No. 9 – Motion was made by Commissioner Johnson seconded by Commissioner Schuldt, motion unanimously carried to deny a Grievance Submitted by Patrick Molling / Law Enforcement Labor Services, Inc. Local #237. The Commissioners voted by roll. Commissioners Wright, Johnson, Zehnder, Schuldt, and Myhre voted yes.

DISCUSSION ITEMS

Coordinator Parker said the County Board of Adjustment and Equalization would be held that evening June 16th at 6:00 p.m. in the Commissioner's room. Coordinator Parker said the County was working with IT to create a data request portal on the new website. Coordinator Parker and the County Attorney would be copied on all data requests going through the portal.

The Commissioners discussed recent and upcoming meetings including a Personnel, Solid Waste, ECB, Jail/Sheriff's Office, SELCO, and Workforce Development meeting.

There would not be a June Planning Commission or Board of Adjustment meeting as no public hearings had been requested.

Closing Public Comment:

Donna Buckbee said it was important to be heard. She said she couldn't always hear people speaking in the room, and when she asked people to speak up it was not meant to be disrespectful.

Cindy Crestwell-Hatleli said she was concerned about the decision made that day. She said Rushford was expanding and was an important town. She said the decision made no sense to her. She said she appreciated those who were in support of the rezone and respected those who were not.

Rebecca Christenson said she lived in a small neighborhood who looked out for one another. She said they were watching closely what was happening in their neighborhood. She said the City of Rushford was totally encased by the City of Rushford Village.

There being no further business, a motion was made by Commissioner Zehnder, seconded by Commissioner Johnson, motion unanimously carried to adjourn the meeting at 11:05 a.m. The next meeting would be a regular meeting on June 23, 2026.

BOARD OF COUNTY COMMISSIONERS
HOUSTON COUNTY, MINNESOTA

By: ________________________________
Greg Myhre, Chairperson

Attest: _____________________________
Brent Parker, Coordinator

**REVIEW LICENSE CENTER PAYMENTS**

**2026/06/12 AUDITOR WARRANTS:**

| VENDOR NAME | AMOUNT |
|---|---|
| DAVISON PROPERTIES LLC | 4,972.50 |
| OLMSTED SWCD | 17,112.00 |
| | 22,084.50 |
| 21 VENDORS PAID LESS THAN $2000.00 | 6,045.35 |
| | 28,129.85 |

**REVIEW LICENSE CENTER PAYMENTS**

**2026/06/17 AUDITOR WARRANTS:**

| VENDOR NAME | AMOUNT |
|---|---|
| CARLSEN/RON | 2,574.00 |
| | 2,574.00 |
| 2 VENDORS PAID LESS THAN $2000.00 | 2,056.91 |
| | 4,630.91 |

**REQUEST APPROVAL FOR PAYMENTS**

**2026/06/23 COMMISSIONER WARRANTS:**

| VENDOR NAME | AMOUNT |
|---|---|
| ABILITY BUILDING COMMUNITY | 2,626.69 |
| BKC CONSTRUCTION LLC | 151,552.92 |
| CALEDONIA OIL CO INC | 5,174.00 |
| DUNN BLACKTOP COMPANY | 364,866.44 |
| ELECTION SYSTEMS & SOFTWARE INC | 4,623.33 |
| KWIK TRIP | 8,032.85 |
| MINNESOTA ENERGY RESOURCES | 3,624.65 |
| OVERHEAD DOOR COMPANY | 2,547.77 |
| QUADIENT FINANCE USA, INC | 20,000.00 |
| TWIN VILLAGE LLC | 2,087.33 |
| | 565,135.98 |
| 26 VENDORS PAID LESS THAN $2000.00 | 10,367.08 |
| | 575,503.06 |
| PUBLIC HEALTH & HUMAN SERVICES | 7,177.54 |
| | 582,680.60 |

# HOUSTON COUNTY

## BOARD OF COMMISSIONER MEETING
## AGENDA REQUEST FORM

Historic Courthouse
304 S Marshall Street
Caledonia, MN 55921

**Board Meeting Date: 6/23/26**
**Date Request Submitted: 6/15/26**
**Submitted By (Name and Title): Jordan Knoke- Public Health Director**

**Please fill in item(s) requested for agenda in correct category below. Add numbers as needed.**

Appointment Request:

Consent Agenda Request:

Action Item Request:

1. Accept the SMIF Literacy Grant, Public Health will receive 225 books to promote early literacy.

Discussion Item:

1)

Background/additional information can be typed below and/or included with request:

Note: Please submit all agenda request forms and supporting documentation to the BOC email at **BOC@HoCoMN.gov** by noon the Thursday before each BOC meeting to be included on the agenda. If your department needs a resolution number, please ask for the number ahead of time via the BOC email. Resolutions should be emailed in word format so they can be easily copied and pasted into the meeting minutes. Departments are responsible for scheduling their own public hearings, but please email the BOC to verify a date and time is available prior to advertising the hearing to ensure we do not double book times. Questions regarding agenda requests and board meetings can be sent to the BOC email. Thank you!

Historic Courthouse
304 S Marshall Street
Caledonia, MN 55921

# HOUSTON COUNTY

## BOARD OF COMMISSIONER MEETING
## AGENDA REQUEST FORM

**Board Meeting Date: 6/23/2026**
**Date Request Submitted: 6/17/2026**
**Submitted By: Polly Heberlein, Auditor-Treasurer**

**Please fill in item(s) requested for agenda in correct category below. Add numbers as needed.**

Appointment Request:

Consent Agenda Request:

Action Item Request:

Request approval of the '2026 - Houston County Election Emergency Plan' which is required by Minnesota law to be on file at the Office of the Secretary of State.

Discussion Item:

1)

Background/additional information can be typed below and/or included with request:

Note: Please submit all agenda request forms and supporting documentation to the BOC email at **BOC@HoCoMN.gov** by noon the Thursday before each BOC meeting to be included on the agenda. If your department needs a resolution number, please ask for the number ahead of time via the BOC email. Resolutions should be emailed in word format so they can be easily copied and pasted into the meeting minutes. Departments are responsible for scheduling their own public hearings, but please email the BOC to verify a date and time is available prior to advertising the hearing to ensure we do not double book times. Questions regarding agenda requests and board meetings can be sent to the BOC email. Thank you!

Historic Courthouse
304 S Marshall Street
Caledonia, MN 55921

# HOUSTON COUNTY

## BOARD OF COMMISSIONER MEETING
## AGENDA REQUEST FORM

**Board Meeting Date: June 23, 2026**
**Date Request Submitted: June 18, 2026**
**Submitted By (Name and Title): Amelia Meiners, Environmental Services Director**

**Please fill in item(s) requested for agenda in correct category below. Add numbers as needed.**

Appointment Request:

Consent Agenda Request:

1)

Action Item Request:

Discuss and vote on the need for an Environmental Assessment Worksheet (EAW) to be completed on Bruening Rock Products proposed Olson Quarry in Yucatan Township, resulting from a citizen petition.

Discussion Item:

1)

Background/additional information can be typed below and/or included with request:

Resolution, EQB Letter and Petition

Note: Please submit all agenda request forms and supporting documentation to the BOC email at **BOC@HoCoMN.gov** by noon the Thursday before each BOC meeting to be included on the agenda. If your department needs a resolution number, please ask for the number ahead of time via the BOC email. Resolutions should be emailed in word format so they can be easily copied and pasted into the meeting minutes. Departments are responsible for scheduling their own public hearings, but please email the BOC to verify a date and time is available prior to advertising the hearing to ensure we do not double book times. Questions regarding agenda requests and board meetings can be sent to the BOC email. Thank you!

# RESOLUTION NO. 26-17

## A RESOLUTION APPROVING THE FINDINGS AND PETITION FOR AN ENVIRONMENTAL ASSESSMENT WORKSHEET FOR THE PROPOSED BRUENING ROCK PRODUCTS SAND MINE

**WHEREAS,** a petition for an Environmental Assessment Worksheet (EAW) has been submitted for the proposed project in accordance with Minn Rule, Chapter 4410; and

**WHEREAS,** the Minnesota Environmental Quality Board (EQB) has designated Houston County as the Responsible Governmental Unit (RGU) for the proposed Olson Sand Mine in Yucatan Township, Houston County, Minnesota; and

**WHEREAS,** Houston County received notice of the petition from the EQB on May 18, 2026; and

**WHEREAS,** a notice of the petition was published in the EQB Monitor on May 26, 2026; and

**WHEREAS,** based upon evidence presented by the petitioners, proposers, and other persons or otherwise known to the RGU, findings have been prepared; and

**NOW THEREFORE BE IT RESOLVED** that the Houston County Board of Commissioners makes the following findings:

## <u>FINDINGS</u>

1. The above recitals are incorporated as if set forth herein.
2. The Project is a proposed sand mine as described in the Houston County Conditional Use Permit application and supplementary materials submitted on February 25, 2026 and later resubmitted on April 10, 2026.
3. Petitioners have filed a request for discretionary environmental review pursuant to the Administrative Rules promulgated under the Minnesota Environmental Policy Act. Petitioners suggest that an EAW is necessary because the Project demonstrates the potential for significant environmental effects.
4. The Project does not meet mandatory thresholds listed under Minn. Rule 4410.4300, subp. 12.
5. The Project is not exempt under Minn. Rule 4410.4600.
6. Minn. Rule 4410.1000 subp. 3B identifies that the governmental unit need only find that the project may have the potential for significant environmental effects.
7. The criteria established in Minn. Rule 4410.1700 shall be used in deciding whether a project has the potential for significant environmental effects.
    a. Type, extent, and reversibility of environmental effects;
    b. Cumulative potential effects. The RGU shall consider the following factors: whether the cumulative potential effect is significant; whether the contribution from the project is significant when viewed in connection with other contributions to the cumulative potential effect; the degree to which the project complies with approved mitigation measures specifically designed to address the cumulative potential effect; and the efforts of the proposer to minimize the contributions from the project;

   c. The extent to which the environmental effects are subject to mitigation by ongoing public regulatory authority. The RGU may rely only on mitigation measures that are specific and that can be reasonably expected to effectively mitigate the identified environmental impacts of the project; and
   d. The extent to which environmental effects can be anticipated and controlled as a result of other available environmental studies undertaken by public agencies or the project proposer, including other EISs.
8. The Petitioners identify the following as reasons for potentially significant environmental impacts:
   a. Highly sensitive bluff land and karst topography
   b. Vulnerable groundwater area
   c. Proximity to the Root River, associated wetlands, and a highly erodible section of riverbank
   d. Proximity to a trout stream and trout hatchery
   e. Proximity to the Erickson Mine
   f. Presence of outstanding biodiversity and rare, threatened, and endangered species in the area

**BE IT FURTHER RESOLVED,** that the proposed project does have the potential for significant environmental impacts; and

**BE IT FURTHER RESOLVED,** that a positive declaration be made concerning the need for an Environmental Assessment Worksheet (EAW) for the Bruening Rock Products project in response to the petition.

Adopted by the Board of Commissioners of Houston County on this 23rd day of June 2026.

**HOUSTON COUNTY BOARD OF COMMISSIONERS**

__________________________________

**Greg Myhre, Board Chairperson**

**Attest:**

__________________________________

**Brent Parker, County Coordinator**

MINNESOTA ENVIRONMENTAL QUALITY BOARD

**Minnesota Environmental Quality Board**
**520 Lafayette Road North**
**Saint Paul, MN 55155**

VIA E-MAIL (cover letter & petition)

May 18, 2026

Amelia Meiners
Environmental Services Director
Houston County
304 S. Marshall Street, Room 209
Caledonia, MN 55921
ameiners@HoCoMN.gov

RE: Petition for an Environmental Assessment Worksheet for the Olson Mine project

Dear Amelia Meiners,

The Environmental Quality Board (EQB) received a petition on May 15, 2026 requesting that an Environmental Assessment Worksheet (EAW) be prepared for the project described in the petition, and on May 18, 2026, the EQB determined that Houston County is the appropriate governmental unit to decide the need for an EAW.

All requirements for Minnesota's Environmental Review Program, including when review is required and when review is exempt can be found in Minnesota Rules, chapter 4410. Please note, a project may not be started, and a final governmental decision may not be made to grant a permit, approve a project, or begin a project, until a decision has been made for this petition. Project construction includes any activities which directly affect the environment, including preparation of land.

The procedures to be followed in making the decision on the enclosed petition (EAW need decision) are found in part 4410.1100. Key points in the procedures include:

1. As the designated RGU, you are required to decide the need for preparation of an EAW, considering the evidence presented by the petitioners or otherwise known to you about the nature and location of the project. In making your decision, you should consider the evidence submitted and take into account the factors listed in part 4410.1700, subpart 7. Note that these procedures require that a record of decision, including specific findings of fact, be maintained.

2. You have 15 working days from the date of the receipt of this petition to decide on the need for an EAW. (See part 4410.1100.)
   - For RGU decisions made by a board, council, or other body which meets on a periodic basis, the time period may be extended by the RGU for an additional 15 days.
   - For RGU decisions not made by a board, council, or other body, the RGU may request an extension from the EQB of up to an additional 15 days.

3. You must provide written notification of your final decision to the proposer, the petitioners' representative, and the EQB, within 5 working days of that decision.
    a. To notify the EQB of your decision on the need for an EAW, please email env.review@state.mn.us. The EQB requests that you include a copy of your record of decision, including instances where environmental review is mandatory, voluntary, or exempt.

4. When notices of decision are sent to EQB, please ensure that:
    a. Decisions have undergone all foreseeable and applicable local administrative processes.
    b. The representative providing notices is authorized to do so on behalf of your responsible unit of government.

5. Should you have any concerns about the timelines for final decisions and the timing of any needed processes, please contact the EQB as soon as possible.

6. If for any reason you are unable to act on the petition at this time (e.g., no application has yet been filed or the application has been withdrawn or denied), the petition will remain in effect for a period of one year and must be acted upon prior to any final decision concerning the project identified in the petition. It is recommended that you notify in writing both the petitioners' representative and the EQB if you are unable to act on the petition at the time it is received.

Notice of the petition and its assignment to your unit of government will be published in the *EQB Monitor* on May 26, 2026.

If you have any questions or need any assistance, please do not hesitate to contact us at env.review@state.mn.us or 651-757-2873.

Sincerely,

Sarah Lerohl

Sarah Lerohl
Environmental Review Program
Environmental Quality Board

cc: Petitioners' Representative Jackie Baker
[redacted]

May 14, 2026

Ms. Sarah Lerohl, Environmental Review
Minnesota Environmental Quality Board
520 Lafayette Road N
Saint Paul, MN  55155

RE: Request for Discretionary Environmental Assessment Worksheet (EAW) – Proposed Mining Project in Houston County

Dear Ms. Lerohl,

Please accept the enclosed Request for a Discretionary Environmental Assessment Worksheet (EAW) and accompanying citizen petition regarding a proposed mining project in Houston County, Minnesota.

We believe the project has the potential for significant and irreversible environmental effects due to the project's location within a highly sensitive bluffland and karst region, proximity to vulnerable groundwater, shoreline, trout streams, fish hatchery, rural homes, and therefore warrants discretionary environmental review under Minnesota environmental review rules.

The enclosed materials outline concerns related to:

- Groundwater and Karst geology
- Trout streams, hatchery, erosion, RIM Land and surface water resources
- Air quality and silica dust exposure
- Traffic, noise, and road safety hazards
- Outstanding biodiversity and rare, threatened, endangered species
- Tourism and recreation

We respectfully request that the Environmental Quality Board review this submission and work with the Responsible Governmental Unit to ensure that a Discretionary Environmental Assessment Worksheet is ordered and completed prior to any decisions related to the project. .

Thank you for your time and for your continued work to protect Minnesota's natural resources and communities through the environmental review process.

Sincerely,

Jackie Baker
22848 State Hwy 16
Rushford, MN  55971
[redacted]

**REQUEST FOR DISCRETIONARY ENVIRONMENTAL ASSESSMENT WORKSHEET (EAW)**

**PETITION INTRODUCTION**

Pursuant to Minnesota State Statutes and the Rules of the Minnesota Environmental Quality Board, the undersigned residents of Houston, Fillmore, Winona Counties hereby request preparation of an Environmental Assessment Worksheet (EAW) for the proposed Olson Mine, Houston County, Minnesota. Given the unique environmental sensitivity of the project area and the potential for significant impacts, a discretionary EAW is necessary to ensure informed decision-making and public transparency.

Petitioners' Representative: Jackie Baker, 22848 State Hwy 16, Rushford, MN  55971
[redacted]

**PROJECT DESCRIPTION**

Project Name: Olson Mine

Project Location:  Parcel Id's 17.0010.000, 17.0010.001, 17.0035.000.  Houston County, State Hwy 16 E, Rushford, MN 55971

Project Proposers:
G-Cubed Engineering, 14070 Highway 52 Southeast, Chatfield, MN  55923
Bruening Rock Products Inc., 900 Montgomery Street, Decorah, IA 52101
Clair, Patricia, Jarad Olson, 22563 County 13, Rushford, MN 55971

The plans submitted to the Houston County Zoning Administrator on February 25, 2026 stated that 17.21 acres of the Olson property will initially be mined. The proposed mine area, adjacent to a segment of National Historic Bluff Country Scenic Byway, State Highway 16, is a free standing hill covered primarily with hardwoods typical of the area located within Richard J Dorer Memorial Hardwood State Forest.  This property sits directly along the Root River (an already classified impaired river), it adjoins neighboring RIM Land, additional wetlands, it is less than 900 feet from Ferndale trout stream, and the Daley Creek trout stream is nearby.  Additionally, it is within 1600 feet from the operating state-registered Ferndale Fish Hatchery.

According to plans submitted to the Zoning Office, the mine operator plans to remove existing trees on the bluff, the forest floor, vegetation and up to 25' of overburden. The mine face is expected to be 25' to 220' in height. According to the proposal, this is a long-term operation proposed to operate for 30+ years.  The Jordan Formation will be accessed, the mined sand will be run through a crusher and screener for size.  On-site water will be used for washing.  Material will be stored in stockpiles on-site.  Blasting will also occur.  The processed sand will be loaded on trucks and hauled East or West on State Hwy 16.  The location beyond that point is unknown at this time.

The proposed mining operation threatens one of Minnesota's most distinctive regions and raises critical issues due to its location in the Root River Valley. The area's karst topography presents ecological, geological, and hydraulic complexity. Combined with the presence of endangered and threatened species and sensitive plant communities on this free standing bluff, this proposal will cause irreparable environmental damage.

These activities represent large-scale sand mining in a rural and environmentally sensitive region.

Additionally, the proposed mine is located in a unique and highly residential area of the County. The nearest house is just 361 feet from the proposed mining operations, other residences are roughly 433 feet, 645 feet, and 897 feet from the proposed mining operations. In total there are 8 single family residences in close proximity as well as a public golf course. The close proximity to these properties will inevitably raise noise, dust, and public health concerns.

**POTENTIAL FOR SIGNIFICANT ENVIRONMENTAL IMPACT**

Petitioners assert that the proposed project has the potential for significant environmental effects and therefore the following critical concerns serve as justification for an EAW requirement:

**1. Sensitive Karst Geology and Groundwater Vulnerability**

The proposed project lies within the Driftless Area of Southeast Minnesota, characterized by karst geology, including sinkholes, fractured limestone bedrock, underground drainage systems, and direct groundwater recharge pathways. Karst landscapes are highly vulnerable to groundwater contamination, and disturbances from blasting, excavation, and stormwater infiltration pose serious risks to drinking water wells, springs and seeps, cold-water trout streams, and aquifer integrity. There are multiple residences with wells in the immediate area.

The proposed operations map indicates intended disturbance of the Jordan formation. The proposed project area is less than 40 feet from wetlands. The proposed mining site is located in a vulnerable quarter section according to the MN Dept. of Ag. Additionally the Groundwater Atlas of Houston County states "Much of the county is a karst terrain formed by precipitation and groundwater dissolving underlying carbonate sedimentary rock. Karst provides rapid water movement between the land surface and underlying aquifers, increasing their pollution sensitivity." "In karst areas, there is a close relationship between the land surface and the bedrock below. Connections to enlarged underground pathways allows for rapid transport of water, creating unpredictable groundwater travel times and flow directions This makes karst aquifers particularly vulnerable to human activities and complicates remediation efforts."

The Daley Creek dye trace study is evidence of complex underground activity in the Karst landscape.

## 2. Proximity to Trout Streams and Surface Waters

The proposed project area lies within the Root River watershed, which contains designated cold-water resources, including trout streams that are highly sensitive to sedimentation, stormwater runoff, groundwater changes, temperature increases, and contaminant transport.

The site is located less than 900 feet from Ferndale Creek, a designated trout stream, and within close proximity to Ferndale Fish Hatchery. The Ferndale Fish Hatchery raises 40,000 - 60,000 trout annually according to the owner. His letter is included in this packet. The Daley Creek is also nearby, another designated trout stream. Due to this proximity, the project may involve both point and non-point discharges of stormwater and wastewater that could reach nearby surface waters. A recent Daley Creek Dye Trace Report indicated the dye travelled 3400 feet in less than 7 days with underground activity. It reached Ferndale Creek not long after (Appendix A of the report). The Erickson mine adjoins the Olson property and Ericksons are currently mining silica sand under their 1992 permit. Any further expansion of that mine will require a Trout Stream Setback Permit. See the DNR attached letter. The proposed project is mining the same material, therefore is subject to the same Trout Stream Setback permit requirements. According to their Operation Map Jordan Sandstone will be mined which is 99% silica sand. An Environmental Assessment Worksheet will ensure an accurate and reliable sample is obtained with oversight as well as making sure the boring holes are correctly sealed to prevent contamination. It's important to require that all soil boring sampling be done by a third party and not the applicants themselves. Soil sampling should be completed using professional soil boring equipment rather than excavators, and the sampling depth should align with the depths proposed in the operational plan.

The proposed site is situated directly along the Root River. The Root River is listed on the Minnesota Pollution Control Agency's 2012 Total Maximum Daily Load (TMDL) list (303(d) list) of impaired waters requiring study and restoration. Existing conditions in the watershed indicate that the effects of stormwater runoff entering the river are not fully understood and may already exceed water quality limits. Any additional disturbance within the watershed has the potential to exacerbate existing impairments. Mining in karst terrain can rapidly transmit pollutants to surface waters.

## 3. Wildlife Habitat, Ecological Impacts, Outstanding Biodiversity

The proposed project area is bluffland that contains rare and sensitive plant communities, migratory bird habitat, unique bluff and prairie ecosystems, sensitive wildlife corridors, rare and threatened and endangered species. It is located in the Richard Doerr Hardwood State Forest. All proposed mining activity such as clear cutting, removal of overburden, and blasting poses a serious threat to rare, threatened, endangered species that live on the unique bluffland. Mining and associated disturbances may cause permanent habitat loss and fragmentation.

The proposed project involves mining 17+ acres of pristine bluffland that has been identified as having “outstanding biodiversity”. The outstanding biodiversity ranking by the MN Biological Survey is special and unique. There are three native plant communities that occupy nearly the entire bluff with state rankings of critically imperiled (Dry Barrens Oak Savanna, Vulnerable to Extirpation (Dry Bedrock Bluff Prairie and Oak Shagbark Hickory Woodland). According to MN DNR ““More than 99% of the prairie and savanna that were present in the state before settlement has been destroyed, and more that one-third of Minnesota’s endangered, threatened and special concern species are now dependent on the remaining small fragments of Minnesota's prairie and savanna ecosystem. Therefore, we (MN DNR) feel that all prairie and savanna remnants merit protection.” This proposed mining project would destroy these native plant communities. Two critical pieces of evidence included with this report are 1) study of RoseMary Iversen's property which is located on the same bluff and 2) a recent NHIS study of the proposed project area.

Several species listed on the MN Rules Chapter 6134 are on the proposed mining site bluffland including the Timber rattlesnake, North American racer and the gopher snake along with several others listed in multiple studies highlighted in the evidence document. The proposed mining site is a High Potential Zone for the Rusty Patched Bumble Bee, which is federally listed as endangered and is expected to be on the MN endangered list in 2026.

**4. Wetlands, Shoreland, Bluffland, Reinvest In Minnesota (RIM) Land**

The proposed project area involves an interconnected network of bluffland, wetlands and shoreland that are especially sensitive to disturbance. The adjoining property is RIM Land. The RIM program creates conservation easements and seeks to improve water quality and wildlife habitat by protecting environmentally sensitive areas and enhancing ecological value. The proposed adjacent sand mine and the inevitable destruction will negatively affect the already identified and established RIM Land and intent of the conservation easements. The owner of the RIM land has committed to a perpetual conservation easement to ensure multiple environmental factors are protected and preserved. His letter is included in this packet.

The area's thin soils, karst geology, and highly erodible slopes create a strong hydrologic connection between surface activities and groundwater. Wetlands in this region perform critical ecological functions, including stormwater storage, groundwater recharge, sediment and nutrient filtration, and wildlife habitat. Disturbance or filling of wetlands can reduce these functions, increasing downstream flooding potential and degrading water quality in nearby trout streams and the Mississippi River watershed. Mining, grading, vegetation removal, and heavy truck traffic can alter drainage patterns, compact soils, and introduce sediment and pollutants, all of which may directly or indirectly impact adjacent wetland complexes.

Shoreland and bluffland resources in Houston County are similarly vulnerable. Development or extraction activities near shoreland areas can increase runoff velocity and sediment delivery to streams, raising water temperatures and harming coldwater fisheries that depend on clean, shaded, and stable stream corridors. Blufflands present additional concerns due to their steep slopes and thin vegetative cover. Removal of vegetation or excavation on or near bluff slopes can destabilize soils, increase landslide risk, and accelerate erosion into nearby waterways. Visual impacts to the county's scenic bluffland corridors and potential degradation of habitat for rare and sensitive species are also important considerations. Given the interconnected nature of wetlands, shorelands, and blufflands, even localized disturbance has the potential to create cumulative downstream impacts, underscoring the need for careful environmental review and mitigation planning.

**5. Erosion**

The proposed project has the potential for creating substantial erosion. Erosion is a critical concern due to the project's location on a bluff with steep slopes directly adjacent to the impaired Root River. The neighboring property owner to the East has witnessed frequent and ongoing slough off from the bluff. Her letter is included in this packet. Bluff slopes are inherently unstable and highly susceptible to erosion when vegetation is removed and soils are disturbed. Mining activities would require clearing, grading, blasting and ongoing heavy equipment use, all of which increase the likelihood of soil detachment and transport during precipitation events. According to the proposed operation plan, 25 feet of overburden will be removed from the site, stock piled and up to a 220' mine face is planned.

Stormwater runoff from disturbed bluff areas has the potential to carry significant sediment loads into nearby drainageways and ultimately into the Root River, adjacent wetlands, trout streams and adjoining properties. Increased sedimentation can degrade water quality, impair aquatic habitat, and alter channel morphology. Sediment deposition can smother spawning habitat, reduce water clarity, and increase water temperatures, which are particularly harmful to cold-water fisheries and sensitive aquatic species. Because erosion rates increase exponentially with slope gradient and soil disturbance, even short-duration storm events may generate substantial sediment transport from the site. According to Minnesota Natural Resource Atlas the proposed mining site "Soil Erosion Risk" is HIGH.

The steep topography also increases the risk of rill and gully formation, slope slumping, and localized landslides, particularly during intense rainfall or rapid snowmelt. These processes could lead to long-term instability of the bluff face and adjacent properties downslope. Given the site's topographic sensitivity and proximity to surface waters, detailed evaluation of erosion potential, stormwater management, and long-term slope stabilization is necessary to fully assess the project's environmental impacts.

**6. Air Quality, Silica Dust, and Public Health**

There is a neighboring sand mine location roughly 500 feet from Olson's property line. The Erickson mine is extracting silica sand, under a 1992 permit. Since the proposed project is mining the same location they will also be accessing the same formation to retrieve high quality silica sand in the bluffland. The operation plan of the proposed project indicates using the Jordan sandstone which consists of 99% silica sand (Section 2 evidence document). Silica sand mining generates respirable crystalline silica dust, a known public health hazard linked to silicosis, lung disease, and increased respiratory risks. Potential dust sources include blasting and excavation, crushing and processing, truck traffic on the mine access road and Scenic Byway State Highway 16, and wind erosion from stockpiles. This is of particular concern to nearby neighbors, including the elderly neighbors, local golf course populations, and young children who live less than 700 ft from proposed mining operations. See Beacon map. If the sand trucks travel East through Houston they will be driving directly in front of a nursing home. An EAW will analyze exposure risks to those nearby and assess cumulative impacts over the life of the mine.

**7. Noise and Light Pollution**

Noise and light pollution are anticipated to be significant concerns due to the project's proximity to nearby residences, including truck traffic traveling within approximately 361 to 645 feet of neighboring homes. The proposed project will inevitably create a high level of noise for the close neighbors. Mining operations typically involve heavy equipment, blasting or crushing activities, backup alarms, and frequent truck loading and hauling. These activities generate sustained and intermittent high noise levels that may exceed typical rural background conditions. Increased noise has the potential to disrupt sleep, outdoor activities, and overall quality of life for nearby residents, particularly during early morning or evening hours when ambient sound levels are normally low. Haul truck traffic is expected to be a primary source of both noise and light impacts. Trucks traveling to and from the site would produce engine noise, braking, shifting, and vibration, as well as repeated use of backup alarms and tailgate impacts. Headlights from nighttime or early morning operations may shine directly toward neighboring homes due to the elevated topography and roadway alignment, creating recurring light trespass and glare. As trucks leave the mining site the lights will shine directly into the neighboring residence. This type of intermittent, high-intensity lighting can interfere with residential enjoyment of property and may affect sleep patterns and nighttime visibility. MPCA Noise Control Classification 1 - for household units including farmhouses has statutory limits that range between 50-60 DBA as outlined in the evidence document. Given the close proximity of mining operations to others, evaluation of potential noise levels, vibration, and light trespass is necessary to fully assess whether or not the proposed mine operations do not exceed statutory limits.

**8. Traffic, Road Damage, and Public Safety**

The project will generate substantial heavy truck traffic on a National Scenic Byway, creating hazards at the ingress and egress points. The traffic travelling at high speeds will be disrupted by industrial hauling in and out of the mine 6 days a week between the hours of 6 am - 8 pm according to the proposed operation plan. It states "trucks will be entering and exiting throughout the day. This will create increased accident risks. Vehicles and semis travel at an extremely high rate of speed on that particular stretch of highway with frequent passing. It's one of the rare areas when passing is allowed since it is not directly on a curve. The ingress and egress is currently permitted for a "field road” and not commercial use with no appropriate turning lanes. Potential impacts also include road deterioration and maintenance costs on a State Highway.

**9. Tourism and Recreation**

Tourism and outdoor recreation are central to Houston County’s economy and neighboring Fillmore County. The proposed project has the potential to negatively affect these resources. Particular concern exists for the nearby Root River State Trail, a major regional draw that attracts cyclists and pedestrians seeking scenic bluffland and river views. The proposed mine sits right on the Root River and will be clearly visible from the river. The Root River is a major draw for canoeists, tubers, and fisherman from across the state. The Root River State Trail runs adjacent to the Root River and the proposed mining site. Visitors come from all over to ride bikes on the Root River State Trail and visit the trail towns. Similarly, the Historic Bluff Country Scenic Byway is promoted for its scenic vistas, wildlife viewing, and rural character. Industrial activity visible from the byway could degrade the scenic quality that supports tourism marketing and visitor travel. Taken together, these impacts could reduce recreational use, weaken the county’s tourism economy, and diminish the region’s appeal. One local business owner recently tracked his July point of sale runs and recorded 1100 unique visitors to his business. Through conversations with his customers he can confidently say these were tourists in the area visiting a tourist destination (Root River, the State Trail, camping, golfing, fishing etc). Every season brings new visitors (hunting, fall colors). His letter is included in this packet.

**10. Archaeological Significance and Historical Resources**

There is anecdotal information that the hill has native archaeological importance. The Mississippi Valley Archeology Center and HoCunk studied this hill in 2012 when the Ericksons wanted to expand their mine. According to them “the hill proposed for the sand mine has a very high likelihood of having archeological resources.” There is also reason to believe a cave with markings in it exists on the hill. See evidence letter.

**11. Cumulative, Long-Term Impacts and Conclusion**

The proposed sand mining operation has the potential to create significant cumulative and long-term environmental impacts when considered in combination with the neighboring existing Erickson mine. Cumulative and phased effects must be considered since Bruening Rock Products has proposed at least one other similar project in the adjoining county within the last three months. The area may be at risk for phased and connected actions. Alternatives to the proposed Olson mine include using sand from several of Bruening's already existing mines in Houston County and neighboring counties.

Over time, the incremental loss of forest cover, and natural bluffland and karst features can permanently alter the ecological integrity and rural character of the area. Repeated disturbance of soils and vegetation across multiple projects increases the risk of erosion, sedimentation, and degradation of groundwater recharge areas, particularly in the sensitive karst geology common to southeastern Minnesota. Once these landscapes are altered, full restoration of native ecosystems and hydrologic function is uncertain and may take decades or may never be fully achieved. The outstanding biodiversity of the bluffland merits protection.  The proposed project area is at great risk for irreversible environmental damage. For the reasons mentioned in this report, we believe an Environmental Assessment Worksheet is necessary.

## SUPPORTING EVIDENCE AND DOCUMENTATION

Aerial Photos of the Proposed Mining Site

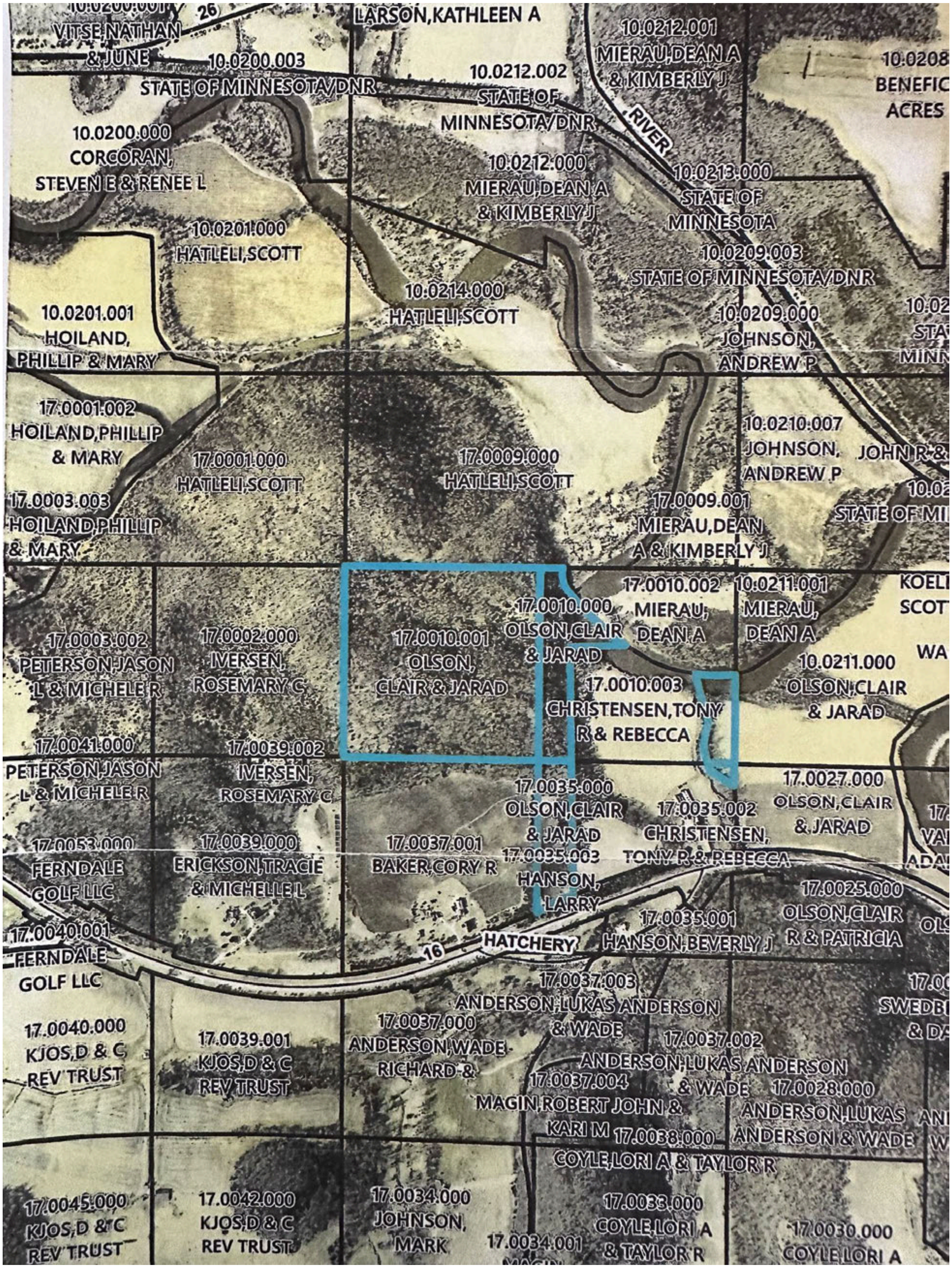
YouTube Video of Proposed Mining Site Rushford Proposed Mine Site 9-25
https://www.youtube.com/watch?v=ocNCdyk54eQ

Project Description

- Conditional Use Permit (CUP) application (17.21 acres)
- Operations Map and Reclamation Map for the Olson Mine - Jordan Sandstone
- Existing Conditions Map and Boundary Exhibit - Olson Mine
- Lease Agreement with Clair, Jarad and Patricia Olson
- Retainer agreement between Bruening Rock Products and G-Cubed

1. Sensitive Karst Geology and Groundwater Vulnerability
    - Citizen presentation “Reckless Sand Mining,” by Linda Griggs. Presented to the community - November 2, 2025
    - Vulnerable Groundwater Area Map | Minnesota Department of Agriculture
    - Daley Creek Dye Trace 2009
    - Groundwater Atlas of Houston County
2. Proximity to Trout Streams and Surface Waters
    - Silica Sand Mining Trout Stream Setback Permit/Fact Sheet
    - DNR letter notifying adjoining Erickson Mine that it requires Trout Stream Setback Permit
    - Jordan sandstone = 99% Silica Sand  “The Stone That Turns To Sand”
    - Formation Graph showing location of Jordan
    - Beacon Maps of nearby trout streams, hatchery, watershed with distances
    - Citizen Letter to DNR, Jackie Baker - March 31, 2026
    - Letter from Owner/Operator of Ferndale Fish Hatchery, Wade Anderson - April 22, 2026
3. Wildlife Habitat, Ecological Impacts, Outstanding Biodiversity
    - National Heritage Review of Proposed Bluff - March 23, 2026
    - Minnesota Natural Resource Atlas Map showing “Outstanding Biodiversity Significance”
    - Property Evaluation for Native Plant Communities and Wildlife of proposed bluff adjoining property owned by RoseMary Iversonn- September 2012
    - 6134 - MN Rules Chapter Endangered, Threatened, Special Concern Species
4. Wetlands, Shoreland, Bluffland
    - Bluffland Subsection Profile
    - Ecological Subsections Map - Division of Forestry
    - Beacon Shoreland Map
    - Beacon Wetlands Map
    - Minnesota Natural Resource Atlas Map showing Adjoining RIM Easements
    - Citizen letter concerning potential damage to his RIM Land, Dean Mierau - May 4, 2026

5. Erosion
   - Minnesota Natural Resource Atlas - Soil Erosion Risk of Proposed Mine
   - Stabilizing shoreland property to prevent erosion | UMN Extension
   - Neighbor witnessing existing and ongoing erosion, wildlife, trout streams and wetland, Rebecca Christianson - April 20, 2026
   - Citizen conversation with Lanesboro Fish Hatchery, Cindy Hatleli - April 20, 2026
6. Air Quality, Silica Dust, and Public Health
   - Crystalline Silica in Air andamp; Water, and Health Effects - MN Dept. of Health
   - Silicosis: Causes, Symptoms, Diagnosis & Treatment
   - Beacon maps of nearby residences (with distances) and Ferndale Public Golf Course
7. Noise and Light Pollution
   - A Guide to Noise Control in Minnesota MPCA
   - Noise, Light & Vibration | Environmental Health Project
8. Traffic, Road Damage, and Public Safety
   - Map of State Highway 16 showing large curves with small window to pass at ingress/egress point creating safety hazard with trucks entering/exiting
9. Tourism and Recreation
   - Map of Root River State Trail
   - Root River STate Water Trails Handout - MN DNR
   - State Water Trail Guide And Map To The Root River - MN DNR
   - National Historic Bluff Country Scenic Byway Map and Information
   - Explore an Ancient Landscape | November–December 2015 | Minnesota Conservation Volunteer | Minnesota DNR
   - Business owner letter regarding importance of tourism in the area, Dean Mierau - May 4, 2026
10. Archaeological Significance and Historical Resources
    - Letter from Mississippi Valley Archeology Center on proposed bluff - June 18, 2012
    - Citizen letter regarding archaeological resources on the bluff, Scott Hatleli - April 20, 2026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LARSON,KATHLEEN A
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MIERAU,DEAN A & KIMBERLY J
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STATE OF MINNESOTA/DNR
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CORCORAN, STEVEN E & RENEE L
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MIERAU,DEAN A & KIMBERLY J
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17.0010.003
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17.0041.000
PETERSON,JASON L & MICHELE R
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IVERSEN, ROSEMARY C
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CHRISTENSEN, TONY R & REBECCA
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FERNDALE GOLF LLC
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ERICKSON,TRACIE & MICHELLE L
17.0037.001
BAKER,CORY R
17.0035.003
HANSON, LARRY
17.0025.000
OLSON,CLAIR R & PATRICIA
17.0040.001
FERNDALE GOLF LLC
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HATCHERY
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HANSON,BEVERLY J
17.0037.003
ANDERSON,LUKAS ANDERSON & WADE
17.0040.000
KJOS,D & C REV TRUST
17.0039.001
KJOS,D & C REV TRUST
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ANDERSON,WADE RICHARD &
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ANDERSON,LUKAS ANDERSON & WADE
17.0037.004
MAGIN,ROBERT JOHN & KARI M
17.0028.000
ANDERSON,LUKAS ANDERSON & WADE
17.0038.000
COYLE,LORI A & TAYLOR R
17.0045.000
KJOS,D & C REV TRUST
17.0042.000
KJOS,D & C REV TRUST
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JOHNSON, MARK
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COYLE,LORI A & TAYLOR R
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COYLE,LORI A


17.21 acres

The Root River is already classified as Impaired Waters requiring study and restoration


Wetlands


Wetlands

May 14, 2026

Chris Priebe
G-Cubed
14070 Highway 52 SE
Chatfield, MN  55923

This letter is to notify you that a Citizen Petition for an EAW has been submitted on the Olson Mine project.

Sincerely,
Jackie Baker
Houston County Resident

May 14, 2026

Bruening Rock Products, Inc
Ronald Fadness
900 Montgomery Street
PO Box 127
Decorah, IA  52101

This letter is to notify you that a Citizen Petition for an EAW has been submitted on the Olson Mine project.

Sincerely,
Jackie Baker
Houston County Resident

May 14, 2026

Clair, Patricia, Jarad Olson
22563 County 13
Rushford, MN  55971

This letter is to notify you that a Citizen Petition for an EAW has been submitted on your sand mine project.

Sincerely,
Jackie Baker
Houston County Resident

## Project Description

- Conditional Use Permit (CUP) application (17.21 acres)
- Operations Map and Reclamation Map for the Olson Mine - Jordan Sandstone
- Existing Conditions Map and Boundary Exhibit - Olson Mine
- Lease Agreement with Clair, Jarad and Patricia Olson
- Retainer agreement between Bruening Rock Products and G-Cubed

CUP Application 1



Conditional Use Request
2026-CUP-554679

Amount Paid
$0.00

Number
2026-CUP-554679

Bruening Rock Products | 170010001 | Yucatan
Submitted by [redacted] on 2/25/2026

Applicant
Chris Priebe

Created
February 25, 2026

Status
In Progress

## Applicant

Chris Priebe

[redacted]

## Search Parcel Data

Completed On Wednesday, February 25, 2026 at 9:03 AM CST by [redacted]

| ParcelID | Address | City | OwnerName | Acres |
|---|---|---|---|---|
| 170010001 | | | OLSON,CLAIR & JARAD | 40.000 |

## CONDITIONAL USE INTRO

Completed On Wednesday, February 25, 2026 at 9:03 AM CST by [redacted]

**Conditional Use Application Fee**

$700.00

**Recording Fee**

$46.00

**Application Type:**

Conditional Use

## APPLICANT INFORMATION

Completed On Wednesday, February 25, 2026 at 9:07 AM CST by [redacted]

**Applicant Name**

Bruening Rock Products

**Parcel Tax ID**

170010001

**Telephone Number**

[redacted]

**Address**

900 Montgomery Street

**City**

Decorah

**Zip**

Legal Description

SW1/4 SW1/4 B 325 P 221 & B 332 P 451 DOC 310990 & 310991 2

Section-Township-Range

20-104-007

Do you own additional adjacent parcels

Yes

Township of:

Yucatan

I understand I am required to inform my township of my application.

Yes

## CONDITIONAL USE REQUEST Completed On Wednesday, February 25, 2026 at 9:10 AM CST by [redacted]

Describe in detail your request.

We are proposing a Construction Materials Sand Quarry.

Citation of Ordinance Section from which the Conditional Use is requested:

Section 27 - Mineral Extraction

Requested Dimension:

17.21 Acres

Please upload any supporting documents:

- 01 Application Supplimental Narritive.pdf
- 02 Quarry Maps.pdf
- 03 Quarry BND Exhibit.pdf
- 04 Lease Agreement.pdf
- 05 Houston County G-Cubed Authorization.pdf

## CONDITIONAL USE FINDING OF FACTS Completed On Wednesday, February 25, 2026 at 9:15 AM CST by [redacted]

1. That the proposed use conforms to the County Land Use Plan.

Yes

**Comments:**

The proposed quarry is located in an agricultural protection district. Mineral extraction is a conditional use allowed in the district. Mineral extraction is a temporary use, as the construction sand is removed the quarry will be reclaimed to grassland. This can be utilized as agricultural pasture or open green space. Both uses conform to the Counties Land Use Plan.

**2. That the applicant demonstrates a need for the proposed use.**

Yes

**Comments:**

Quality construction sand and dairy bedding is in high demand for use in public and private infrastructure projects. The material excavated will be utilized in local dairy operations and construction projects.

**3. That the proposed use will not degrade the water quality of the County.**

Yes

**Comments:**

Excavations are proposed to be above the water table. This will limit potential to degrade the water quality of the county.

**4. That the proposed use will not adversely increase the quantity of water runoff.**

Yes

**Comments:**

The quarry is generally the high point of the area which limits off-site stormwater entering this site. The screening berms will divert off-site stormwater around the mining area as to not co-mingle with on-site stormwater.

**5. That soil conditions are adequate to accommodate the proposed use.**

Yes

**Comments:**

On-site soils/overburden will be stripped, stockpiled, and utilized for reclamation once quarry operations are complete.

4

6. That potential pollution hazards have been addressed and standards have been met.

Yes

Comments:

The site will have a NPDES permit active prior to any land disturbing activities.

7. That adequate utilities, access roads, drainage and other necessary facilities have been or are being provided.

Yes

Comments:

The utilities, access roads, drainage areas are available to the site.

8. That adequate measures have been or will be taken to provide sufficient off-street parking and loading space to serve the proposed use.

Yes

Comments:

8. All parking will be within the quarry.

9. That adequate facilities are provided to eliminate any traffic congestion or traffic hazard which may result from the proposed use.

Yes

Comments:

Traffic will be entering and exiting throughout the day. This will aid in multiple vehicles entering or exiting at the same time. This should limit congestion on the highway access point.

10. That the conditional use will not be injurious to the use and enjoyment of other property in the immediate vicinity for the purposes already permitted.

Yes

Comments:

The quarry proposes to meet all setbacks within the agricultural protection district. Hours of operation will minimize conflicts with any adjacent properties.

**11. That the establishment of the Conditional Use will not impede the normal and orderly development and improvement of surrounding vacant property for predominant uses in the area.**

Yes

**Comments:**

Adjacent properties are agricultural in nature. The proposed quarry will not impede the development and/or improvement of surrounding properties.

**12. That adequate measures have been or will be taken to prevent or control offensive odor, fumes, dust, noise and vibration, so that none of these will constitute a nuisance, and to control lighted signs and other lights in such a manner that no disturbance to neighboring properties will result.**

Yes

**Comments:**

The quarry itself will be shielded from dust and noise pollution with the quarry face being 25 to 220 feet in height. Hours of operation will minimize noise issues. Wet suppression may also be utilized for dust control. The entire quarry will have a min. of a 50' vegetated buffer will remain in place.

**13. That the density of any proposed residential development is not greater than the intensity of the surrounding uses or not greater than the intensity characteristic of the applicable zoning district**

N/A

**Comments:**

Residential development density standards would not be applicable to this development.

**14. That the density of any proposed commercial or industrial development is not greater than the intensity of the surrounding uses or not greater than the intensity characteristic of the applicable zoning district.**

Yes

**Comments:**

The development of the construction/dairy sand quarry is in line with the area in which it is proposed.

**15. That site specific conditions and such other conditions are established as required for the protection of the public's health, safety, morals, and general welfare.**

Yes

6

**Comments:**

The quarry site was chosen due to its access to paved roads, the sand deposit, and the zoning district in which it lays. The quarry will have minimal impacts on the public's health, safety, morals, and general welfare.

## SITE PLAN INFORMATION Completed On Wednesday, February 25, 2026 at 9:16 AM CST by [redacted]

**Upload Site Plan**

02 Quarry Maps.pdf

Use the Interactive Map to Create a Site Plan. Map tools: Click the plus and minus buttons in the upper left of the map window, to zoom in/out. Navigation Mode - Scroll up to zoom in, scroll down to zoom out. Click and hold to pan around map. Text Mode - To place text on the map, click on the "Add Text" tool, click the place on the map where you would like the text to be displayed, then enter the text in the box that appears at the top of the screen, click ok to display the text on the map. Draw a point – Click once on the map where you would like the point to be. Draw a Line - Click once on map to start drawing a line, double click to stop drawing line. Draw a Polyline - Click once on map to start drawing a polygon, click map at each vertex and double click to finish polygon drawing. Draw a Rectangle - Click once on the map where you would like the rectangle to be. The rectangle will appear on the map. Click on the Select tool and click on the rectangle to resize (click an outside square and drag to resize), rotate (click, hold and drag the circle on top of the rectangle to rotate) or delete (click the rectangle and hit the delete button). Measure - Click once on map to start draw a line with a measurement, click map at each vertex and double click to finish drawing. If you double click near starting point area measurement will also be calculated. Undo Last Edit - Click tool to undo last drawing edit. Undo All Edits - Click tool to undo all drawing edits.

Sketch Layer

Reference Layer

Mapproxy


Powered by Esri

**Use the space below to include site plan comments, if necessary**

Site Plan Attached

## APPLICATION SUBMITTAL Completed On Wednesday, February 25, 2026 at 9:17 AM CST by [redacted]

**By checking this box, I grant Houston County access to my property for the purpose of evaluating this application.**

Yes

By checking this box, I certified that I have notified my town board of my application.

Yes

By checking this box, I certify that the information provided in this application is true and accurate to the best of my knowledge.

Yes

Signature

Date Signed:

2/25/2026

Check this box if Staff Signature on behalf of Applicant.

Yes

Email APPLICATION SUBMITTAL Completed On Wednesday, February 25, 2026 at 9:17 AM CST by [redacted]

External Notes

Documents

Internal Notes

Documents

8

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## Olson Quarry – Bruening Rock Products Application Supplemental

### Criteria for Granting Conditional Use Permits

1. The proposed quarry is located in an agricultural protection district. Mineral extraction is a conditional use allowed in the district. Mineral extraction is a temporary use, as the construction sand is removed the quarry will be reclaimed to grassland. This can be utilized as agricultural pasture or open green space. Both uses conform to the Counties Land Use Plan.
2. Quality construction sand and dairy bedding is in high demand for use in public and private infrastructure projects. The material excavated will be utilized in local dairy operations and construction projects.
3. Excavations are proposed to be above the water table. This will limit potential to degrade the water quality of the county.
4. The quarry is generally the high point of the area which limits off-site stormwater entering this site. The screening berms will divert off-site stormwater around the mining area as to not co-mingle with on-site stormwater.
5. On-site soils/overburden will be stripped, stockpiled, and utilized for reclamation once quarry operations are complete.
6. The site will have a NPDES permit active prior to any land disturbing activities.
7. The utilities, access roads, drainage areas are available to the site.
8. All parking will be within the quarry.
9. Traffic will be entering and exiting throughout the day. This will aid in multiple vehicles entering or exiting at the same time. This should limit congestion on the highway access point.
10. The quarry proposes to meet all setbacks within the agricultural protection district. Hours of operation will minimize conflicts with any adjacent properties.
11. Adjacent properties are agricultural in nature. The proposed quarry will not impede the development and/or improvement of surrounding properties.
12. The quarry itself will be shielded from dust and noise pollution with the quarry face being 25 to 220 feet in height. Hours of operation will minimize noise issues. Wet suppression may also be utilized for dust control. The entire quarry will have a min. of a 50' vegetated buffer will remain in place.
13. Residential development density standards would not be applicable to this development.
14. The development of the construction/dairy sand quarry is in line with the area in which it is proposed.
15. The quarry site was chosen due to its access to paved roads, the sand deposit, and the zoning district in which it lays. The quarry will have minimal impacts on the public's health, safety, morals, and general welfare.

14070 Highway 52 Southeast, Chatfield, Minnesota 55923
Phone [redacted] ♦ Fax 507-867-1665 ♦ www.ggg.to

**Houston County Zoning Ordinance Section 27 – Mineral Extraction.**

**Section 27.6 Conditional Use Permit Required**

**Subd. 1. Application for Permit**

1. The applicant and operator contact shall be:
   Bruening Rock Products, Inc
   Attn: Ronald Fadness (General Counsel)
   900 Montgomery Street
   P.O. Box 127
   Decorah, IA 52101
   ([redacted]
   The lease agreements for the property are attached
2. A Quarry Boundary Exhibit with the boundary description is attached.
3. An Existing Conditions Map is attached
4. An Operation Plan and Map are attached.
5. A Reclamation Plan and Map are attached.
6. Proposed material to be excavated is overburden material, construction sand and dairy bedding sand. Material will be excavated using common construction equipment. It will be run through a crusher and a screener for size. Material will be stored in stockpiles on-site. Blasting is proposed and depending on demand for material is proposed 1 to 3 times a year. This will be contracted to a licensed blasting contractor. The quarry is proposed to operate up to 30 years.
7. Overburden on-site averages 10' to 25' in depth.

**Section 27.7 Existing Conditions Map**

**Subd. 1. Information Required on the Existing Conditions Map.**
All information required is depicted and outlined on the attached Existing Conditions Map.

**Section 27.8 Operations Performance Standards**

**Subd. 1 General Requirements**

1. **Compliance.** The mining Operation shall follow all Federal, State, and local laws and ordinances.
2. **Operation of Equipment.** All equipment shall be constructed and maintained to minimize, as far as practicable, noises and vibrations.
3. **Explosives.** No explosives shall be stored on-site. The operator is proposing to utilize a licensed blasting contractor. The contractor shall follow all federal, state, and local laws and regulations.
4. **Mine Area Standards.** The quarry proposed will be a maximum of 20 acres under this CUP.
5. **Mine Density Standards.** The quarry proposed is a construction minerals quarry.

**Subd. 2. Vegetation.**

1. **Removal of Trees and Shrubs.** All existing vegetation shall remain in place until the area is to be mined. Vegetation removal and stripping will be completed in phases as the quarry operation move from west to east.
2. **Weeds and Noxious Vegetation.** The quarry site will be maintained for noxious vegetation.

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3. **Preservation of Existing Trees and Ground Cover.** The quarry will maintain a minimum of 50' vegetated buffer along the perimeter of the quarry with exception of the access location where trees will hinder site distance.

**Subd. 3. Access**

1. **Jurisdiction.** The existing quarry access is from Highway 16. The existing driveway will need to have a change of use application to MnDOT. This application will be made upon approval of the Conditional Use permit.
2. **Avoid Residential Streets.** Access is not proposed on any residential streets.
3. **Access Signage.** Quarry signage will be constructed at the entrance.
4. **Spillage on Roadways.** All trucks will be loaded in accordance with their specific specifications. Any road spillage will be cleaned from the roadways.
5. **Dust.** Highway 16 is a paved road.

**Subd. 4. Water Resources.**

1. **Drainage Interference Prohibited.** All quarry drainage will be contained on-site. The quarry will not impound waters on adjacent properties.
2. **Surface and Subsurface Water Quality.** The mining operation shall be above the water table and all surface water will be collected in the low points of the quarry to allow settling of solids on-site.
3. **Non-degradation of Surface Water.** The mining site is generally the high point of the area which limits off-site stormwater entering this site. The screening berms will divert off-site stormwater around the mining area as to not co-mingle with on-site stormwater.

**Subd. 5. Safety Fencing**

The proposed quarry is not adjacent to a residential zone and is not within 300 feet of two or more residential structures.

**Subd. 6. Screening**

1. **Residential and Commercial Properties.** The proposed quarry and adjacent properties are all zoned Agricultural Protection.
2. **Dwellings in Agricultural Protection Districts.** There are no dwellings within 1000' of the proposed quarry boundary.
3. **Public Roads.** The quarry is 1,100'+/- from the public road. With the natural vegetated screening and elevation change the quarry will not be visible from the public road.

**Subd. 7. Setback Requirements**

1. **Prohibited in District**. NA
2. **Residentially Zoned**. NA
3. **Adjoining Property Line**. The quarry proposes a min. of a 50' setback for excavations to all property lines.
4. **Excavating or Stockpiling**. The quarry proposes to maintain a 100' excavation and stockpiling setback to Highway 16.
5. **Public Waters**. The quarry excavation limits are 150' +/- from the ordinary high-water (OHW) level of the root river. In no instance is there disturbance within 100' to the OHW.
6. **Dust and Noise**. All applicable dwellings are greater than 1000' to any proposed mining expansion where processing and loading will take place.
7. **Dwellings**. NA

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**Subd. 8 Appearance**
All buildings and structures will be maintained.

**Subd. 9 Days of Operation**
All mining operations will be conducted Monday – Saturday except for legal holidays.

**Subd. 10 Dust.**
All equipment used for mining operations will be constructed, maintained and operated in such a manner as to minimize dust conditions as far as practicable.

**27.9 Operation Plan**

**Subd. 1 Operation Plan Requirements.**

1. **Estimated Life Expectancy.** The life expectancy of the proposed quarry is expected to be 30+ years.
2. **Material to be mined.** Construction Sand and Dairy Bedding Sand.
3. **On-Site Processing.** Material will be excavated using common construction equipment. It will be run through a crusher and a screener for size. Material will be stored in stockpiles on-site. If washing takes place. On-site water will be utilized. If the threshold for an appropriations permit is to be met a DNR water appropriation permit will be acquired.
4. **Days and hours of operations.** Quarry operations may be conducted Monday through Saturday, except for legal holidays. Hours of operation are 6:00 am and 8:00 pm.
5. **Haul routes.** Trucks will head east or west on highway 16 depending on the end user.
6. **Soil erosion and sediment control plan**. This quarry will have a NPDES permit active prior to mining activities. All existing vegetation will remain in place until quarry operations reach the area. All contact stormwater will be contained on-site. Overburden stockpiles shall be seeded when not in use to prevent erosion.
7. **A dust and noise control plan**. The quarry itself will be shielded from dust and noise pollution with the quarry face being 25 to 45 feet in height. Hours of operation will minimize noise issues. Wet suppression may also be utilized for dust control.

**Subd. 2 Operations Map**
All information required is depicted and outlined on the attached proposed operations map.

**27.10 Reclamation Plan**

**Subd. 1 Reclamation Plan Required**
The reclamation plan is outlined below and on the attached Reclamation Plan Maps.

**Subd. 2. Reclamation Plan Commencement Requirement**
Reclamation shall commence within 3 months of one of the following happenings:

a) Termination of the mining operation
b) After the mining operation has been abandoned for 6 months.
c) After the mining permit has been expired.

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**Subd. 3. Reclamation Plan Standards.**

1. **Removal of Buildings and Structures.** All building, structures and plants incidental to the mining operation shall be dismantled and removed by, and at the expense of the mining operator.
2. **Grading and Filling.** The quarry shall be graded and back filled to create gently rolling topography which will minimize erosion. With exception to the exposed face of the quarry all slopes shall be less thank 18%.
3. **Soil Quality.** On-site salvaged topsoil shall be spread across the quarry floor at a minimum thickness of 3".
4. **Ground Cover.** All disturbed areas are to be coved in salvaged topsoil and seeded with MnDOT mixture 330 at 84.5 lbs./acre or an approved equivalent.
5. **Ponds.** Any areas excavated to a water producing depth shall be less than 10 feet in depth and a maximum slope of 3:1.
6. **Finish Grades.** The reclaimed quarry grade is to be a gradual grade greater than elevation 755.0. The quarry floor shall be a green space that creates grassland habitat.

**Subd. 4. Reclamation Plan.**

The proposed end use of the proposed quarry will be grassland to be used as animal habitat. Outlined above are the standards in accordance to the Houston County zoning ordinance.

Once quarry operations have been completed the operator will be responsible for the removal of all internal roads, scale, scale house, and machinery (miscellaneous removals). The site shall then be graded per the reclamation map (common excavation). Once mass grading is complete 6" salvaged topsoil shall be spread across all disturbed areas (salvaged topsoil respread). Upon completion of topsoil spreading the entire site shall be seeded, mulched, and fertilized in accordance with the latest Minnesota Manual for Erosion Control and MnDOT Regulations. Vegetation shall be inspected at 6 months and 12 months, noxious weeds shall be removed and non-vegetated areas reseeded as needed (seed, fertilize and mulch).

The reclamation estimate is included on the reclamation plan map.

**Subd. 5. Reclamation Plan Map.**

All information required is depicted and outlined on the attached proposed reclamation map

**Subd. 6. Changes in the Reclamation Plan.**

All changes in the approved reclamation plan shall be approved by the operator and the County Planning Agency.

**27.11 Performance Bond Required.**

The operator agrees to a performance bond for reclamation based on the estimated reclamation cost.

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VICINITY OVERVIEW MAP
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14070 Hwy 52 S.E.
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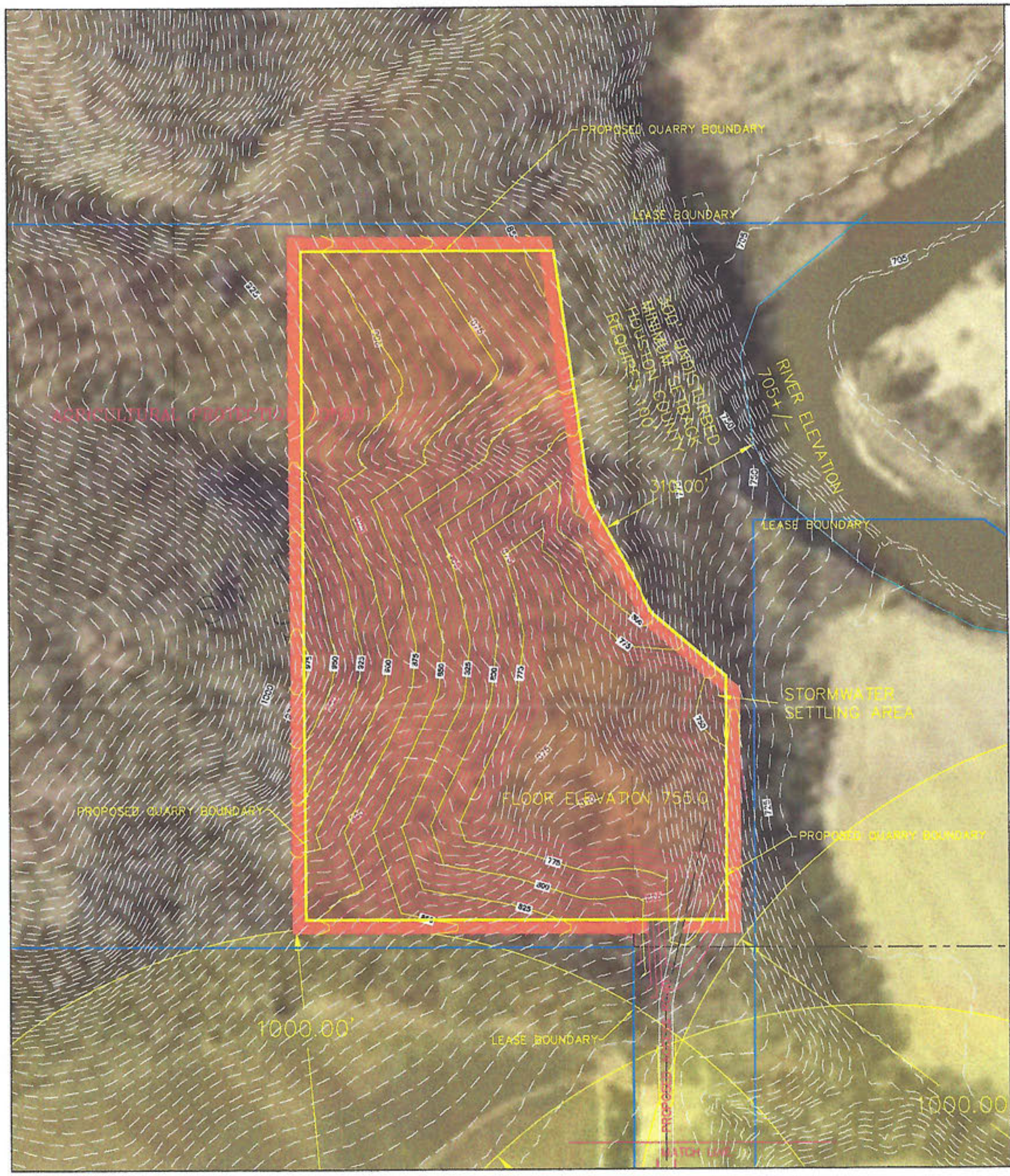
Prepared For:
BRUENING ROCK PRODUCTS
900 MONTGOMERY STREET
DECORAH, IA 52101
SHEET 4 OF 4
OLSON PROPERTY BOUNDARY
SE 1/4 SW 1/4
NE 1/4 NW 1/4
NW 1/4 NW 1/4
RIVER ELEVATION 705+/-
1000.00'
EXISTING SAND QUARRY

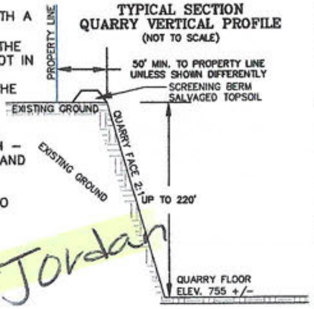



# PROPOSED OPERATIONS MAP

OPERATIONS MAP SUMMARY:

1. MAXIMUM AREA TO BE EXCAVATED IS OUTLINED IN ORANGE. 17.21 ACRES
2. VERTICAL PROFILE IS SHOWN IN THE TYPICAL SECTION.
   - 2.1. SOURCE SAND AND FORMATION PROFILE FROM THE GEOLOGICAL ATLAS ARE SHOWN ABOVE.
3. THE PROPOSED SCALE HOUSE IS LOCATED AT THE ENTRANCE OF THE QUARRY
   - 3.1. THE SCALE HOUSE SHALL BE THE ONLY STRUCTURE WITHIN THE QUARRY
4. ALL MINED MATERIALS WILL BE LOCATED ON THE QUARRY FLOOR WITH A MAXIMUM HEIGHT OF 25'
5. MACHINERY WILL MOVE THROUGHOUT THE QUARRY DEPENDING ON THE ACTIVE MINING AREA. ALL MACHINERY WILL BE STORED ON-SITE NOT IN PUBLIC ROADWAYS.
6. STOCKPILES WILL MOVE THROUGHOUT THE QUARRY DEPENDING ON THE ACTIVE MINING AREA.
7. ALL VEHICLE PARKING WILL BE LOCATED WITHIN THE QUARRY.
8. NO EXPLOSIVES WILL BE STORED ONSITE.
9. ALL STORMWATER WILL BE CONTAINED ON-SITE. ALONG THE NORTH – NORTHEAST SIDE OF THE QUARRY THE STORMWATER WILL COLLECT AND ALLOW FOR SETTLING OF SEDIMENTS.
10. INGRESS AND EGRESS WILL BE ON HIGHWAY 16 AS SHOWN.
11. MACHINERY, EXCAVATIONS, AND STOCK PILES ARE ALL PROPOSED TO MEET THE 50' SETBACK

TYPICAL SECTION
QUARRY VERTICAL PROFILE
(NOT TO SCALE)

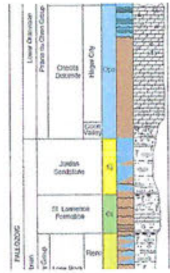


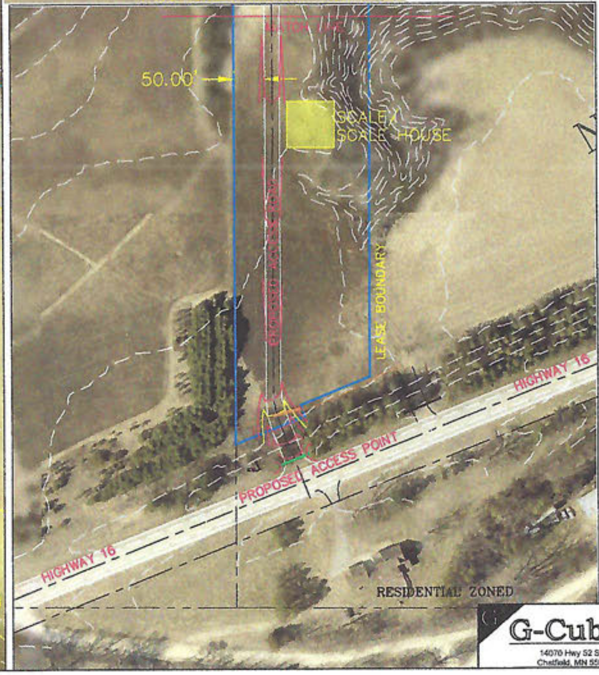

LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LEASE BOUNDARY
- PROPOSED QUARRY
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR

*Jordan

Cj Jordan Sandstone (Upper Cambrian)—Dominantly whitish-tan to orange, very fine- to coarse-grained, quartzose, friable sandstone. Characterized by coarsening-upward sequences of two interlayered facies (Runkel, 1994), which are not separated on the map. They are medium- to coarse-grained, commonly bioturbated, with trough or tabular cross stratification and a fine-grained, feldspathic, burrow-mottled facies with hummocky cross stratification. The maximum thickness of the formation is 80 to 100 feet (24 to 30 meters).




0 100 200 Feet

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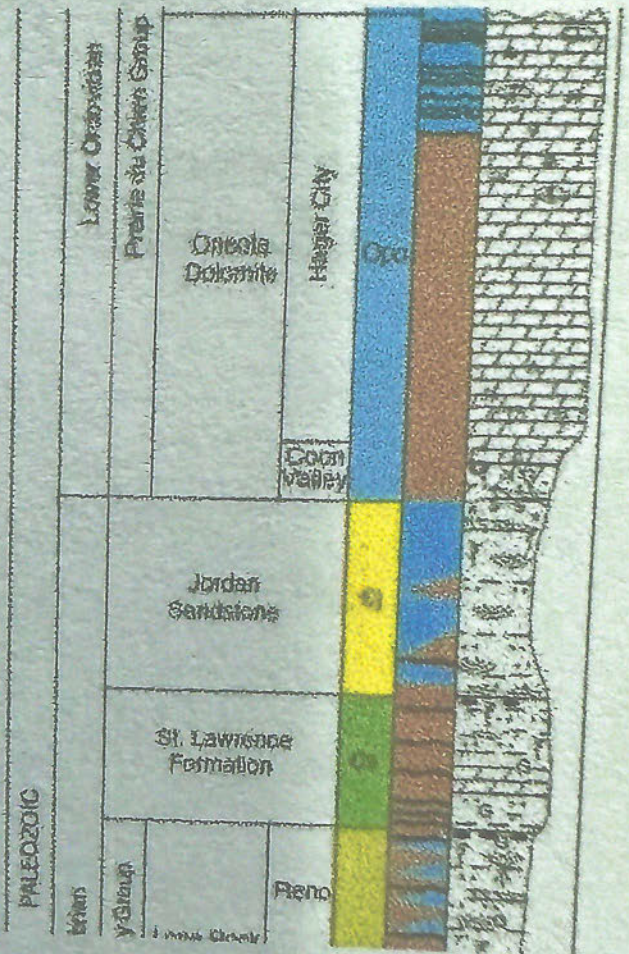
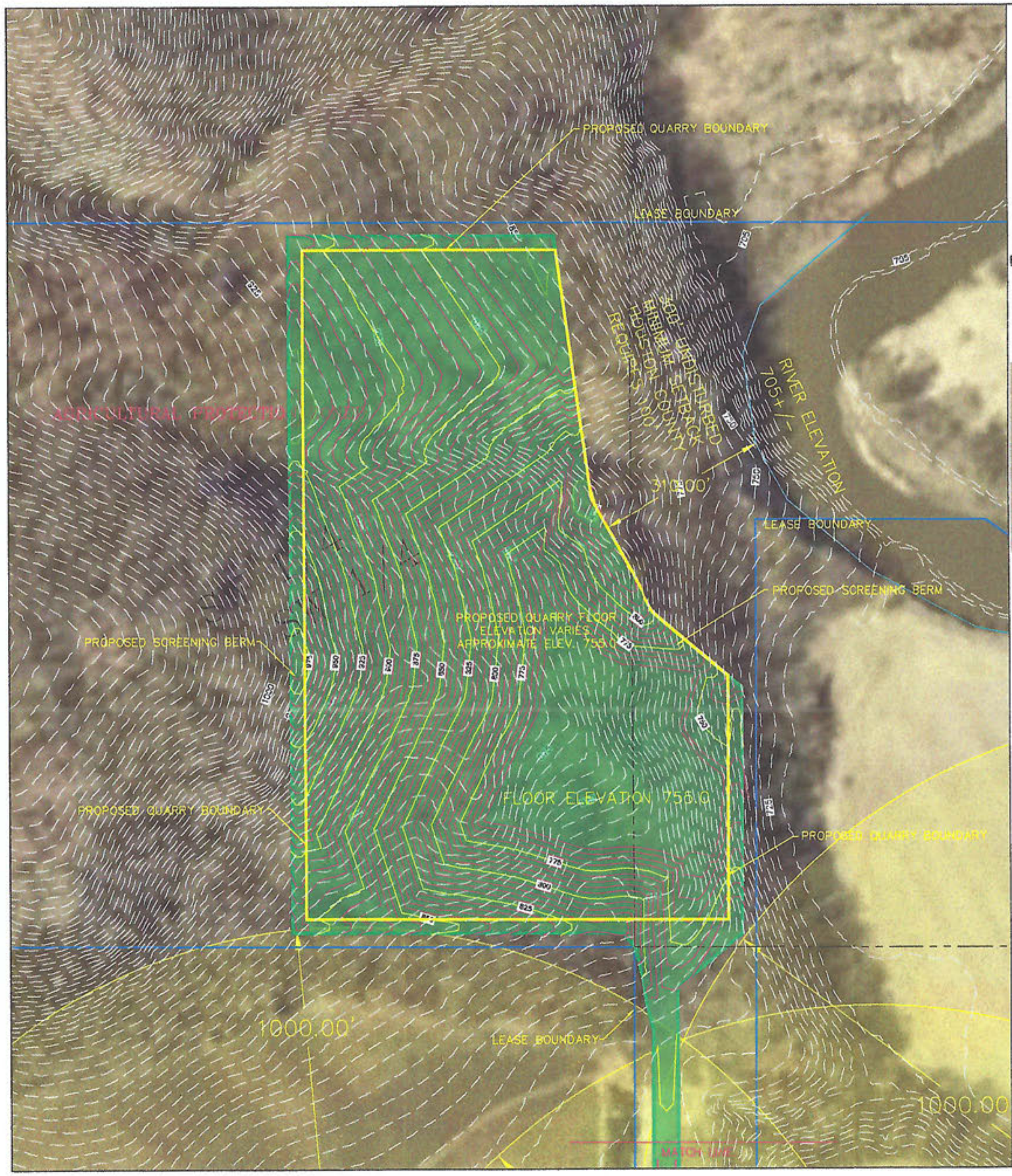
SHEET 2 OF 4


✳ From operations map

**Єj** **Jordan Sandstone (Upper Cambrian)**—Dominantly whitish-tan to orange, very fine- to coarse-grained, quartzose, friable sandstone. Characterized by coarsening-upward sequences of two interlayered facies (Runkel, 1994), which are not separated on the map. They are medium- to coarse-grained, commonly bioturbated, with trough or tabular cross stratification and a fine-grained, feldspathic, burrow-mottled facies with hummocky cross stratification. The maximum thickness of the formation is 80 to 100 feet (24 to 30 meters).

# PROPOSED RECLAMATION MAP



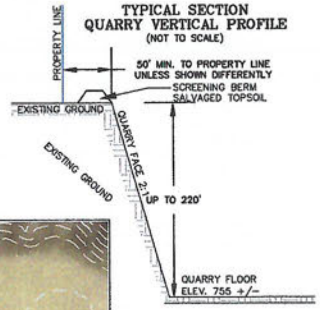

RECLAMATION MAP SUMMARY:

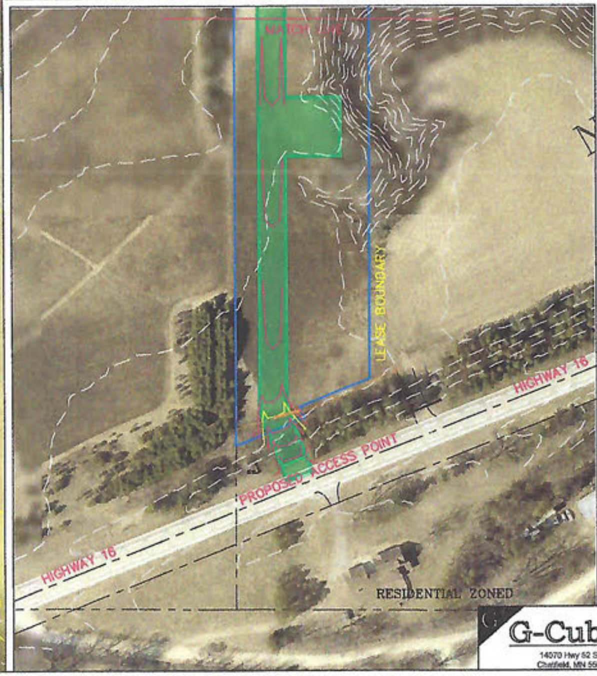
1. FINAL GRADES ARE SHOWN IN 5 FOOT INTERVALS. FINAL FLOOR ELEVATION IS > 755.0 EXACT ELEVATION WILL VARY BASED ON VOLUME OF OVERBURDEN REMAINING.
2. THE SITE SHALL BE SEEDED WITH MNDOT SEED MIXTURE 330 AT 84.5 LBS/ACRE OR APPROVED EQUIVALENT TO CREATE A GRASSY HABITAT.
3. NO STRUCTURES SHALL BE CONSTRUCTED AS PART OF THE RECLAMATION PLAN.

LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LEASE BOUNDARY
- PROPOSED QUARRY
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- RECLAMATION AREA

TYPICAL SECTION
QUARRY VERTICAL PROFILE
(NOT TO SCALE)

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DATE OF SURVEY: 08/19/2025
Prepared For:
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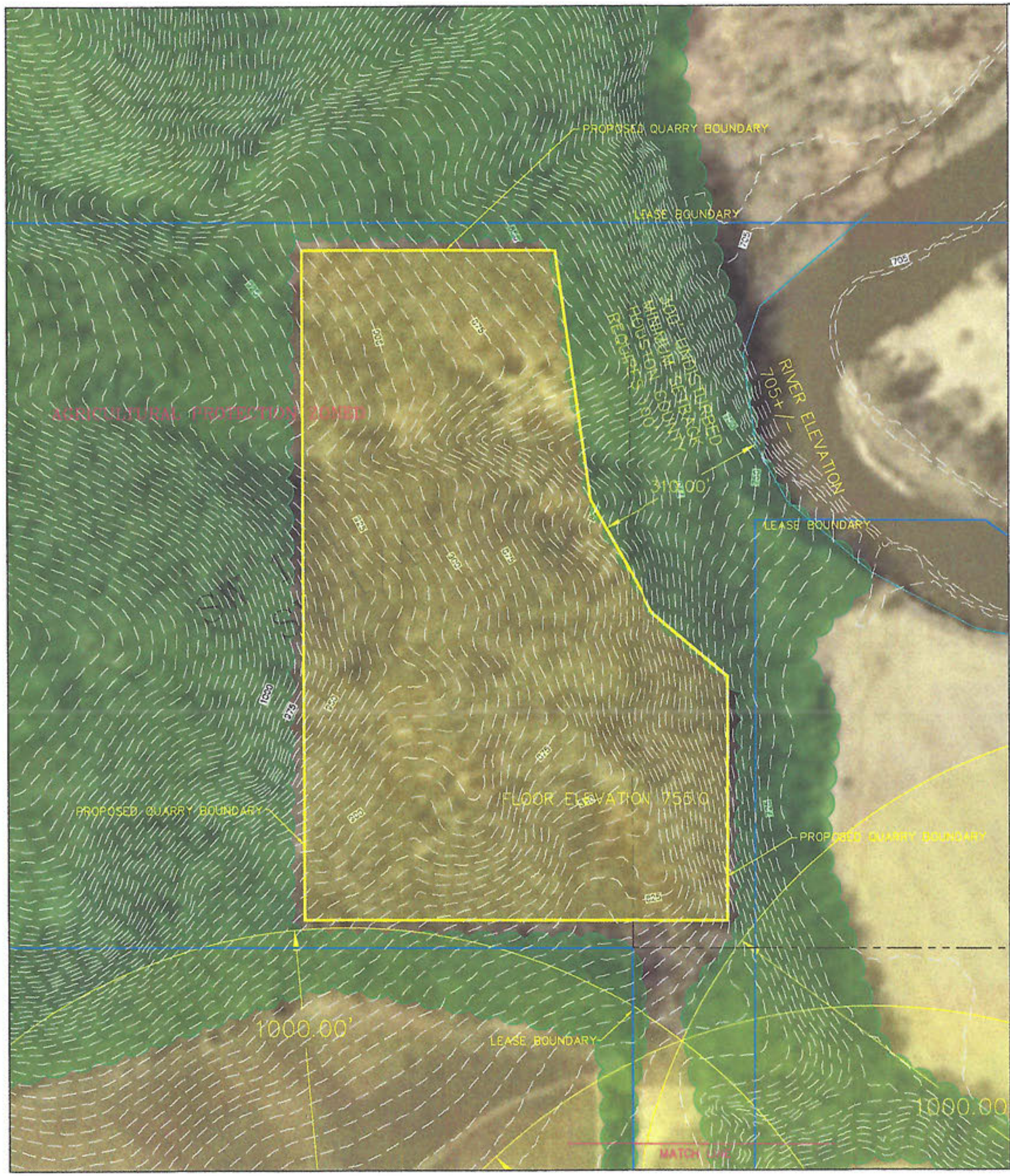
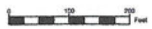
900 MONTGOMERY STREET
DECORAH, IA 52101
SHEET 3 OF 4 | FILE NO 25-030

# EXISTING CONDITIONS MAP

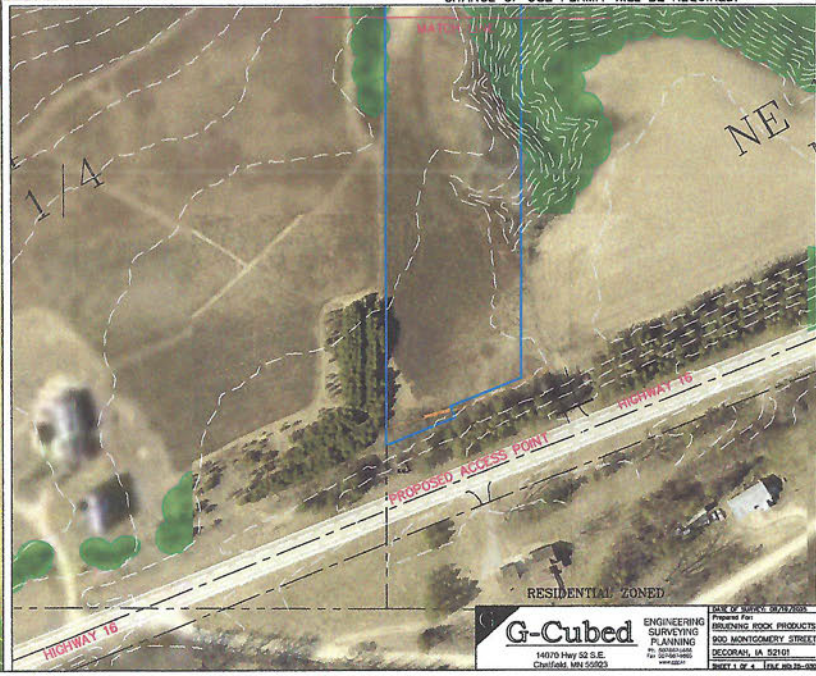




LEGEND
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LEASE BOUNDARY
- PROPOSED QUARRY

EXISTING CONDITIONS MAP SUMMARY:
1. EXISTING CONTOURS ARE SHOWN AT 5' INTERVALS.
2. THERE ARE NO WETLANDS ON-SITE.
3. THE UNDERLYING AERIAL PHOTO DEPICTS THE EXISTING WOODED AREAS.
4. THERE ARE NO EXISTING STRUCTURES OR WELLS ON-SITE.
5. THE PROPOSED ACCESS IS OFF OF HIGHWAY 16. A CHANGE OF USE PERMIT WILL BE REQUIRED.

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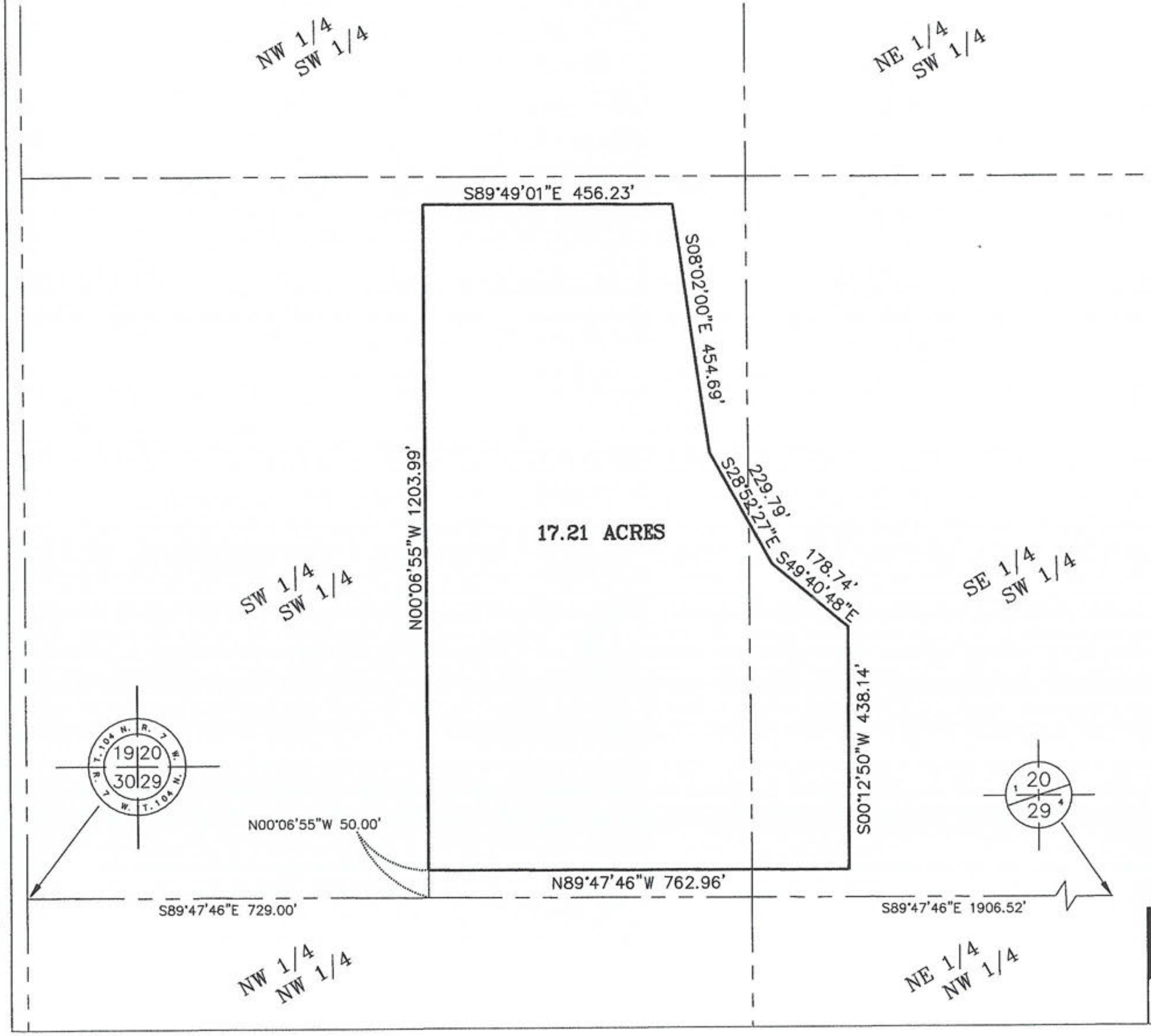
SHEET 1 OF 4

# QUARRY BOUNDARY EXHIBIT

## SECTION 20
## T. 104 N., R. 7 W.




**QUARRY BOUNDARY DESCRIPTION:**

That part of the South Half of the Southwest Quarter of Section 20, Township 104 North, Range 7 West, Houston County, Minnesota, described as follows:

Commencing at the southwest corner of said South Half of the Southwest Quarter; thence on an assumed bearing South 89°47'46" East, along the south line of said South Half of the Southwest Quarter, 729.00 feet; thence North 00°06'55" West 50.00 feet to the point of beginning; thence continue North 00°06'55" West 1203.99 feet; thence South 89°49'01" East 456.23 feet; thence South 08°02'00" East 454.69 feet; thence South 28°52'27" East 229.79 feet; thence South 49°40'48" East 178.74 feet; thence South 00°12'50" West 438.14 feet; thence North 89°47'46" West, parallel with said south line of the South Half of the Southwest Quarter, 762.96 feet to the point of beginning.

The above described conveyance contains 17.21 acres and is subject to any easements, covenants and restrictions of record.

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Chatfield, MN 55923

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Ph. 507-867-1666
Fax 507-867-1665
www.ggg.to

DATE OF SURVEY: 6-26-2025
Prepared For:
Bruening Rock Products
900 Montgomery Street
Decorah, IA 52101
SHEET 1 OF 1 | FILE NO: 24-035

To Sef Griffen

**LEASE AGREEMENT**
**Olson Sand Pit**

This agreement is made this 31 day of January, 2024, by and between Clair Olson and Patricia Olson, husband and wife, and Jarad Olson, a single person ("Lessor"), whose address for purposes of this lease is 22563 County 13, Rushford, MN 55971, and Bruening Rock Products Inc. ("Lessee"), whose address for purposes of this lease is P.O. Box 127, Decorah, IA 52101.

**WHEREAS,** Lessor is the owner of real estate legally described as:

The Southwest Quarter of the Southwest Quarter of Section 20-104-7 (Parcel No. 17.0010.001)

and

The Southeast Quarter of the Southwest Quarter of Section 20-104-7, except Tax Parcel Nos. 17.0010.002 and 17.0010.003 (Parcel No. 17.0010.000)

and

The West 225 feet of that portion of Northeast Quarter of the Northwest Quarter of Section 29-104-7 lying North of the right-of-way of the public roadway (Parcel No. 17.0035.000)

("the Real Estate"); and

**WHEREAS,** Lessee wants to establish the extraction of sand and gravel from the Real Estate on the terms set forth below; and

**WHEREAS,** Lessor wants Lessee to establish the extraction of sand and gravel from the Real Estate on the terms set forth below;

**NOW THEREFORE,** in consideration of the mutual obligations set forth in this lease agreement ("the Agreement"), the adequacy of which is hereby acknowledged, Lessors and Lessee hereby agree as follows.

1. **PREMISES AND TERM.** Lessor leases the Real Estate to Lessee for a term of fifteen years which shall commence on the first day of the month following zoning approval ("the Commencement Date").

2. **ZONING CONTINGENCY.** Lessee shall promptly apply for a conditional use permit to allow for mineral extraction activity on the Real Estate. Lessor shall sign such documents as may be necessary to obtain such permit. In the event that required permits cannot be obtained, Lessee may notify Lessor in writing that Lessee elects not to proceed, and all further obligations under this agreement shall be null and void.

3. **ROYALTY PAYMENTS.**

(a) Lessee shall pay Lessor the sum of [redacted] per ton of material transported from the Real Estate.

(b) Lessee shall pay Lessor a minimum royalty of [redacted] per year.

(c) The minimum royalty payment shall be paid in advance, beginning on the Commencement Date. Any royalties due in excess of the minimum royalty shall be paid on a quarterly basis. All royalty payments shall be sent by ordinary mail to the addresses listed in paragraph 11 below, as may subsequently be modified in writing.

(d) Lessee shall have the right to establish and maintain stockpiles of materials on the Real Estate. Royalties are not due for such stockpiles until the material is transported from the Real Estate.

(e) The payments set forth in this paragraph are the only compensation to be paid to Lessors for the operations contemplated in this Agreement, including the inherent consequences thereof, including but not limited to the changes the operation shall cause to the Real Estate.

4. **GOVERNMENTAL APPROVALS.** Lessee shall obtain all necessary permits required by applicable governing bodies to conduct mineral extraction operations on the Real Estate. Lessors shall take all reasonable steps to facilitate such governmental actions.

5. **REPRESENTATIONS.**

(a) Lessor represents and warrants as follows.

1. Lessor is the fee title holder of the Real Estate, and the undersigned partners are authorized to execute this Agreement without the consent of any third party, and know of no claim by any third party which would disturb Lessee's quiet enjoyment of the Real Estate.
2. Lessor knows of no hazardous substances on the Real Estate, and have no knowledge of any pending or threatened enforcement action by any governmental entity.
3. Lessee shall have the exclusive possession of the quarry during the term of this Agreement, and the exclusive right to remove sand or gravel from the Real Estate for the term of this Agreement.

(b) Lessee represents and warrants as follows.

1. All operations on the Real Estate shall be conducted in compliance with applicable laws.
2. Lessee shall indemnify and hold Lessor harmless from any damages to life or property proximately caused by Lessee's operations on the Real Estate, except that Lessee shall not be responsible for the ordinary consequences of quarrying and related activities.

6. **NO JOINT VENTURE.** This Agreement shall not be construed to establish a joint venture or partnership of any kind.

7. **TERMINATION.**

(a) If Lessee defaults in the payment of royalties as set forth herein, or in any other requirement under this Agreement, Lessors may terminate this agreement upon 60 days written notice, during which time such default is not cured.

(b) Lessee may terminate this agreement upon 60 days written notice in the event that quarrying operations cannot be economically continued, as determined by Lessee in its sole discretion.

(c) Upon the termination of the Lease, Lessee shall perform any reclamation required by applicable governmental authorities at no expense to Lessors.

(d) Except as set forth in this Agreement, neither Lessor nor any third party shall have any claim against Lessee for the changed condition of the Real Estate resulting from the quarrying operations conducted thereon.

(e) Upon the termination of this Agreement, Lessee may complete the production of any deposits that have been stripped prior to the end of the lease term, and continue to maintain stockpiles and necessary equipment on the Real Estate until such stockpiles are sold by Lessee. Lessee shall owe no additional compensation to Lessor, except for the payment of royalties on materials removed, including minimum royalty payments.

(f) Lessors waive any right to a landlord's lien under statutory or common law.

8. **LIABILITY INSURANCE.** Tenant shall obtain commercial general liability insurance in the amounts of $1,000,000.00 each occurrence and $2,000,000.00 annual aggregate per location. Such policy shall include liability arising from premises operations, independent contractors, personal injury, products and completed operations and liability assumed under an insured contract. This policy shall be endorsed to include the Landlord as an additional insured.

9. **CONFIDENTIALITY.**

(a) Lessor agrees to keep the royalty rate and other financial terms of this Agreement confidential, except that Lessor may disclose such information to family members, attorneys, accountants, financial advisers and necessary government officials.

(b) The parties agree that only the "Memorandum of Lease Agreement" attached hereto as Exhibit A shall be recorded.

10. **TAXES.** Lessor shall pay all real estate taxes and other governmental assessments against the Real Estate before they become delinquent. If such taxes or assessments become delinquent, Lessee may (but shall not be required to) pay such taxes or assessments, and offset such sums against the royalty to be paid to Lessor under paragraph 2 above.

11. **ASSIGNABILITY.**

(a) Lessor may transfer ownership of the Real Estate to any third party upon 10 days written notice to Lessee, and the rights and obligations of Lessor under this Agreement shall run with Real Estate.

(b) Lessee may assign its rights and obligations under this Agreement upon 10 days written notice to Lessors.

12. **NOTICES.** Any notices required to be given under this Agreement shall be deemed delivered 48 hours after such notice has been deposited in a receptacle of the United States Postal Service with proper postage affixed, addressed to the parties at the following addresses:

Lessor: Lessee:

Clair & Jarad Olson
22563 County 13
Rushford, MN 55971

Bruening Rock Products, Inc.
P.O. Box 127
Decorah, IA 52101

13. **MISCELLANEOUS PROVISIONS.**

(a) Lessor retains the exclusive right to hunt and fish on the Real Estate.

(b) Lessor may purchase, for their own use, sand from the Real Estate for the price of $7.50 per ton, and trucking of the same for $4.00 for the haul.

(c) This instrument sets forth the entire agreement between the parties and may be amended only by written instrument signed by each party.

**BRUENING ROCK PRODUCTS, INC.**

Keith B. Bruening, Secretary/Treasurer

Clair Olson

Patricia Olson

Jard Olson

# EXHIBIT A
# MEMORANDUM OF LEASE AGREEMENT

# MEMORANDUM OF LEASE AGREEMENT

**Preparer Information:**
Ronald D. Fadness, 900 Montgomery Street, P.O. Box 325, Decorah, IA 52101 (563) 382-2933

**Return Address**
Bruening Rock Products, Inc., 900 Montgomery Street, P.O. Box 127, Decorah, IA 52101

**Lessor:**
Clair Olson and Patricia Olson, husband and wife, and Jarad Olson, a single person

**Lessee:**
Bruening Rock Products, Inc, an Iowa corporation

**Legal Description:**
That part of the Southwest Quarter of Section 17-94-20 lying West of the creek

## MEMORANDUM OF LEASE

Be advised that Clair Olson and Patricia Olson, husband and wife, and Jarad Olson, a single person, on behalf of themselves, their successors and assigns, have this ____ day of ______________, 2024, entered into a lease agreement with Bruening Rock Products, Inc, an Iowa corporation, its successors and assigns for the real estate legally described as:

The Southwest Quarter of the Southwest Quarter of Section 20-104-7 (Parcel No. 17.0010.001)

and

The Southeast Quarter of the Southwest Quarter of Section 20-104-7, except Tax Parcel Nos. 17.0010.002 and 17.0010.003 (Parcel No. 17.0010.000)

The West 225 feet of that portion of Northeast Quarter of the Northwest Quarter of Section 29-104-7 lying North of the right-of-way of the public roadway (Parcel No. 17.0035.000)

for a term continuing through ________________.

The agreement provides for the existence of mineral extraction operations on the Real Estate.

**BRUENING ROCK PRODUCTS, INC.**

K. B. Bruening

Keith B. Bruening, Secretary/Treasurer

Clair Olson

Clair Olson

Patricia Olson

Patricia Olson

Jarad Olson

Jarad Olson

**STATE OF IOWA, WINNESHIEK COUNTY**

This instrument was acknowledged before me this 30 day of January, 2024, by Keith B. Bruening as Secretary/Treasurer of Bruening Rock Products, Inc.

NOTARIAL SEAL IOWA
FLOYD HACKMAN
Commission Number 838510
My Commission Expires
April 1, 2025

FLOYD HACKMAN
Commission Number 838516
My Commission Expires
April 1, 2025
NOTARIAL SEAL IOWA

Floyd Hackman
Notary Public

**STATE OF MINNESOTA, HOUSTON COUNTY**

This instrument was acknowledged before me this 31 day of January, 2024, by Clair Olson and Patricia Olson, husband and wife.

CRAIG SCHROEDER
NOTARY PUBLIC
MINNESOTA
My Commission Expires 01/31/2026

Craig Schroeder
Notary Public

**STATE OF MINNESOTA, HOUSTON COUNTY**

This instrument was acknowledged before me this 31st day of January, 2024, by Jarad Olson, a single person.

Craig Schroeder
Notary Public

CRAIG SCHROEDER
NOTARY PUBLIC
MINNESOTA
My Commission Expires 01/31/2026

BRUENING
# BRUENING ROCK PRODUCTS, INC.

900 MONTGOMERY STREET, P.O. BOX 127
DECORAH, IOWA 52101
[redacted]

November 3, 2023

Houston County Planning and Zoning
Attn: Martin Herrick
304 S. Marshall St.
Caledonia, MN 55921

Re: Representation by G-Cubed Engineering

Please be advised that G-Cubed Engineering has been retained to represent Bruening Rock Products, Inc. for purposes of zoning and development matters before Houston County. This includes affiliated entities Skyline Materials, Ltd. and G & K Development, L.C.

Please contact me with any questions.

BRUENING ROCK PRODUCTS, INC.

Ronald D. Fadness
General Counsel

## 1. Sensitive Karst Geology and Groundwater Vulnerability

- Citizen presentation "Reckless Sand Mining"
- Vulnerable Groundwater Area Map | Minnesota Department of Agriculture
- Daley Creek Dye Trace 2009 Appendix A
- Groundwater Atlas of Houston County

"Citizen presentation "Reckless Sand Mining" 1

Linda S. Griggs
[redacted]
Houston, MN 55943
[redacted]

**April 20, 2026**

**Minnesota Environmental Quality Board**

**Re: Request for EQB Oversight and EAW Requirement for Proposed Sand Mine**

To the Members of the Environmental Quality Board,

I am submitting the attached presentation and supporting materials to request that the EQB review the need for an Environmental Assessment Worksheet for a proposed nonmetallic sand mine in Houston County. The project area contains outstanding sensitive biodiversity, including rare species, highvalue habitat corridors, and groundwaterdependent ecosystems identified in EQB and DNR planning documents as requiring heightened scrutiny.

Recent zoning changes in Houston County have enabled this proposal to advance without adequate environmental analysis or public transparency. Given the site's Plainfield sandy soils, vulnerable groundwater systems, and erosionprone landscape, the project meets multiple thresholds for potential significant environmental effects.

Because this situation raises broader concerns about environmental review consistency, cumulative impacts, and public participation, I respectfully request EQB oversight to ensure that the EAW process is initiated and that all environmental considerations are thoroughly evaluated before any local approvals proceed.

Thank you for your attention and for your leadership in upholding Minnesota's environmental review framework.

Sincerely,

Linda S. Griggs

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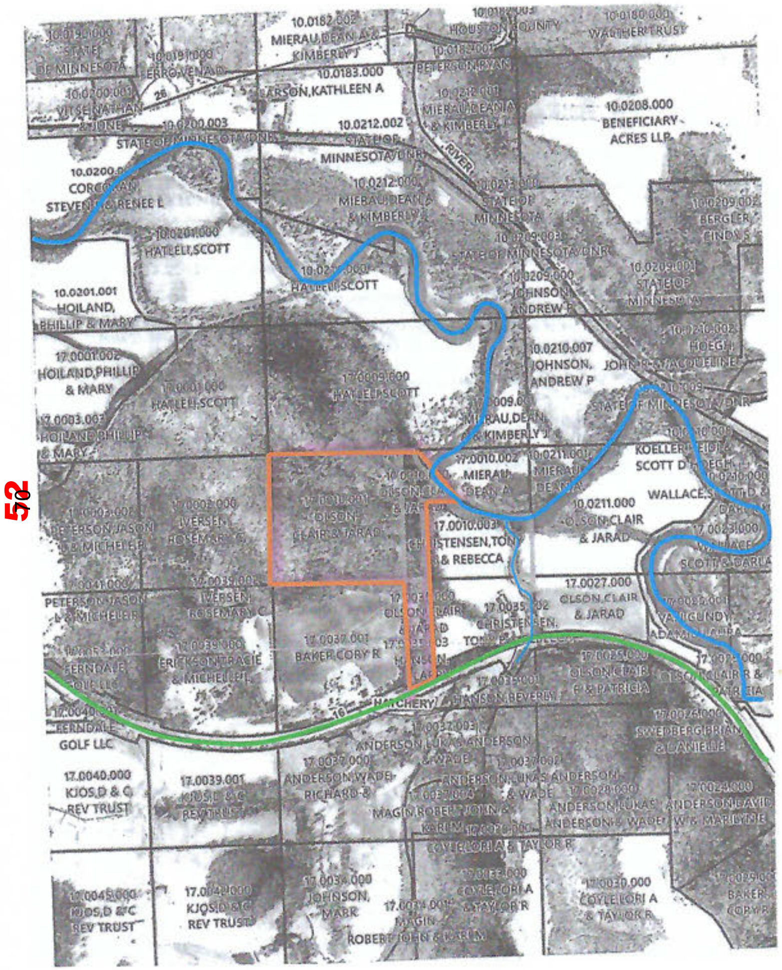
# Reckless Sand Mining




# Project Overview

**Location**: Yucatan Township, Houston County, Minnesota

**Proponent**: G3 (based in Chatfield, MN), Bruening Rock (based in Decorah, IA)

**Site**: Clair Olson property, proposed for nonmetallic mineral extraction (silica sand)

**Purpose**: Construction sand mining, potentially for hydraulic fracturing (frack sand)

# Soil Types at the Site

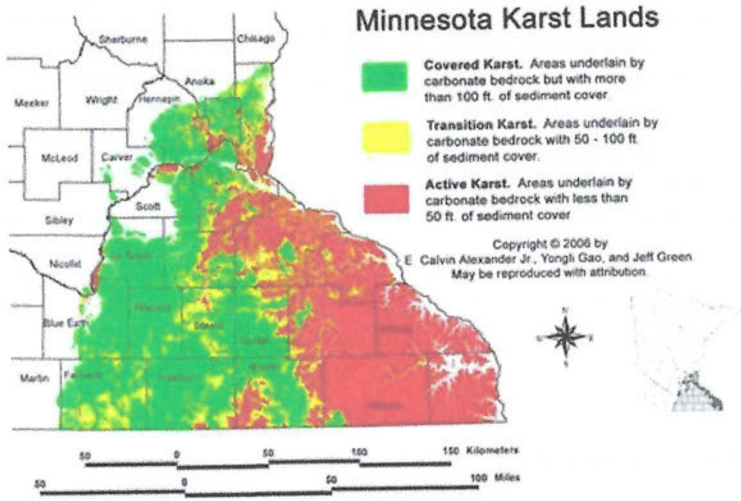
USDA Soil Survey for Houston County, MN,

- **Plainfield sand**:
  - Rapid permeability, excessively drained, low organic matter—
  - Commonly targeted for frac sand.
  - Deep deposits
- **Loamy sand**:
  - Similar profile, supports pine and oak vegetation

**These soils are deep, highly erodible and vulnerable to disturbance, especially on slopes**

# Karst Geology

- Karst landscapes form in limestone or dolomite which dissolves over time to creating
  - Sinkholes
  - Underground streams
  - Caves and voids
- Houston County, including Yucatan Township, sits atop the formations which are karst-prone dolomites.



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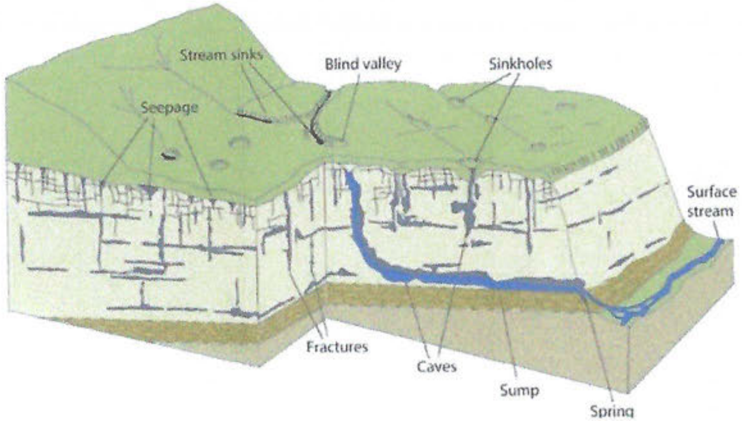
# Why Karst Matters for Sand Mining




- **Groundwater Vulnerability**:
  - Highly permeable
  - Contaminants can travel quickly and unpredictably
- **Sinkhole Risk**:
  - Excavation and vibration may trigger collapse of subsurface voids.
- **Surface Water Connection**:
  - Streams and wetlands hydrologically connected to underground systems
  - Disturbance could alter flow or dry up springs and underground wells.
- **Limited Natural Filtration:**
  - Pollutants can reach drinking water sources rapidly.

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# Impacts of Deforestation

- **Loss of Biodiversity**
  - Removal of oak, pine, and mixed hardwoods disrupts habitat for birds, mammals, and pollinators
  - Fragmentation of forest corridors reduces ecological resilience
- **Soil Erosion**
  - Tree roots stabilize sandy soils—deforestation increases erosion
  - Exposed slopes will lead to gullying and sediment runoff
- **Carbon Sequestration Loss**
  - Mature trees store significant carbon—clearing reduces climate mitigation capacity
- **Water Cycle Disruption**
  - Trees regulate transpiration and groundwater recharge
  - Loss of canopy alters microclimate and stream flow patterns

# EQB - Sand Mining Impact on Water

- Reduced water availability in domestic wells
- Reduced water availability in municipal production wells
- Reduced discharge to water dependent resources including calcareous fens, wetlands, ponds, lakes, trout streams, springs, seeps, and watercourses
- Degradation of fish and wildlife habitat
- Impacts to state protected species
- Impacts on existing groundwater pollution plumes
- Well interference complaints
- Water use conflicts

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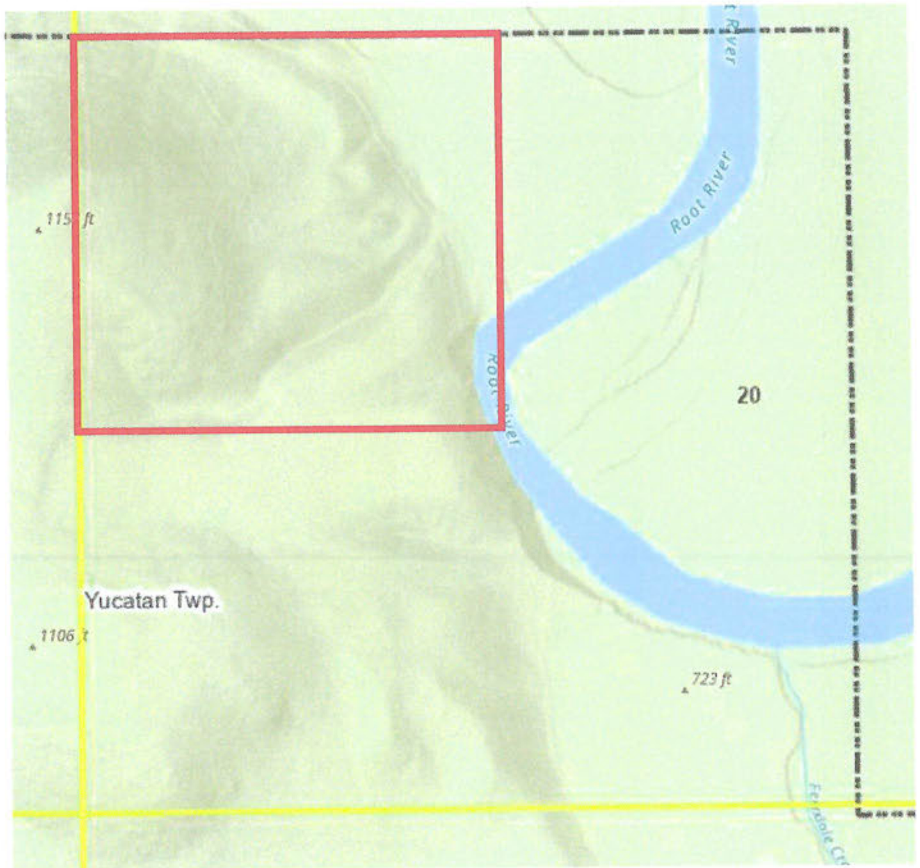
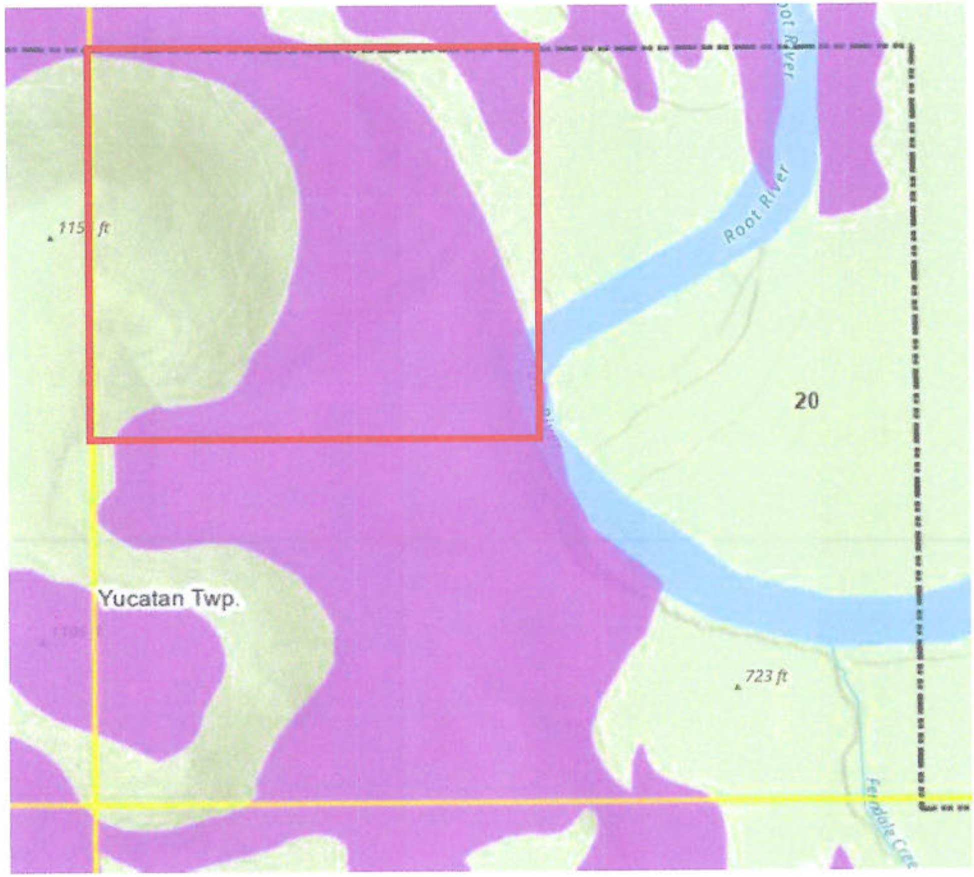
# Proposed Mine Area



10

# Coarse Textured Soils



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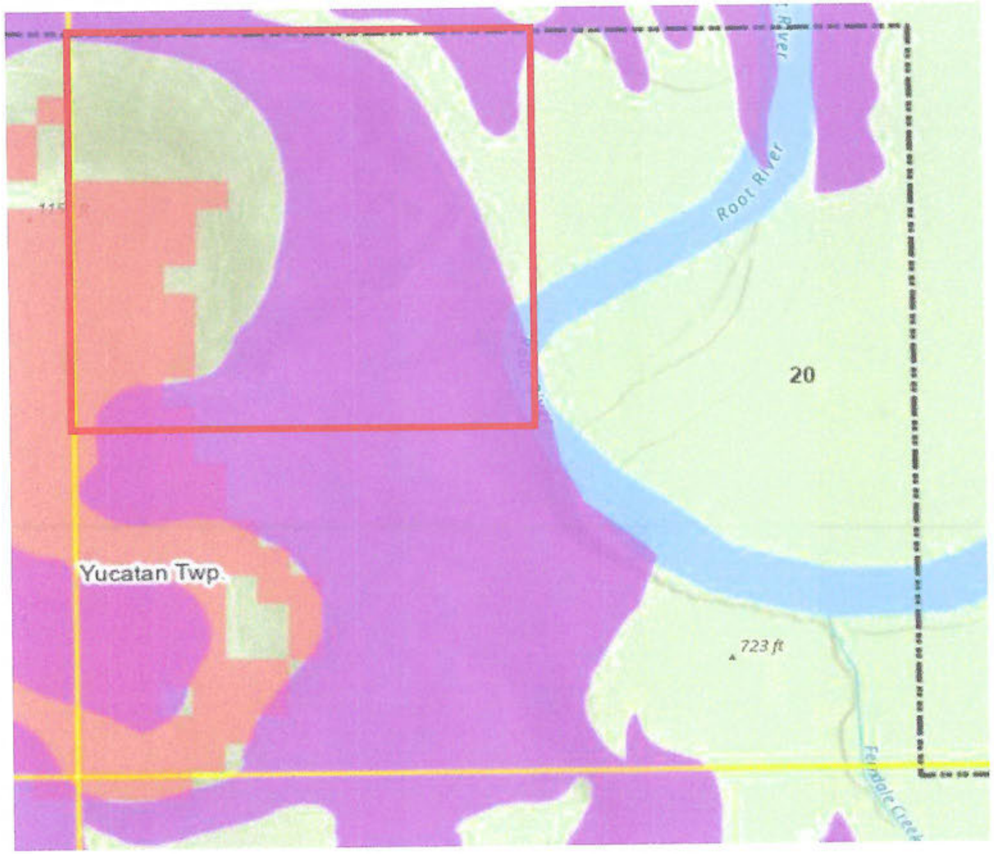
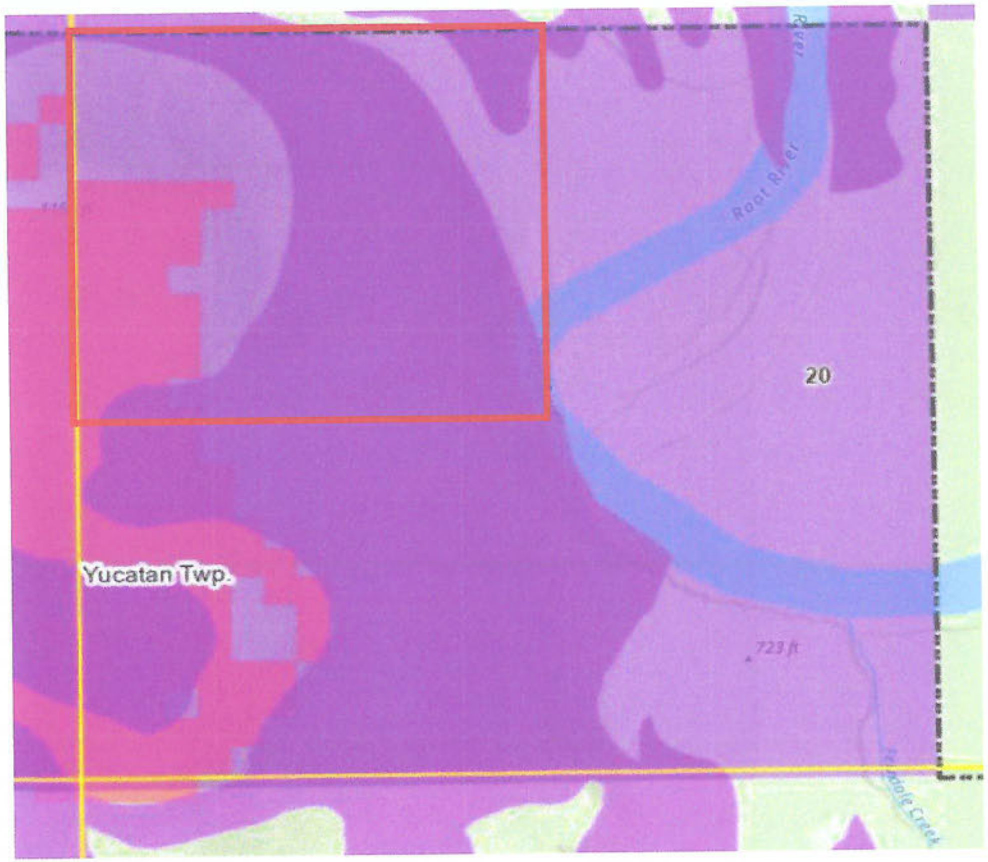
# Coarse Soil and Karst



12

# Begs A Question ???




**MDA Groundwater Protection Rule: Nitrogen Fertilizer Restrictions**

**Vs**

**No Mining Restrictions ???**

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# Site Specific Concerns

- **Proximity** to Root River and Ferndale Creek (a designated trout stream)
- **Deforestation** and soil removal can destabilize subsurface aquifers and threatens wildlife.
- **Blasting** or heavy equipment can stress weaknesses in the bedrock and cause noise & dust
- **Water** usage and impacts on aquifers
- **Transportation** dangerous truck traffic
- **Slope** of 12 – 70% toward the Root River, erosion & flooding downstream
- **Face Depth** up to 220 ft and reclamation
- **Moonscaping** - Distance to Erickson Mine

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# Summary

- **Sand mining high-silica sandy soils** can causing erosion
- **Sand mining over karst geology** threatens our waters
- **Sand mining and deforestation** poses risks to air, water, biodiversity, and community health
- **Sand mining in proximity** to waterways, homes, other mines
- **Current zoning ordinance** pushed by outside interests encourages expansion of sand mining throughout Houston County
- **Alternatives and mitigation** like buffer zones, setbacks, mine density, water impact and reclamation plan enforcement must be reevaluated.
- **Community engagement and Environmental Review** are essential before proceeding

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- Project Overview: https://www.driftlesslegacy.com/_files/ugd/2581ff_b50038808eb74da88eee32b80e10e58e.pdf
- USDA Soil Survey: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
- Minnesota Environmental Quality Board Report on Silica Sand: https://www.eqb.state.mn.us/sites/eqb/files/documents/23.%20March%20Final%20Silica%20Sand%20report.pdf
- Karst and SE Minnesota Groundwater: https://youtu.be/fpebOEi5UgQ?si=3hmw93htqOB3yTjs
- Deforestation: https://www.britannica.com/science/deforestation/Effects
- MN Dept of Agriculture Groundwater Protection Rule: https://www.mda.state.mn.us/part-1-groundwater-protection-rule
- Houston County Zoning Ordinance: https://www.co.houston.mn.us/departments/zoning-planning/?mdocs-file=9231

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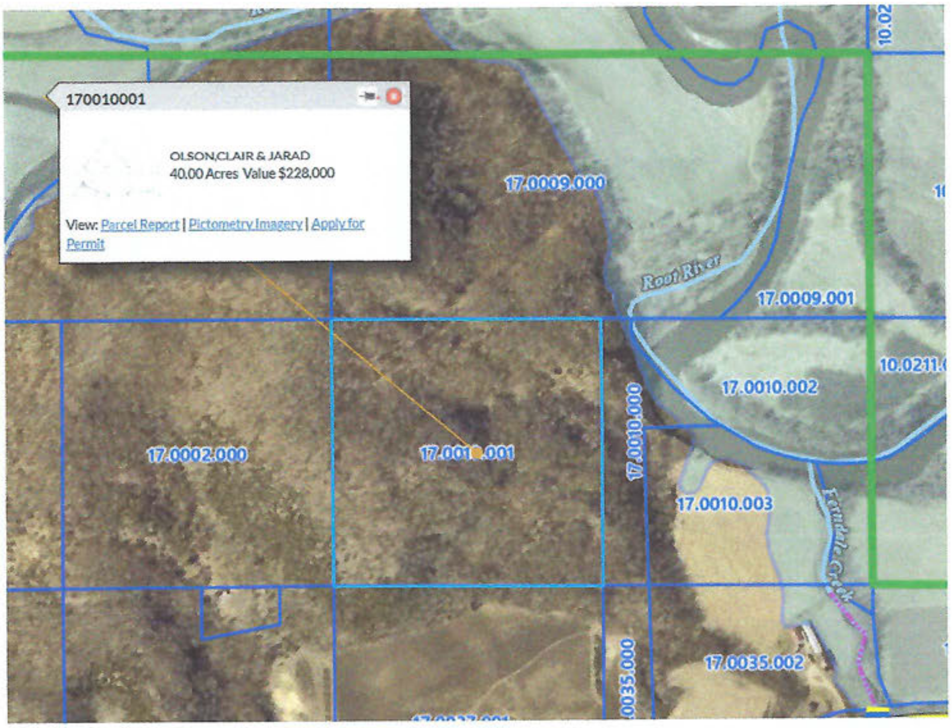
SHORELINE


FLOOD HAZARD ZONE



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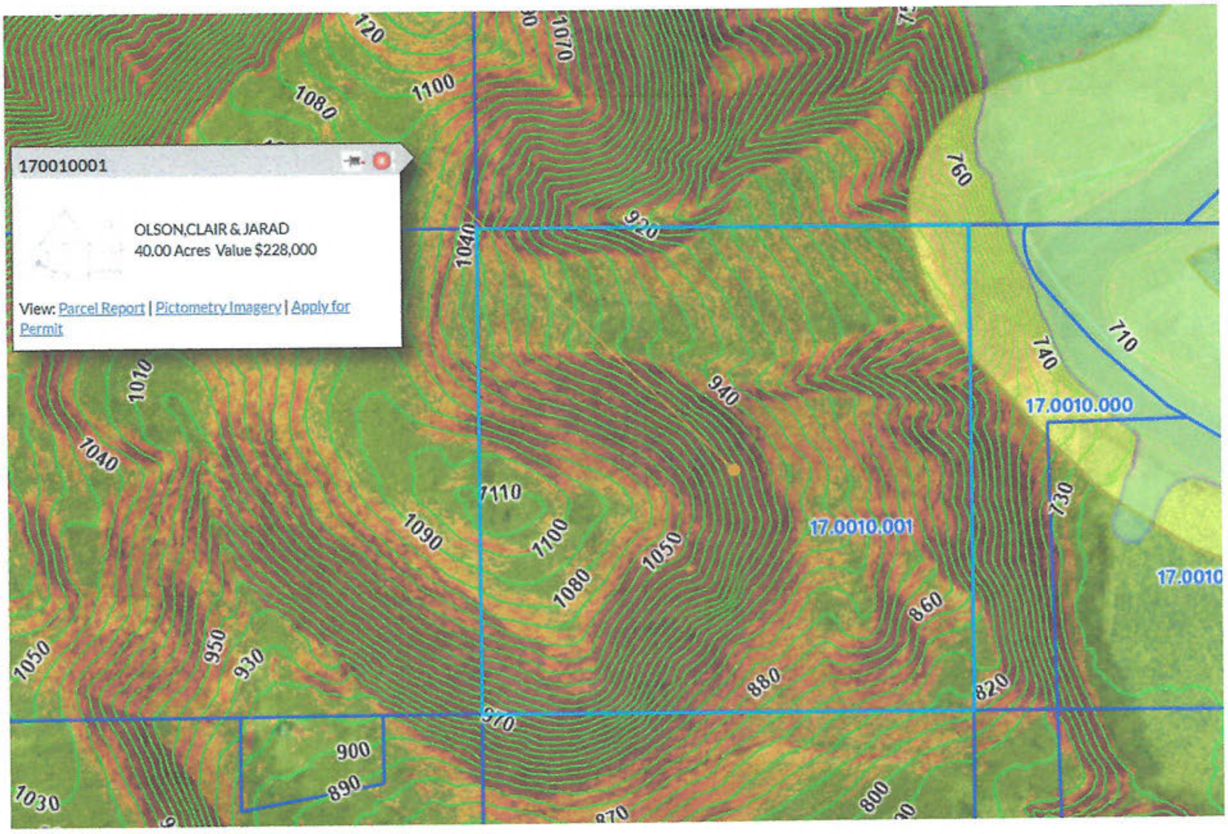
SHORELINE – FLOODHAZARD – AND SLOPE (MINIMUM OF 16% DEPENDING ON MINE SIZE AND LOCATION)




**Key facts about a 16% slope and slope stability**

- **Stability depends on soil and water** — Noncohesive soils (sand, loose gravel) are much more prone to erosion and translational slides than cohesive soils; pore water pressures from rain or dewatering can rapidly reduce shear strength and trigger failure.

**Main risks for sand mining at this slope**

- **Surface erosion and rilling** during storms that can quickly enlarge into gullies.
- **Slope failure (translational slides or sloughing)** if toe support is removed or groundwater increases.
- **Regulatory noncompliance** if stormwater, dewatering, or reclamation requirements are not met. In Minnesota, nonmetallic mining operations must follow MPCA and DNR permitting and reclamation guidance.

## Karst-Specific Risks for Sand Mining

MN Department of Agriculture identifies Houston County as having "Vulnerable Ground Water Area" due to karst geology (see map). (MN Dept of Ag)

Purpose: Summarize the primary risks to wells, springs, and streams from two sand mines sited within ½ mile in karst terrain.

Key point: Karst transmits water rapidly through sinkholes, conduits, and springs, so surface disturbances, sand washing, and dewatering can move contaminants and cause drawdown quickly and unpredictably.

Primary risks

- **Vulnerable Private Wells:** Most rural homes in Houston County rely on private wells. Construction aggregate processing involves washing sand, which can release silt into underlying aquifers. A mining operation that hits a major fracture or "vug" (a large cavity) can cause nearby wells to go dry or become turbid (cloudy) almost instantly. Rapid underground transport of contaminants like fuels, wash water, sediment, and other pollutants can reach private wells and springs with little filtration.
- **Cumulative effects**: Two operations within ½ mile can share spring sheds and conduits, producing synergistic impacts that are greater than the sum of individual mines. Water and contaminants can travel through "conduits" (caves and fractures) at speeds of hundreds of feet per day. A 1/2-mile distance between mines provides **virtually no protection** when a conduit is present. (**Daley Creek Dye Trace**)
- **Impact on Trout Streams:** Southeastern Minnesota is famous for cold-water trout streams fed by springs. Mining can threaten these ecosystems through sedimentation or by depleting the cold-water springs that sustain them.
- **Altered groundwater flow and drawdown**: Combined dewatering can lower spring discharge and reduce baseflow in nearby streams.
- **Unmapped conduits and sinkholes**: Surface absence of sinkholes does not guarantee subsurface safety. Direct underground connections are a high risk within a 1/2-mile radius of any mine. Scientific studies by the DNR and University

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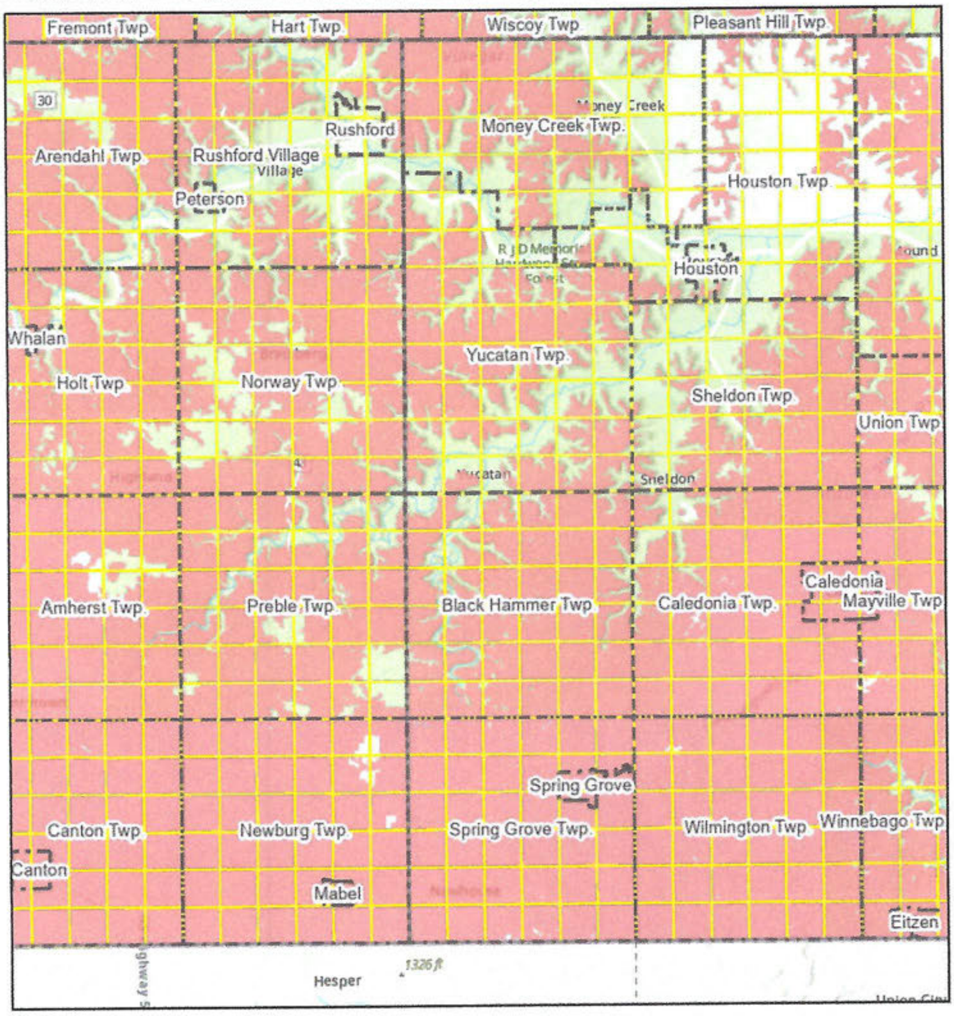
of Minnesota have shown that water entering a sinkhole or a mining pit can emerge at a spring over a mile away in just hours

- **Altered Hydrology:** Excavating near the surface in karst areas can remove the protective "overburden" of soil, making it easier for contaminants to reach the underlying limestone aquifers.

## MN Department of Agriculture Karst Geology in Houston

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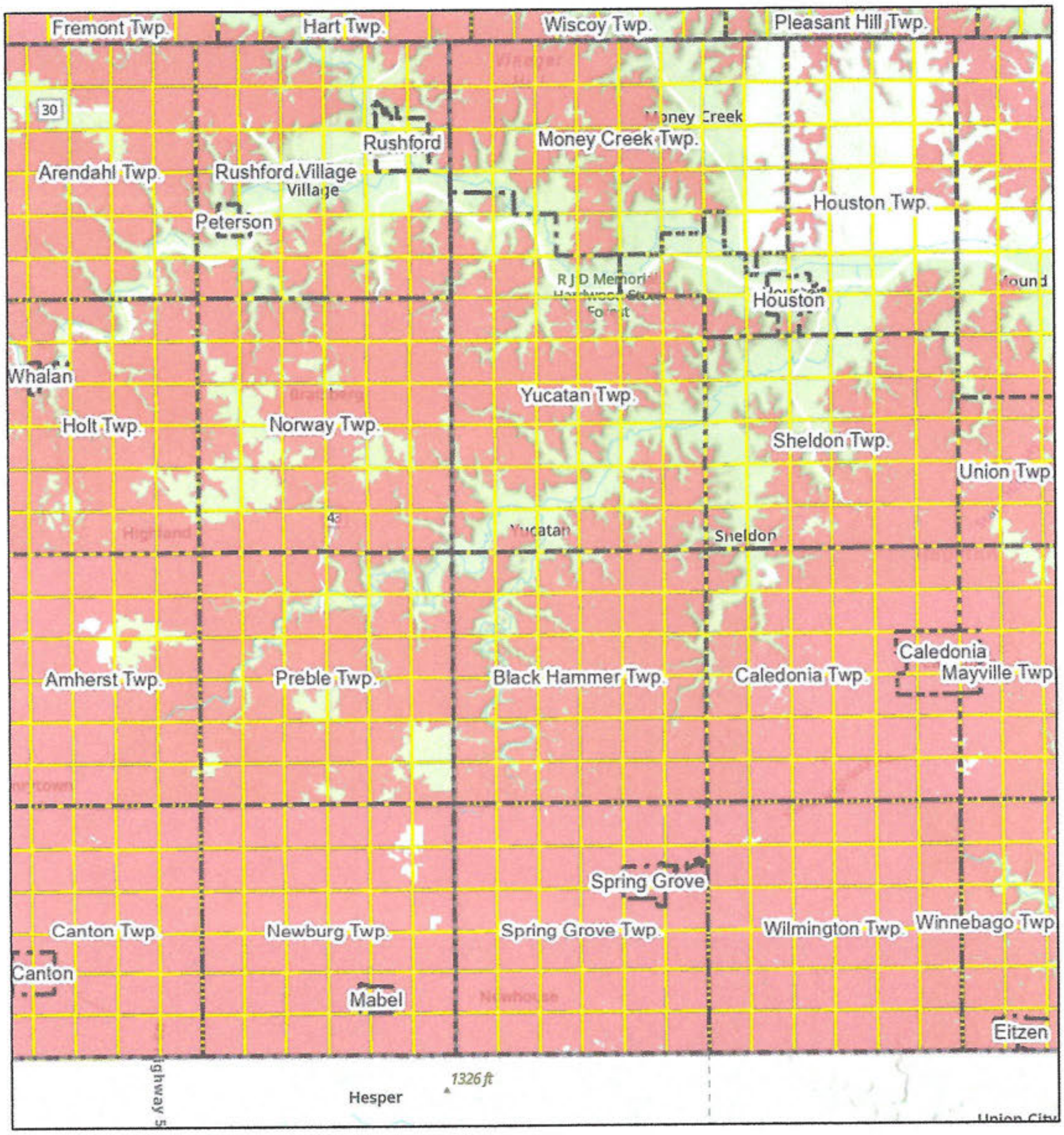
0 1.75 3.5 7 mi
0 2.75 5.5 11 km

- Public Land Survey Sections
- Counties
- Cities, Townships, and Unorganized Territories
- Karst

Minnesota Department of Agriculture, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS

Minnesota Department of Agriculture
Esri, USGS | MN Dept Natural Resources, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS | Minnesota Department of Agriculture |

## Fall Nitrogen Fertilizer Application Restrictions

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Public Land Survey Sections

Counties

Cities, Townships, and Unorganized Territories

Karst

Minnesota Department of Agriculture, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS

Minnesota Department of Agriculture
Esri, USGS | MN Dept Natural Resources, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS | Minnesota Department of Agriculture |

DEPARTMENT OF AGRICULTURE

# VULNERABLE GROUNDWATER AREA MAP

**View the interactive Vulnerable Groundwater Area Map (https://mnag.maps.arcgis.com/apps/webappviewer/index.html?id=47a342afe6654640b935c8e76023da92)**

The application of nitrogen fertilizer on cropland in the fall or on frozen soils will be restricted in vulnerable groundwater areas. This includes quarter-sections of land where 50 percent or more of the quarter-section is in an area with vulnerable groundwater and in DWSMAs that have nitrate-nitrogen concentrations at or in excess of 5.4 mg/L nitrate-nitrogen.

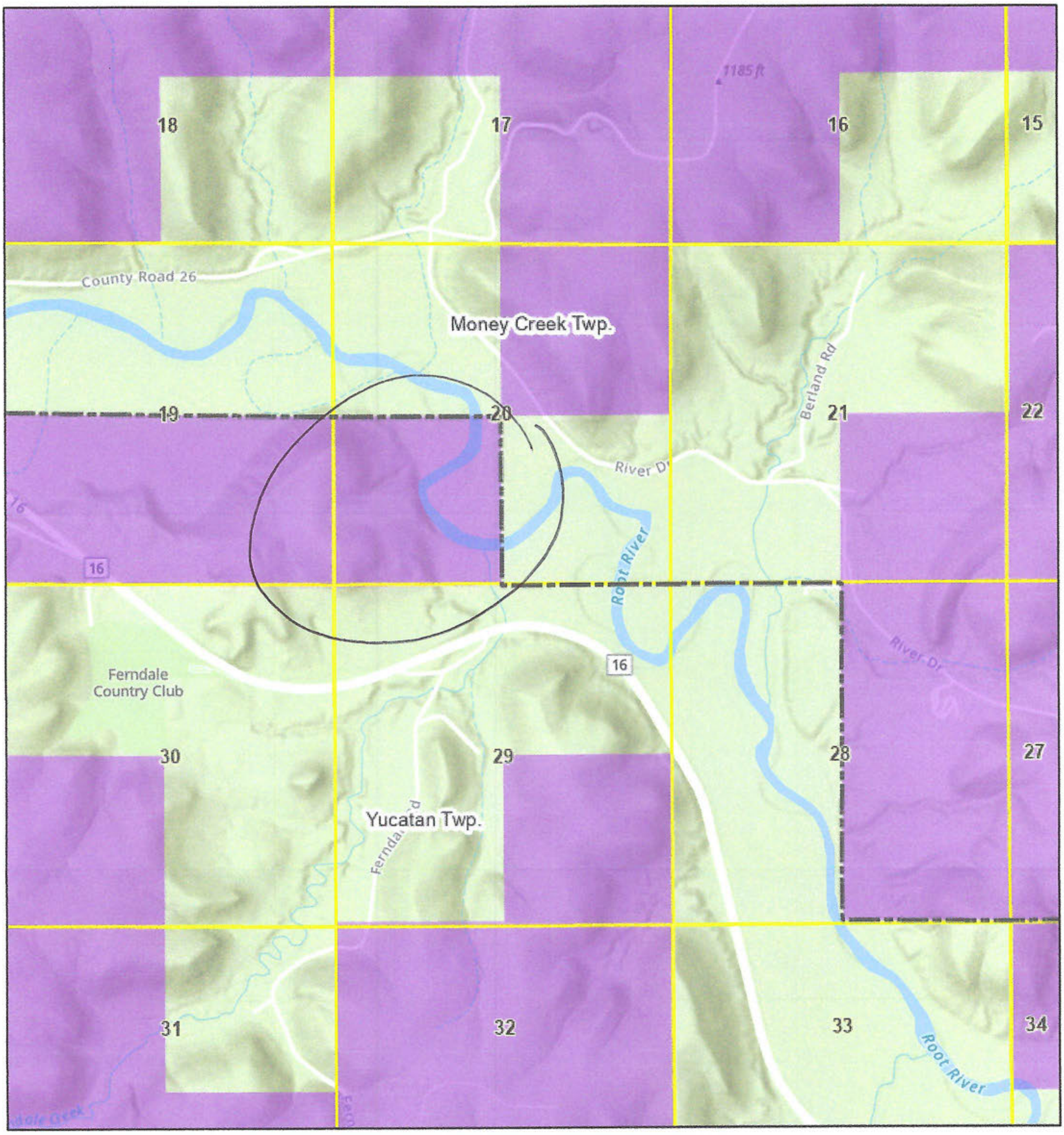
An area with vulnerable groundwater is an area where nitrate can move easily through soil and into groundwater, contaminating drinking water sources. Some portions of the DWSMAs have low and very low vulnerability, those areas are not subject to the fall restriction. Vulnerable areas for Part 1 of the rule (/part-1-groundwater-protection-rule) are defined as:

- coarse textured soils based on USDA NRCS soils maps (http://www.mngeo.state.mn.us/chouse/soil.html)
- shallow bedrock based on USDA NRCS soils maps (http://www.mngeo.state.mn.us/chouse/soil.html); or
- karst geology based on MN DNR map (https://gisdata.mn.gov/dataset/geos-hydrogeology-atlas-hg02).

Areas within a DWSMA which are low risk to groundwater contamination in the Minnesota Department of Health Wellhead Protection Plan are exempt from fall application restrictions.

2

# Fall Nitrogen Fertilizer Application Restrictions

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0 | 0.23 | 0.45 | 0.9 mi
0 | 0.35 | 0.7 | 1.4 km

Counties

Public Land Survey Sections

Counties

Cities, Townships, and Unorganized Territories

VulnerableQuarterSections

Minnesota Department of Agriculture, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, NASA, NGA, USGS, FEMA

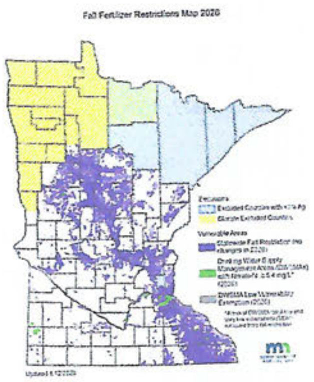
Minnesota Department of Agriculture

Esri, USGS | MN Dept Natural Resources, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, USFWS | Minnesota Department of Agriculture |

To access all of the mapping layers select the layer list icon in the upper left corner of the map page. To view a layer, check the box to the left of the layer title. Note that some adjustments were made to the Drinking Water Supply Management Area layers in January 2025.

The map shapefiles can be downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/dataset/water-fall-fert-restriction-2026)

**View the interactive Vulnerable Groundwater Area Map (https://mnag.maps.arcgis.com/apps/webappviewer/index.html?id=47a342afe6654640b935c8e76023da92)**



## LEARN MORE

- Groundwater Protection Rule (/nfr)

## FORMS + RESOURCES

> Groundwater Protection Rule (/nfr)

> Groundwater Protection Rule FAQ (/gwpr-faqs)

> Interactive Groundwater Protection Area Map (https://mnag.maps.arcgis.com/apps/webappviewer/index.html?id=47a342afe6654640b935c8e76023da92)

# CONTACT US

Luke Stuewe (/luke-stuewe)
Pesticide & Fertilizer Management / Detroit Lakes
218-850-9454 (tel:218-850-9454)
Luke.Stuewe@state.mn.us (mailto:Luke.Stuewe@state.mn.us)

Margaret Wagner (/margaret-wagner)
Pesticide & Fertilizer Management
651-201-6488 (tel:651-201-6488)
Margaret.Wagner@state.mn.us (mailto:Margaret.Wagner@state.mn.us)

# Daley Creek Dye Trace Report

## 2009

## Houston County, Minnesota

## Minnesota Department of Natural Resources

Jeffrey A. Green[1], Andrew J. Peters[1, 4],

Andrew J. Luhmann[2, 3], E. Calvin Alexander, Jr.[2]

[1] Minnesota Department of Natural Resources Ecological and Water Resources Division 3555 9th St. NW Suite 350, Rochester MN 55901

[2] University of Minnesota Earth Sciences Department 310 Pillsbury Dr. SE, Minneapolis MN 55455

[3] Current address: New Mexico Institute of Mining & and Technology Department of Earth & and Environmental Science Department 801 Leroy Place, Socorro, NM 87801

[4] Current address: Milestone Materials 920 10th Ave North, Onalaska, WI 54650

December 2009

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

***Funding for this Project is Provided by the Minnesota Environment and Natural Resources Trust Fund and the Clean Water, Land and Legacy Amendment***

CLEAN WATER LAND & LEGACY AMENDMENT

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## Introduction

A dye trace was conducted from a stream sink on Daley Creek in Houston County. Daley Creek is a state designated trout stream west of the City of Houston (Figure 1). This trace was run to begin to delineate springsheds in this area. The springs that form Daley Creek discharge from the St. Lawrence and Lone Rock Formations. The St. Lawrence springs are on the upper end of the stream and the Lone Rock springs are on the lower end. Dye trace sample packets were placed in springs on Daley Creek (Figure 1) and at other springs in adjacent valleys. Table 1 contains the dye input information and Table 2 summarizes the location information for the sample sites.

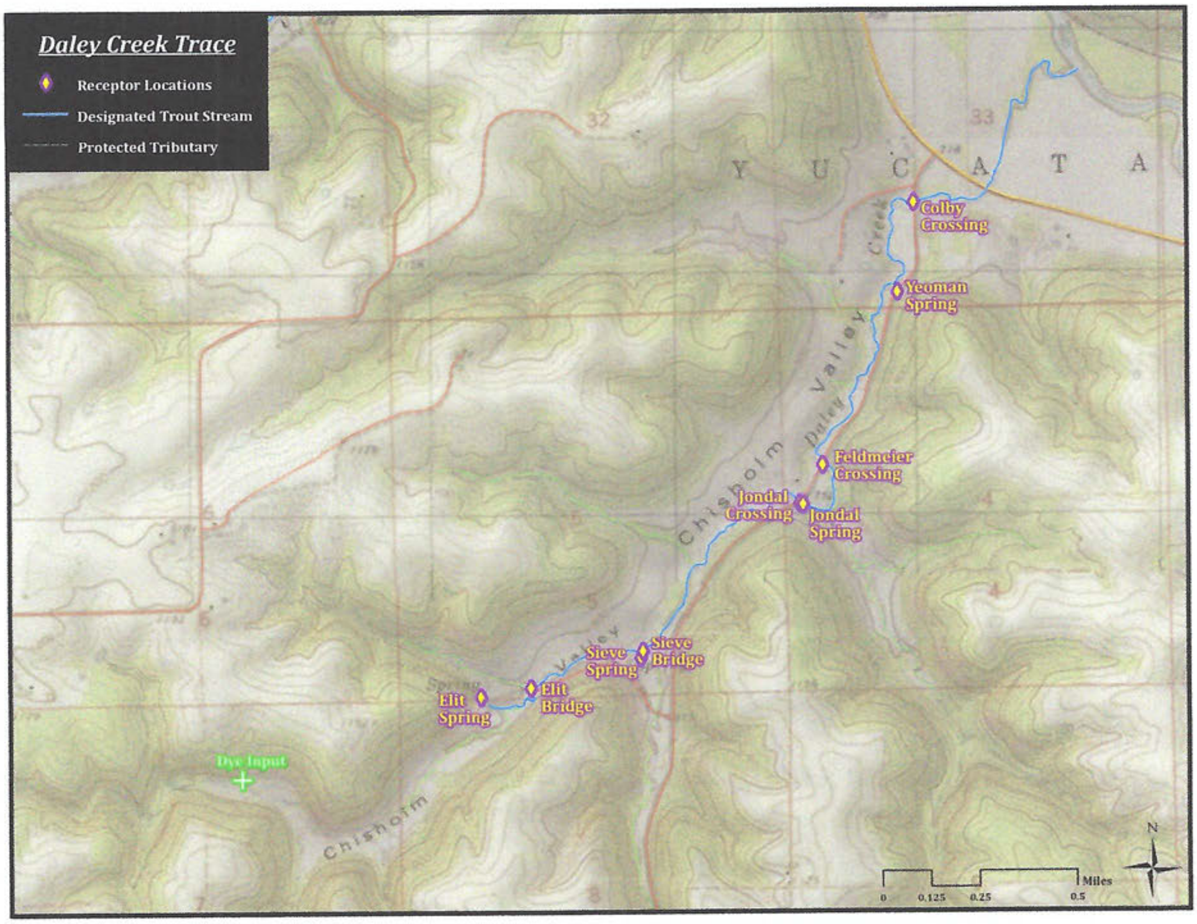



**Figure 1**. Dye trace sample sites on Daley Creek.

Dye tracing entails using fluorescent dyes to track groundwater flow directions and travel times. The dye is poured into a sinking stream or sinkhole; from there it flows through a conduit system until it re-emerges at a spring. All direct water samples and charcoal detectors used to trace groundwater flow were returned to the University of

Minnesota Geology & Geophysics Department Hydrochemistry Laboratory for analysis. There, the charcoal detectors were opened, the charcoal was removed, and using an eluent solution of 70% isopropyl alcohol, 30% deionized water, and 10g/L NaOH, the fluorescent materials were then extracted for analysis. The eluent solution was then run through the Shimadzu RF5000U scanning spectrofluorometer to detect and record the spectra. Direct water samples were also analyzed using the Shimadzu RF5000U scanning spectrofluorometer. Spectral components, including the background spectral components, were quantified using PeakFit software as described in Alexander (2005). E. Calvin Alexander, Jr., of the University of Minnesota Geology Department performed sample analysis and interpretation.

**Table 1**. Dye input information

| Dye Input Point | Dye (type, quantity) | Time | Stream Flow (Est.) | Detect point |
|---|---|---|---|---|
| Stream Sink 28:B001 | Uranine HS 1127.99 gm. | 1131 hrs. | 0.25 CFS | Elit Spring 28:A0031 |

**Table 2**. Dye trace sampling locations

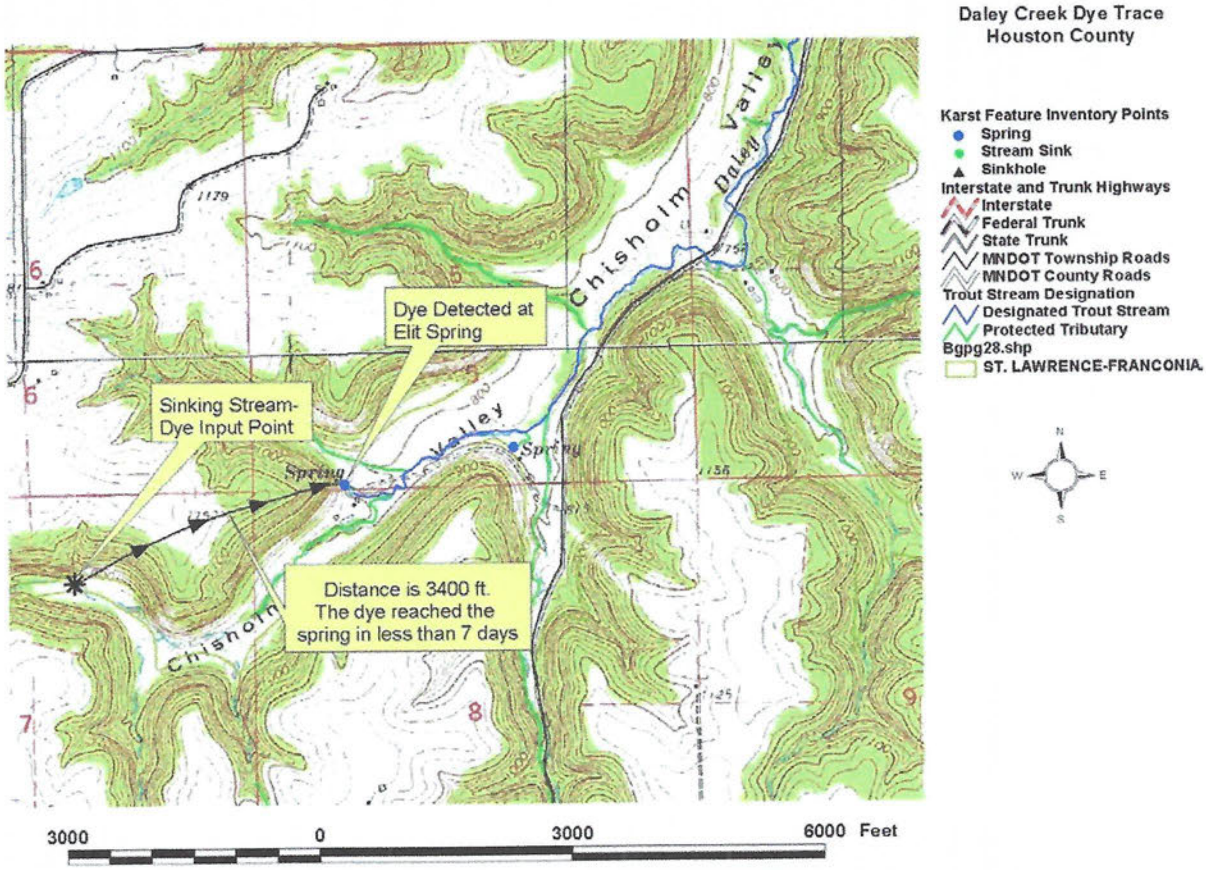
| Feature | KFDB | Easting | Northing | Property Owner |
|---|---|---|---|---|
| Bridge Creek | 28:X0005 | 607888 | 4839518 | County Road Right-of-Way |
| South Fork Root | 28:X0004 | 607846 | 4838929 | County Road Right-of-Way |
| Rostvold Spring | 28:A0073 | 607546 | 4839002 | Diane Rostvold |
| Elit Spring | 28:A0031 | 604178 | 4844439 | Larry Elit |
| Elit Bridge | 28:X0006 | 604386 | 4844475 | County Road Right-of-Way |
| Sieve Spring | 28:A0030 | 604841 | 4844600 | Michael Sieve |
| Sieve Bridge | 28:X0007 | 604850 | 4844628 | Michael Sieve |
| Jondal Crossing | 28:X0008 | 605501 | 4845246 | Steven Jondal |
| Jondal Spring | 28:A0074 | 605515 | 4845241 | Steven Jondal |
| Fledmeier Crossing | 28:X0009 | 605601 | 4845398 | Gerald Feldmeier |
| Yeoman Spring | 28:A0075 | 605942 | 4846122 | Jerome Beranek |
| Colby Crossing | 28:X0010 | 605978 | 4846487 | Fred Engelhart |

**Results**

The dye was detected at MN28:A0031, Elit Spring, which is the headwater spring of Daley Creek. The groundwater flow velocity based on this trace is over 500ft./day from the stream sink to Elit Spring. Subsequently, the dye was detected at the downstream sites that were stream road crossings. Figure 3 is a map view of the dye trace. The results are summarized in Appendix A. Appendix B has the scanned field notes for the dye input.

4

Figure 3. Dye Trace Vector




**Acknowledgements**

This trace could not have been possible without the cooperation of the landowners in the valley and area including Larry Elit, Michael Sieve, Steven Jondal, Gerald Feldmeier, Jerome Beranek, Fred Engelhart and Diane Rostvold.

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# Appendix A

Daley Creek Dye Trace (2009)

| KFDB #s | Site | DC1<br>Apr. 22-May 11, 2009 | DC2<br>May 11-20, 2009 | DC3<br>May 20-28, 2009 | DC4<br>May 28-June 11, 2009 | DC5<br>June 11-24, 2009 |
|---|---|---|---|---|---|---|
| 28:X0005 | Bridge Creek | | | Eos (28 σ)* | nd | nd |
| 28:X0010 | Colby Crossing | Eos (12 σ)* | Eos (17 σ)* | uran | uran | uran |
| 28:X0006 | Elit Bridge | nd | nd | uran | uran | uran |
| 28:A0031 | Elit Spring | nd | nd | uran | uran | uran |
| 28:X0009 | Feldmeier Crossing | nd | nd | uran | uran | uran |
| 28:X0011 | Ferndale Creek | | nd | Eos (16 σ)* | Eos (6 σ)* | uran (5 σ) |
| 28:X0008 | Jondal Crossing | Eos (18 σ)* | Eos (14 σ)* | uran | uran | uran |
| 28:A0074 | Jondal Spring | nd | nd | nd | nd | nd |
| 28:A0073 | Rostvold Spring | | | nd | nd | nd |
| 28:X0007 | Sieve Bridge | nd | nd | uran | uran | uran |
| 28:A0030 | Sieve Spring | nd | nd | nd | nd | nd |
| 28:X0004 | South Fort Root | | | Eos (10 σ)* | Eos (14 σ)* | Eos (9 σ)* |
| 28:A0075 | Yeoman Spring | nd | nd | nd | nd | nd |

nd = no dye detected
lost = bug lost
uran = uranine dye detected
Eos* = Eosin that came from some other unknown source

Uranine poured May 20, 2009

# Appendix B

6

5/20/09: Daley Creek Trace

New Receptors:

Bridge Creek - 4839518, 607888

South Fork Root - 4838929, 607846

Rostvold Spring - 4839002, 607546

Changed Receptors:

| | | |
|---|---|---|
| Colby Crossing | R/R | WS |
| Yeoman Spring | R/R | WS |
| Feldmeier Crossing | R/R | WS |
| Jondal Crossing | R/R | WS |
| Jondal Spring | R/R | WS |
| Sieve Bridge | R/R | WS |
| Sieve Spring | R/R | WS |
| Elit Bridge | R/R | WS |
| Elit Spring | R/R | WS |

Dye Input:

Input Point - 4844094, 603150

Uranine HS, Chromatint Lot 092508

1127.99 grams at 1131

Flow estimated at 0.25 cfs and decreased as it met with the terminal sink at 603202, 4844096

# Groundwater Atlas of Houston County, Minnesota

## County Atlas Series C-33, Part B - Hydrogeology

## Report

To accompany these atlas components:

Plate 5, Water Chemistry

Plate 6, Hydrogeologic Cross Sections

DEPARTMENT OF NATURAL RESOURCES

St. Paul 2025

mndnr.gov/groundwatermapping

## The County Atlas Series

The Minnesota County Geologic Atlas (CGA) Series has been produced since 1982. Recent atlases are published in two parts: Part A: Geology and Part B: Groundwater (this atlas). Before 2019, Part B was titled the "*Geologic* Atlas of X County - Hydrogeology." The title was changed to "*Groundwater* Atlas of X County" to better distinguish the content.

### Part A - Geologic Atlas

The precursor to this atlas is the *Geologic Atlas of Houston County, Minnesota*, C-33, Part A (Setterholm, 2014), published by the Minnesota Geological Survey (MGS). It contains Plate 1, Data-Base Map (Bauer and Chandler); Plate 2, Bedrock Geology (Steenberg); Plate 3, Surficial Geology (Lusardi, Adams, and Hobbs); Plate 4, Bedrock Topography and Depth to Bedrock (Steenberg).

Information is available on the MGS webpage (cse.umn.edu/mgs/county-geologic-atlas).

### Part B - Groundwater Atlas

This atlas was published by the Minnesota Department of Natural Resources (DNR), expanding on the geologic information in Part A. Completed atlases, chemistry data, and more information are available through the DNR Groundwater Atlas Program webpage (mndnr.gov/groundwatermapping).

Citation for this atlas:

Barry, J.D., 2025, *Groundwater atlas of Houston County, Minnesota*: Minnesota Department of Natural Resources, County Atlas Series C-33, Part B, report, 2 pls., GIS files.

## Acknowledgments

Author/GIS John D. Barry, Cartographer Holly Johnson, and Editor Susan Montgomery.

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The author also thanks the following current and former DNR staff for their assistance with collecting water samples: Vanessa Baratta-Person, Meagan Harold, Holly Johnson, Linse Lahti, Rachel Lindgren, and Wes Rutelonis. John Hoxmeier, Steven Klotz, Vaughn Snook, and James Melander assisted in selecting and arranging access to spring sampling locations. Colleagues from the DNR State Climatology Office assisted with this project: Kenneth Blumenfeld developed the climate summary, and Pete Boulay collected the precipitation isotope samples. Scott Alexander, formerly with the University of Minnesota, assisted in the collection and interpretation of the carbon-14 results of this report. Seamus Barry assisted with data processing.

A special thanks to all the well owners who graciously offered to let us collect water samples from their wells. Without their voluntary participation, this program could not achieve its goals.

# Report Contents

# Report Figures

# Report Tables



# Plates (accompanying folded inserts)



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## Technical reference

Maps were compiled and generated in a geographic information system. Digital data products are available on the Minnesota Department of Natural Resources Groundwater Atlas Program webpage (mndnr.gov/groundwatermapping).

Maps were prepared from Minnesota Department of Natural Resources and other publicly available information. Every reasonable effort has been made to ensure the accuracy of the data on which the report and map interpretations were based. However, the Minnesota Department of Natural Resources does not warrant the accuracy, completeness, or any implied uses of these data. Users may wish to verify critical information; sources include both the references here and information on file in the offices of the Minnesota Geological Survey and the Minnesota Department of Natural Resources. Every effort has been made to ensure the interpretations conform to sound geologic and cartographic principles. These maps should not be used to establish legal title, boundaries, or locations of improvements.

Base maps were modified from the Minnesota Geological Survey, *Geologic Atlas of Houston County, Minnesota*, 2014. Universal Transverse Mercator projection, Zone 15N, North American Datum of 1983. North American Vertical Datum of 1988.

### Conversion factors

1 inch per hour = 7.056 x $10^{-6}$ meter per second
1 part per million = 1 milligram per liter
1 part per billion = 1 microgram per liter
1 foot$^2$ per day = 7.48 gallons per day per foot

# Groundwater Atlas of Houston County, Minnesota

by John D. Barry

## Executive summary

This report and the accompanying plates describe the groundwater characteristics of Houston County and were produced by the Minnesota Department of Natural Resources (DNR). Groundwater is a mixture of water of various chemical compositions and ages that exists underground, filling the pores and fractures of geologic materials beneath the land surface.

This report builds on the geology described in Part A, previously published by the Minnesota Geological Survey (MGS) (Setterholm, 2014), illustrating the hydrogeologic setting using maps, plates, figures, tables, and text. Principal products include groundwater flow maps, illustrations summarizing the results of select water chemistry, aquifer pollution sensitivity maps, and hydrogeologic cross sections. Key elements and findings are summarized in this section.

**Physical setting and climate** (page 3) describes the location of the county, summarizes average temperature and precipitation, and lays the framework for how these influence groundwater recharge.

Houston County is in southeastern Minnesota with land use that is a mix of agricultural cropland, forest, and small towns. The county lies within four surface watersheds: the Root River, Mississippi River–Reno, Mississippi River–La Crescent, and Upper Iowa River. It has a cool subhumid climate with average temperatures of 69.6 degrees Fahrenheit (°F) in the summer and 20°F in the winter. Average annual precipitation is approximately 37 inches, making it one of the wettest counties within the statewide range of 21 to 38 inches.

**Physical geology and hydrogeology** (pages 6 to 20) describes the aquifers and aquitards and identifies their hydrostratigraphic characteristics and corresponding geologic units from Part A. Groundwater-elevation maps broadly illustrate the direction of groundwater flow in unconfined conditions (water-table elevation) and confined conditions (potentiometric-surface contours).

The county is underlain by a thick sequence of Paleozoic sedimentary bedrock layers. Bedrock is generally within 50 feet of the land surface and is covered by a veneer of unconsolidated sediment, such as loess, sand, and colluvium. Thick layers of unconsolidated sediment generally only exist in valley bottoms, making bedrock aquifers the primary source of drinking water and groundwater discharge to streams.

Much of the county is a karst terrain formed by precipitation and groundwater dissolving the underlying carbonate sedimentary rock. Karst provides rapid water movement between the land surface and underlying aquifers and may be characterized on the surface by sinkholes, caves, and springs. Even where surficial evidence of karst features is absent, there can still be connections for rapid water movement between the land surface and aquifers (higher pollution sensitivity).

Groundwater flow directions in the water table are regionally toward the Mississippi River and locally toward streams and creeks. Water-table depth is shallow (0 to 20 feet) in valley bottoms. Elsewhere, it can be very deep and difficult to determine because of the karst setting, unsaturated soils, and few shallow bedrock wells. In sporadic areas, soil moisture suggests there is a perched water table. Bedrock aquifers show groundwater flow patterns similar to the water table, regionally toward the Mississippi River and locally toward streams and creeks. Rapid recharge can occur in aquifers above the St. Lawrence aquitard or where aquitards are not present.

**Water chemistry** (pages 21 to 32, Plate 5) provides information about the groundwater sources, flow paths, and travel times. Water chemistry can indicate high pollution sensitivity or problems with naturally occurring geologic (geogenic) contaminants. Human-caused (anthropogenic) occurrences of chloride and nitrate-nitrogen (nitrate) are relatively widespread in the water-table aquifer. The water-table aquifer comprises the Prairie du Chien and Jordan aquifers in upland settings and the sand and gravel aquifer in lowland settings. Elevated levels of chloride and nitrate most commonly occur in wells completed in aquifers located above the first regionally competent aquitard, the St. Lawrence aquitard, or in valley bottoms where overlying aquitards are not present. Springs commonly have elevated levels of both chloride and nitrate, as even springs emanating beneath aquitards include a component of recent water susceptible to contamination.

Arsenic and manganese are geogenic contaminants that generally have low concentrations in the county. The Minnesota Department of Health (MDH) recommends water treatment if any arsenic is present.

**Pollution sensitivity** (pages 33 to 47) of an aquifer is estimated based on the time it takes water to flow from the land surface through various types and thicknesses of soils and geologic materials. Pollutants are assumed to travel with water at the same rate. Sensitivity is modeled with different methods for the near-surface materials and bedrock aquifers. The model results are evaluated by comparing select chemistry from sampled wells and springs. Rapid recharge is associated with high pollution sensitivities.

Near-surface sensitivity ratings can be broadly grouped into two types:

1. Very high sensitivity in the area prone to karst feature development, which covers most of the county.
2. High to moderate sensitivity areas that occur along the Mississippi River Valley and in valley bottoms with coarse-grained deposits.

Sensitivity ratings for bedrock aquifers were developed using chemical constituents, such as tritium and carbon-14 data, for residence time, and select inorganic chemicals, such as chloride and nitrate, for contamination. Groundwater residence times range from less than 100 to 30,000 years. Anthropogenic chloride and nitrate are relatively widespread in shallow aquifers, especially where wells are completed in aquifers above the St. Lawrence aquitard. Below the St. Lawrence aquitard, groundwater has longer residence times and less contamination. Wells completed in aquifers below the St. Lawrence can generally provide groundwater that is typically unimpacted by human activities, if properly installed according to the Minnesota Well Code. Springs commonly have elevated levels of both chloride and nitrate, even if located below the St. Lawrence aquitard. A portion of the water emanating from these springs is anthropogenically impacted water that flows vertically downward through conduits and fractures in valley settings.

**Hydrogeologic cross sections** (pages 48 and 49, Plate 6) illustrate groundwater flow, residence time, and distribution of chemical indicators. Cross sections help define areas of interest, such as locations of important groundwater recharge, discharge, and sensitivity to pollution.

**Aquifer characteristics and groundwater use** (pages 50 to 55) summarizes specific capacity tests, aquifer tests, water use records, and groundwater level monitoring data. These data can be used to characterize aquifer recharge in the county and plan for new well installations. The majority of permitted water use is for municipal and public water supply, which is primarily from the Mt. Simon aquifer. High-volume use is generally centered in the city of La Crescent, but is also near the cities of Caledonia, Spring Grove, and Houston. The next most common use categories are pollution containment and livestock watering.

# Physical setting and climate

Houston County is located in the southeastern corner of Minnesota (Figure 1). Its landscape is characterized by broad plateaus intersected with deeply incised valleys. Elevation changes from ridgetops to valleys can be greater than 500 feet. The modern landscape was primarily shaped by erosion from river systems.

Minnesota is a headwaters state where surface water and groundwater are replenished solely by precipitation. Surface-water flow and groundwater levels fluctuate with wet and dry years, with water levels fluctuating rapidly in rivers and water-table aquifers following precipitation. Water takes longer to travel to deeply buried aquifers, so the changes are often delayed or subdued. Surface water leaves the state by a network of rivers that flow north to the Red River basin, east to the Great Lakes basin, southwest to the Missouri River basin, or southeast to the Mississippi River basin (Figure 1). Groundwater provides baseflow to streams and major river systems.

The county is located on a portion of the western edge of the upper Mississippi River Valley commonly referred to as the Driftless Area. The term driftless implies the area was never glaciated; however, this is not accurate in Houston County. Glacial till of pre-Illinoian age is found in the western portion of the county, and scattered glacial material can be found in the east (Part A, Plate 3). Since Houston County was not covered by sediment during recent glaciations, its landscape represents a mature and heavily eroded ancient surface. Surface-water flow in the county is controlled by elevation and landform and drains toward four separate surface watersheds (Figure 1), all of which ultimately flow into the Mississippi River. Surface-water features (lakes and wetlands) in upland areas are limited due to fracture and conduit networks that prevent water from ponding at the surface. Surface-water features are mostly streams in valleys, many of which are cold-water trout streams with springs in their headwaters. Groundwater discharge provides critical baseflow to these cold-water resources.

The Mississippi River forms the entire eastern border of the county, and the Root River prominently crosses the northern portion. Smaller streams flow in valleys east to the Mississippi, to the Root River, or south to the Iowa River.

The climate is humid continental with warm to hot summers, cold winters, and an annual temperature range typically greater than 110°F. Based on 1991 to 2020 climate normals, the June through August average temperature is 69.6°F (DNR, 2023a). The typical growing season is from April to October, when average monthly air temperatures are over 45°F (Figure 2). Evaporation increases dramatically during the growing season through plant uptake and transpiration, reducing the amount of precipitation that ultimately becomes groundwater. Winter temperatures are cold, with December through February averaging 20°F (DNR, 2023a). The soil frost depth can reach from 3 to more than 5 feet below ground, limiting precipitation that can infiltrate and become groundwater. Although diffuse recharge is limited in the winter, focused recharge to sinkholes and stream sinks can still occur.

Average annual precipitation is approximately 37 inches, placing Houston County at the high end of the statewide range of 21 to 38 inches (DNR, 2023b). The region has pronounced wet and dry seasons, with precipitation during the summer nearly four times greater than during the winter. Historically, most annual precipitation (approximately 23 inches) occurs from April to August (Figure 2). Only a small fraction of this eventually becomes groundwater because of evaporation, transpiration, and overland runoff to streams. Most groundwater recharge occurs in the spring, when snowmelt and precipitation infiltrate the land surface prior to the growing season.

From 1895 through 2023, average annual temperatures increased by 1.4°F, which is below the statewide average temperature increase of 3.1°F. The increases were fastest during winter, at night, and especially in the period since 1970, when daily minimum temperatures have risen nearly 70% faster than daily maximum temperatures, and average winter temperatures have risen three to four times faster than average summer temperatures.

Annual precipitation has increased by 6.2 inches since 1895, with virtually all of that change occurring since 1970. Houston County's precipitation has increased four times faster than the statewide average since 1970. Intense rainfall events producing daily totals in excess of 1, 2, and 3 inches have been more common since 1990 than during any other period on record.

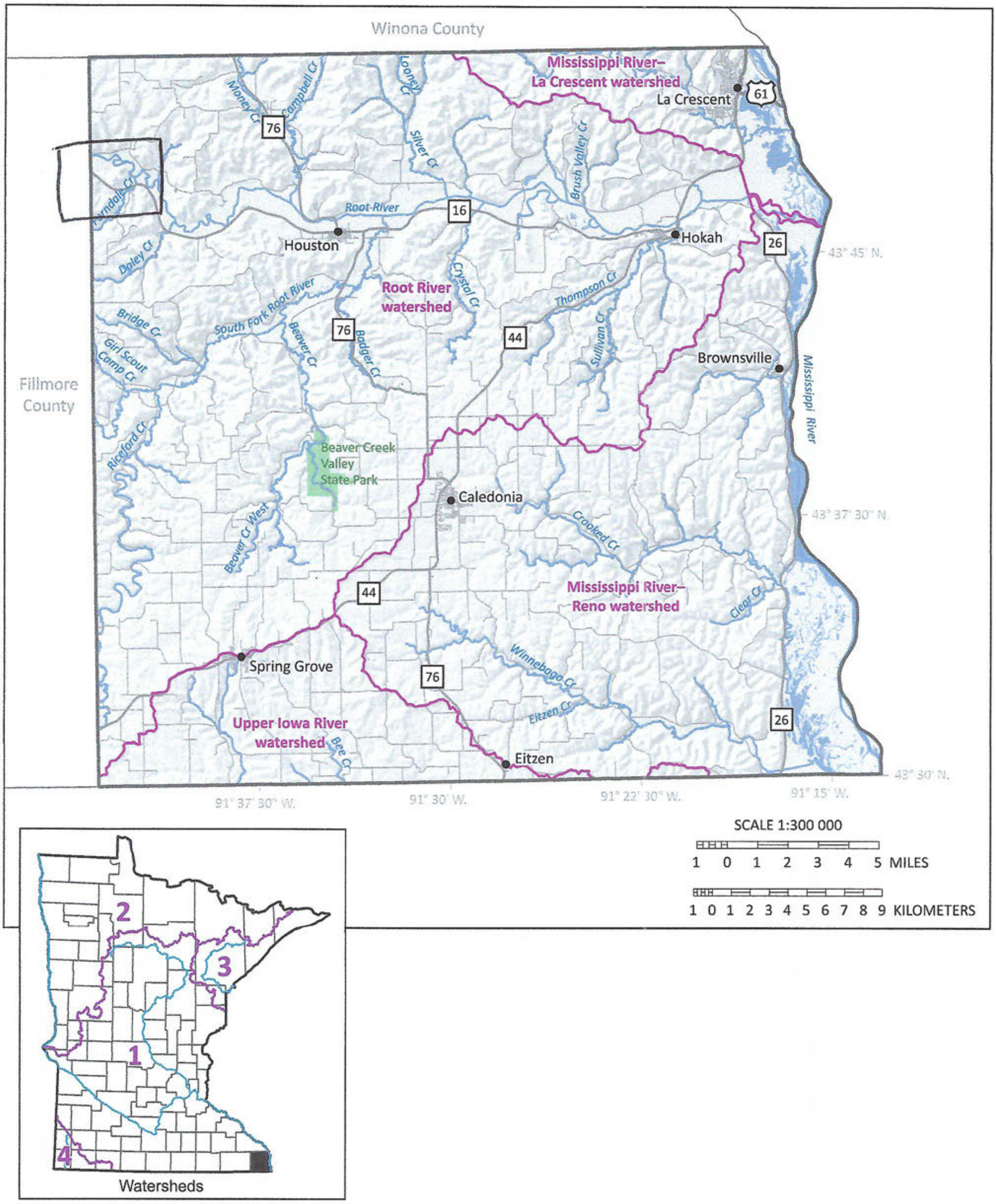



**Figure 1. Houston County, Minnesota**

Houston County is in southeastern Minnesota, within the surface watershed (labeled 1 on the statewide map) of the southeast-flowing Mississippi River. Statewide, additional surface watersheds are drained by networks of rivers that (2) flow north to the Red River basin, (3) east to the Great Lakes basin, or (4) southwest to the Missouri River basin.

Climate projections summarized in the 2014, 2017, 2018, and 2023 National Climate Assessments, and others available for the state of Minnesota, indicate that Houston County will warm by an additional 2.5 to 5°F by 2050, while annual precipitation will increase by an additional 1 to 2 inches. Short-term variations can be expected, leading to episodes of cooler conditions and drought, even as trends toward warmer and wetter conditions continue (Pryor and others, 2014; Vose and others, 2017; Easterling and others, 2017; Jay and others, 2018; Marvel and others, 2023; Wilson and others, 2023).

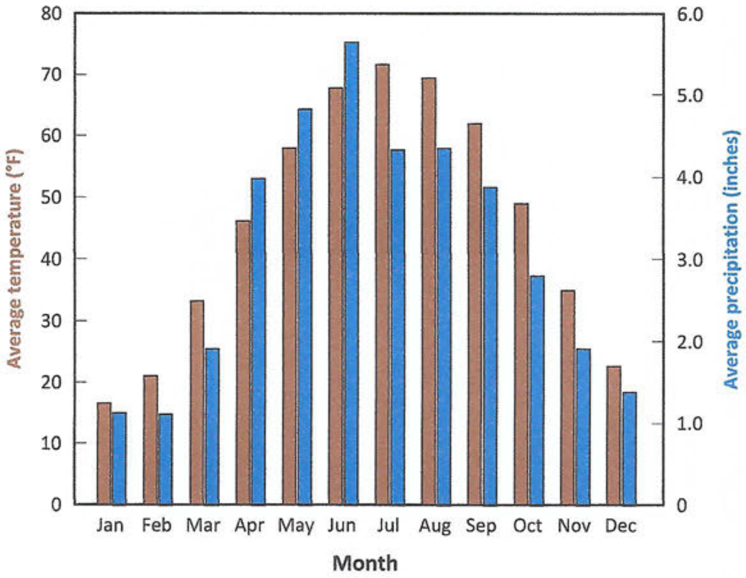



**Figure 2. Average monthly temperature and precipitation for Houston County, Minnesota**

Data from Minnesota Climate Trends (1991 to 2020, 30-year record; DNR, 2023a; DNR, 2023b).

# Physical geology and hydrogeology

Bedrock dominates the geology of Houston County. It is generally within 50 feet of the land surface and covered by a veneer of unconsolidated sediment, such as loess, sand, and colluvium (Part A, Plates 3 and 4). Thick layers of saturated unconsolidated sediment generally only exist in valley bottoms, making bedrock aquifers the primary source of drinking water and groundwater discharge to springs and streams.

## Bedrock aquifers and aquitards

In general, the bedrock geologic units in Houston County are composed of carbonate (limestone and dolostone), sandstone, or siltstone. The rock composition, presence of fractures, and degree of karstification ultimately govern whether they behave hydraulically as an aquifer or aquitard.

Aquifers are water-bearing, permeable rock from which groundwater can be extracted via a well. Many of the aquifers in the county also provide continual cold-water discharge to springs and streams. Aquitards are layers of material with low permeability, such as siltstone and shale, that impede the vertical movement of water. However, some aquitards contain high-permeability fractures and bedding plane openings that can yield large quantities of groundwater to springs or wells. For instance, many springs emerge from near the base of the St. Lawrence aquitard (Figure 3).

The depth from the land surface partially controls the ease with which an aquifer or aquitard transmits groundwater. Hydrologists can broadly describe hydrogeologic behavior using the relative terms of shallow bedrock conditions and deep bedrock conditions. The boundary between these conditions is not consistent throughout the state; it is estimated to be 50 feet below the bedrock surface in Houston County and most of southeastern Minnesota. Shallow bedrock conditions (the first 50 feet in the uppermost bedrock units) have a zone of enhanced permeability from fractures that developed when the bedrock was originally exposed and weathered at the land surface. As groundwater flows through these fractures, carbonic acid continues to slowly dissolve carbonate bedrock, which increases the aquifer's permeability over time through the progressive development of conduits and voids. The enhanced permeability zone can increase the ability of an aquifer to transmit water, but can also degrade the ability of aquitards to provide protection to underlying aquifers. In deep bedrock conditions, there is typically lower permeability, as there are fewer interconnected fractures and dissolution networks at deeper depths (Runkel and others, 2006; Barry and others, 2023b).

### Geomorphology

The Spring Grove region of southwestern Houston County forms a plateau capped by the erosion-resistant limestone of the Cummingsville Formation (Part A, Plate 2). Underlying the Cummingsville is the Decorah Shale through the St. Peter Sandstone. This local sequence of rock overlies a prominent regional plateau, the Prairie du Chien Plateau, that is present over most of the county and extends to the edge of the Mississippi River Valley. These plateaus exist because of the erosion-resistant properties of carbonate.

Underlying the Prairie du Chien Group is a sequence of sedimentary bedrock layers that are more easily eroded. Numerous deeply incised valleys truncate the overlying Prairie du Chien Plateau, exposing the Jordan Sandstone, St. Lawrence Formation, Lone Rock Formation, Wonewoc Sandstone, and Eau Claire Formation. The Mt. Simon Sandstone is present as uppermost bedrock in the deepest parts of these valleys, but is not exposed at the land surface (Figure 3). These units predominantly consist of sandstones, siltstones, and shales and are exposed within the Root River valley and its tributaries, and also along and within narrow valleys of the Mississippi River. The deeply incised valleys have an influence on groundwater, as they penetrate both aquifers and aquitards.

### Karst

Much of Houston County is covered by karst (Figure 4). The term karst is typically used to describe unique landforms and hydrology formed by precipitation and groundwater dissolving carbonate rock. In Minnesota, St. Peter Sandstone can also exhibit karst characteristics (DNR, 2016b; Broberg, 2015). Karst is often characterized on the surface by the presence of sinkholes, sinking streams, caves, and springs, but where these features are absent, there can still be rapid connections between the land surface and underlying aquifers. Rapid water movement can also occur within the county's carbonate aquifers because they have been subjected to karst dissolution in the past (Alexander and others, 2013).

In karst areas, there is a close relationship between the land surface and the bedrock below. Connections to enlarged underground pathways allow for rapid transport of water, creating unpredictable groundwater travel times and flow directions. This makes karst aquifers particularly vulnerable to human activities and complicates remediation efforts for issues like spills or surface applications of chemicals. Classification of the karst landscape helps identify the groundwater characteristics beneath it. A companion report identifies these landscapes through analysis of karst feature position, geologic setting, and landscape position: *Karst Landscape Units of Houston and Winona Counties* (Green and Barry, 2021).

In Houston County, over 98% of mapped sinkholes and stream sinks occur where there is 50 feet or less of unconsolidated sediment overlying bedrock (Figure 5), which is consistent with other areas of karst in southeastern Minnesota (Alexander and Maki, 1988). Sinkhole and sinking stream locations are from the Karst Feature Inventory (DNR, 2020a); depth to bedrock GIS files are from Part A, Plate 4. Approximately 82% of the mapped sinkholes and stream sinks in Houston County occur where the Prairie du Chien Group is the first bedrock unit below the land surface (bedrock geology GIS files from Part A, Plate 2).

The Prairie du Chien Group contains fracture networks and solution-enhanced conduits. It is one of four prominent karst systems described for southeastern Minnesota (Runkel and others, 2003, 2014a). Much of the karstification occurred roughly 460 to 490 million years ago when the tops of the Shakopee Formation and Oneota Dolomite were at the land surface over different periods and were subjected to chemical weathering (Alexander and others, 2013). These weathered formations were subsequently buried by younger rocks and are referred to as paleokarst.

A significant zone of high permeability is found regionally throughout southeastern Minnesota at the contact of the Shakopee and Oneota formations and is a result of karstification of the Oneota Dolomite (Dalgleish and Alexander, 1984; Runkel and others, 2003; Tipping and others, 2006). Sinkhole frequency is greatest near this geological contact, but is also elevated near the contact of the St. Peter Sandstone and Shakopee Formation (Figure 3). There have been at least four catastrophic failures of sewage treatment ponds in neighboring counties in southeastern Minnesota where this zone of high permeability is close to the land surface, including failures in the cities of Altura, Lewiston, and Bellechester (Book and Alexander, 1984; Jannik and others, 1991; Alexander and others, 1993; Runkel and others, 2003; Alexander and others, 2013). Additional collapses of stormwater ponds and water retention structures have occurred where pond bottoms were close to the St. Peter Sandstone and Shakopee Formation contact (Barr and Alexander, 2012; E.C. Alexander Jr., University of Minnesota Department of Earth and Environmental Sciences, personal communication, 2018).

In incised valleys, rapid groundwater flow has been documented through siliciclastic units: sandstone, siltstone, and shale (Green and others, 2008, 2012; Barry and others, 2015). These units are classified as pseudokarst because they mimic the rapid groundwater flow of karst but were formed by processes other than dissolution (Barry and others, 2018). At these locations, surface water in valley streams frequently sinks underground and rapidly resurges at springs located farther down the valley (DNR, 2020c).

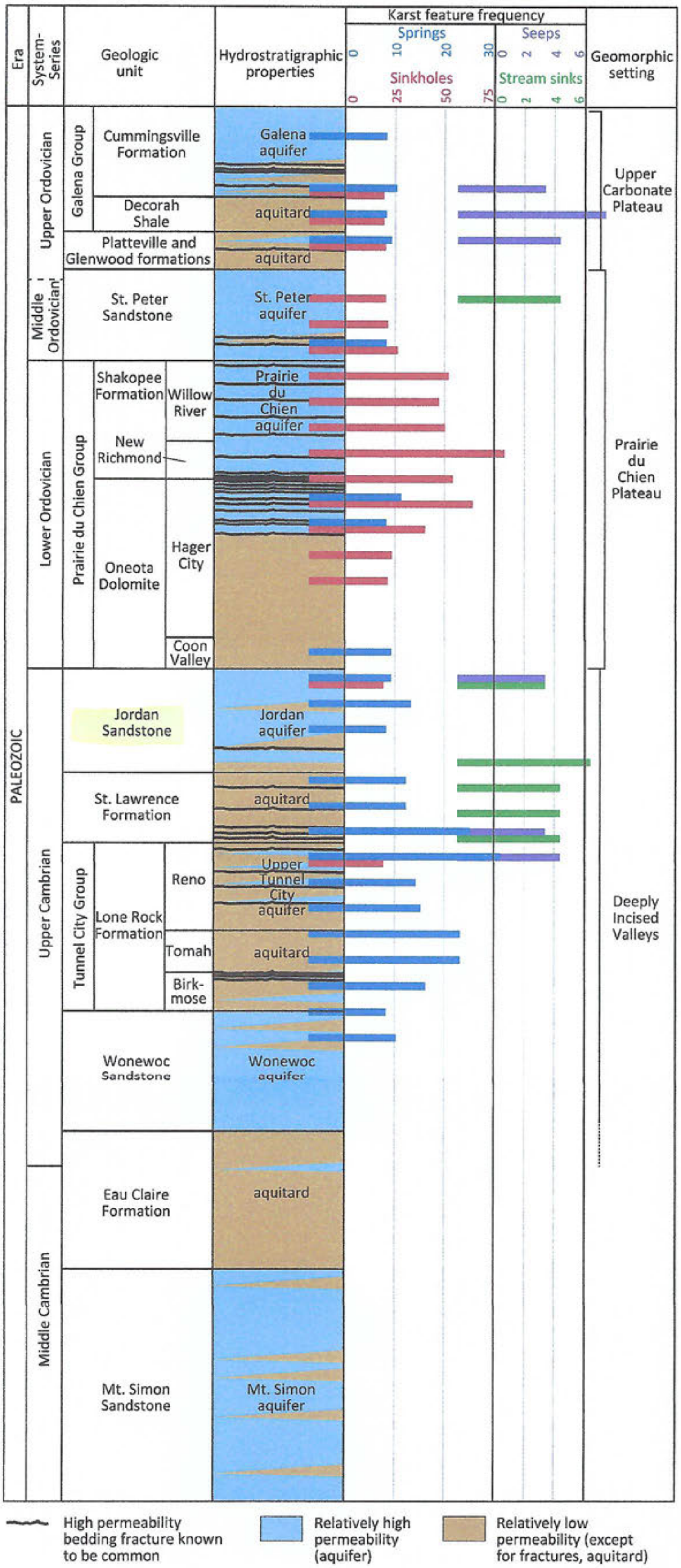
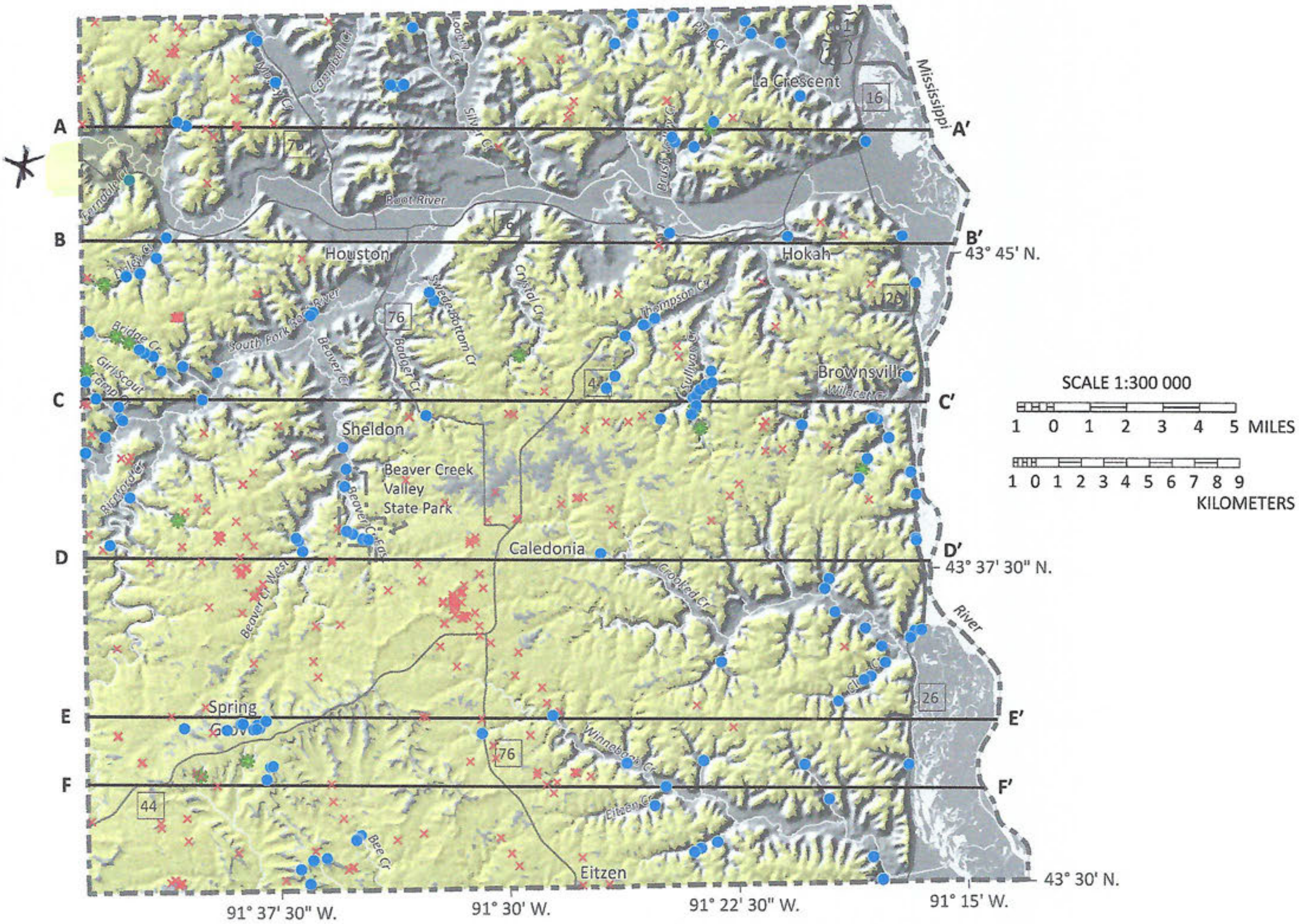



**Figure 3. Bedrock stratigraphy, hydrostratigraphy, approximate distribution of karst features, and geomorphic setting**

Geologic stratigraphic units (formations or groups) do not always correspond to hydrogeologic units (aquifers and aquitards). The distribution of sinkholes, stream sinks, springs, and seeps is partially controlled by bedrock stratigraphy, hydrostratigraphy, and geologic structure. Karst distribution frequency was estimated using modified techniques from Tipping and others, 2001, and Steenberg and others, 2014. Column modified from Part A, Plate 2, Figure 1.




**Karst features**

- Spring
- Sinkhole
- Stream sink

**Symbols and labels**

- B ——B′ Line of cross section (Part B)
- Body of water
- Area prone to karst feature development

* proposed mining site

**Figure 4. Area prone to karst feature development and distribution of karst features**

The area prone to karst feature development is shown draped on a hillshade model of the county landform. The area was created by identifying regions with less than 50 feet of sediment underlain by carbonate bedrock, as described in DNR, 2016b. Most of the area prone to karst feature development occurs in upland settings. Sinkholes primarily occur on the plateaus, while springs and stream sinks occur within valleys. Sinkholes and stream sink locations are from the Karst Feature Inventory (DNR, 2020a). Spring locations are from the Minnesota Spring Inventory (DNR, 2020b).

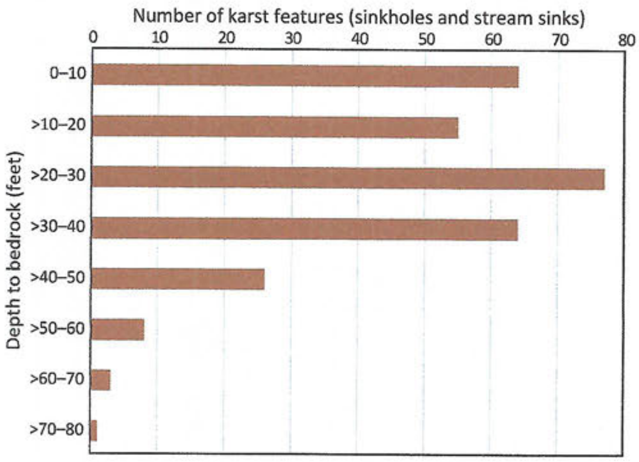



**Figure 5. Sinkhole and stream sink occurrence versus depth to bedrock**

Over 98% of mapped sinkholes and stream sinks occur where there is 50 feet or less of unconsolidated sediment overlying bedrock. Data used to generate this figure are from the Karst Feature Inventory (DNR, 2020a) and Depth to bedrock GIS files from Part A, Plate 4.

## Surficial aquifers

The bedrock plateaus across much of Houston County are capped by surficial unconsolidated geologic deposits that are generally less than 25 feet thick and covered by a veneer of loess that generally thins eastward (Part A, Plate 3). The sediment in these uplands is generally not fully saturated and cannot provide sufficient quantities of water to supply a user economically.

Coarse-grained terrace deposits occur along the modern-day Mississippi River and within the main valley of the Root River and smaller tributaries (Part A, Plate 3). Where saturated, this coarse-grained sediment makes up the surficial sand and gravel aquifer (Figure 6).

The texture of surficial deposits influences the rate and amount of precipitation that infiltrates the surface and eventually becomes groundwater (DNR, 2016a). A detailed explanation of the county's glacial history and how it relates to present-day surficial geologic deposits is presented in Part A, Plate 3.

In this atlas, the ***surficial sand and gravel*** aquifers will be referred to as ***surficial sand*** aquifers.

## Geologic units

The following section describes the distribution and hydrologic properties of the bedrock aquifers and aquitards in the county. The units are described from the top down to match the stratigraphic column (Figure 3). Units are grouped into three geomorphic settings: Upper Carbonate Plateau, Prairie du Chien Plateau, and deeply incised valleys.

Much of the hydrologic descriptions come from Runkel and others, 2003. Detailed lithologic descriptions of each unit are available in Part A, Plate 2. Mapped karst features are shown in Figure 4, totaling 146 springs, 286 sinkholes, and 12 stream sinks. These numbers represent lower limits of potential karst features because mapping is incomplete, and sinkholes develop and are filled regularly.

### *Upper Carbonate Plateau*

- **Cummingsville Formation (aquifer)**

  The Cummingsville is a carbonate formation that commonly forms a karst aquifer in southeastern Minnesota. In Houston County, it is only present in the southwest near Spring Grove. The aquifer is not used for water wells because it is near the land surface and has a limited extent.

  Laterally continuous shale beds in the lower Cummingsville can act as an aquitard and cause groundwater to emerge as small springs and seeps. Mapped karst features include 8 springs and 1 sinkhole.

- **Decorah Shale (aquitard)**

  The Decorah Shale serves as a regional aquitard across much of southeastern Minnesota, but it is only present in Houston County in the southwest near Spring Grove. It is primarily composed of shale that restricts the downward movement of water.

  Mapped karst features include 5 springs. Seeps are common, but not all are mapped.

- **Platteville and Glenwood formations (aquitards)**

The Platteville and Glenwood are present in southwestern Houston County in the Spring Grove area. The Platteville is presented as an aquitard, but internal layers can be connected vertically and exhibit a secondary porosity from fractures and karst dissolution.

The Glenwood shale exhibits low hydraulic conductivity in shallow bedrock conditions, creating numerous groundwater seeps that frequently occur near the top of the Glenwood. It generally behaves as an aquitard, but it can be thin with vertical fractures that can connect the overlying Platteville Formation to the underlying St. Peter Sandstone.

Mapped karst features include 2 springs and 3 sinkholes.

### *Prairie du Chien Plateau*

- **St. Peter Sandstone (aquifer)**

The St. Peter is primarily composed of medium to coarse sandstone across much of southeastern Minnesota, but extensive fine-grained beds may be found at its base. This aquifer is present in southwestern Houston County near Spring Grove. Although several characteristics make it a good aquifer, it contains few wells because it is near the land surface and limited in saturated areal extent.

The St. Peter commonly contains voids and fractures in shallow bedrock settings; for this reason, it is included as an area prone to karst feature development (Figure 4). Voids are relatively common in the Rochester area of nearby Olmsted County, where they have periodically required remediation using geoengineered solutions (Broberg, 2015; E.C. Alexander Jr., University of Minnesota Department of Earth and Environmental Sciences, personal communication, 2018).

Mapped karst features include 1 spring, 37 sinkholes, and 2 stream sinks. Many of the sinkholes appear at the bottom of slopes or near the contact with the underlying Shakopee Formation of the Prairie du Chien Group.

- **Prairie du Chien Group (aquifer/aquitard)**

The Prairie du Chien forms an extensive and prominent plateau across the county. It is composed of two formations, the upper Shakopee Formation and the lower Oneota Dolomite (Figure 3). Although this group is primarily composed of carbonate rock, the lower portions of both formations have coarse sandstone components referred to as the New Richmond Member and the Coon Valley Member, respectively.

The New Richmond Member is regionally distributed as a substantially thick sandstone interval with high intergranular permeability. Karst horizons exist at the top of the Shakopee Formation and near the contact of the Shakopee and Oneota formations (Alexander and others, 2013). Both the Shakopee and Oneota are highly fractured under shallow bedrock conditions, allowing for rapid groundwater transport through fractures and voids.

Dye-trace investigations in the Prairie du Chien in nearby Olmsted County determined a horizontal groundwater velocity of 800 feet per day (Alexander and others, 1991). Dye traces in nearby Fillmore County found shallow horizontal velocities ranging from approximately 1 to 10 miles per day (Wheeler, 2017; Barry and others, 2023a). The Prairie du Chien has low vertical permeability, with horizontal permeability as much as 10 times greater.

Rapid vertical migration of water is limited in deep bedrock conditions in the Prairie du Chien, where the lower part of the Oneota behaves as an aquitard. Despite this, sufficient water can be extracted for low-yield uses, such as residential wells.

Mapped karst features include 8 springs in the Oneota, 115 sinkholes in the Shakopee, and 130 in the Oneota. Sinkholes prominently occur near the geologic contact between the Shakopee and Oneota (Figure 3).

### *Deeply incised valleys*

- **Jordan Sandstone (aquifer)**

The Jordan is a regional aquifer across much of southeastern Minnesota. The upper portion is primarily composed of coarse sandstone, making it a productive aquifer. The lower portion is finer grained but can yield productive wells because bedding fractures are common. Fine grained layers in the lower portion can serve as internal aquitards that isolate old water. Fractures in shallow bedrock conditions are particularly abundant and can allow surface waters in valley settings to rapidly sink into the aquifer.

Mapped karst features include 6 springs and 2 stream sinks.

- **St. Lawrence Formation (aquitard)**

The St. Lawrence is an important aquitard in southeastern Minnesota. In deep bedrock conditions, it is a competent and regionally significant aquitard. It is primarily composed of very fine-grained sandstone and siltstone in its upper part and carbonate rock in its lower part. The unit has low vertical permeability, which restricts downward flow.

The Minnesota Well Rule handbook specifically states that "a stratum at least 10 feet in vertical thickness of the St. Lawrence" is a confining layer (MDH, 2011). However, the aquitard loses its protective characteristics in shallow bedrock conditions or where it is dissected by deeply incised valleys. In these settings, water can flow rapidly through the St. Lawrence, both vertically and horizontally. Vertical hydraulic conductivity increases with fractures near bedrock valleys (Runkel and others, 2014b, 2018). Dye tracing in St. Lawrence pseudokarst in Winona and Houston counties has revealed groundwater velocities of 150 to 890 feet per day (Green and others, 2008; Barry and others, 2018).

Mapped karst features include 12 springs and 6 stream sinks.

- **Tunnel City Group–Lone Rock Formation (aquifer/aquitard)**

  The Lone Rock is an important regional aquifer in southeastern Minnesota. It was formerly known as the Franconia Formation but was renamed to be consistent with the nomenclature used in surrounding states (Mossler, 2008). Many older well logs and reports still use the Franconia nomenclature.

  The Lone Rock is primarily composed of very fine-grained sandstone and siltstone in its upper portion, with progressively increasing carbonate rock in its lower portion. The lower portion also has very fine-grained sandstone, siltstone, and shale (Tomah Member), which limits the vertical hydraulic conductivity (Runkel and others, 2006). The Lone Rock can be highly fractured in shallow bedrock conditions. Dye tracing in Lone Rock pseudokarst has revealed groundwater velocities of tens to hundreds of feet per day (Barry and others, 2015, 2018). Groundwater freely moves laterally through the upper Lone Rock. It contains the highest number of springs, many of which form the headwaters of trout streams.

  Mapped karst features include 81 springs and 2 stream sinks.

- **Wonewoc Sandstone (aquifer)**

  The Wonewoc is a regional aquifer across much of southeastern Minnesota and is present across all of Houston County. This sandstone-rich aquifer system was formerly known as the Ironton and Galesville formations. These two formations were combined and renamed to Wonewoc to be consistent with the nomenclature used in surrounding states (Mossler, 2008).

  Groundwater flow is primarily intragranular, although fracture flow has been documented in both shallow and deep bedrock conditions (A. Runkel, Minnesota Geological Survey, personal communication, 2018). Although primarily composed of sandstone, the upper half also contains silt and shale with lower permeability.

  Mapped karst features include 22 springs.

- **Eau Claire Formation (aquitard)**

  The Eau Claire is an important regional aquitard in southeastern Minnesota. It is primarily composed of shale and siltstone, which limit vertical flow. In Winona, Houston, and Wabasha counties, it contains very fine sandstone in the upper portion that can be used for water supply.

  Mapped karst features include 1 spring.

- **Mt. Simon Sandstone (aquifer)**

  The Mt. Simon is an important regional aquifer in southeastern Minnesota. It can be broadly described in two parts. The upper portion consists of stacked layers of coarse-grained sandstone and fine-grained siltstone with differing permeabilities. The lower portion is primarily coarse-grained sandstone with relatively higher permeability. The aquifer is primarily used in the Root River valley and in eastern portions of the county, where its depth is shallower than in other areas of the county. The Mt. Simon aquifer is used for municipal and public water supply in the cities of Houston, Hokah, and La Crescent.

  No mapped karst features.

## Groundwater flow

There are two types of groundwater flow illustrated in the maps of this report.

1. The water-table map illustrates the shallowest groundwater, where groundwater is unconfined and at equilibrium with atmospheric pressure. The water table flows from higher to lower elevations.
2. Potentiometric surface maps illustrate groundwater flow in confined aquifers where hydrostatic pressure exceeds atmospheric pressure. Confined groundwater flows from higher to lower pressure.

### Water table

The water table (Figure 6) is the surface between the unsaturated and saturated zones, where water pressure equals atmospheric pressure. Water-table elevations are contoured similarly to land-surface elevations on a topographic map. In Houston County, the water table occurs in both the surficial sand aquifer present in valley bottoms and in multiple bedrock aquifers that are under unconfined conditions. Although it is shown in the figure as a static surface, it fluctuates over time.

The water table in the uplands and plateaus is influenced by karst and is best represented by the groundwater elevation contours of unconfined portions of the Prairie du Chien and Jordan aquifers (Figures 7, 8, and 9).

Figure 6 provides guidance for many applications, but site-specific information is needed at local scales. The water table is a dynamic system that varies in response to changes in recharge and discharge. Some of these changes include seasonal weather conditions, land-use practices, vegetation composition and distribution, and large groundwater withdrawals.

Water-table elevation was estimated from several sources of data.

- Surface elevation of surface-water bodies, like rivers, perennial streams, lakes, and open-water wetlands
- Static water levels in water-table wells obtained from the County Well Index (CWI) database*
- Estimates of depth to wet soil conditions from the Natural Resources Conservation Service (NRCS) county soil survey*

*Data were converted to elevations using a digital elevation model derived from Light Detection and Ranging (LiDAR) technology. More details can be found in *Methods for estimating water table elevation and depth to water table* (DNR, 2016a).

### Potentiometric surface

In confined aquifers, hydrostatic pressure greater than atmospheric pressure causes the water level in a tightly cased well to rise above the top of the aquifer. These water-level elevations are measured, mapped, and contoured to create potentiometric surface maps similar to how topographic maps show land-surface elevations. Potentiometric surface maps show the direction of groundwater flow.

The potentiometric surface of an aquifer represents the potential energy that is available to move groundwater. As groundwater moves from higher to lower potentiometric elevations, it flows perpendicular to the potentiometric elevation contours. Flow directions are shown on the maps with arrows.

Groundwater flows from recharge areas to discharge locations within a wide continuum of depth, distance, and time. Flow into, through, and out of shallow aquifers can take hours to years to travel distances of up to a mile. Flow in deeper aquifers can take centuries to millennia to travel dozens of miles. High elevation areas of the potentiometric surface can indicate important recharge areas. River valleys are typical examples of low-elevation groundwater discharge areas.

Potentiometric surface maps were created using confined aquifer static water-level data from the CWI, measurements made by DNR staff, and surface water elevation points along major rivers and streams where perennial groundwater discharge is likely. The CWI records represent groundwater conditions collected under various climatic and seasonal conditions spanning more than eight decades. This data variability creates some uncertainty in potentiometric surface elevations.

The hydrology of Houston County is heavily influenced by surface topography and enhanced permeability in karst and pseudokarst. Groundwater elevations of the deepest aquifers are subdued replicas of surface topography, evident in the contour spacing of the potentiometric surface maps (Figures 10, 11, and 12).

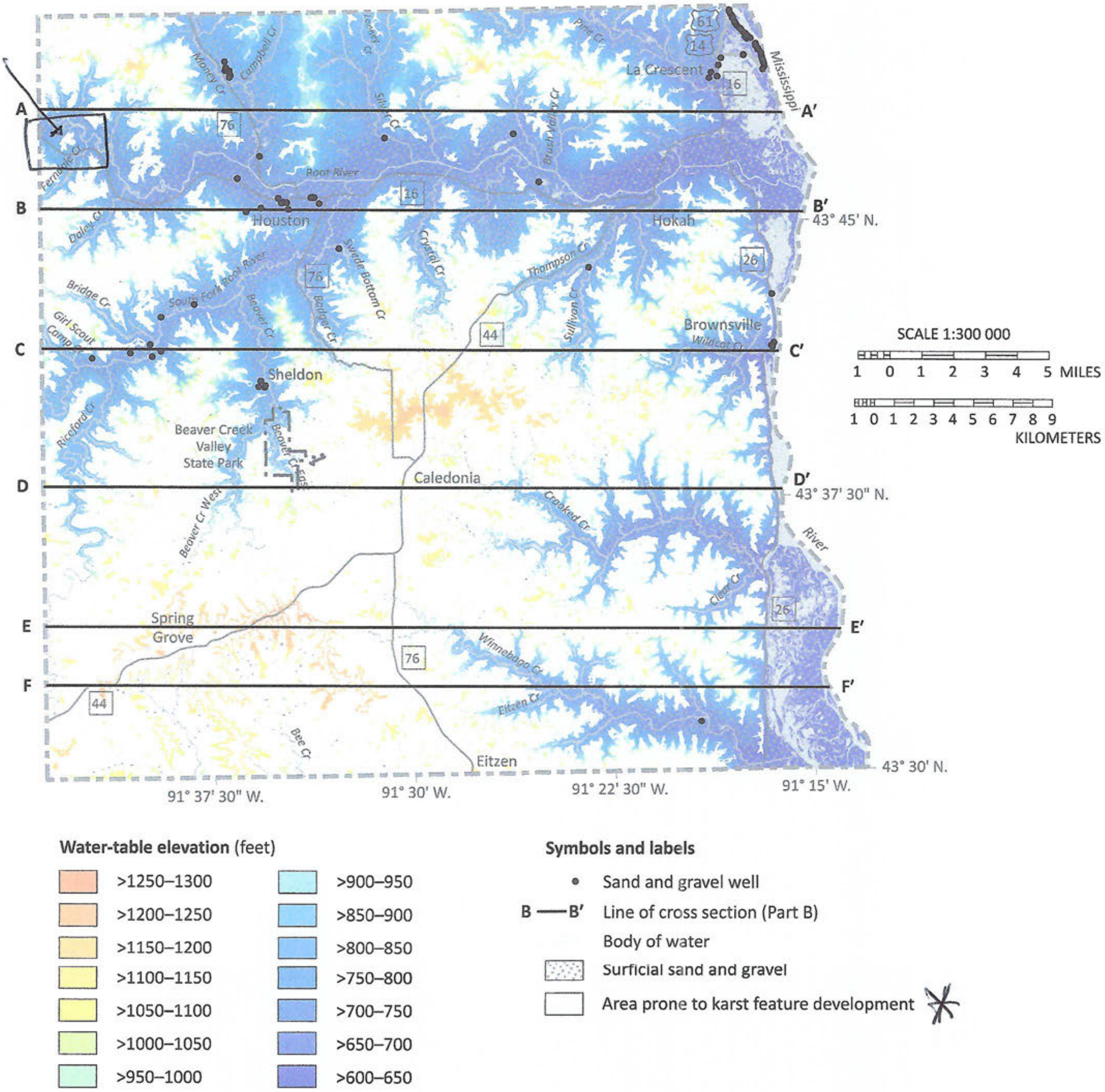



**Figure 6. Water-table elevation and sand and gravel wells**

Water-table elevation is poorly defined in the areas prone to karst feature development. Within the karst area, the water table often exceeds 100 feet deep and is best approximated by the groundwater elevation of the Prairie du Chien and Jordan aquifers. In valley bottoms and along the Mississippi River, the water table is estimated from wells completed in the surficial sand aquifer, the elevation of surface waters, and soil moisture. Soil moisture in unconsolidated deposits suggests there is a perched water table in the central area of the county near Caledonia and that perched water conditions may exist sporadically in other areas as well. Water-table flow is generally toward the Root River and its tributaries in the north and northwest, and the Mississippi River Valley and tributaries in the east.

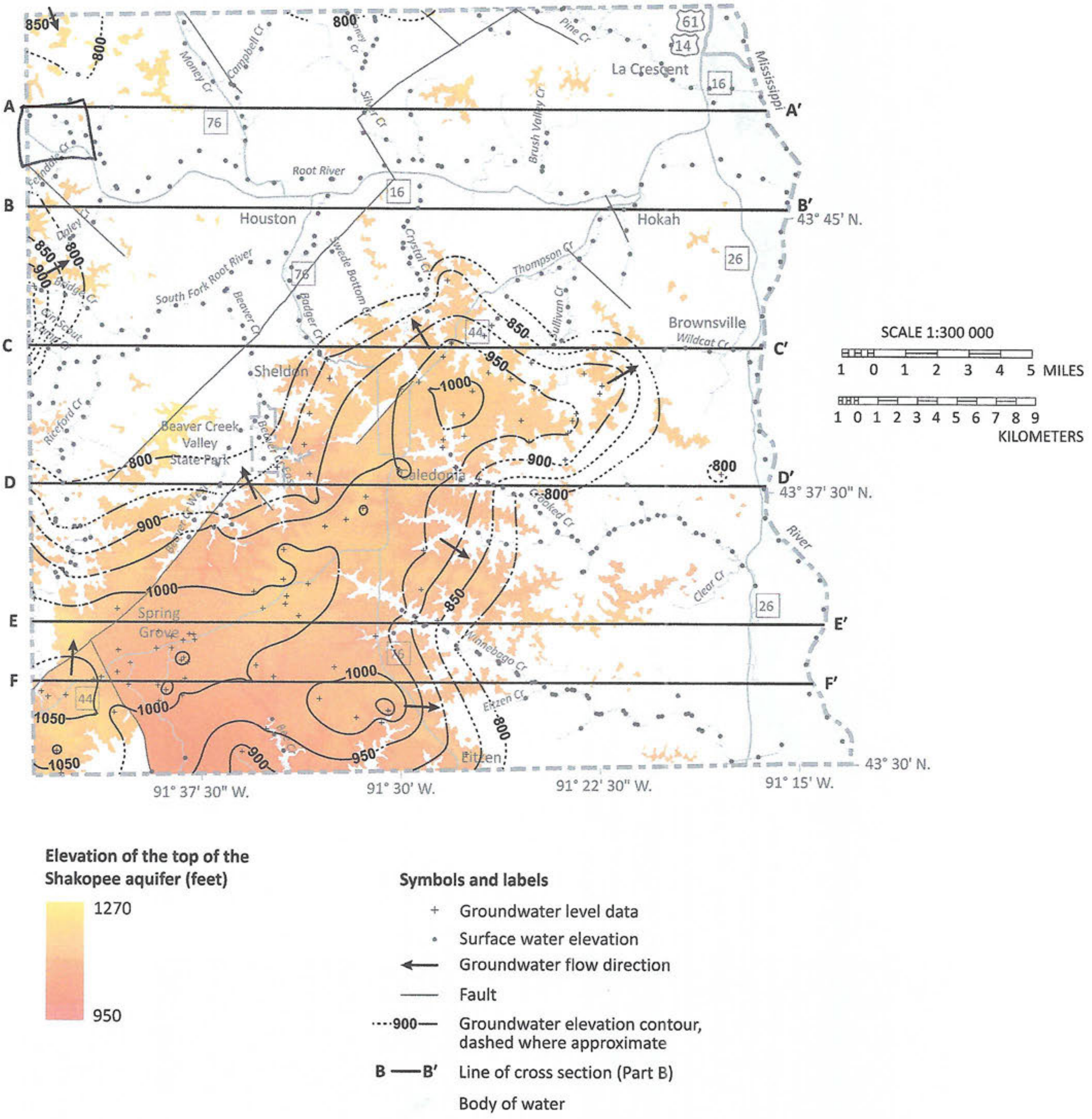



**Figure 7. Water-table elevation contours of the Shakopee aquifer**

Due to sparse data, groundwater elevation contours were developed using combined Shakopee, Oneota, and Jordan aquifer wells. In large areas of the county, the Prairie du Chien and Jordan aquifers are unconfined and make up the water-table system. Groundwater flow is generally toward the Root River and its tributaries in the north and northwest, and toward the Mississippi River Valley and its tributaries in the east. Potentiometric surfaces do not extend outside the area of the aquifer but are shown as dashed contours to assist in conveying groundwater flow directions. Top of aquifer elevations are from Part A, Plate 4, GIS files.

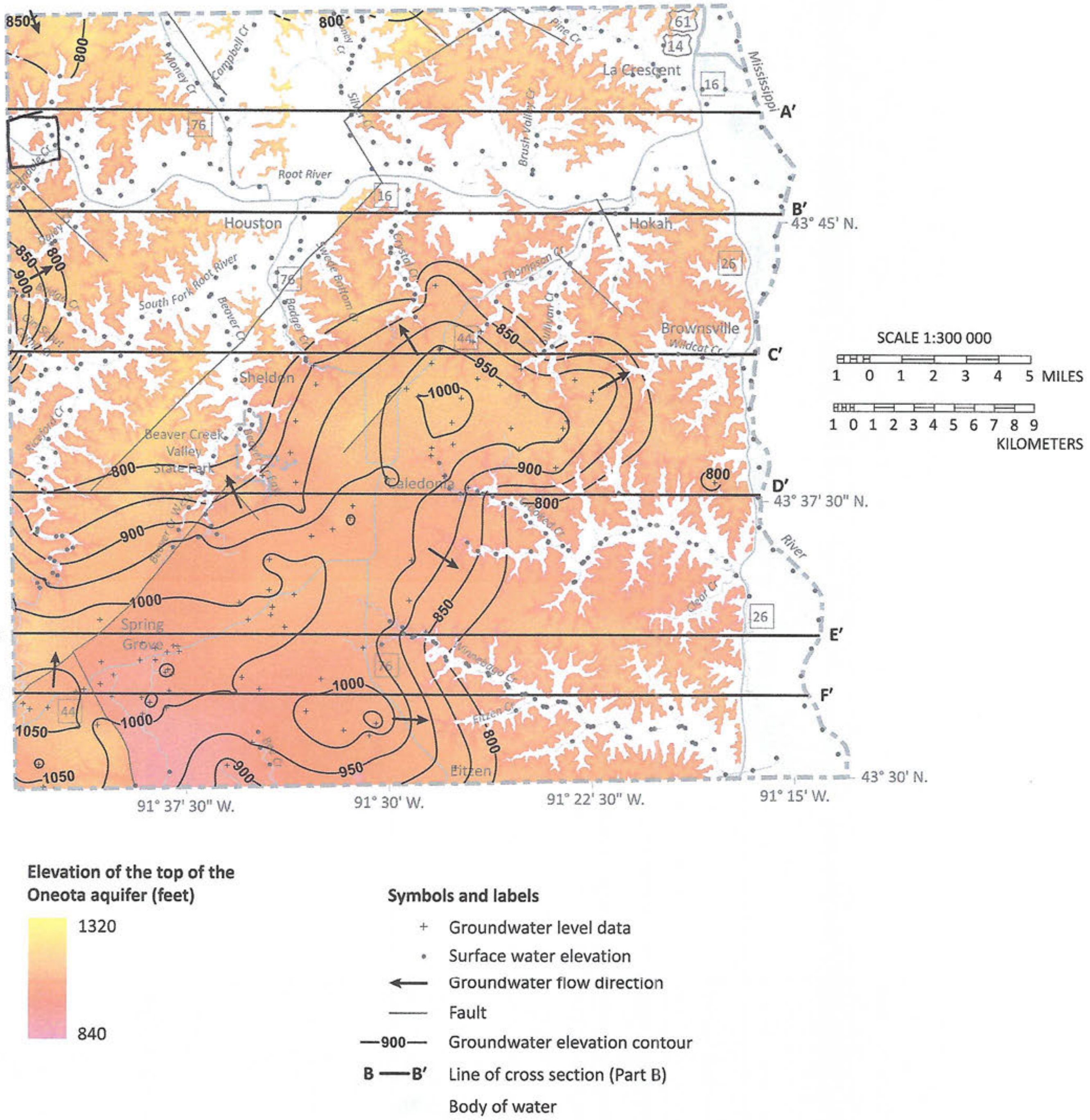



**Figure 8. Water-table elevation contours of the Oneota aquifer**

Due to sparse data, contours were developed using combined Shakopee, Oneota, and Jordan aquifer wells. In large areas of the county, the Prairie du Chien and Jordan aquifers are unconfined and make up the water-table system. On a regional scale, the Oneota Formation has characteristics of an aquitard, but at a local scale, it can frequently supply sufficient water for residential well use. Groundwater flow is generally toward the Root River and its tributaries in the north and northwest, and toward the Mississippi River Valley and its tributaries in the east. Top of aquifer elevations are from Part A, Plate 4, GIS files.

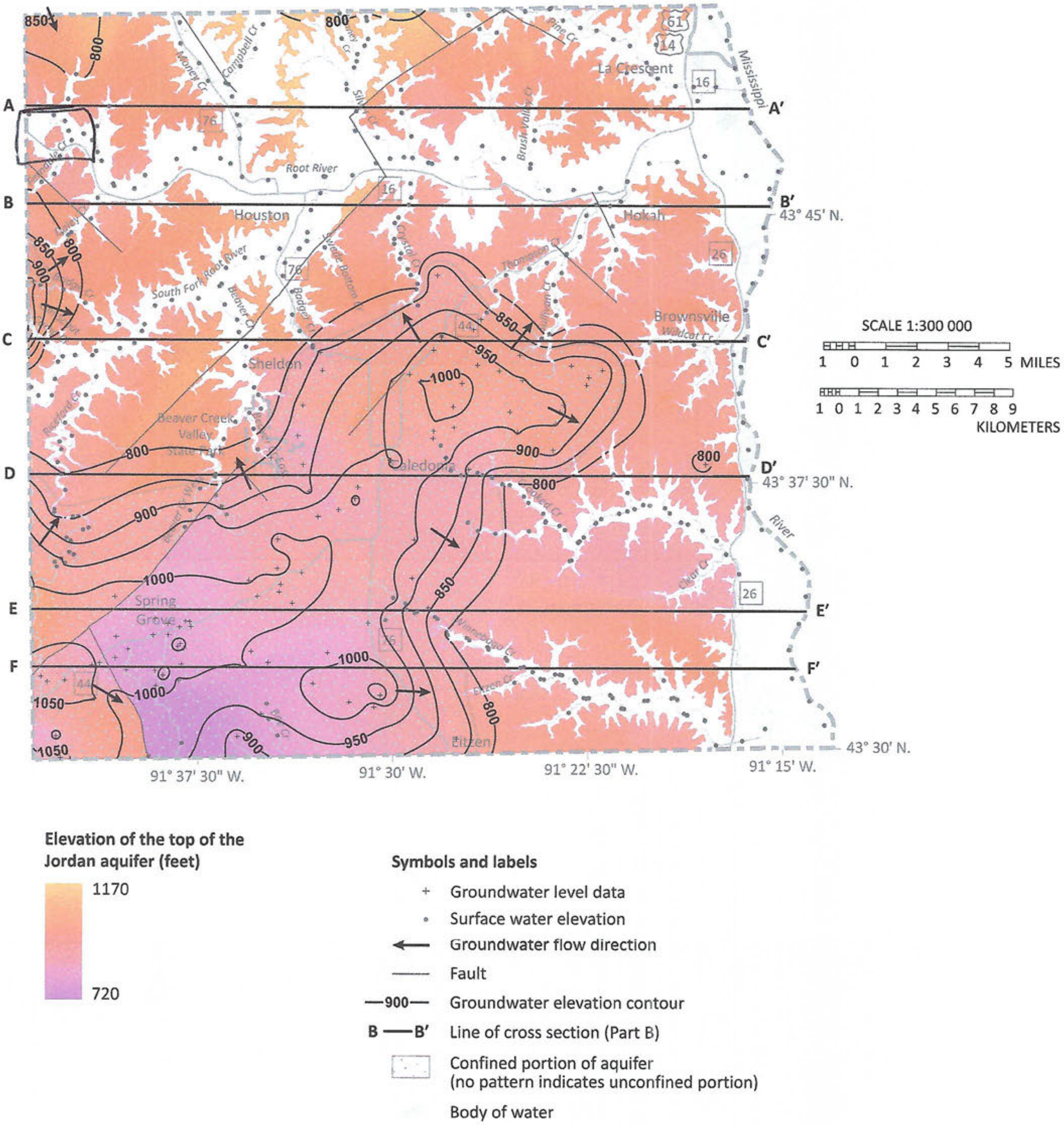



**Figure 9. Water-table elevation and potentiometric surface contours of the Jordan aquifer**

Due to sparse data, contours were developed using combined Shakopee, Oneota, and Jordan aquifer wells. Confined areas of the Jordan are indicated with a stippled pattern representing the potentiometric surface. Unconfined areas of the aquifer are indicated with no pattern and represent the water-table system. Groundwater flow is generally toward the Root River and its tributaries in the north and northwest, and toward the Mississippi River Valley and its tributaries in the east. Top of aquifer elevations are from Part A, Plate 4, GIS files.

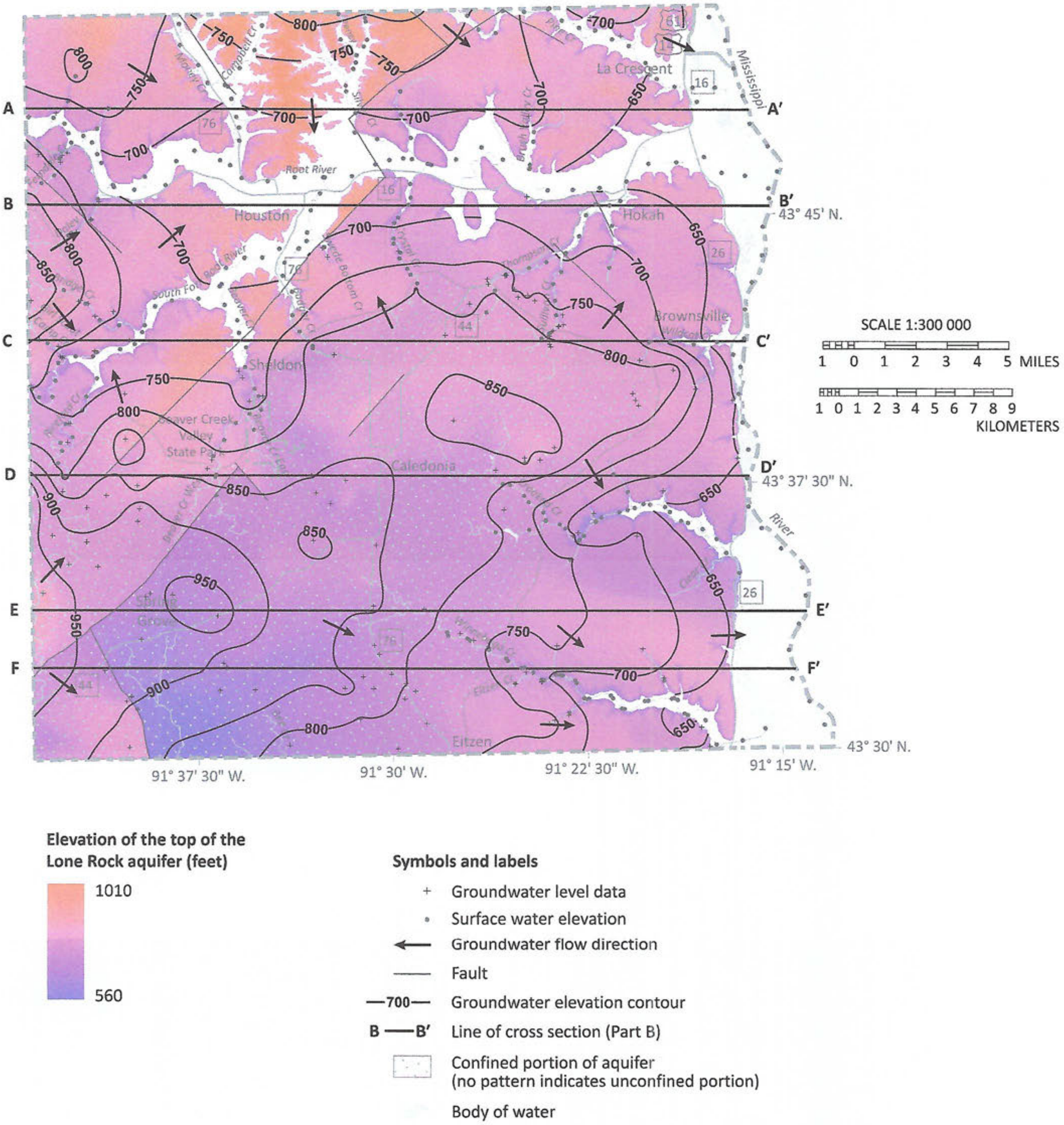



**Figure 10. Potentiometric surface contours of the Lone Rock aquifer**

The Lone Rock aquifer is confined over the south-central portion of the county, indicated with a stippled pattern. Unconfined areas are indicated with no pattern. Groundwater flow is generally toward the Root River and its tributaries in the north and northwest, and toward the Mississippi River Valley and its tributaries in the east. Top of aquifer elevations are from Part A, Plate 4, GIS files.

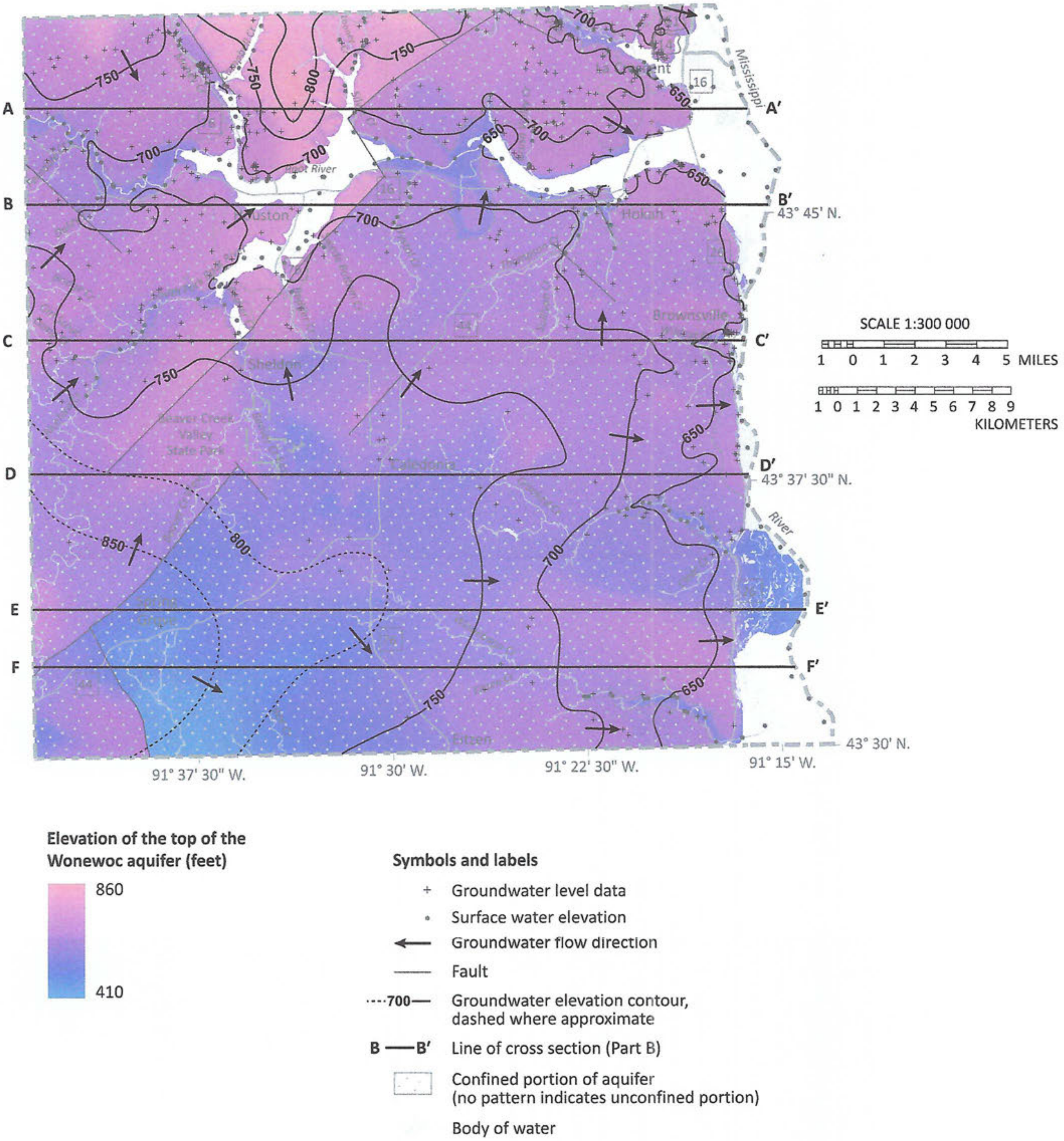
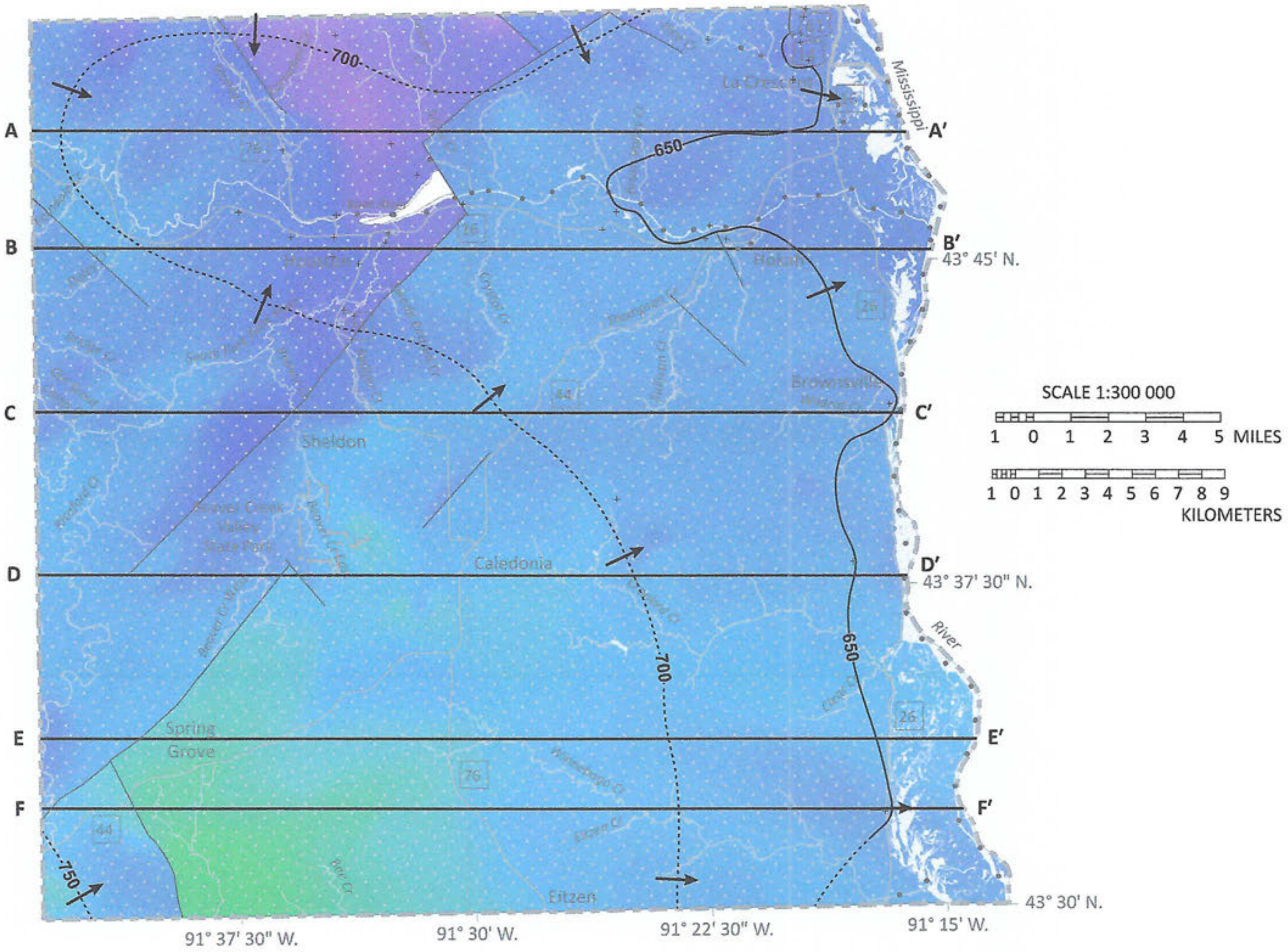



**Figure 11. Potentiometric surface contours of the Wonewoc aquifer**

The Wonewoc aquifer is confined over most of the county, indicated with a stippled pattern. Unconfined areas are indicated with no pattern. Few wells are completed in the aquifer in the southwestern portions of the county. Dashed lines show areas of the aquifer where potentiometric surface contours are poorly constrained. Groundwater flow is generally toward the Root River and its tributaries in the north and northwest, and toward the Mississippi River Valley and its tributaries in the east. Top of aquifer elevations are from Part A, Plate 4, GIS files.




**Elevation of the top of the Mt. Simon aquifer (feet)**

620

170

**Symbols and labels**

+ Groundwater level data

• Surface water elevation

Groundwater flow direction

Fault

····700— Groundwater elevation contour, dashed where approximate

B —— B′ Line of cross section (Part B)

Confined portion of aquifer (no pattern indicates unconfined portion)

Body of water

**Figure 12. Potentiometric surface contours of the Mt. Simon aquifer**

The Mt. Simon aquifer is confined over most of the county, indicated by a stippled pattern. Unconfined portions exist within the Mississippi River Valley where overlying strata have been eroded away, indicated with no pattern. Well data in the central and western portions of the county are limited. Dashed lines indicate areas of the aquifer where elevation contours are poorly constrained. Dashed contours are from a regional dataset developed by the MDH (J. Blum, MDH, written communication, 2014). Groundwater flow is generally toward the Root River and its tributaries in the north and northwest and toward the Mississippi River Valley and its tributaries in the east. Top of aquifer elevations are from Part A, Plate 4, GIS files.

# Water chemistry (Plate 5)

All groundwater originated as precipitation that infiltrated through soil layers and into pores and crevices of aquifers and aquitards. Water moves in complicated but definable patterns: into aquifers as recharge, through aquifers, and out of aquifers as discharge. The types of dissolved elements and compounds in groundwater provide information about recharge areas, groundwater flow paths, and approximately how long the water has been underground (residence time). Water chemistry is used to provide information, such as the following:

- Groundwater **recharge** from surface water can be identified from the effect of evaporation on the isotopes of hydrogen and oxygen.
- Groundwater **residence time** is estimated from tritium and carbon-14 isotopes. Tritium is used to identify water that moved into the subsurface since the 1950s. Carbon-14 is used to determine groundwater residence times of centuries to millennia.
- The distribution of select chemicals can indicate areas of high pollution sensitivity or where groundwater consumption is a potential concern to human health.

## Water sampling

Samples were collected from wells in aquifers most frequently used for domestic water supply and from springs that supply perennial flow to many of the county's cold-water trout streams. Wells were selected based on their aquifer characteristics and distribution. Samples were collected according to the protocols outlined in Appendix A. Chemical data from well and spring samples were used along with physical measurements (temperature, specific conductivity, dissolved oxygen, etc.) to understand water movement.

An ideal well-sampling network is evenly distributed across the county, includes populated areas, targets surface-water and groundwater interaction, and contains wells constructed to meet MDH standards with construction documentation. The final network sampled for an atlas depends on the willingness of citizens to participate. Approximately 1,000 well owners were contacted for permission to sample, and approximately 90 were selected for groundwater sampling. Eighty percent of the wells sampled by the DNR had adequate construction documentation (grouting, depth, open hole length, etc.). The remaining 20% lacked construction information and were spread across the aquifers sampled.

For this atlas, the DNR collected 87 well, 26 spring, and 3 river samples. These data were combined with 6 historic well samples for carbon-14 residence time investigations, 27 well samples collected by the MDH, 8 historic or special project spring samples, and 1 spring sample collected by the Minnesota Department of Agriculture (MDA). Data from the MDH are from two separate sources: the Minnesota Drinking Water Information System, a compliance-monitoring database that emphasizes treated water; and the Water Chemistry Database, a nonregulatory investigatory chemistry database.

## Groundwater recharge pathways

Stable isotopes of oxygen and hydrogen are used to distinguish groundwater recharged by direct infiltration of precipitation at the land surface from groundwater recharged through lakes or open-water wetlands. Surface water that is open to the atmosphere can evaporate, which will change the isotopic composition through the process of *fractionation*.

Fractionation occurs because oxygen and hydrogen each have isotopes of different masses ($^{18}O$ and $^{16}O$, and $^{2}H$ and $^{1}H$). This causes each isotope to evaporate at different rates, leaving the water with different ratios of heavy to light isotopes, resulting in unique isotopic signatures for groundwater with different recharge pathways (Kendall and Doctor, 2003).

- **Meteoric isotopic signature**: groundwater recharged from unevaporated precipitation. The water infiltrated directly into the ground, leaving the isotopic ratio unchanged.
- **Evaporative isotopic signature**: groundwater recharged through surface water, such as lakes or open-water wetlands. This water was subjected to fractionation by evaporation, resulting in lake water with a heavier isotopic ratio.

To identify the source of a groundwater sample, oxygen and hydrogen isotopic data are plotted against each other. The x-axis represents the oxygen isotope value ($\delta^{18}O$), and the y-axis represents the hydrogen isotope value ($\delta^{2}H$). The measured ratio in the sample is divided by the ratio in a standard. The standard used is Vienna Standard Mean Ocean Water (VSMOW).

**Definition of delta (δ)**

The stable isotope composition of oxygen and hydrogen are reported as δ values: $\boldsymbol{\delta\,(^0/_{00}) = (R_x/R_s-1)*1000}$.

- R represents the ratio of the heavy to light isotope, e.g., $^{18}O/^{16}O$ or $^{2}H/^{1}H$.
- $R_x$ represents the ratio of the sample.
- $R_s$ represents the ratio in the standard.
- Delta values are reported in units of parts per thousand ($^0/_{00}$ or permil).

## Recharge results

County results were compared to the global meteoric water line (GMWL), which was developed from precipitation data from around the world (Craig, 1961). Groundwater samples plot parallel to the GMWL (Figure 13), indicating that most groundwater is recharged by precipitation directly infiltrating into the subsurface, consistent with groundwater recharge in karst and the lack of lakes and wetlands in southeastern Minnesota. Groundwater samples that plot above the GMWL differ from samples from many other counties in Minnesota sampled by the Groundwater Atlas Program, where samples plot along and on either side of the GMWL. However, groundwater samples plotting above the GMWL is common for southeastern Minnesota and was also observed in Winona, Olmsted, and Dodge counties (Barry, 2021; Barry, in preparation; Bradt and Barry, 2024).

The y-intercept value of +10 in the GMWL equation ($\delta^2H = 8.0\ \delta^{18}O + 10.0$) is called the deuterium excess value. The median deuterium excess for groundwater in Houston County is +12.7. The deuterium excess values found in southeastern Minnesota are consistent with deuterium excess values shown in Figure 9 of Kendall and Coplen (2001) and may be an indication that more evaporated moisture is contributing to air masses sourcing precipitation in this part of the state.

Houston County groundwater samples mostly fall above the meteoric water line; two samples trend along an evaporation line (Figure 13). Partial evaporative signatures are from a water-table well and a buried sand aquifer well east of the city of La Crescent (Figure 14). The source of evaporative water to the wells is uncertain but may be Blue Lake, the open water wetlands that are to the west and upgradient of the wells, or the Mississippi River (Figure 14 inset).

Two surface-water samples, collected from the Root River, plot along the deuterium excess line, consistent with a karstic watershed with no lakes and limited open water wetlands (limited surface waters subjected to significant fractionation) (Figure 13). The third surface-water sample, collected from the Mississippi River, shows minor evidence of fractionation, likely from the many opportunities for fractionation in the lakes and wetlands that contribute to the Mississippi River upstream of Houston County.

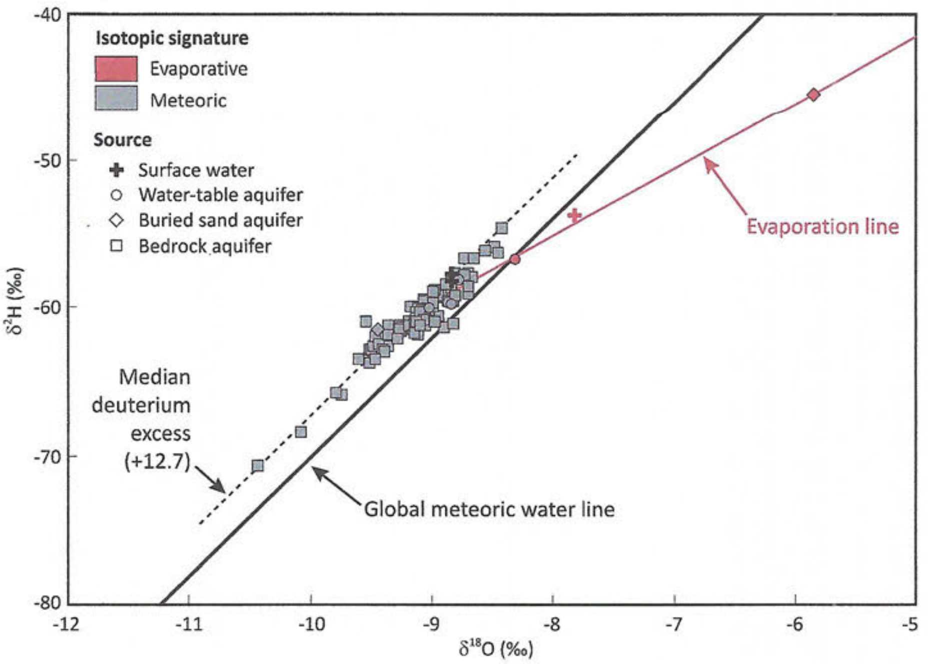



**Figure 13. Stable isotope values from water samples**

The meteoric water line represents precipitation values from direct infiltration. The GMWL was developed using precipitation samples from around the world and is described by the following equation: $\delta^2H = 8.0\ \delta^{18}O + 10.0$ (Craig, 1961). Most samples in Houston County have deuterium excess and plot above the GMWL, consistent with deuterium excess values found elsewhere in southeastern Minnesota.

The evaporation line represents groundwater recharge that came partially from surface-water sources. Since there aren't lake samples available for Houston County, the evaporation line is from a regression of the two evaporative signature trend well samples and is described by the following equation: $\delta^2H = 4.5\ \delta^{18}O - 18.8$. Two groundwater samples showed evidence of evaporative signatures and are shown as red symbols.

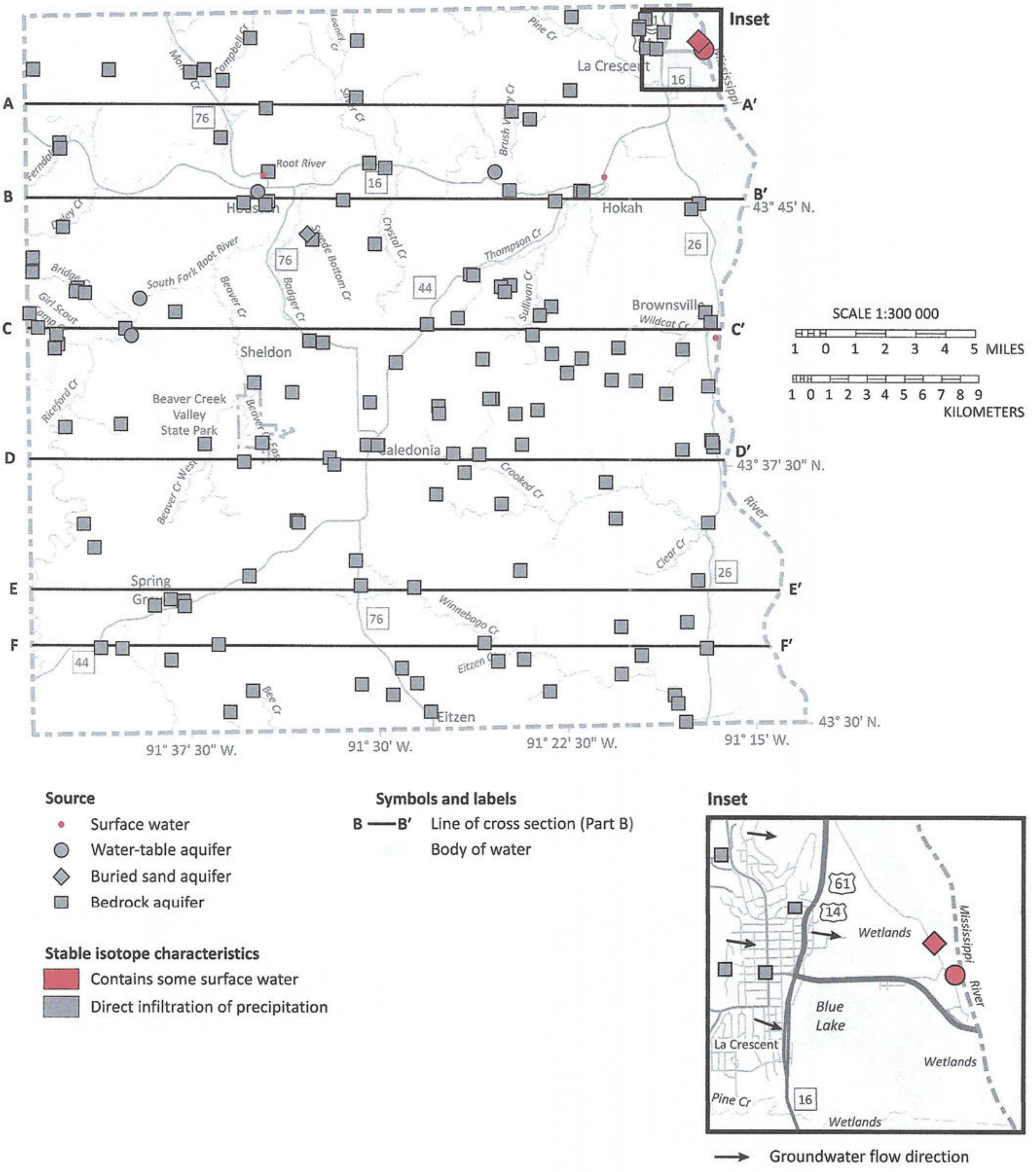



**Figure 14. Stable isotope characteristics of groundwater samples**

Most groundwater samples originated as direct infiltration of precipitation and are symbolized in gray, representing meteoric signatures. The red symbols represent partial evaporative signatures. The inset shows possible evaporative surface-water sources (Blue Lake, open-water wetlands, and the Mississippi River) for the two wells with partial evaporative signatures.

## Groundwater residence time

Groundwater residence time is the approximate time that has elapsed since water infiltrated the land surface to the time it was pumped from a well or discharged to a surface water body (spring, creek, or river). Short residence time generally suggests short travel paths or high recharge rates; long residence time suggests long travel paths or low recharge rates. Since groundwaters are mixtures, groundwater residence time estimates are averages of the multiple differing groundwater flow paths represented in a single sample. For instance, a groundwater sample from a karst aquifer may contain some water from open conduit flow paths that are hours to days old, combined with water that flows much more slowly through the rock matrix itself.

The residence time of groundwater was estimated for this atlas using isotopic analysis of the radioactive elements tritium and carbon-14. Groundwater residence time results are shown on Plates 5 (Water Chemistry) and 6 (Hydrogeologic Cross Sections), and Figures 19 (Piper diagram), 21, and 24 to 30 (Pollution sensitivity).

### Tritium

Groundwater residence time was interpreted from the concentration of tritium. Although tritium is a naturally occurring isotope of hydrogen, atmospheric concentrations were greatly increased from atmospheric testing of nuclear weapons between 1953 and 1963 (Alexander and Alexander, 1989). Tritium concentrations were used to estimate groundwater residence time using the known half-life of 12.32 years (Lucas and Unterweger, 2000). The concentrations are presented in tritium units (TU) and are referred to as tritium age in the following categories.

- **Recent**: water entered the ground since about 1953 (greater than or equal to 8 TU).
- **Mixed**: water is a mixture of recent and vintage (greater than 1 TU to less than 8 TU).
- **Vintage**: water entered the ground before 1953 (less than or equal to 1 TU).

Historical data (sample dates from 1987 to 2017) are used in the residence time interpretations of this report and are classified according to Table B-2 in Appendix B.

Tritium was collected from 100 wells and 26 springs to assist in residence-time interpretations. Of the 126 samples analyzed for tritium, 62 were vintage, 57 were mixed, and 7 were recent.

### Carbon-14

Select wells with vintage and mixed tritium-age results were further sampled for carbon-14 ($^{14}C$) to estimate longer residence times. This naturally occurring isotope has a half-life of 5,730 years and is used to estimate groundwater residence time ranging from less than 100 to greater than 40,000 years.

Carbon-14 sample collection, analysis, and modeling is described in Alexander and Alexander, 2018. In general, when precipitation infiltrates the unsaturated zone it adsorbs carbon dioxide, including carbon-14, forming carbonic acid. This mildly acidic water dissolves calcite and dolomite present in the soil or bedrock. Plant communities present at the time of infiltration determine soil $\delta^{13}C$ ratios that are used within the model to estimate the groundwater residence time. Approximately half of the dissolved carbon in the groundwater comes from atmospheric carbon in the soil zone during infiltration and half comes from very old bedrock sources where carbon-14 has decayed completely.

Residence times from 17 sampled wells varied from less than 100 years to 30,000 years. The oldest carbon-14 residence times are in the Mt. Simon aquifer. Carbon-14 residence time generally increases with depth from land surface.

## Inorganic chemistry of groundwater

Water begins dissolving minerals in the soil, sediment, and bedrock as soon as precipitation infiltrates the soil layer. Groundwater chemistry changes as it moves along flow paths.

Groundwater contamination can come from human (anthropogenic) pollution or the dissolution of naturally occurring geologic (geogenic) sources. Elevated concentrations of particular chemicals can indicate short groundwater residence time, high sensitivity, or where groundwater consumption is a potential concern to human health.

Anthropogenic sources can be identified by comparing concentrations to naturally occurring background levels. Water quality evaluations describe contaminants that are potentially harmful (either geogenic or anthropogenic) or that affect aesthetics. This atlas uses the following guidelines.

### Drinking water guidelines

**U.S. Environmental Protection Agency**
(EPA, 2023 January; EPA, 2023 February)

**Maximum Contaminant Level (MCL)**: legally enforceable federal standards that apply to public water systems to limit the levels of contaminants in drinking water.

**Maximum Contaminant Level Goal (MCLG)**: nonenforceable health goals set on possible health risks from exposure over a lifetime.

**Secondary Maximum Contaminant Level (SMCL)**: nonenforceable guidelines for contaminants that can cause aesthetic effects or taste and odor problems in drinking water.

**Minnesota Department of Health** (MDH, 2023)

**Health Risk Limit (HRL)**: the concentration of a groundwater contaminant, or a mixture of contaminants that can be consumed with little or no risk to health, and that has been promulgated under rule.

**Health Based Value (HBV)**: derived using the same algorithm as HRLs; however, they have not yet been promulgated as rules.

**Risk Assessment Advice (RAA)**: technical guidance concerning exposures and risks to human health. RAA values contain more uncertainty than HRLs.

## Chemical descriptions and results

The following chemicals are naturally occurring, but some can be elevated by anthropogenic activities. Water quality guidelines and sampled results are presented for inorganic chemistry and include the following.

- The major cations and major anions are reported in units of parts per million (ppm)
- Trace elements, such as arsenic, manganese, and boron, are reported in units of parts per billion (ppb)

Organic chemicals were not studied as they are out of the scope of this project, but can be found in reports from other state agencies (for example, pesticides and their breakdown products, solvents, and degreasers). Geogenic, naturally occurring radionuclides, such as radium and radon, were additionally out of scope for this project, but can be elevated in the Mt. Simon aquifer (Lively and others, 1992). Radium is commonly found in southeastern Minnesota's Paleozoic aquifers (Lundy, 2010). Two municipal drinking water systems, Houston and La Crescent, require treatment for radium removal (J. Woodside, MDH, written communication, 2025).

### *Chloride*

*SMCL 250 ppm, elevated ≥5 ppm, anthropogenic: chloride/bromide ratio >300*

Chloride can occur naturally from deep sources, such as groundwater basin brines, or it can come from anthropogenic sources, such as road salt, water softener salt, or fertilizer. The chloride concentration of atmospheric deposition in southeastern Minnesota is less than 1 ppm (NADP, 2025).

Chloride to bromide (Cl/Br) ratios are commonly used in hydrologic investigations to identify sources of chloride in groundwater (Whittemore, 1988; Davis and others, 1998; Thomas, 2000; Jagucki and Darner, 2001; Panno and others, 2006; Mullaney and others, 2009).

Chloride sources have different Cl/Br ratios that fall along unique mixing trends. Figure 15 shows Cl/Br ratios of Houston County samples plotted with groundwater mixing trends from Wilson (2012). Many samples plot along binary mixing curves 1 to 4, suggesting that elevated chloride in these waters is from anthropogenic sources.

The binary mixing curve from dilute groundwater/basin brines (curve 5) differs from the line shown in Wilson (2012) and was developed for Minnesota using a subset of Mt. Simon aquifer well chemistry from the MDH (MDH, 2025). The Minnesota-specific brine mixing curve is slightly different, which may reflect subtle differences between the brine of the Hollandale Embayment and those of the Illinois Basin shown in Wilson (2012). Basins are broad structural depressions of bedrock layers. The Hollandale Embayment is a basin that underlies southeastern Minnesota; the Illinois Basin includes parts of the states of Illinois, Indiana, Kentucky, Tennessee, and Missouri. Groundwater found in deep geologic basins often has naturally elevated chloride.

For this study, samples with Cl/Br mass ratios above 300 and chloride concentrations above 5 ppm likely indicate anthropogenic sources of chloride (Figure 15). The 300-break point was determined using a combination of chloride and nitrate concentrations, tritium ages, carbon-14 residence time estimates, and results from the research referenced above.

*Sampling results (Figure 16)*

- Of the 143 samples analyzed for chloride, 33 were elevated from anthropogenic influences. Anthropogenically elevated samples were collected from 17 springs and 16 wells; none equaled or exceeded the SMCL. Anthropogenically elevated occurrences were primarily from wells and springs in aquifers above the St. Lawrence aquitard or in valley bottoms where overlying aquitards are absent or have diminished protective characteristics.

### *Nitrate*

*MCL and HRL 10 ppm, elevated ≥1 ppm*

Nitrate can occur naturally at low concentrations, but elevated concentrations indicate impacts from fertilizer and animal or human waste (Dubrovsky and others, 2010; Wilson, 2012; Kroening and Vaughan, 2019). The majority of nitrate that impacts the state's waters, including groundwater, is from agricultural activities (MPCA, 2013). Nitrate concentrations may lessen with time (denitrification) in deep and confined aquifers where there is little oxygen in the groundwater. In Minnesota, groundwater with long residence time typically has little available oxygen and little to no nitrate.

Nitrate concentrations are commonly elevated in southeastern Minnesota, in the root zone underlying row-crop agriculture. A 5-year study collected nitrate concentrations in soil water from lysimeters in cultivated row crop settings of Minnesota. Results were highly variable, averaging 22.3 ppm with a typical range of 8 to 28 ppm (Kuehner and others, 2020). Nonagricultural nitrate concentrations from lysimeters installed in prairie and forest settings had average concentrations less than 0.5 ppm.

Elevated levels of nitrate may indicate that other surface contaminants have the potential to reach an aquifer. Pesticides were not sampled as part of this study, but frequently co-occur with nitrate. The MDA has found that the likelihood of detecting at least one pesticide compound increases as the concentration of nitrate increases (MDA, 2019). In Houston County, 98% (100 of 102) of wells with a nitrate concentration greater than or equal to 3 ppm contained pesticides or pesticide metabolites (B. Schaefer, MDA, written communication, 2025). The Houston County findings are similar to the results from an investigation in Dakota County that found a median of 15 different herbicide compounds in study wells with a median nitrate concentration greater than 3 ppm (Demuth and Scott, 2020).

*Sampling results (Figures 17 and 18)*

- Of the 144 samples analyzed for nitrate, 53 were elevated. Elevated samples were collected from 29 springs and 24 wells; 2 well samples exceeded the MCL.
- Elevated occurrences were primarily from the Prairie du Chien and Jordan aquifers or in wells completed in valley bottoms where overlying bedrock aquitards are absent.
- Springs with elevated nitrate are common and are primarily at the edge of valleys where overlying aquitards have diminished protective characteristics.

This report's findings are consistent with the results from the MDA Township Testing Program, which found areas with a high percentage of row crop agriculture and karst vulnerability to be at risk for nitrate contamination (MDA, 2020). The MDA program consists of two assessments. The initial MDA assessment included wells where specific details about participant wells, such as aquifer, depth, and well construction, weren't always available.

The initial assessment found nitrate concentrations greater than the MCL in 10% or more of the samples collected in the following townships: Black Hammer, Caledonia, Mayville, Spring Grove, Wilmington, and Winnebago. Townships are shown on Plate 5. For the second assessment, the MDA did follow-up tests in these same townships and found nitrate concentrations consistent with the initial testing. Following the second round of testing, the MDA removed the results of wells that had insufficient documentation describing the well's depth, aquifer, or construction details, or wells that could be influenced by point sources of nitrogen. The final well assessment found nitrate concentrations greater than the MCL (10 ppm) in more than 10% of wells in Black Hammer, Caledonia, Mayville, Spring Grove, and Wilmington townships.

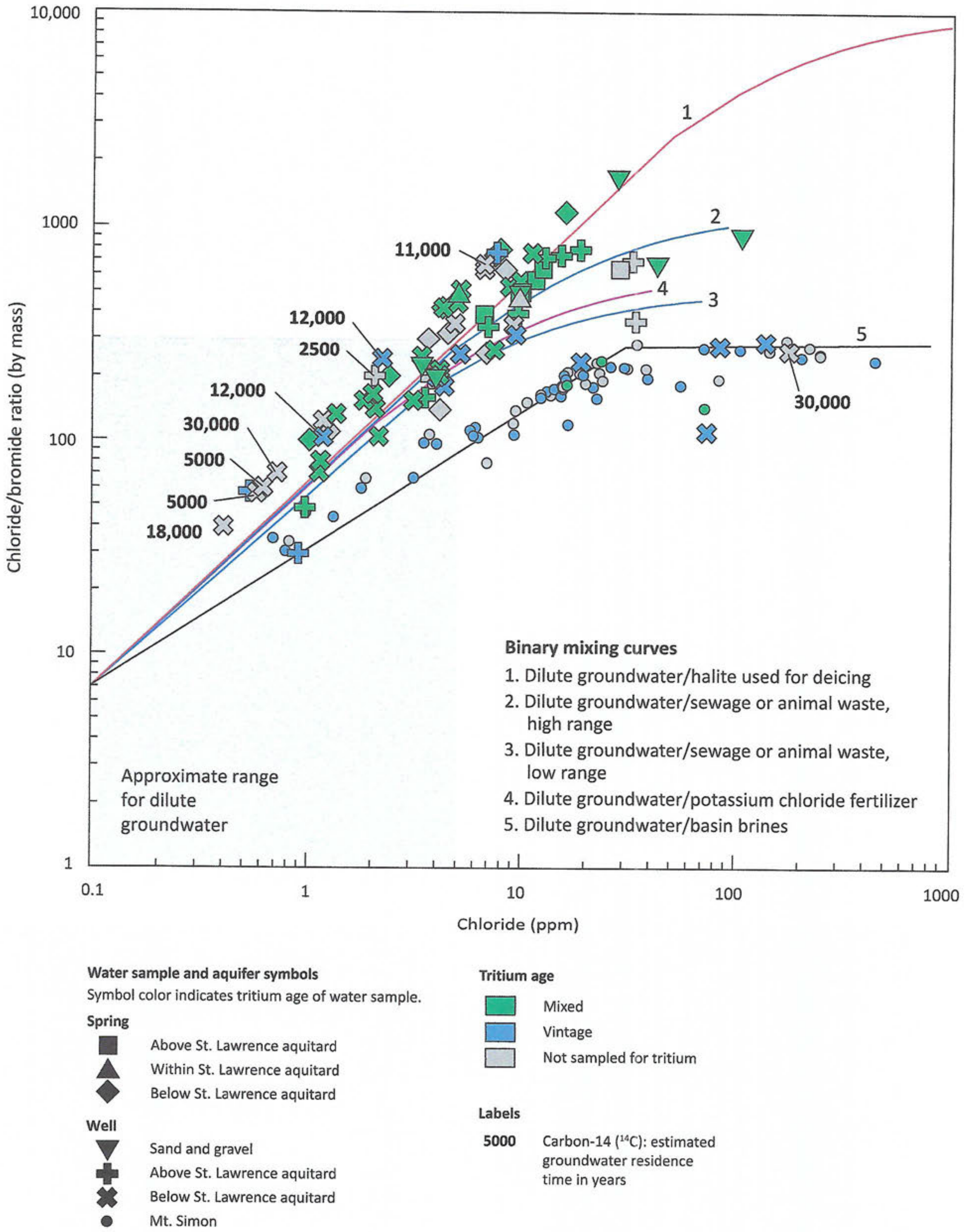



**Figure 15. Chloride/bromide ratios to chloride concentration**

All groundwaters are mixtures. Binary mixing curves are used to visualize the mixing of waters from two distinct waters (such as pristine groundwater and groundwater impacted by road salt or potassium chloride fertilizers). Houston County water samples are shown projected on mixing curves from Wilson (2012). Binary mixing curve number 5, dilute groundwater/basin brines, differs from the line shown in Wilson (2012) and was developed for Minnesota using a subset of Mt. Simon aquifer well chemistry from the MDH (MDH, 2025).

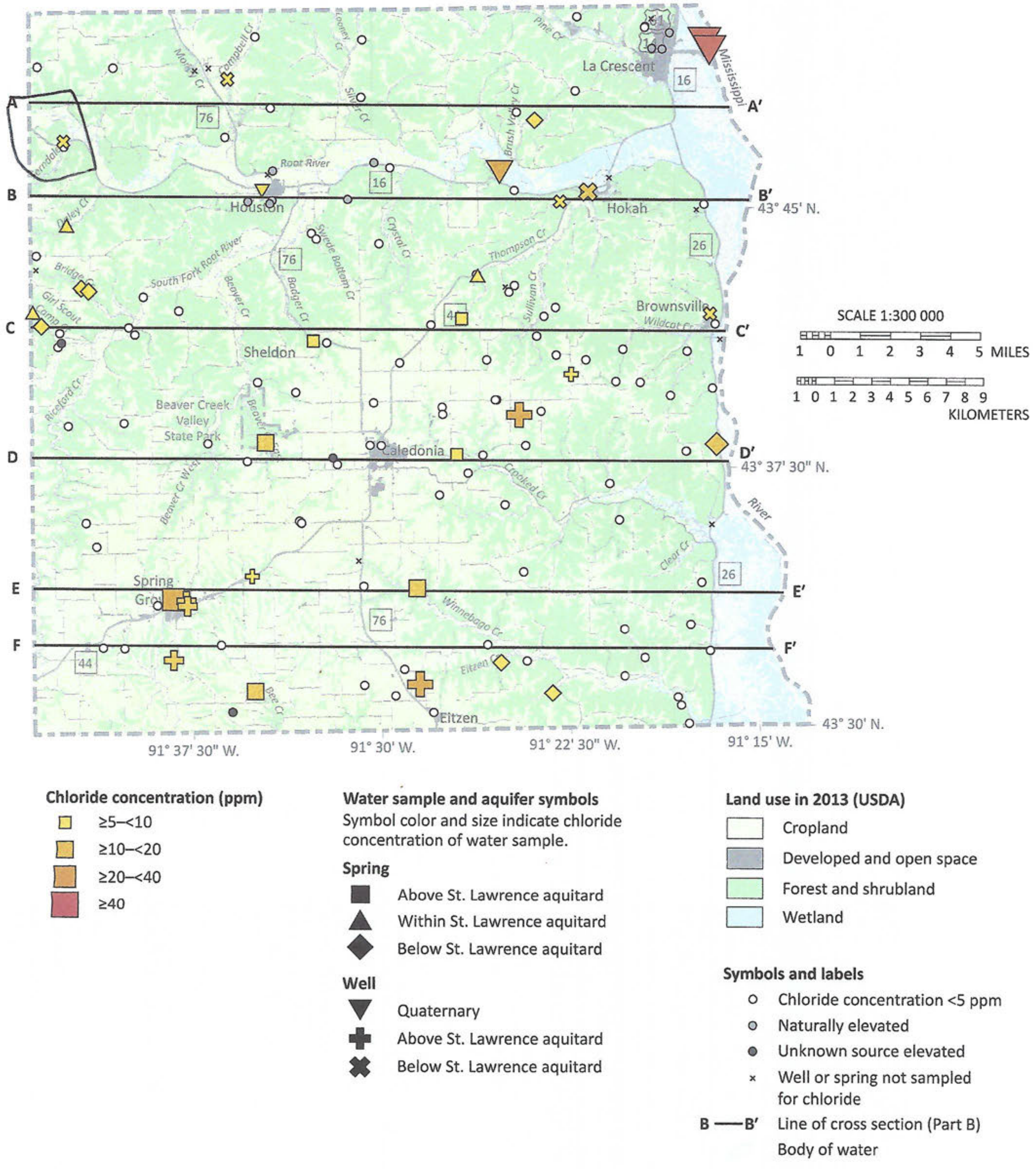
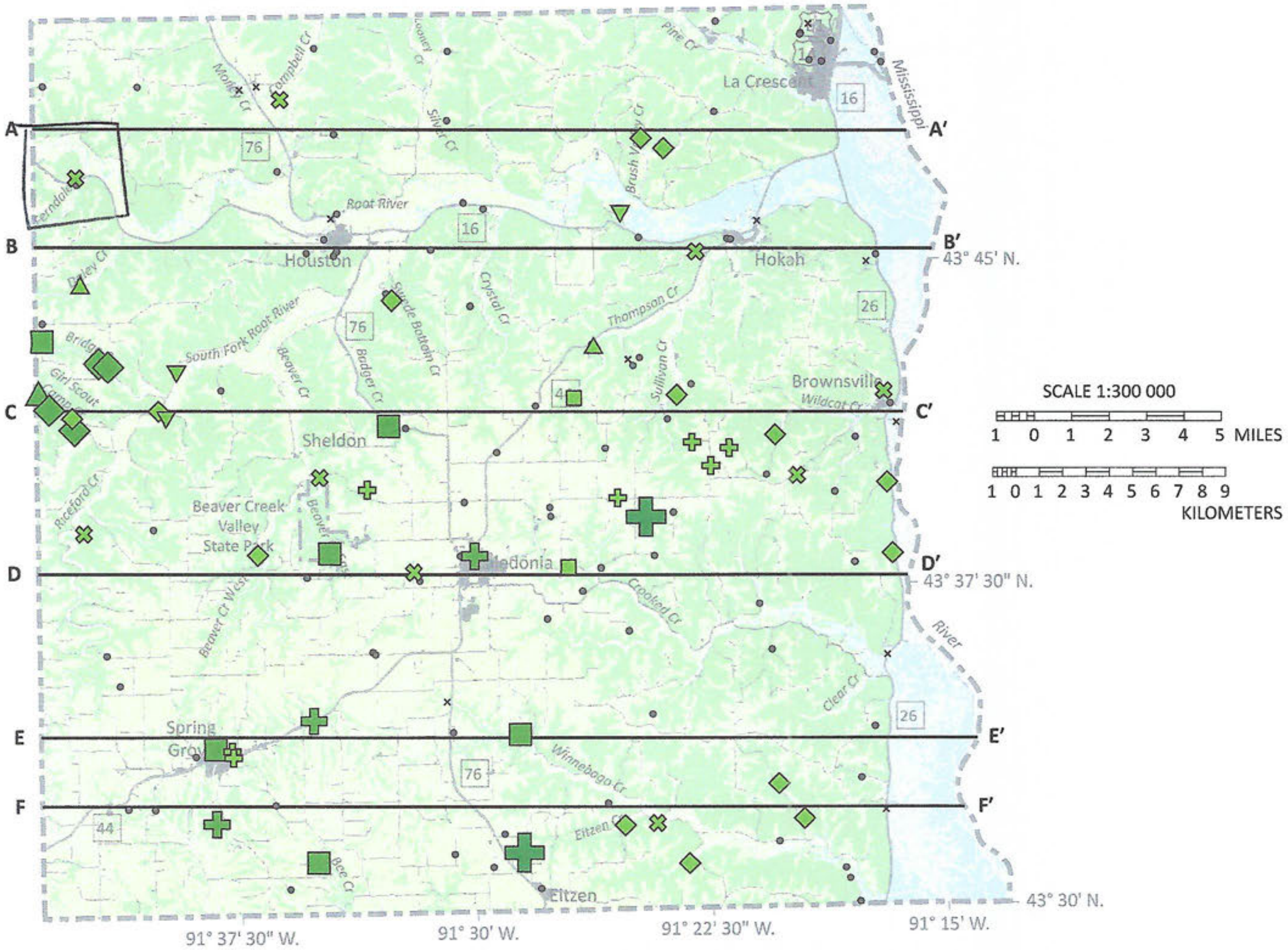



**Figure 16. Elevated chloride concentrations from groundwater samples**

Anthropogenically elevated chloride exceeding 5 ppm was found in 33 of 143 groundwater samples. The two highest chloride samples came from sand and gravel wells in La Crescent. Naturally elevated chloride was determined using Cl/Br ratios of less than 300 and was encountered most in wells completed in the Mt. Simon aquifer.




**Nitrate concentration (ppm)**

- ≥1–<5
- ≥5–<10
- ≥10

**Water sample and aquifer symbols**

Symbol color and size indicate nitrate concentration of water sample.

**Spring**

- Above St. Lawrence aquitard
- Within St. Lawrence aquitard
- Below St. Lawrence aquitard

**Well**

- Quaternary
- Above St. Lawrence aquitard
- Below St. Lawrence aquitard

**Land use in 2013 (USDA)**

- Cropland
- Developed and open space
- Forest and shrubland
- Wetland

**Symbols and labels**

- Nitrate concentration <1 ppm
- Well or spring not sampled for nitrate
- B —— B′ Line of cross section (Part B)
- Body of water

**Figure 17. Distribution of nitrate concentrations from groundwater samples**

Elevated nitrate is common in Houston County, with 53 of 144 groundwater samples equal to or exceeding 1 ppm, and 2 samples exceeding the MCL. Springs commonly have elevated nitrate. Elevated nitrate primarily occurs in wells completed in aquifers located above the St. Lawrence aquitard or in wells in valley bottoms where overlying aquitards are absent.

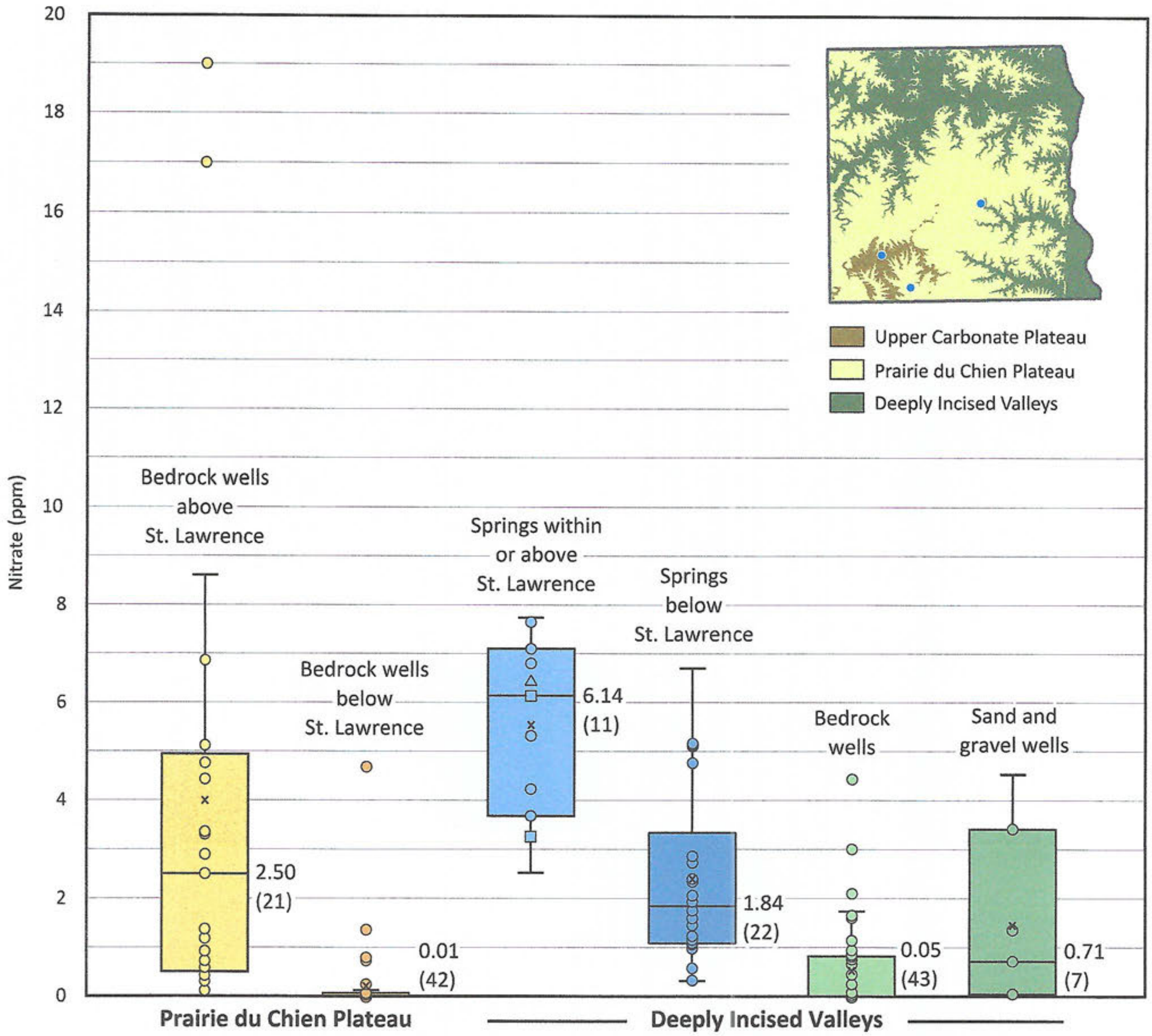



**Figure 18. Nitrate box plots of groundwater samples**

Nitrate concentration box plots help illustrate nitrate concentration differences, depending on the well's geomorphic setting and aquifer position above or below the St. Lawrence aquitard. Three springs included in the "Springs within or above the St. Lawrence" box plot emerged from plateaus (inset figure); the triangle symbol represents a spring from the Upper Carbonate Plateau, and the two squares represent springs of the Prairie du Chien Plateau.

Numbers to the right of each box plot represent the median nitrate concentrations; numbers within parentheses represent the number of samples within each category. Horizontal lines within each box represent median concentrations, the X represents the average value, and the whiskers represent the ranges for the top and bottom 25% (excluding outliers).

### *Arsenic*

*MCL 10 ppb; MCLG 0*

Arsenic is a naturally occurring element that has been linked to negative health effects, including cancer. If arsenic is present, the MDH advises domestic well owners to treat drinking water (MDH, 2023). Current science cannot predict which wells will have high arsenic concentrations; therefore, all newly constructed drinking-water wells are analyzed for arsenic (Minnesota Administrative Rules 4725.5650, 2008).

The factors affecting arsenic concentrations in groundwater are not completely understood. There is a strong correlation between arsenic in groundwater and glacial sediment derived from rocks northwest of Minnesota (Erickson and Barnes, 2005a). Arsenic is most likely to be present in glacial drift and shallow bedrock wells that lie within the footprint of the most recent glaciation that originated from the Riding Mountain provenance (northwest). This glaciation never reached Houston County, likely influencing the relatively low number of arsenic detections.

Nicholas and others (2017) found that changes in redox conditions are largely responsible for releasing solid phase arsenic into groundwater by one of three mechanisms: desorption, reductive dissolution, or oxidative dissolution, and that the aquitard-aquifer interface is very geochemically active. Research also indicates that arsenic concentrations are higher in wells that have short-screened sections near the boundary of an aquifer and aquitard (Erickson and Barnes, 2005b).

*Sampling results*

- Of the 127 samples analyzed for arsenic, arsenic was present in 28, 1 of those exceeded 1 ppb, and none exceeded the MCL.

### *Manganese*

*HBV 100 ppb; SMCL 50 ppb*

Manganese is a naturally occurring element beneficial to humans at low levels, but at high levels can harm the nervous system (MDH, 2021). In addition to health effects, concentrations above the SMCL can cause negative secondary effects, such as poor taste, odor, and water discoloration (stained laundry and plumbing fixtures).

Statewide, manganese concentrations were greater than the HBV in drinking-water wells for 57% of water-table aquifers and 63% of buried sand aquifers (MDH, 2012). Although there are no clear patterns of manganese distribution across most of Minnesota, the MDH has found that southeastern Minnesota tends to have low levels of manganese (below 50 ppb), and southwestern Minnesota tends to have high levels (some over 1,000 ppb).

*Sampling results*

- Of the 106 samples analyzed for manganese, 6 were greater than the SMCL and 5 were greater than the HBV.

### *Boron*

*RAA 500 ppb*

Boron is a naturally occurring element that has been linked to negative health effects. The MDH developed the RAA for boron in drinking water at 500 ppb to protect formula-fed infants (MDH, 2017).

*Sampling results*

- Of the 52 samples analyzed for boron, none were greater than the RAA.

### *Sulfate*

*SMCL 250 ppm*

Sulfate is largely naturally occurring. Common sources are the oxidation of sulfide minerals and the dissolution of gypsum. Minor amounts are introduced from the burning of fossil fuels (Crawford and Lee, 2015). High concentrations in groundwater can negatively affect taste and can act as a laxative.

*Sampling results*

- Of the 135 samples analyzed for sulfate, all were less than the SMCL.

## Major cations and anions

Calcium, magnesium, and sodium cations, as well as bicarbonate anions, are dissolved out of glacial sediment and bedrock by groundwater. The constituents are derived from limestone and dolomite bedrock and are also common in unconsolidated aquifers (Hem, 1985). Bicarbonate is also derived from carbon dioxide present in the atmosphere and in soil above the water table.

Sodium is often present in deep aquifers or at mineral interfaces. As groundwater moves through aquifer systems, calcium and magnesium ions are exchanged for sodium ions (Hounslow, 1995). Potassium is naturally released from the weathering of silicate minerals (Hem, 1985). In agricultural areas, fertilizer provides an additional source of potassium.

Water is considered hard or soft by its concentrations of calcium, magnesium, and bicarbonate. Hard water contains higher levels of calcium and magnesium. Most bedrock aquifers in Houston County produce hard water. Though not required, most residents typically soften their water to improve the taste and smell, and to limit the build-up of minerals (scale) on plumbing fixtures, the insides of pipes, and hot water heaters.

The Piper diagram (Figure 19) graphically represents each water sample for the most common ionic constituents in natural waters: calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and nitrate.

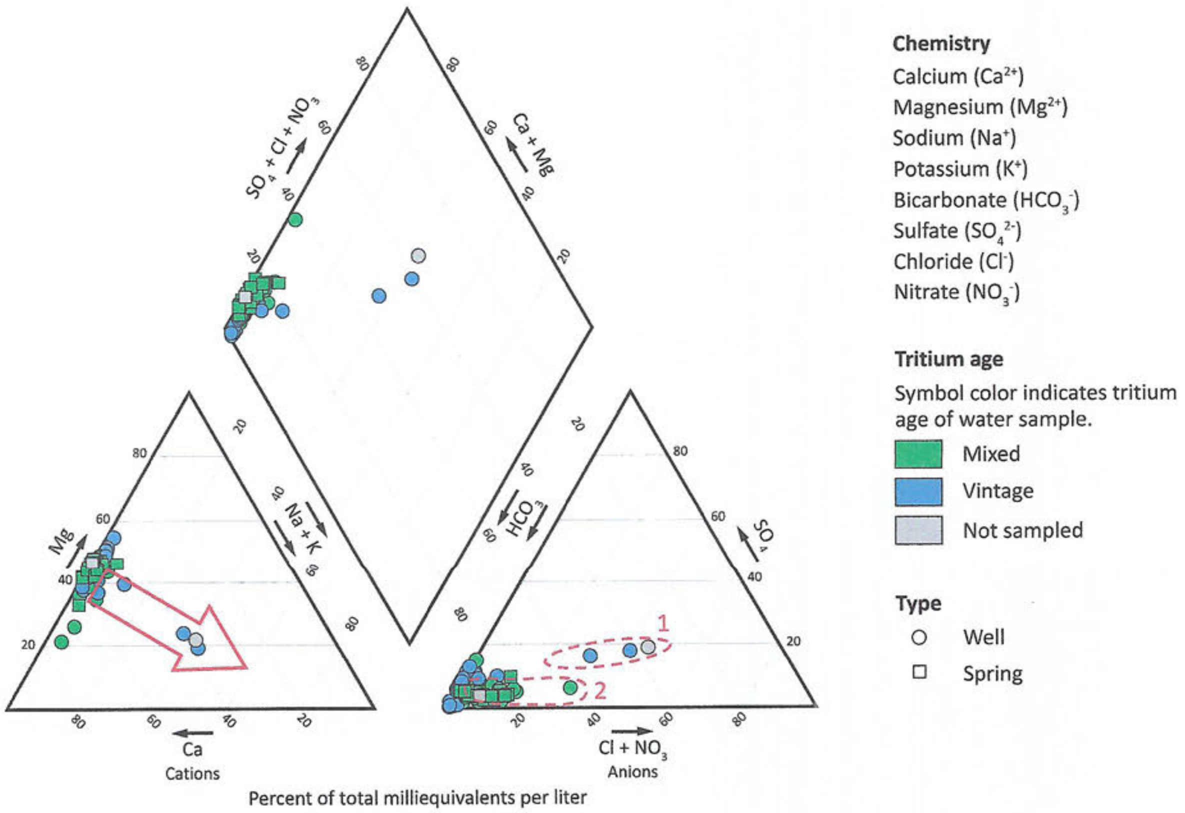



**Figure 19. Groundwater Piper diagram**

This diagram compares the relative proportions of cations and anions in groundwater samples. The most common water type is calcium+magnesium bicarbonate, which is typical for southeastern Minnesota.

Groundwater residence time generally increases along the path of the red arrow. Waters that plot along this path evolve from calcium bicarbonate waters to sodium+potassium bicarbonate waters. Waters within the ellipses of the anion triangle have unique geochemical signatures and trends similar to those found in Winona County (Barry, 2021).

- Ellipse 1 has two samples with vintage tritium ages and one with an estimated carbon-14 residence time of 30,000 years. Each is from the Mt. Simon aquifer. The three samples within this ellipse have naturally elevated chloride that shifts their plots along the chloride+nitrate (lower right) axis on the anion diagram.
- Ellipse 2 samples have mixed tritium ages, anthropogenically elevated chloride and nitrate, and are from all aquifers sampled except the Mt. Simon.

# Pollution sensitivity

Pollution sensitivity is defined as the potential for groundwater to be contaminated by land surface activities because of the properties of the geologic material. Dissolved contaminants migrate with water through sediment and are typically affected by complex processes, such as biological degradation and oxidizing or reducing conditions. The methods used to interpret pollution sensitivity include the following general assumptions:

- Flow paths are vertical and downward from the land surface through the soil and underlying sediment to the saturated zone.
- Contaminants travel at the same rate as water.
- Dissolved contaminants move with water from the surface and are not chemically or physically altered over time.

River valleys can be important groundwater discharge areas where local groundwater movement is upward, and the actual pollution sensitivity can be lower than rated.

Two methods were used to estimate pollution sensitivity. The central concept for both models is the relative rate of water movement. This is described as infiltration in the unsaturated zone and recharge in the saturated zone.

The following describes the two methods:

- **Near-surface materials:** unsaturated flow to a depth of 10 feet (the assumed depth of the water table); the primary properties used to estimate sensitivity are texture and distance. This method is used in valleys and along the Mississippi River.

In large portions of the county, the near-surface materials are underlain by shallowly buried karst bedrock. These areas are mapped as ***prone to karst feature development***, and near-surface sensitivity is very high.

Areas of high sensitivity can be areas of high recharge. In addition to soil properties, land cover affects potential recharge (Smith and Westenbroek, 2015).

- **Bedrock aquifers**: aquifer chemistry and residence time are combined with depth from the land surface and the presence or absence of karst features and overlying aquitards. These data are used to estimate bedrock pollution sensitivity, in conjunction with the findings of historical investigations that describe the hydrologic properties of Minnesota's Paleozoic bedrock aquifers and aquitards.

## Near-surface materials model

### Method

The method used to estimate infiltration rates through soil and shallow geologic materials is applied successfully to large portions of Minnesota and is valid in valleys in southeastern Minnesota with thick sequences of unconsolidated deposits. The pollution sensitivity ratings of the near-surface materials model are superseded where certain geologic conditions are present. These include areas where karst is present, where bedrock is at or near the land surface, or near disturbed lands (DNR, 2016c). In Houston County and large portions of southeastern Minnesota, karst conditions supersede the near-surface pollution sensitivity method. In areas mapped as karst, the potential for extremely rapid contaminant travel is assumed.

The method estimates the time it takes for water to infiltrate the land surface, travel through the unsaturated zone, and reach the water table, which is assumed to be 10 feet below the land surface. The first 3 feet is assumed to be soil; the next 7 feet is assumed to be surficial geological material. If there are no soil data, the transmission rate is based on 10 feet of the surficial geologic unit.

Coarse-grained materials generally have faster transmission rates than fine-grained materials. The two primary inputs used to estimate transmission rate are the hydrologic soil group and the surficial geologic matrix texture. Attributes of both are used to estimate the time of travel (Table 1) (Natural Resources Conservation Service, 2020; Part A, Plate 3).

The time of travel through near-surface sediment varies from hours to approximately a year (Figure 20).

- Areas with a short travel time (hours to a week) are rated high sensitivity.
- Areas with a longer travel time (weeks to a year) are rated low or very low.
- Areas with travel times of more than a year are rated ultra low. There are no ultra-low areas in this county.

For further details, see *Methods to estimate near-surface pollution sensitivity* (DNR, 2016c).

Results are depicted in Figure 21.

**Table 1. Transmission rates through unsaturated materials**

Used to assess the pollution sensitivity rating of the near-surface materials

| Hydrologic Soil Group (0–3 feet) | | Surficial Geologic Texture (3–10 feet) | | |
|---|---|---|---|---|
| **Group*** | **Transmission rate (in/hr)** | **Classification** | **Transmission rate (in/hr)** | **Surficial geology map unit (Part A, Plate 3)** |
| A, A/D | 1 | gravel, sandy gravel, silty gravel | 1 | Qb |
| | | sand, silty sand | 0.71 | Qa, Qat |
| B, B/D | 0.50 | silt, loamy sand | 0.50 | Qr** |
| | | sandy loam, peat | 0.28 | Not mapped in county |
| C, C/D | 0.075 | silt loam, loam | 0.075 | Qc |
| | | sandy clay loam | 0.035 | Not mapped in county |
| D | 0.015 | clay, clay loam, silty clay loam, sandy clay, silty clay | 0.015 | Not mapped in county |

Note that peat is used as an overlay on the map due to variable and typically unknown thicknesses.

*The NRCS defines hydrologic soil groups primarily based on texture and the occurrence of low permeability layers (Natural Resources Conservation Service, 2009):

Group A: water is freely transmitted. Soils are more than 90% sand and gravel.

Group B: soils are less permeable but water transmission is still unimpeded.

Group C: water transmission is somewhat restricted.

Group D: water movement is restricted or very restricted.

**Residuum transmission rate was modified per discussion with the MGS.

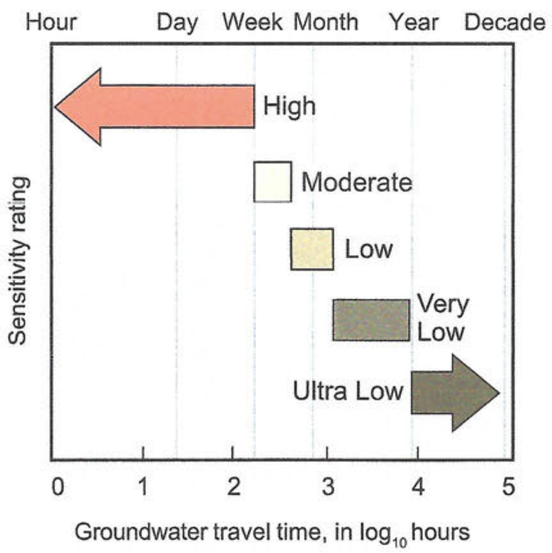
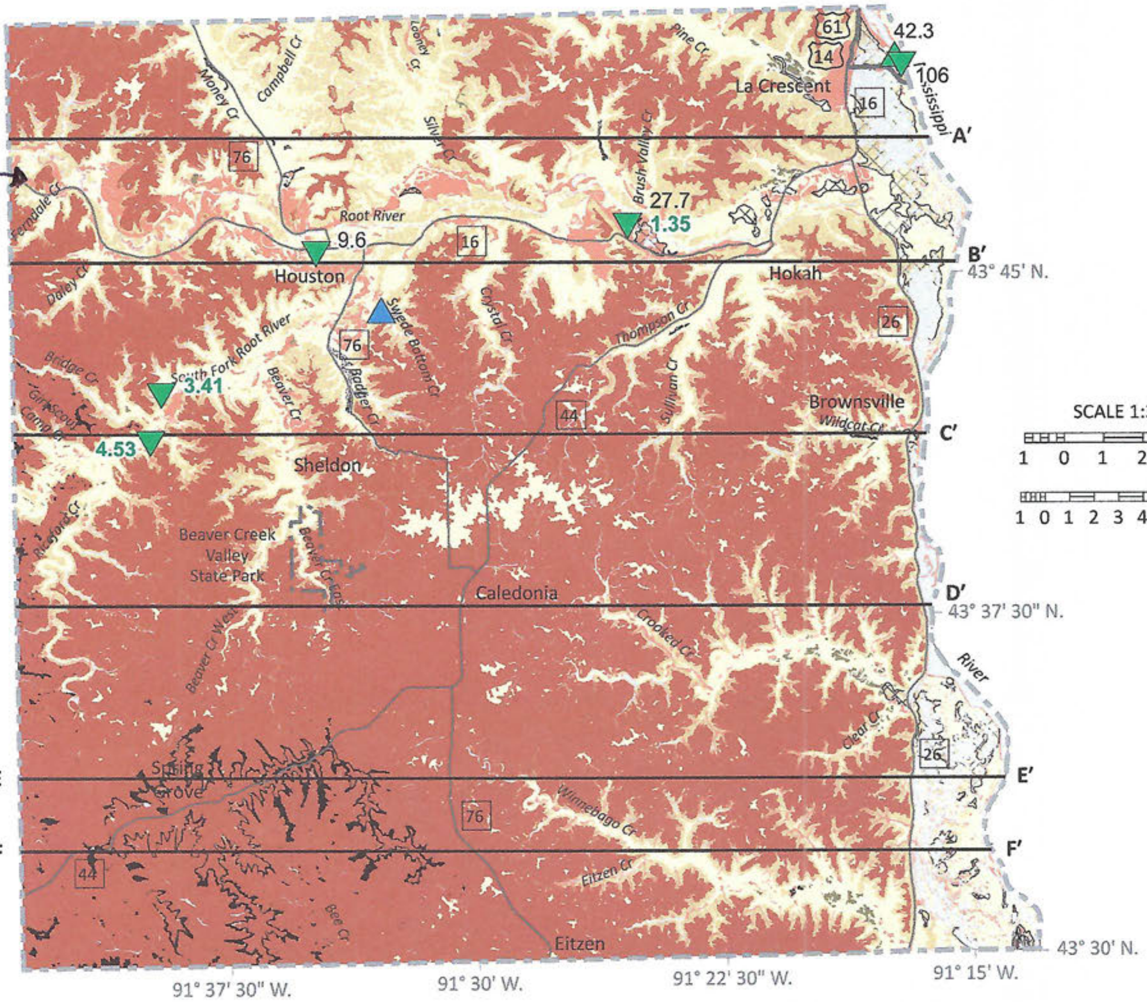



**Figure 20. Geologic sensitivity ratings for near-surface materials**




**Estimated vertical travel time through near-surface materials**

- High: hours to a week
- Moderate: a week to weeks
- Low: weeks to months
- Very low: months to a year

* Proposed Site

**Special conditions**

- Area prone to karst feature development
- Bedrock at or near surface

* Proposed Site

**Water sample and aquifer symbols**

Symbol color indicates tritium age of water sample.

- ▼ Water table
- ▲ Buried sand

**Tritium age**

Symbol color indicates tritium age of water sample.

- Mixed
- Vintage

**Symbols and labels**

- 27.7 Chloride: if shown, concentration is ≥5 ppm. (* naturally elevated, ⁺ source unknown)
- 3.41 Nitrate: if shown, concentration is ≥1 ppm.
- B —— B′ Line of cross section (Part B)
- Body of water
- Peat

**Figure 21. Pollution sensitivity rating of near-surface materials**

Most of the county has bedrock near the land surface that is prone to karst feature development and is a unique, very high-sensitivity area (DNR, 2016b). Elsewhere, the estimated sensitivity predominantly ranges from high to moderate in the sandy unconsolidated deposits in valley bottoms and along the Mississippi River. The surficial sand aquifer is used by approximately 6% of county wells with known construction information.

Samples were collected from 5 wells in unconfined surficial (water-table) aquifers and 2 wells in confined buried sand aquifers; each was analyzed for tritium. The water-table wells had a mixed tritium age, and the buried sand aquifers resulted in 1 mixed and 1 vintage. The vintage sample is likely Mt. Simon water that upwells into the water-table system along the edges of the South Fork Root River. Of the 7 samples analyzed for nitrate, 3 were elevated, each in the water-table aquifer. Of the 7 samples analyzed for chloride, 4 were elevated from anthropogenic sources: 3 from the water-table aquifer and the other from a buried sand aquifer.

## Bedrock aquifer model

### Method

The pollution sensitivity ratings for bedrock aquifers are based on estimated vertical travel times defined by the Geologic Sensitivity Workgroup (1991). Travel time varies from hours to thousands of years. Areas with very high or high ratings have relatively short travel times of less than a few years; areas rated low or very low have estimated travel times of decades or longer (Figure 22).

The ratings are based on estimated vertical travel times inferred from tritium analysis, carbon-14 age dating, the presence or absence of anthropogenic indicators, dye trace investigations (DNR, 2020c), the presence or absence of sinkholes and stream sinks, and the findings from many previous investigations (Tipping, 1994; Tipping and others, 2006; Runkel and others, 2003, 2006, 2014a, 2014b, 2018; Kuehner and others, 2025).

Sensitivity ratings were assigned to delineate areas of the aquifers using GIS analysis of the data listed above.

### Groundwater systems

Groundwater collected from aquifers located stratigraphically above the St. Lawrence aquitard often shows anthropogenic influences: elevated nitrate and chloride, or recent and mixed tritium ages (residence times of less than 70 years). Groundwater from these aquifers also frequently has measurable dissolved oxygen. Oxygenated groundwater likely reflects aeration within conduit networks that allow for rapid vertical recharge from the land surface to deeper aquifers.

Wells and springs located within or near incised valleys generally have elevated nitrate, chloride, tritium, and detectable dissolved oxygen. In valleys, the St. Lawrence aquitard is typically thinner, compromised by fractures, or absent. In shallow bedrock conditions of valleys, the St. Lawrence transitions from an aquitard to a pseudokarst aquifer (Figure 23). This finding is based on the numerous locations documented in southeastern Minnesota where streams sink into the St. Lawrence aquitard. At several of these locations, water has been documented to travel rapidly to downgradient springs and wells (Green and others, 2008, 2012; Barry and others, 2015, 2018).

Springs are highly susceptible to human impact and contamination (Barry and others, 2018; Goedjen and others, 2024; Kuehner and others, 2025). Of the 35 spring samples collected, 26 were analyzed for tritium with the following results: 3 recent and 23 mixed. Of the 33 spring samples analyzed for nitrate, 29 were elevated. Of the 32 spring samples analyzed for chloride, 18 were elevated from anthropogenic sources.

Wells located away from incised valleys in southeastern Minnesota and in aquifers below the St. Lawrence typically have low nitrate, low anthropogenic chloride, nondetectable tritium, and no detectable dissolved oxygen (Barry and others, 2018; Barry, 2021).

Pollution sensitivity ratings were compared with the tritium age of groundwater and the presence or absence of other anthropogenic chemical indicators (nitrate and chloride). Higher sensitivity is associated with the following:

- Tritium age is recent or mixed.
- Nitrate is elevated and anthropogenic if concentrations are greater than or equal to 1 ppm.
- Chloride is elevated if concentrations are greater than or equal to 5 ppm. It is anthropogenic if Cl/Br ratios are greater than 300.

The tritium dataset is a combination of sampling efforts by the DNR and MDH for projects since 1992, with most samples collected in 2015 and 2016. Groundwater chemistry was qualitatively compared to the results of the modeled pollution sensitivity. Tritium detections from aquifers in areas mapped as very low sensitivity should rarely occur, assuming that flow of groundwater to the aquifer is vertical and not altered by nearby pumping or compromised well integrity.

The following section describes and illustrates the results of the bedrock aquifers in stratigraphic order (Figure 3). It includes the extent, depth, thickness, use, mapped karst features, pollution sensitivity, residence time, and chemistry.

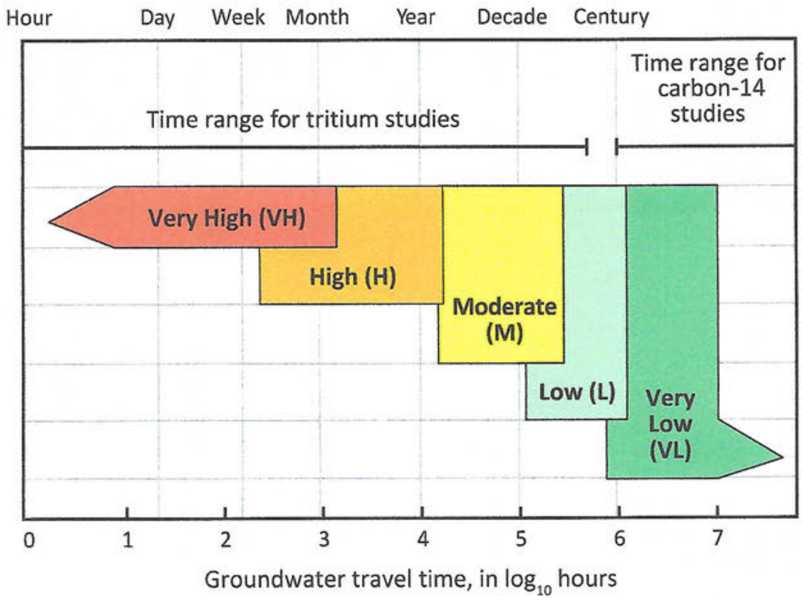



**Figure 22. Pollution sensitivity ratings for bedrock aquifers**

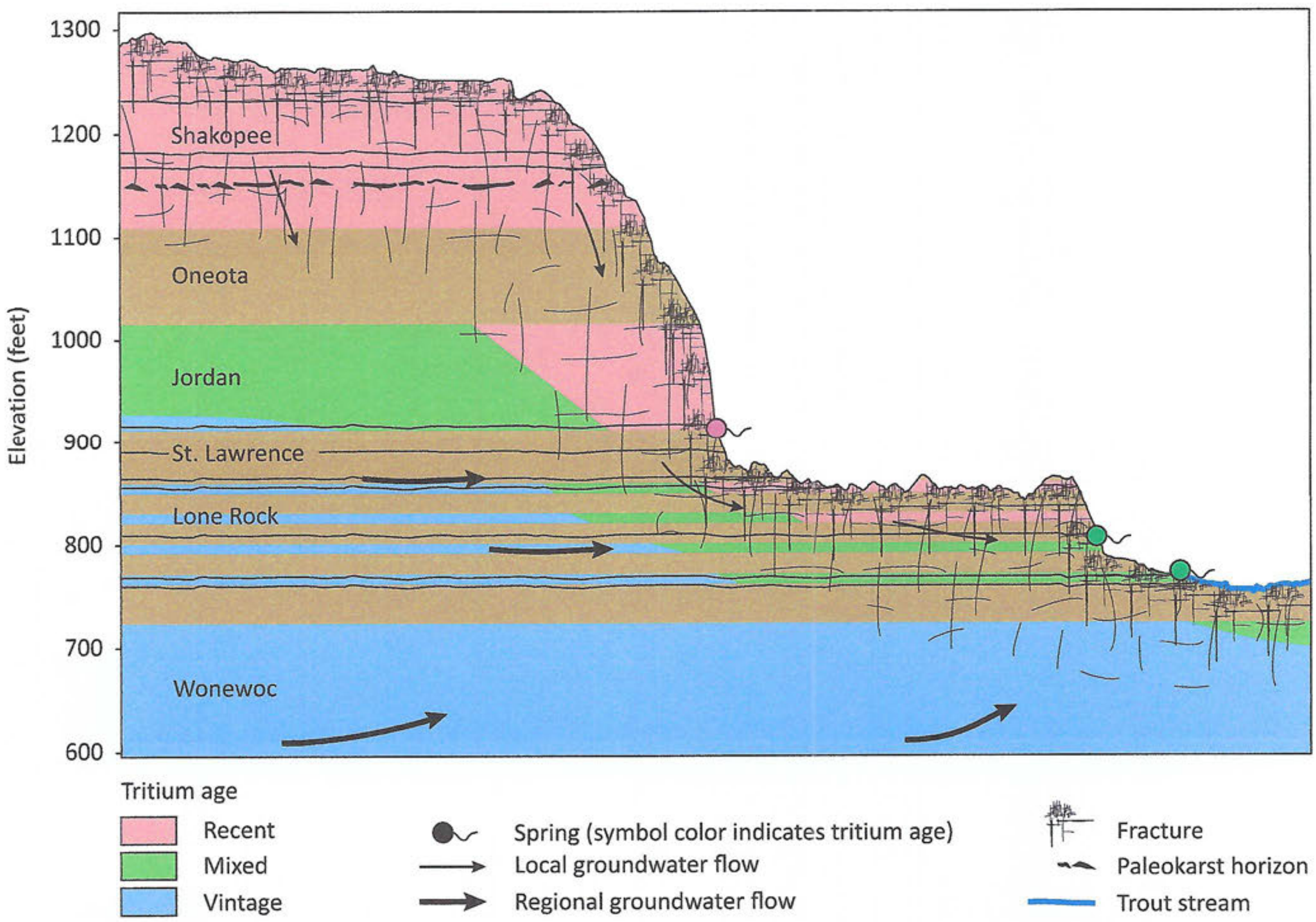



**Figure 23. Generalized hydrogeologic cross section illustrating the groundwater system and springs**

Springs in valleys are a mixture of younger local impacted water and older regional groundwater; springs that emanate above the St. Lawrence aquitard are especially susceptible to contamination. Tritium-age color is based on chemical results from spring and well samples collected from aquifers ranging from the Prairie du Chien to the Wonewoc. Aquitard units are represented with brown hues.

## Results

### *Cummingsville through St. Peter aquifers (Figure 24)*

- *Extent*: Present in the southwest and includes the intervening Decorah–Platteville–Glenwood aquitard units.
- *Depth*: 0 to 270 feet.
- *Thickness*: The Cummingsville ranges from 0 to 75 feet; the St. Peter ranges from 0 to 90 feet.
- *Use*: No county wells with known construction information. Because these aquifers are near the land surface, they are sensitive to pollution and are generally not used for potable water supply.
- *Mapped karst features/springs*: 41 sinkholes, 2 stream sinks, and 16 springs/seeps. Springs and seeps most commonly occur near the Decorah.
- *Pollution sensitivity*: Very high, due to proximity to land surface, mapped karst features, and the presence of anthropogenic influences in groundwater chemistry.
- *Residence time*: No residence time samples collected.
- *Anthropogenic chemistry*: A spring in Spring Grove had elevated nitrate and chloride.

### *Prairie du Chien aquifer (Figure 25)*

- *Extent*: Present over most of the county as the first bedrock unit beneath the land surface.
- *Depth*: 0 to 550 feet. Its greatest depth occurs in the southwestern area of the county, where it is deeply buried under overlying bedrock.
- *Thickness*: 0 to 320 feet.
- *Use*: Less than 1% of county wells with known construction information. The aquifer is made up of two geologic formations with different hydrologic properties: the Shakopee and the Oneota. The Shakopee is more productive than the Oneota, which has properties of an aquitard on a regional scale. The Prairie du Chien aquifer is saturated over the southwestern and central portions of the county. In the narrow ridges of the northern and eastern portions, it is frequently dewatered.
- *Mapped karst features/springs*: 245 sinkholes, no stream sinks, and 8 springs. Sinkholes most frequently occur near the Shakopee–Oneota geologic contact; springs emanate from the Oneota.
- *Pollution sensitivity*: Very high due to its proximity to the land surface over much of the county, karst features, and the presence of anthropogenic influences on groundwater chemistry.
- *Residence time*: Samples were collected from 4 springs and 1 well from the Shakopee and Oneota combined; each was analyzed for tritium age and had a mixed tritium age. A recent investigation focused on nitrate and pesticide concentration trends in southeastern Minnesota determined average residence times for Prairie du Chien springs to be approximately two to three decades (Kuehner and others, 2025). Longer residence times corresponded to wells and springs emanating from the deepest stratigraphy.
- *Anthropogenic chemistry*: Of the 5 samples analyzed for nitrate, all were elevated. Of the 5 samples analyzed for chloride, all were elevated from anthropogenic sources.

### *Jordan aquifer (Figure 26)*

- *Extent*: Present over most of the county.
- *Depth*: 0 to 645 feet. The greatest depth occurs in the southwestern area of the county, where it is deeply buried under overlying bedrock.
- *Thickness*: 0 to 100 feet. The aquifer is fully saturated in the western portions of the county, generally where it is confined. However, in the narrow ridges of the northern and eastern portions, it may be substantially dewatered.
- *Use*: Less than 1% of county wells with known construction information.
- *Mapped karst features/springs*: No sinkholes, 2 stream sinks, and 6 springs. Stream sinks occur in valleys where overlying units have eroded away.
- *Pollution sensitivity*: Ranges from very high to moderate. Wells cased near the top of the Jordan can extract water that is geochemically different from wells cased near the bottom, possibly from internal aquitards within the lower Jordan.

  Very high sensitivity occurs where the Jordan aquifer has no overlying bedrock units. In this setting, surface water can disappear into stream sinks and travel rapidly to springs farther down the valley.

  High sensitivity occurs where the Oneota is the first bedrock unit or where there is the entire thickness of the Oneota, and the thickness of the Shakopee Formation is less than 30 feet.

  Moderate sensitivity occurs where there is complete thickness of the Oneota and greater than a 30-foot thickness of the Shakopee Formation. This condition generally occurs where the Jordan is confined, an area covering the southwestern portion of the county, extending northeast from Spring Grove past Caledonia. The area mapped as moderate exhibits a range of residence time and connectivity to overlying aquifers, with some well samples showing vintage tritium age and carbon-14 residence times that are several thousand years old, and others showing mixed tritium age and elevated nitrate and chloride.

- *Residence time*: Samples were collected from 3 springs and 15 wells. Of these 18 samples, 16 were analyzed for tritium age with the following results: 7 mixed and 9 vintage. Two samples had carbon-14 residence times of 2,000 and 2,500 years. A recent investigation focused on nitrate and pesticide concentration trends in southeastern Minnesota determined average residence times of Jordan aquifer springs to be approximately two to three decades (Kuehner and others, 2025). Longer residence times corresponded to springs emanating from the deepest stratigraphy. Residence time for wells was similar to springs, with the longer residence times from deeper wells.
- *Anthropogenic chemistry*: Of the 18 samples analyzed for nitrate, 10 were elevated. Of the 17 samples analyzed for chloride, 5 were elevated from anthropogenic sources and 1 was from an unknown source.

### *Lone Rock aquifer (Figure 27)*

- *Extent*: Present over most of the county.
- *Depth*: 0 to 860 feet. Its greatest depth occurs in the southwestern area of the county, where it is deeply buried under overlying bedrock.
- *Thickness*: 0 to 150 feet. The aquifer is confined in the south-central portion of the county.
- *Use*: Approximately 9% of wells with known construction information.
- *Mapped karst features/springs*: No sinkholes, 2 stream sinks, and 81 springs. Stream sinks occur in the eastern portion of the county.
- *Pollution sensitivity*: Ranges from very high near valley edges, where the St. Lawrence aquitard is thin or absent, to very low over most of the rest of the county.

  Very high sensitivity occurs where the Lone Rock has no overlying bedrock units.

  High sensitivity occurs where the St. Lawrence aquitard is the only bedrock unit above the Lone Rock.

  Very low sensitivity occurs where the Lone Rock is buried deeply and underlies the St. Lawrence aquitard.
- *Residence time*: Samples were collected from 24 springs and 22 wells. Of these 46 samples, 39 were analyzed for tritium age with the following results: 4 recent, 19 mixed, and 16 vintage. No spring samples had a vintage tritium age. Carbon-14 residence times of well samples range between 4,000 and 16,000 years. A recent investigation focused on nitrate and pesticide concentration trends in southeastern Minnesota determined the average residence time of St. Lawrence aquitard and Lone Rock aquifer springs to be approximately three to four decades (Kuehner and others, 2025).
- *Anthropogenic chemistry*: Of the 43 samples analyzed for nitrate, 21 were elevated, consisting of 18 springs and 3 wells. Of the 43 samples analyzed for chloride, 7 were elevated from anthropogenic sources, all of which were springs. Elevated samples occurred near valley edges, where the overlying St. Lawrence aquitard loses its protective characteristics.

### *Wonewoc aquifer (Figure 28)*

- *Extent*: Present over most of the county.
- *Depth*: 0 to 975 feet. The greatest depth occurs in the southwestern area of the county, where it is deeply buried under overlying bedrock.
- *Thickness*: 0 to 130 feet. The aquifer is confined in the south-central portion of the county.
- *Mapped karst features/springs*: No sinkholes or stream sinks and 22 springs.
- *Use*: Approximately 46% of wells with known construction information.
- *Pollution sensitivity*: Ranges from high to very low.

  High sensitivity occurs where the Wonewoc aquifer has no overlying bedrock units.

  Moderate sensitivity occurs where the Lone Rock aquifer is the only bedrock unit above the Wonewoc.

  Very low sensitivity occurs across most of the aquifer because of its position below the St. Lawrence aquitard and its distance from the land surface.
- *Residence time*: Samples were collected from 42 wells. Of the 42 total samples, 35 were analyzed for tritium age with the following results: 1 recent, 13 mixed, and 21 vintage. Carbon-14 residence times ranged between less than 100 and 5,000 years.
- *Anthropogenic chemistry*: Of the 40 samples analyzed for nitrate, 4 were elevated. Of the 40 samples analyzed for chloride, 2 were elevated from anthropogenic sources. Almost all samples with recent or mixed tritium or elevated nitrate or chloride occurred in valleys or near valley edges, where pollution sensitivity is elevated.

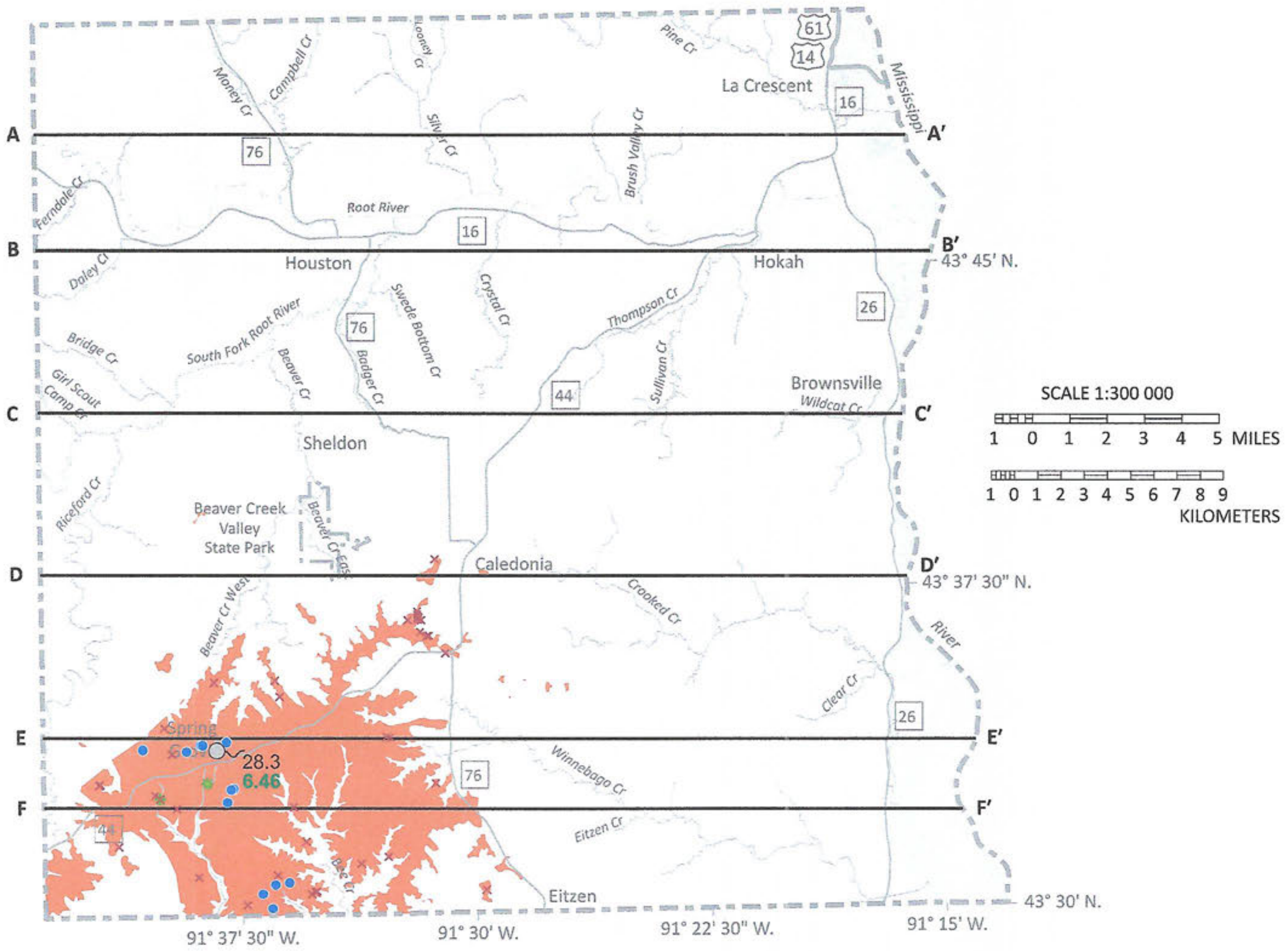
## *Mt. Simon aquifer (Figure 29)*

- *Extent*: Present throughout the entire county.
- *Depth*: Ranges from approximately 100 feet along the Mississippi River to 1,450 feet in the west. The greatest depth occurs in the southwest, where it is deeply buried under overlying bedrock.
- *Thickness*: 300 to 350 feet. It is fully saturated and confined everywhere except in valleys, where the overlying Eau Claire aquitard is thin or absent.
- *Use*: Approximately 2% of wells with known construction information.
- *Mapped karst features/springs*: No sinkholes, stream sinks, or springs are mapped; however, along the Mississippi River, the aquifer provides continuous discharge that serves as baseflow, and artesian pressure can create flowing well conditions.
- *Pollution sensitivity*: Ranges from moderate in valleys and along the Mississippi River, where the overlying Eau Claire aquitard is absent, to very low over the majority of the rest of the county.
- *Residence time*: All 11 samples were from wells; 7 were analyzed for tritium age with the following results: 1 mixed and 6 vintage. Carbon-14 residence time from 5 well samples ranged between 12,000 and 30,000 years.
- *Anthropogenic chemistry*: Of the 11 samples analyzed for nitrate, none were elevated. Of the 11 samples analyzed for chloride, 5 were naturally elevated by ancient brine. Elevated natural chloride in the Mt. Simon is common in nearby Winona County and elsewhere in Minnesota.

## *Multiple-aquifer wells (Figure 30)*

Multiple-aquifer wells intersect more than one aquifer. Since 2008, the Minnesota Well Code prevents new wells from interconnecting aquifers separated by a confining layer, because they can become conduits for contamination (Minnesota Administrative Rules, 4725.2020, Subpart 1).

- *Residence time*: Of the 17 samples collected, 12 were analyzed for tritium age with the following results: 2 recent, 3 mixed, and 7 vintage. One Eau Claire–Mt. Simon aquifer well had an estimated carbon-14 residence time of 11,000 years.
- *Anthropogenic chemistry*: Of the 13 samples analyzed for nitrate, 5 were elevated; 4 of these occurred above the St. Lawrence aquitard, and 1 occurred in a combined Tunnel City–Wonewoc well in a valley, where the overlying St. Lawrence aquitard is eroded away. Of the 13 samples analyzed for chloride, 5 were elevated from anthropogenic sources; 3 were naturally elevated by ancient brine.




**Pollution sensitivity rating**

Estimated vertical travel time.

Very high: hours to months

**Water sample and aquifer symbols**

Symbol color indicates tritium age of water sample.

Spring

**Karst features**

- Spring
- Sinkhole
- Stream sink

**Tritium age**

Symbol color indicates tritium age of water sample.

Not sampled for tritium

**Symbols and labels**

28.3 Chloride: if shown, concentration is ≥5 ppm. (* naturally elevated, ⁺ source unknown)

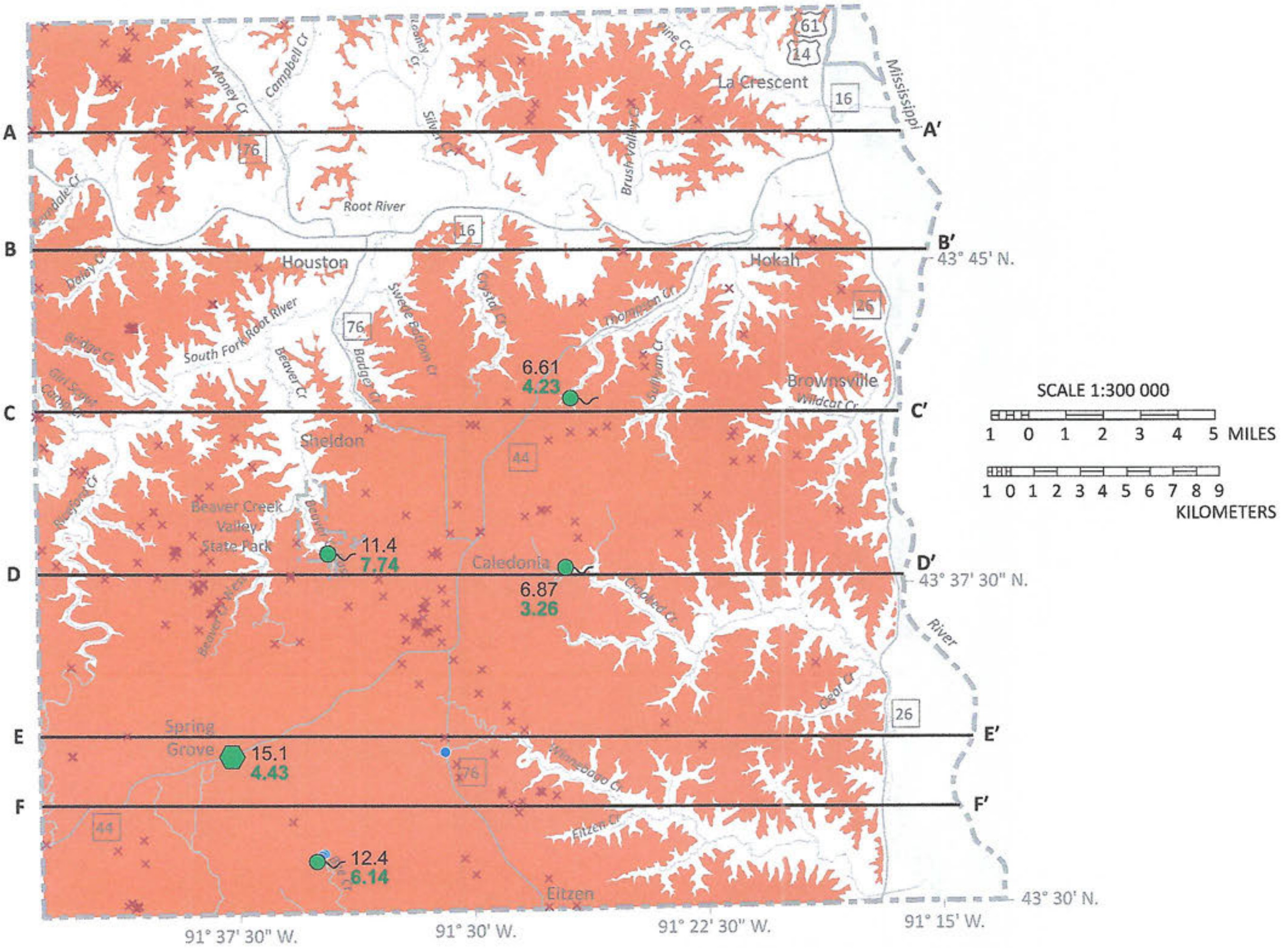
6.46 Nitrate: if shown, concentration is ≥1 ppm.

B —— B' Line of cross section (Part B)

Body of water

**Figure 24. Pollution sensitivity of the Cummingsville through St. Peter aquifers**

The sensitivity of each aquifer is very high due to proximity to the land surface, mapped karst features, and the presence of anthropogenic influences on groundwater chemistry.




**Pollution sensitivity rating**

Estimated vertical travel time.

Very high: hours to months

**Water sample and aquifer symbols**

Symbol color indicates tritium age of water sample.

Well

Spring

**Karst features**

Spring

Sinkhole

**Tritium age**

Symbol color indicates tritium age of water sample.

Mixed

**Symbols and labels**

11.4 Chloride: if shown, concentration is ≥5 ppm. (* naturally elevated, + source unknown)

4.23 Nitrate: if shown, concentration is ≥1 ppm.

B —— B′ Line of cross section (Part B)

Body of water

**Figure 25. Pollution sensitivity of the Prairie du Chien aquifer**

Sensitivity is very high due to proximity to the land surface over much of the county, mapped karst features, and the presence of anthropogenic influences on groundwater chemistry.

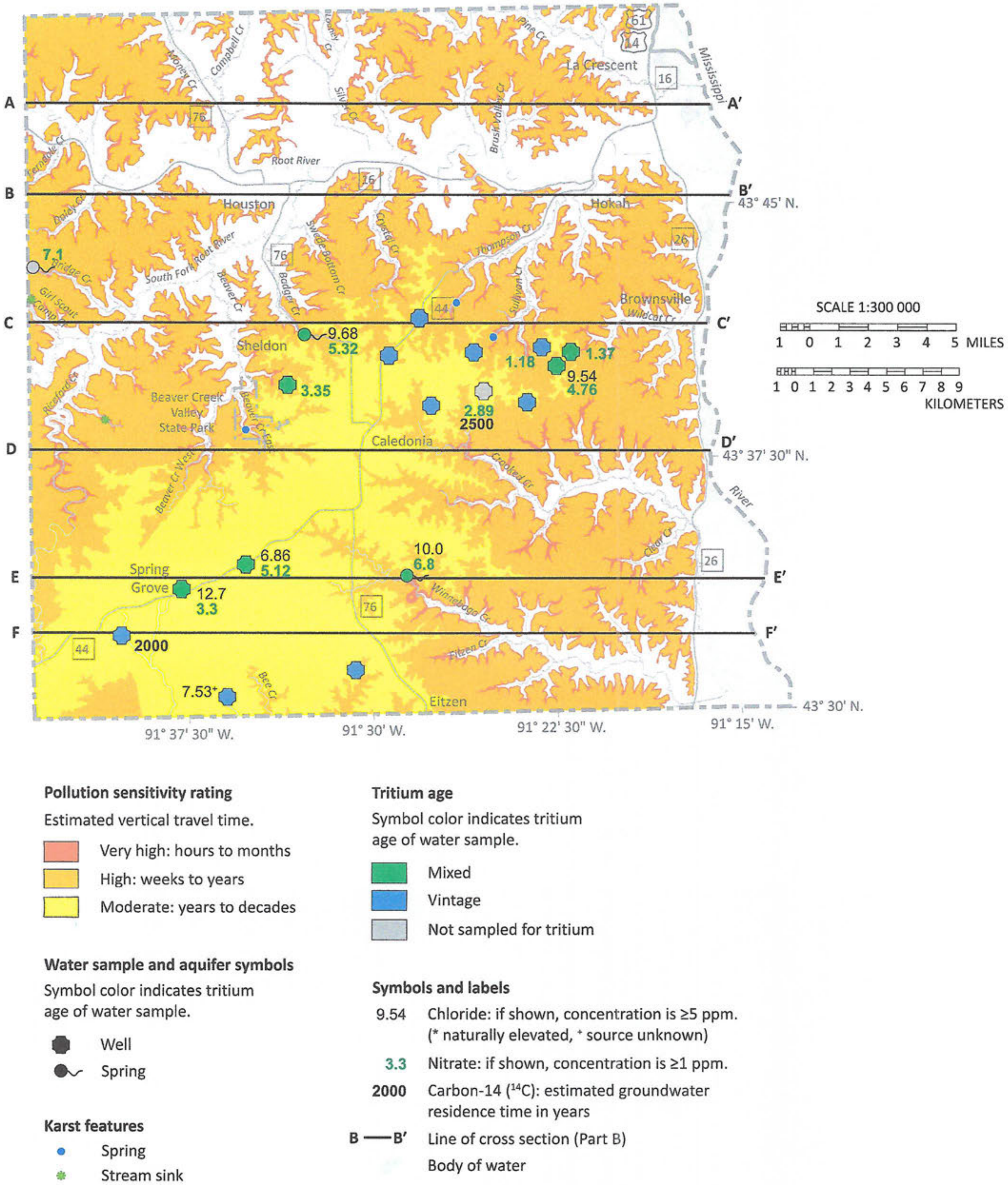
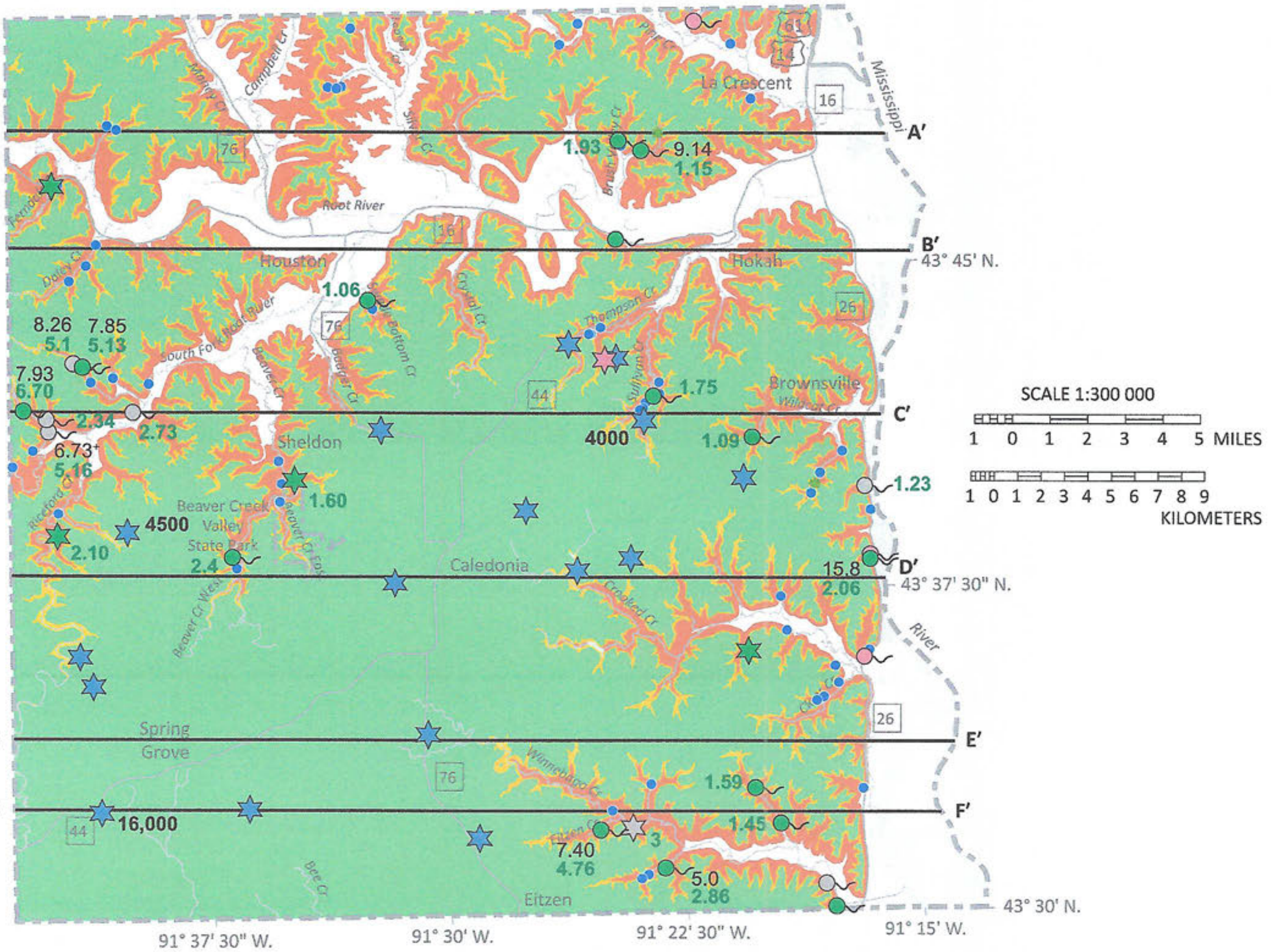



**Figure 26. Pollution sensitivity of the Jordan aquifer**

Moderate sensitivity occurs where there is the entire thickness of the overlying Oneota Dolomite and at least 30 feet of the Shakopee Formation. High sensitivity is found in areas where the overlying Prairie du Chien is thinner than the criteria set for moderate sensitivity. Very high sensitivity occurs in valleys where the Jordan is the first unit below the ground surface. In this setting, surface water can disappear into stream sinks and travel rapidly to springs farther down the valley.




**Pollution sensitivity rating**

Estimated vertical travel time.

- Very high: hours to months
- High: weeks to years
- Very low: a century or more

**Water sample and aquifer symbols**

Symbol color indicates tritium age of water sample.

- Well
- Spring

**Karst features**

- Spring
- Stream sink

**Tritium age**

Symbol color indicates tritium age of water sample.

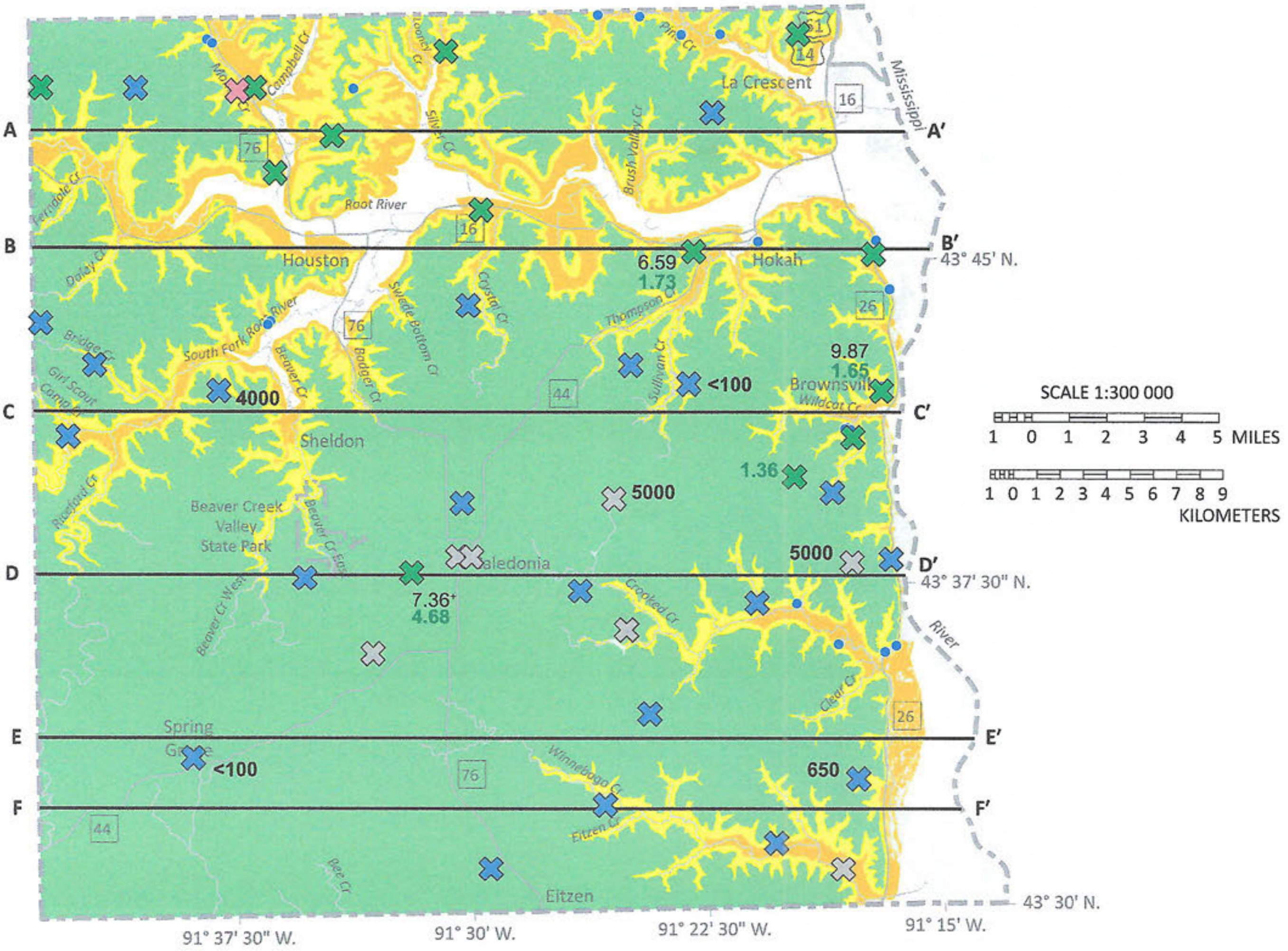
- Recent
- Mixed
- Vintage
- Not sampled for tritium

**Symbols and labels**

- 8.26 Chloride: if shown, concentration is ≥5 ppm. (* naturally elevated, + source unknown)
- 5.13 Nitrate: if shown, concentration is ≥1 ppm.
- 4500 Carbon-14 ($^{14}C$): estimated groundwater residence time in years
- B —— B' Line of cross section (Part B)
- Body of water

**Figure 27. Pollution sensitivity of the Lone Rock aquifer**

Sensitivity is very low over much of the county but increases to high and very high near valley edges where the St. Lawrence aquitard is thin or absent. High sensitivity is delineated where the St. Lawrence aquitard is the only bedrock unit above the Lone Rock. Very high sensitivity is delineated where there are no overlying bedrock units.




**Pollution sensitivity rating**

Estimated vertical travel time.

- High: weeks to years
- Moderate: years to decades
- Very low: a century or more

**Water sample and aquifer symbols**

Symbol color indicates tritium age of water sample.

- Well

**Karst features**

- Spring

**Tritium age**

Symbol color indicates tritium age of water sample.

- Recent
- Mixed
- Vintage
- Not sampled for tritium

**Symbols and labels**

9.87 Chloride: if shown, concentration is ≥5 ppm. (* naturally elevated, + source unknown)

1.73 Nitrate: if shown, concentration is ≥1 ppm.

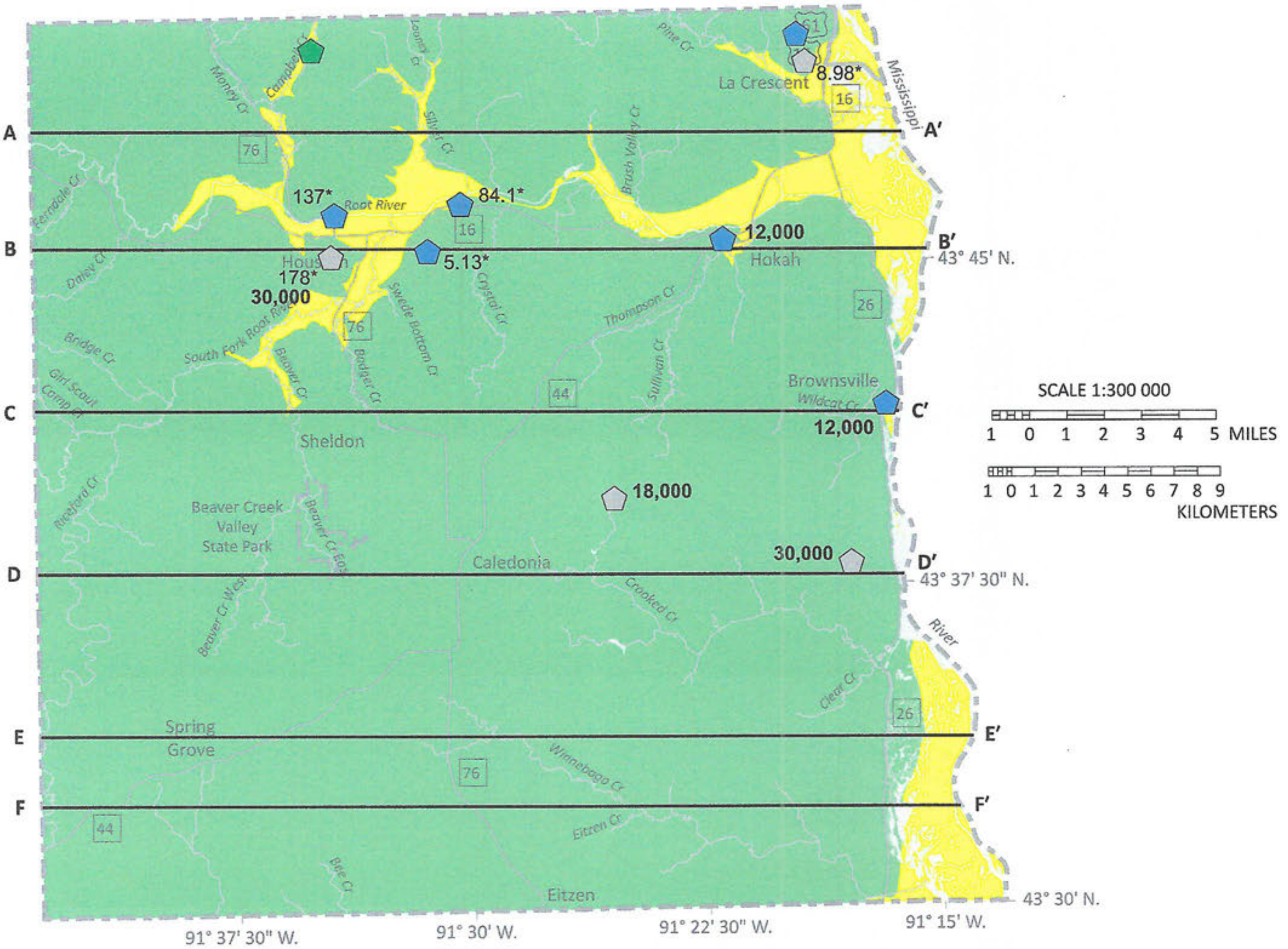
5000 Carbon-14 ($^{14}C$): estimated groundwater residence time in years

B —B' Line of cross section (Part B)

Body of water

**Figure 28. Pollution sensitivity of the Wonewoc aquifer**

Sensitivity is very low for most of the aquifer because of its position below the St. Lawrence aquitard and its distance from the land surface. In valleys, the sensitivity increases to moderate, where the Lone Rock aquifer is the only bedrock unit above the Wonewoc. Sensitivity increases to high in valleys where the Wonewoc is the first bedrock unit below the land surface.




**Pollution sensitivity rating**

Estimated vertical travel time.

- Moderate: years to decades
- Very low: a century or more

**Water sample and aquifer symbols**

Symbol color indicates tritium age of water sample.

- Well

**Tritium age**

Symbol color indicates tritium age of water sample.

- Mixed
- Vintage
- Not sampled for tritium

**Symbols and labels**

| | |
|---|---|
| 137* | Chloride: if shown, concentration is ≥5 ppm. (* naturally elevated, + source unknown) |
| 18,000 | Carbon-14 ($^{14}C$): estimated groundwater residence time in years |
| B —— B′ | Line of cross section (Part B) |
| | Body of water |

**Figure 29. Pollution sensitivity of the Mt. Simon aquifer**

Sensitivity is very low over the majority of the county and moderate in valleys and along the Mississippi River, where the overlying Eau Claire aquitard is absent.

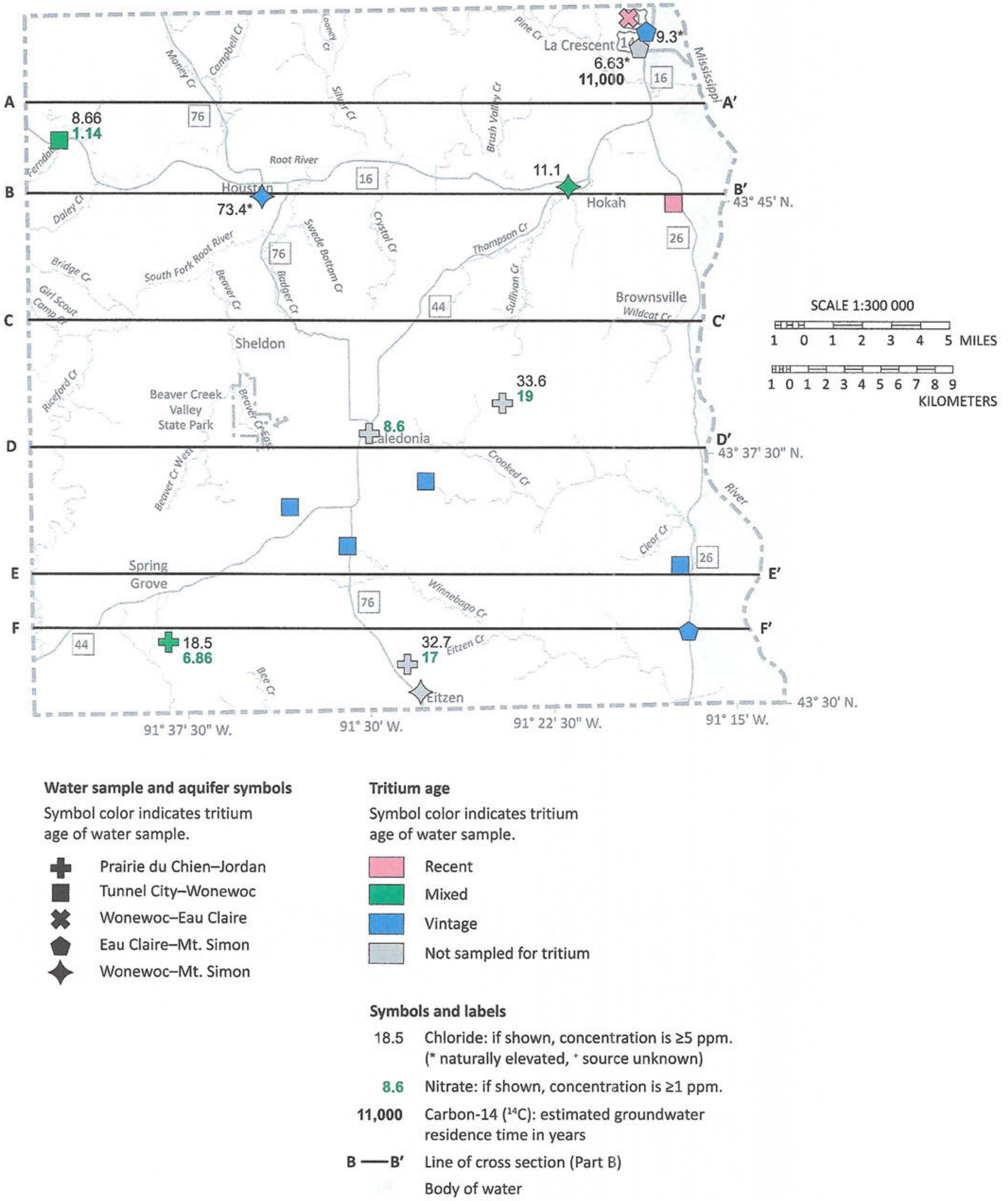



**Figure 30. Multiple-aquifer wells**

Multiple-aquifer wells intersect more than one aquifer. The Minnesota Well Code no longer allows new wells from interconnecting aquifers separated by confining layers because they can become conduits for contamination.

# Hydrogeologic cross sections (Plate 6)

The hydrogeologic cross sections shown on Plate 6 illustrate the horizontal and vertical extent of aquifers and aquitards, general groundwater flow direction, groundwater residence time, and groundwater chemistry.

The cross sections were constructed in GIS using a combination of well data from CWI and sections of Part A: Bedrock Geology (Plate 2), Surficial Geology (Plate 3), and Bedrock Topography and Depth to Bedrock (Plate 4). Most wells projected onto the trace of the cross sections are from distances of less than 0.5 kilometers; the maximum projected distance is 3.2 kilometers.

Aquifers shown on cross sections are shaded with one of three colors representing estimated groundwater residence time. Residence time was assigned based on available chemistry data (tritium age, chloride, and nitrate). Where chemistry data were not available, residence time interpretations were assigned using tritium-age results from other cross sections, pollution sensitivity of the aquifers, and the relative permeability of aquitards.

Aquifers and aquitards within 50 feet of the bedrock surface are delineated with an enhanced-permeability zone, where interconnected fractures can increase the ability of aquifers to transmit water but can also degrade the ability of aquitards to protect underlying aquifers.

### *Northern cross sections: A–A′ and B–B′*

The landscape is deeply dissected by numerous tributary valleys that flow to the Root River. The first bedrock units are the karstic Shakopee (Ops) and Oneota (Opo) formations of the Prairie du Chien Group. Streams have cut through the underlying Jordan aquifer (Ꞓj) and St. Lawrence aquitard (Ꞓs) into the Lone Rock (Ꞓtc) and Wonewoc (Ꞓw) aquifers. Mixed tritium-age waters and elevated chloride and nitrate were found in the Wonewoc aquifer. The Mt. Simon (Ꞓm) aquifer is protected by the Eau Claire (Ꞓe) aquitard, indicated by vintage tritium-age waters and carbon-14 residence times ranging from 12,000 to 30,000 years on cross section B–B′. Local groundwater movement is downward and toward rivers and creeks. Regional groundwater movement is east, where groundwater discharges to the Mississippi River.

### *Central cross sections: C–C′ and D–D′*

The landscape is a relatively flat plateau, with fewer deeply dissected valleys in the central portions. The first bedrock units are the karstic Shakopee (Ops) and Oneota (Opo) formations of the Prairie du Chien Group, where sinkholes are common in the western and central portions. Within valleys, the St. Lawrence (Ꞓs) aquitard's protective characteristics are diminished, and springs show mixed tritium ages and elevated chloride and nitrate. In the western and central portions of cross sections C–C′ and D–D′, where not dissected, the St. Lawrence is a competent aquitard as indicated by vintage tritium age and carbon-14 residence times of 4,000 years in the Wonewoc aquifer (Ꞓw) in the west to 30,000 years in the Mt. Simon (Ꞓm) aquifer in the east. Local groundwater movement is downward and toward rivers and creeks. Regional groundwater movement is east, where groundwater discharge occurs to the Mississippi River.

### *Southern cross sections: E–E′ and F–F′*

The western portions of these cross sections highlight the Upper Carbonate Plateau, an area roughly bound between County Highway 8 and State Highway 76. The first bedrock units are the karstic Cummingsville (Oc) aquifer and the Decorah–Platteville–Glenwood (Od and Opg) aquitards. The shallowly buried aquitards are compromised, evident from the samples on cross section E–E′ in the underlying Prairie du Chien (Opd and Opo) and Jordan (Ꞓj) aquifers, having mixed tritium ages and elevated chloride and nitrate. A carbon-14 residence time of less than 100 years in the Wonewoc aquifer (Ꞓw) on cross section E–E′ is inconsistent with the depth and number of overlying aquitards and may suggest leakage into the well or a pathway along the nearby fault to the west of the well. The Jordan (Ꞓj) aquifer is not impacted on cross section F–F′ and has a carbon-14 residence time of 2,000 years. Groundwater residence times vary greatly above and below the St. Lawrence (Ꞓs) aquitard on cross section F–F′, with a carbon-14 residence time of 2,000 years near the top of the aquitard and 16,000 years below it. Local groundwater movement is downward and toward rivers and creeks. Regional groundwater movement is east, where groundwater discharge occurs to the Mississippi River.

## Groundwater flow direction and recharge

Groundwater moves from higher to lower potential energy. The direction of groundwater movement is interpreted from the equipotential contours constructed from measured water levels in wells. Equipotential contours show areas where the pressure head of groundwater is the same. Groundwater flow is perpendicular to these lines in the direction of decreasing pressure. Equipotential contours can be used to identify groundwater flow direction, recharge zones, and discharge zones.

Regional groundwater flow direction of aquifers above the Eau Claire aquitard is generally to the east, but also locally toward rivers and creeks. Groundwater flow direction of the Mt. Simon aquifer is primarily to the east, where groundwater discharges to the Mississippi River. The Mississippi River is the major groundwater discharge feature for the surficial sand and bedrock aquifers. In addition, groundwater discharge provides cool isothermal baseflow to numerous springs and trout streams.

Precipitation is the source of recharge to unconsolidated deposits, which then provide recharge to underlying aquifers. Recharge to aquifers above the Jordan is heavily influenced by karst, which has high infiltration rates. However, recharge may be limited where less permeable loess overlies bedrock. Estimated recharge to Houston County's surficial aquifers ranges from 3.6 to 12.5 inches per year (Smith and Westenbroek, 2015). Estimated recharge to confined bedrock aquifers is generally less than 1% of average precipitation, or roughly 0.37 inches per year (Delin and Falteisek, 2007). Recharge rates can be influenced by high-volume pumping, which may steepen groundwater gradients locally, increase recharge, and affect groundwater quality (Tipping, 2012).

# Aquifer characteristics and groundwater use

## Aquifer specific capacity and transmissivity

Specific capacity and transmissivity describe how easily water moves through an aquifer. Larger values indicate more productive aquifers.

Specific capacity is the pumping rate per unit depth of drawdown. It is typically expressed in gallons per minute per foot (gpm/ft) and is determined from short-term pumping or well-development tests performed after a well is drilled.

To ensure that the specific-capacity values reflect actual pumping (not air lifting), the pumping-test data were obtained from CWI for wells with the following criteria:

- The casing diameter was at least 6 inches.
- The well was pumped for at least 4 hours.
- The pumping-water level was inside the well casing, at least 2 feet above the well screen or open hole.

Specific-capacity values of 15 wells in Houston County met these conditions: 2 in the water-table aquifer and 13 in bedrock aquifers. The highest mean specific capacity of 21.5 gpm/ft was calculated for a water-table well (Table 2). The wide range between minimum and maximum specific capacity values for bedrock is likely due to maximum value wells intersecting fracture networks within the respective aquifers.

Transmissivity is an aquifer's capacity to transmit water. It provides a more accurate representation of aquifer properties than specific capacity because it is from longer-term and larger-scale aquifer tests. It is determined by multiplying the thickness of the aquifer by the hydraulic conductivity of the aquifer material (the rate groundwater flows through a unit cross section).

Transmissivity values are available for two bedrock aquifers. The Wonewoc aquifer ranged from 1,360 $ft^2$/day to 2,800 $ft^2$/day, and the Eau Claire–Mt. Simon aquifer ranged from 1,540 $ft^2$/day to 1,980 $ft^2$/day (DNR, 2025). Several consulting firms and state agencies have completed aquifer tests in Houston County, but the documentation is insufficient to include in this report.

**Table 2. Specific capacity values of select wells**

| Aquifer | Casing diam. (in.) | Mean (gpm/ft) | Min. (gpm/ft) | Max. (gpm/ft) | No. of wells |
|---|---|---|---|---|---|
| **Unconsolidated** | | | | | |
| Water table | 6 | 21.5 | 5.0 | 38.0 | 2 |
| **Bedrock** | | | | | |
| Jordan | 12 | 2.9 | - | - | 1 |
| Jordan–St. Lawrence | 16 | 9.9 | 9.4 | 10.2 | 3 |
| Wonewoc | 8–18 | 5.2 | 0.9 | 11.9 | 5 |
| Wonewoc–Eau Claire | 18 | 14.3 | - | - | 1 |
| Eau Claire–Mt. Simon | 12 | 14.1 | - | - | 1 |
| Mt. Simon | 12–18 | 6 | 1.1 | 10.3 | 2 |

Specific capacity data adapted from the CWI.
Dash (-) means no data

## Groundwater level monitoring

The DNR maintains a statewide groundwater level monitoring program for assessing groundwater resources, determining long-term trends, interpreting impacts of pumping and climate, planning for water conservation, evaluating water conflicts, and managing water resources (DNR, 2023c).

Well nests consist of closely spaced wells that are constructed at different depths in different aquifers. Long periods of record from multiple aquifers are useful for determining trends and provide insight into how aquifers respond to recharge events, climatic conditions, and pumping stresses.

Figure 31 shows the groundwater elevation hydrographs of three monitoring wells from a well nest located between Brownsville and Reno; the well nest location is shown on Figure 32. Groundwater elevation is compared to annual precipitation collected at the National Weather Service Reporting Station 211198 in Caledonia, Minnesota.

- Well 231848 is constructed to a depth of 322 feet into the Prairie du Chien and Jordan aquifers and shows groundwater elevation changes in response to increases and decreases in precipitation and snowmelt. Groundwater elevation does not react rapidly to individual precipitation events. The largest bulk groundwater elevation changes are in response to increases or decreases in the annual precipitation. The groundwater level over the period of record ranges approximately 40 feet between highs and lows.
- Well 231847 is constructed to a depth of 565 feet in the Wonewoc aquifer. Groundwater level response to precipitation is muted, with the groundwater level over the period of record ranging approximately 8 feet between highs and lows.
- Well 231846 is constructed to a depth of 855 feet in the Mt. Simon aquifer. Groundwater level response to precipitation is muted, with the groundwater level over the period of record ranging approximately 6 feet between highs and lows.

Groundwater elevations of these aquifers differ by over 200 feet, showing a large vertical hydraulic gradient downward from the combined Prairie du Chien and Jordan to the Wonewoc and Mt. Simon aquifers at this location. Groundwater elevation differences between the Wonewoc and Mt. Simon aquifers at this location show a hydraulic gradient upward from the Mt. Simon aquifer to the Wonewoc aquifer.

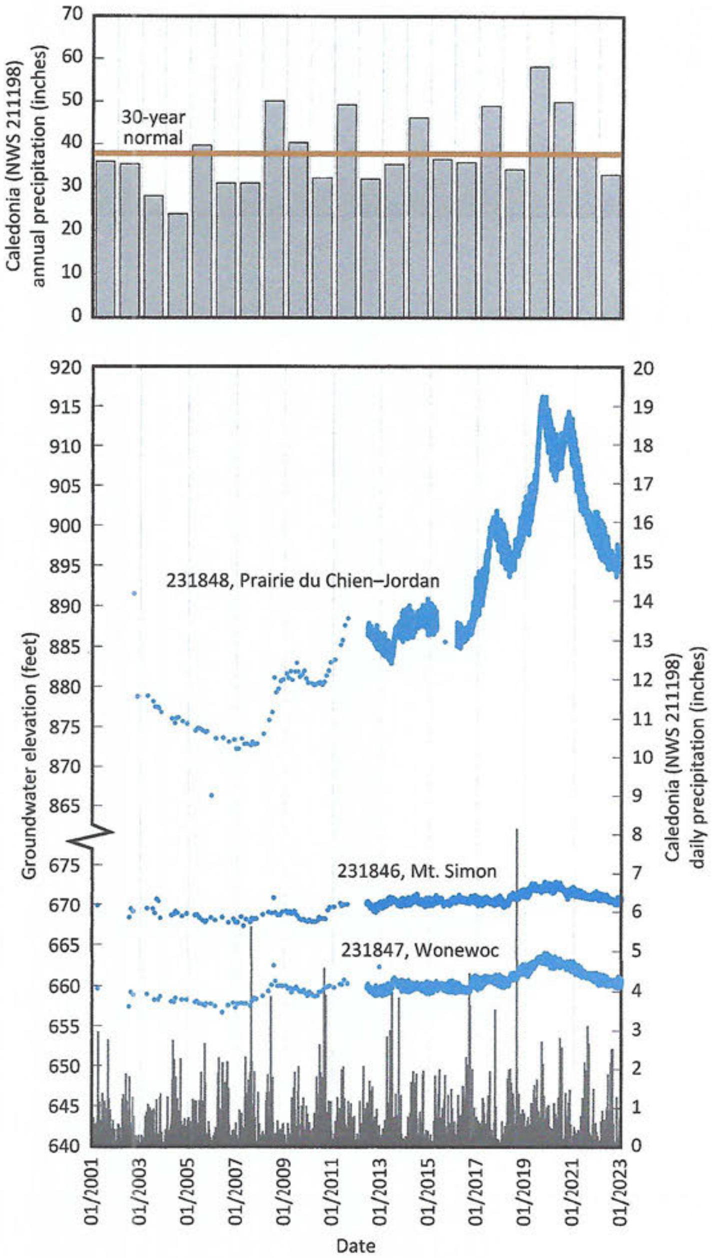



**Figure 31. Hydrographs of groundwater level monitoring wells near Brownsville, Minnesota**

Groundwater elevations of a combined Prairie du Chien–Jordan aquifer well, a Wonewoc aquifer well, and a Mt. Simon aquifer well are compared to annual precipitation data for the years 2001 to 2023. Climate data from DNR (2023a, 2023b). Well nest location is shown on Figure 32.

## Groundwater use

A water appropriation permit is required from the DNR for groundwater users withdrawing more than 10,000 gallons of water per day or 1 million gallons per year. This allows the DNR to assess which aquifers are being used and for what purpose. Permits require annual water-use reporting. This information is recorded using the Minnesota Permitting and Reporting System (MPARS), which helps the DNR track the volume, source aquifer, and type of water use.

Reported water use of high-volume users for 2021 is categorized in Table 3 and Figures 32 and 33 by type of water use and aquifer type (DNR, 2023d). The highest permitted groundwater use (67.4%) is for municipal and public water supply, which is primarily extracted from the Mt. Simon aquifer (or aquifer combinations that include the Mt. Simon). In general, high-volume use is centered around the cities of La Crescent, Spring Grove, Caledonia, and Houston. The second largest use (17.6%) is for pollution containment in Spring Grove, with this water coming from the St. Peter and Prairie du Chien aquifers. The third largest use (7.9%) is for livestock watering, which uses both unconsolidated and bedrock aquifers. These three water uses collectively made up approximately 93% of the permitted water used in 2021.

There are no reporting requirements for well owners that use less than 10,000 gallons per day or 1 million gallons per year, but the CWI maintains data for use type and aquifer type for these wells. Of the 2,222 wells with identified use codes, the majority are for domestic use (92%).

Annual water use for DNR permit holders for the years 1988 to 2021 is shown in Figure 34. Permitted water use varies annually due to annual precipitation, population growth, economic conditions, and other factors. Permitted annual water use increased in the early 1990s, climbing steadily to its peak in 2003. Since then, permitted annual water use has fluctuated. Municipal water supply had the largest use difference over the 5-year period from 2017 to 2021.

**Table 3. Reported 2021 water use from DNR groundwater permit holders**

| Aquifer | No. of wells | Municipal/public water supply | Pollution containment | Livestock watering | Golf course irrigation | Basin (lake) level maintenance | Sand and gravel washing | Total (mgy) | Total (%) |
|---|---|---|---|---|---|---|---|---|---|
| **Unconsolidated** | | | | | | | | | |
| Water table | 1 | -- | -- | 0.9 | -- | -- | -- | 0.9 | 0.2 |
| **Bedrock** | | | | | | | | | |
| St. Peter, St. Peter–Jordan, Prairie du Chien, Prairie du Chien–Jordan, Jordan | 11 | 59.2 | 86.8 | 0.1 | -- | -- | 0.1 | 146.1 | 29.6 |
| Lone Rock | 2 | -- | -- | 2.5 | 5.7 | -- | -- | 8.2 | 1.7 |
| Lone Rock–Wonewoc, Wonewoc, Wonewoc–Eau Claire | 12 | 86.6 | -- | 28.8 | -- | -- | -- | 115.4 | 23.4 |
| Wonewoc–Mt. Simon, Eau Claire–Mt. Simon | 6 | 118.5 | -- | -- | -- | -- | -- | 118.5 | 24 |
| Mt. Simon | 7 | 68.2 | -- | -- | 16.5 | 12.6 | -- | 97.3 | 19.7 |
| Unknown | 3 | -- | -- | 6.8 | -- | -- | -- | 6.8 | 1.4 |
| **Total (mgy)** | **N/A** | **332.5** | **86.8** | **39.1** | **22.2** | **12.6** | **0.1** | **493.3** | -- |
| **Total (%)** | **N/A** | **67.4** | **17.6** | **7.9** | **4.5** | **2.6** | **<0.1** | -- | **100** |
| **Highest annual use from 2017 to 2021 (mgy)** | **N/A** | **332.5** | **91.7** | **39.1** | **22.2** | **12.6** | **2.8** | -- | -- |

Data from MPARS; mgy, million gallons per year
Dash marks (--) indicate no use in those categories
N/A indicates not applicable
Percentages may not equal 100 due to rounding.

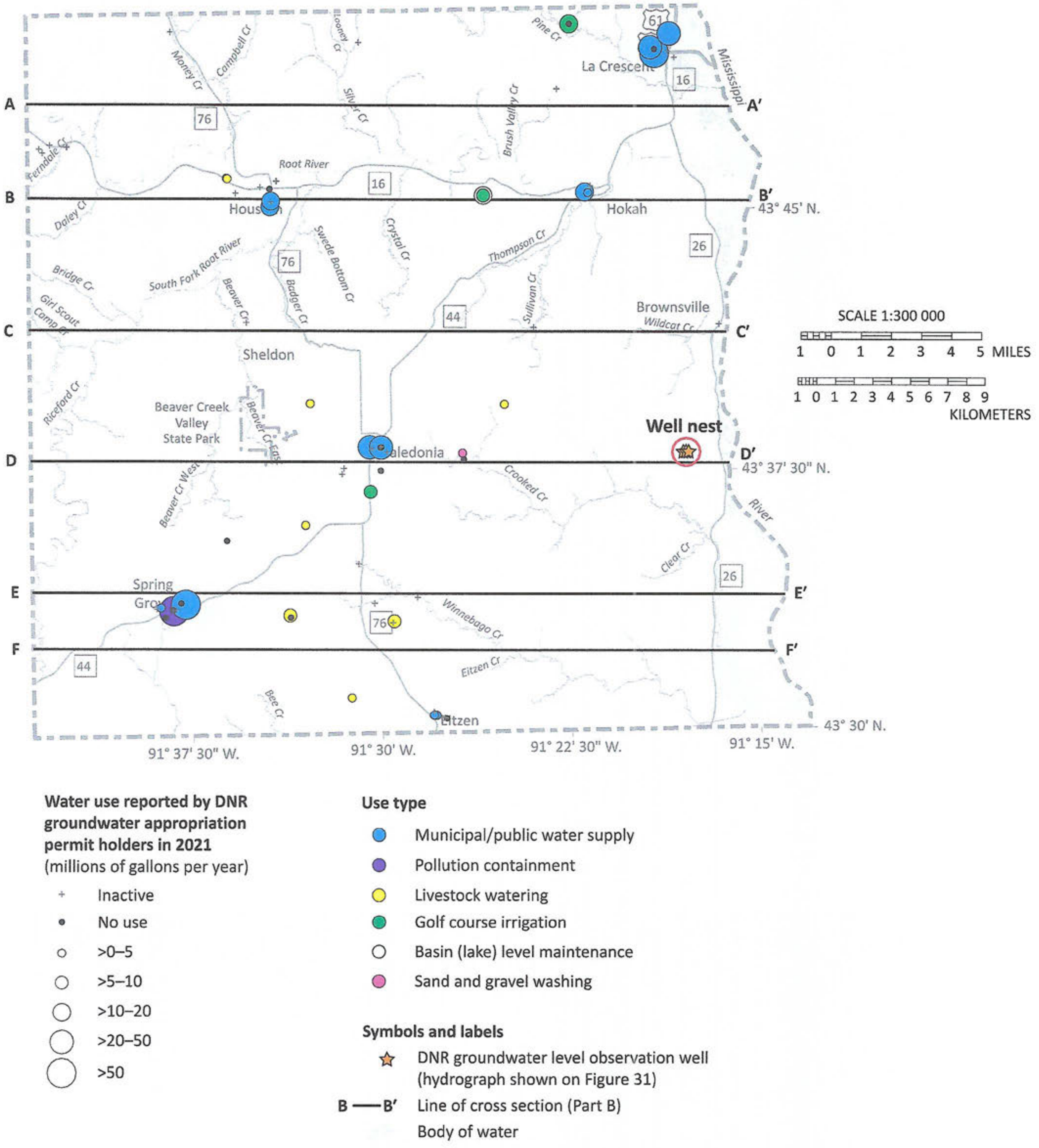
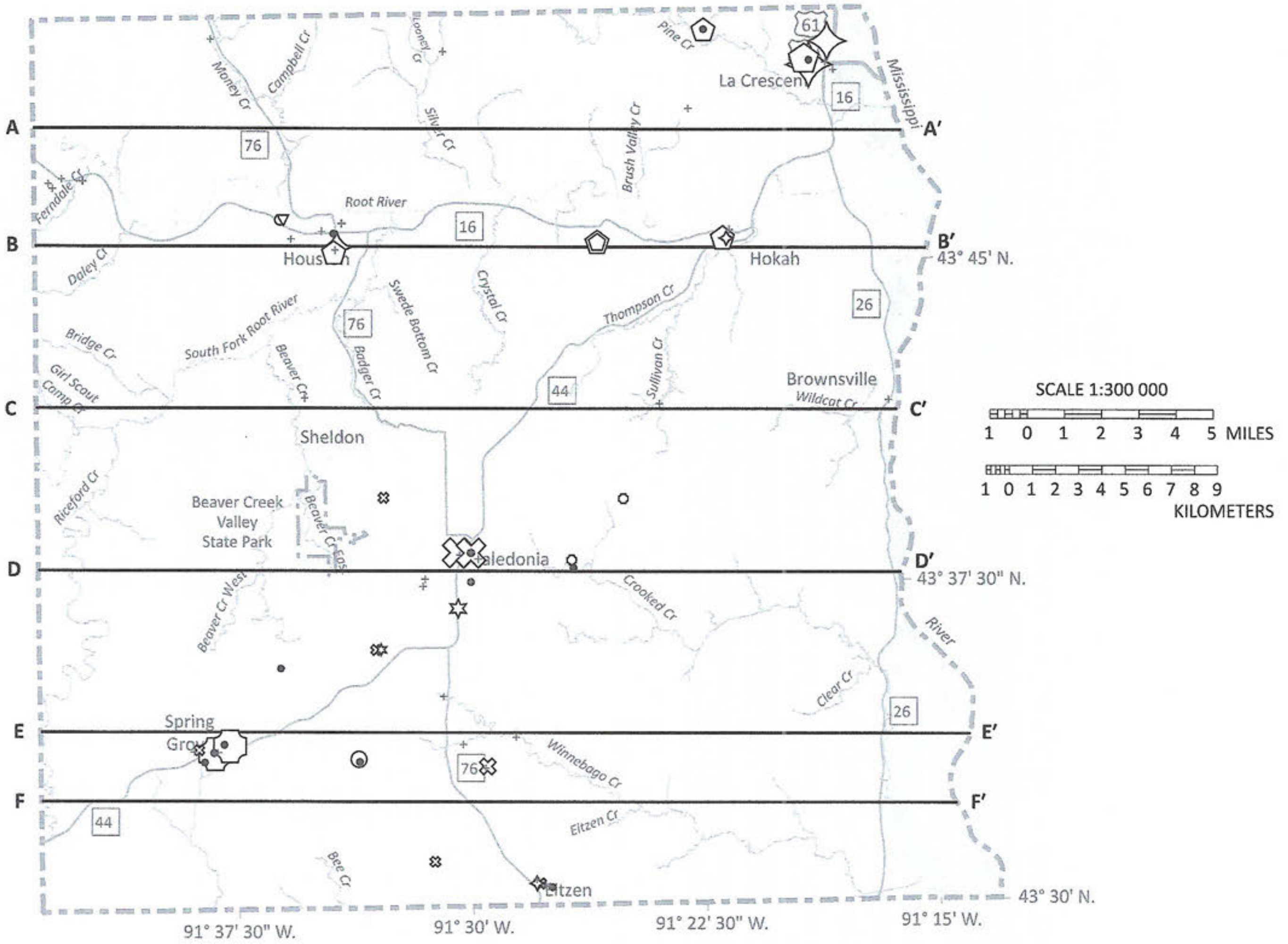



**Figure 32. Distribution of groundwater appropriation permits for 2021 by volume reported and use type**

Municipal and public water supply accounts for the largest permitted groundwater use.




**Water use reported by DNR groundwater appropriation permit holders in 2021**
(millions of gallons per year)

- Inactive
- No use
- >0–5
- >5–10
- >10–20
- >20–50
- >50

**General aquifer classification**

- Water table
- St. Peter, St. Peter–Jordan, Prairie du Chien, Prairie du Chien–Jordan, Jordan
- Lone Rock
- Lone Rock–Wonewoc, Wonewoc, Wonewoc–Eau Claire
- Wonewoc–Mt. Simon, Eau Claire–Mt. Simon
- Mt. Simon
- Unknown

**Symbols and labels**

B —— B' Line of cross section (Part B)

Body of water

**Figure 33. Distribution of groundwater appropriation permits for 2021 by volume reported and general aquifer classification**

The majority of the permitted water used in the county is from bedrock aquifers.

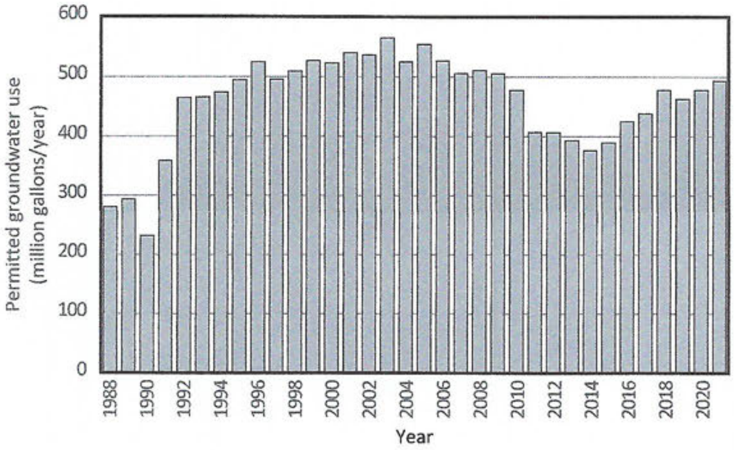



**Figure 34. DNR annual permitted groundwater use for Houston County (1988 to 2021)**

# Conclusions

Houston County's land use is dominated by a mix of agricultural croplands, forest, and small towns. Its underlying geology influences land usage, with agricultural cropland common on the Upper Carbonate Plateau, the Prairie du Chien Plateau, and in valley bottoms. Geology affects the county's water resources. Much of the county is a karst terrain formed by precipitation and groundwater dissolving underlying carbonate sedimentary rock. Karst provides rapid water movement between the land surface and underlying aquifers, increasing their pollution sensitivity. It is one of the wettest counties in the state, with an average annual precipitation of approximately 37 inches. Rapid recharge can occur to aquifers above the St. Lawrence aquitard or where aquitards are not present, such as areas within deeply incised valleys.

Pollution sensitivity ratings were developed for aquifers using a combination of tritium and carbon-14 data for residence time and the inorganic chemicals chloride and nitrate. Human-caused occurrences of chloride and nitrate are relatively widespread in the water-table aquifer, comprised of the Prairie du Chien and Jordan aquifers in upland settings and the sand and gravel aquifer in lowland valley settings. Chloride and nitrate are relatively widespread in shallow aquifers, especially in wells completed above the St. Lawrence aquitard. Springs, not commonly used as sources of water, have elevated levels of both chloride and nitrate. A portion of the water emanating from springs is anthropogenically impacted water that mixes with older water. Below the St. Lawrence aquitard, groundwater shows long residence times and less human-influenced contamination. Wells completed in aquifers below the St. Lawrence can provide groundwater unimpacted by human activities if properly installed according to the Minnesota Well Code.

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# Glossary

**air-lift pumping**—water is pumped from a well by releasing compressed air into a discharge pipe (air line) lowered into the well. It is commonly used for well development, not water production.

**anion**—a negatively charged ion in which the total number of electrons is greater than the total number of protons, resulting in a net negative electrical charge.

**anthropogenic**—relating to or resulting from the influence of humans on nature.

**aquifer**—an underground layer of water-bearing permeable rock or unconsolidated materials (sand and gravel) from which groundwater can be extracted using a water well.

**aquitard (or confining layers)**—a low-permeability geologic layer that slows groundwater movement between aquifers.

**arsenic (As)**—a chemical element that is sometimes dissolved in groundwater and is toxic to humans.

**bedrock**—the consolidated rock underlying unconsolidated surface materials, such as soil or glacial sediment.

**box plot**—a graphical representation of a dataset's distribution.

**buried aquifer**—a body of porous and permeable sediment or rock separated from the land surface by a low-permeability layer(s).

**carbon-14 ($^{14}C$)**—a radioactive isotope of carbon that has a half-life of 5,730 years. It is used to identify groundwater that entered the ground from less than 100 to greater than 40,000 years before the present.

**cation**—a positively charged ion in which the total number of electrons is less than the total number of protons, resulting in a net positive electrical charge.

**clast**—an individual constituent, grain, or fragment of a sediment or rock, produced by the mechanical or chemical disintegration of a larger rock mass.

**County Well Index (CWI)**—a database developed and maintained by the Minnesota Geological Survey and the Minnesota Department of Health containing basic information for wells drilled in Minnesota. It includes location, depth, static water level, construction, and geological information. The database and other features are available through the Minnesota Well Index online mapping application.

**denitrification**—is a microbially facilitated process where nitrate ($NO_3^-$) is ultimately reduced to nitrogen gas ($N_2$). Typically, denitrification occurs in anoxic environments, where the concentration of dissolved oxygen is depleted.

**dolostone, or dolomite rock**—a sedimentary carbonate rock that contains a high percentage of the mineral dolomite. Most dolostone formed as a magnesium replacement of limestone or lime mud prior to lithification. It is resistant to erosion and can either contain bedded layers or be unbedded. It is less soluble than limestone, but it can still develop solution features over time.

**formation**—a fundamental unit of lithostratigraphy. A formation consists of a number of rock strata with comparable lithology, facies, or other similar properties.

**fractionation**—a separation process in which a mixture (solid, liquid, solute, suspension, or isotope) is divided based on the difference of a specific property of the components. Stable isotopes are fractionated by mass.

**groundwater**—water that collects or flows beneath the surface of the earth, filling the porous spaces below the water table in soil, sediment, and rocks.

**half-life**—the time required for one-half of a given mass of a radioactive element to decay.

**hydraulic**—relating to water movement.

**hydraulic conductivity**—the rate at which groundwater flows through a unit cross section of an aquifer.

**hydrogeology**—the study of subsurface water, including its physical and chemical properties, geologic environment, role in geologic processes, natural movement, recovery, contamination, and use.

**incised valley**—a valley formed by flowing water cutting or eroding underlying geological strata.

**infiltration**—the movement of water from the land surface into the subsurface under unsaturated conditions.

**isotope**—variants of a particular chemical element. All isotopes of an element share the same number of protons but a different number of neutrons.

**karstification**—a process where precipitation chemically dissolves soluble rocks, such as limestone and dolostone, creating voids and pathways in the rock.

**meteoric**—relating to or derived from the earth's atmosphere.

**nitrate ($NO_3$, nitrate-nitrogen, nitrate-N)**—a common form of nitrogen (N), the water-soluble anion $NO_3^-$. Elevated nitrate in water samples is a useful indicator of groundwater pollution from human activities. Humans are subject to nitrate toxicity, with infants especially vulnerable to methemoglobinemia, also known as blue baby syndrome. Nitrogen is an important nutrient, a major component of fertilizers, and a significant component of animal and human waste.

**Paleozoic**—an era of geologic time from approximately 541 to 251 million years ago.

**plateau**—a landscape of relatively level topography that is elevated higher than the surrounding land and has a steep slope on its edge.

**pseudokarst (hydrology)**—groundwater moves through conduit-like voids that were developed through a process other than dissolution.

**potentiometric surface**—a surface representing the total head of groundwater in a confined aquifer, defined by the levels to which water will rise in tightly-cased wells.

**Quaternary**—geologic time period that began approximately 2.6 million years ago and continues to today. The Quaternary Period comprises the Pleistocene and Holocene epochs.

**radioactive**—a property of an element that spontaneously decays or changes to a different element through the emission of nuclear particles or gamma rays.

**recharge**—the process by which water enters the groundwater system.

**residence time indicator**—a chemical or isotope used to interpret groundwater residence time.

**saprolite**—a residuum created from extensive chemical weathering of bedrock into clay minerals.

**specific capacity**—the discharge of a well divided by the drawdown in the well.

**stable isotopes**—chemical isotopes that are not radioactive.

**static water level**—the level of water in a well that is not affected by pumping.

**stratigraphy**—a branch of geology that studies rock layers and layering (stratification). It is primarily used in the study of sedimentary and layered volcanic rocks.

**till**—unsorted glacial sediment deposited directly by ice. It is derived from the erosion and entrainment of rock and sediment.

**transmissivity**—an aquifer's capacity to transmit water, determined by multiplying its hydraulic conductivity by its thickness.

**tritium ($^3H$)**—a radioactive isotope of hydrogen that has a half-life of 12.32 years. The nucleus of tritium contains one proton and two neutrons. It is used to identify the relative age of groundwater.

**tritium unit (TU)**—one tritium unit represents the presence of one tritium atom for every $10^{18}$ hydrogen atoms.

**unconfined**—an aquifer that has direct contact with the atmosphere through an unsaturated layer.

**water table**—the surface between the unsaturated and saturated zone where the water pressure equals the atmospheric pressure.

**watershed**—the area of land that drains into a specific downstream location.

**well nest**—two or more wells in close proximity completed at different depths.

# Appendix A

## Groundwater field sample collection protocol

Groundwater samples were collected from an outside faucet or hydrant. The wells were purged before sampling to remove stagnant water from the well bore and plumbing system. Samples were collected after the following field parameters had stabilized: temperature, dissolved oxygen, specific conductivity, oxidation-reduction potential, and pH. Each was filtered and preserved according to the protocols listed below and submitted to laboratories for analysis.

Project samples collected before 2016 were analyzed by DNR staff; the University of Minnesota, Department of Earth and Environmental Sciences Laboratory (UMN); or the University of Waterloo Environmental Isotope Laboratory (Waterloo). Those collected in 2016 and 2017 were analyzed by DNR staff; MDA; MDH; UMN; or Waterloo.

The well owners received a copy of their results, including some background reference information regarding their meaning.

**Appendix Table A-1. Groundwater field sample collection and handling details for project samples collected prior to 2016**

| Parameter | Enriched tritium | $^{18}O$ and $^{2}H$ (Deuterium) | Cations | Anions | Trace constituents | Alkalinity | Carbon-14 ($^{14}C$) |
|---|---|---|---|---|---|---|---|
| Lab | Waterloo | Waterloo | UMN | UMN | UMN | DNR | UMN |
| Sample container | 500 ml HDPE | 60 ml HDPE | 15 ml Fisherbrand blue cap | 50 ml Argos black bottle*** | 15 ml Sarstedt red cap | 500 ml plastic | 30-gallon barrel |
| Head space | yes | yes | yes | yes | yes | no | yes |
| Rinse | no | no | yes* | yes* | yes* | yes** | no |
| Filter | no | no | yes | yes | yes | no | yes |
| Preservation | no | no | 1 drop 6N HCl | no | 5 drops 15N $HNO_3$ | no | $NH_4OH$ added to adjust pH |
| Refrigeration | no | no | yes | yes | yes | yes, if not analyzed onsite | no |
| Shelf life | long | long | 2 to 3 weeks | 2 to 3 weeks | 2 to 3 weeks | 24 to 48 hours | years |
| Field duplicate | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | none |
| Field blank | none | none | 1 for every 20 samples**** | 1 for every 20 samples**** | 1 for every 20 samples**** | none | none |
| Storage duplicate | yes | yes | no | no | no | no | no |

*Rinse the bottle three times with filtered sample water before collection. Rinse means fill the bottle with sample water and then pour the contents out over the cap.

**Rinse the bottle three times with sample water before collecting the sample. Fill the bottle submerged with the cap in hand. Seal the bottle submerged, ensuring no remnant bubbles.

***Sample bottle is stored at 0 to 6°Celsius (C) for convenience. Refrigeration is not required.

****Use deionized water from designated lowboy for blanks. Attach lowboy to the inline filter with a 3/8-inch tube and purge 1 liter of water to rinse the tubing and filter. Rinse and fill the bottles through the filter with the procedures outlined above.

**Appendix Table A-2. Groundwater field sample collection and handling details for project samples collected in 2016 and 2017**

| Parameter | Enriched tritium | $^{18}O$ and $^{2}H$ (Deuterium) | Nitrate/ Nitrite & Total Phosphorus | F, Cl, $SO_4$ | Metals | Bromide | Alkalinity | Carbon-14 ($^{14}C$) |
|---|---|---|---|---|---|---|---|---|
| **Lab** | **Waterloo** | **Waterloo** | **MDA** | **MDA** | **MDA** | **MDH** | **DNR** | **UMN** |
| **Sample container** | 500 ml HDPE | 60 ml HDPE | 250 ml plastic | 250 ml plastic | 250 ml plastic | 125 ml plastic | 500 ml plastic | 30-gallon barrel |
| **Head space** | yes | yes | yes | yes | yes | yes | no | yes |
| **Rinse** | no | no | yes* | yes* | yes* | yes* | yes** | no |
| **Filter (micron)** | no | no | 0.45 | 0.45 | 0.45 | 0.45 | no | no |
| **Preservative** | no | no | 5 ml 10% $H_2SO_4$ (yellow cap) | no | 2.5 ml 20% $HNO_3$ (red cap) | no | no | $NH_4OH$ to pH 8.5 |
| **Refrigeration** | no | no | yes | yes | yes | yes | yes, if not analyzed onsite | no |
| **Holding time** | long | long | 28 days | 28 days | 6 months | 28 days | 24 to 48 hours | years |
| **Field duplicate** | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | 1 for every 20 samples | none |
| **Field blank** | none | none | 1 for every 20 samples*** | 1 for every 20 samples*** | 1 for every 20 samples*** | 1 for every 20 samples*** | none | none |
| **Storage duplicate** | yes | yes | no | no | no | no | no | no |

*Rinse the bottle three times with sample water prior to collecting the sample (filtered if the sample is filtered). Rinsing process was filling the bottle with sample water and then pouring the contents out over the cap.

**Rinsed the bottle three times with sample water prior to collecting the sample. Bottle and cap were submerged and sealed to ensure no remnant bubbles.

***Use DI water from designated lowboy for blanks. Attach lowboy to the inline filter with a 3/8-inch tube and purge 1 L of water to rinse tubing and filter. Rinse and fill bottles through filter with the procedures outlined above.

Minnesota Department of Natural Resources (DNR)
Groundwater Atlas Program
mndnr.gov/groundwatermapping

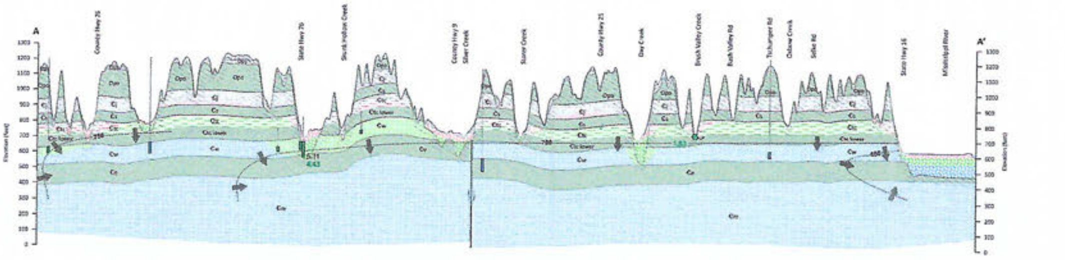
# Hydrogeologic Cross Sections

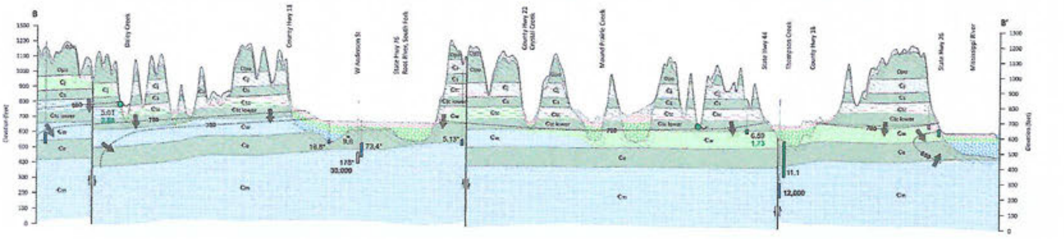
By John D. Barry

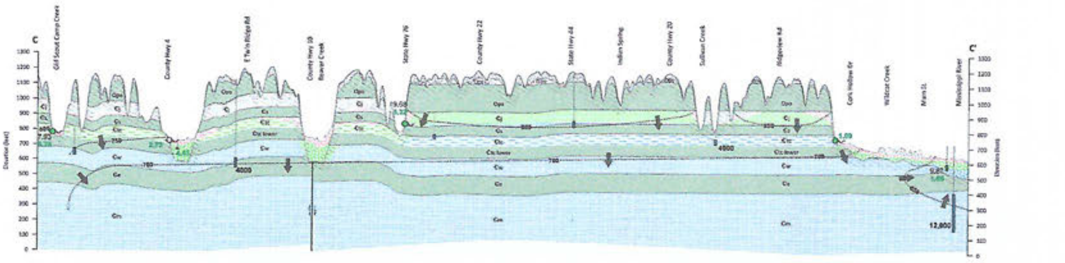
2025

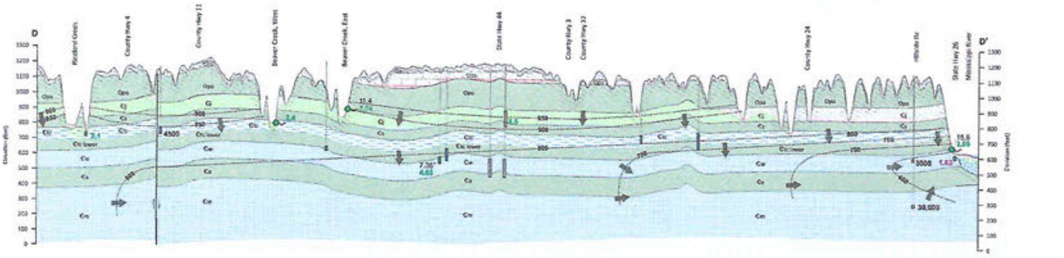
Groundwater Atlas of Houston County
Hydrogeologic Cross Sections, Plate 6
County Atlas Series C-33, Part B

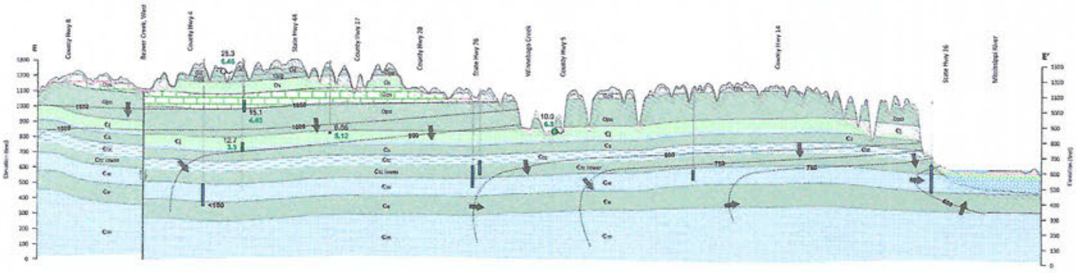
To accompany atlas Report and Plate 5.

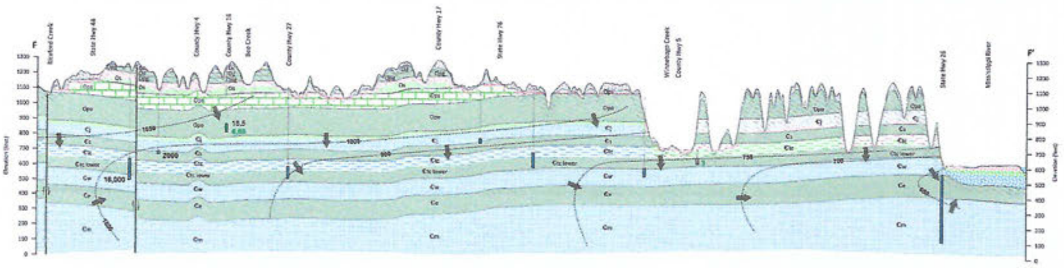



### Cross Section Explanation

**Bedrock aquifers and aquitards**

Interpreted tritium age is indicated by pattern color. See Figure 3 in the report for geologic unit correlation.

- Unconsolidated
- Oc Cummingsville
- Od Decorah Shale*
- Opg Platteville and Glenwood formations*
- Os St. Peter
- Osh Shakopee
- Opo Oneota Dolomite*
- Cj Jordan
- Cs St. Lawrence Formation*
- Clr Upper Lone Rock
- Clr lower Lower Lone Rock Formation*
- Cw Wonewoc
- Ce Eau Claire Formation*
- Cm Mt. Simon

*aquitard

**Tritium age**

Darker color in small vertical rectangle (well screen symbol) indicates tritium age of water sampled in well. Lighter color indicates interpreted age of water in aquifer.

- Recent: water entered the ground since about 1953 (greater than or equal to 8 tritium units [TU] to 15 TU).
- Mixed: water is a mixture of recent and vintage waters (greater than 1 TU to less than 8 TU).
- Vintage: water entered the ground before 1953 (less than or equal to 1 TU).
- Well not sampled for tritium.

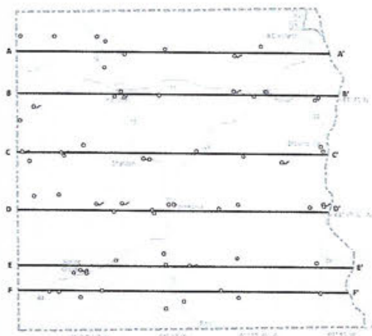
**Symbols and labels**

- Spring (symbol color indicates tritium age of water sample)
- 18.5 Chloride: If shown, concentration is ≥5 ppm. (* naturally elevated, ' source unknown)
- 1.82 Arsenic: If shown, concentration is ≥1 ppb.
- 5.12 Nitrate: If shown, concentration is ≥1 ppm.
- 4800 Carbon-14 ($^{14}C$): If shown, estimated groundwater residence time in years.
- General groundwater flow direction
- 700 Approximate equipotential contour
- Geologic contact
- Direction of fault movement, arrows indicate relative movement
- Enhanced-permeability zone

SCALE 1:100 000
VERTICAL EXAGGERATION X 20

1 0 1 2 3 4 5 MILES

1 0 1 2 3 4 5 6 7 8 9 KILOMETERS




Symbols
- Well samples shown on cross section
- Spring samples shown on cross section
- A—A' Part B line of cross section

SCALE 1:300 000
1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 8 9 KILOMETERS

This map was compiled and generated in a geographic information system (GIS). GIS data files for individual counties can be downloaded from the DNR Groundwater Atlas Program's County Geologic Atlas Series webpage.

This map was prepared from publicly available information. Every reasonable effort has been made to ensure the accuracy of the data on which this map interpretation is based. However, the DNR does not warrant the accuracy, completeness, or any implied uses of these data. Users may wish to verify critical information; sources include both the references in the report and information on file in the offices of the Minnesota Geological Survey and the DNR. Every effort has been made to ensure the interpretation shown conforms to sound geologic and cartographic principles. This map should not be used to establish legal title, boundaries, or locations of improvements.

Base modified from Minnesota Geological Survey, Geologic Atlas of Houston County, 2014.

Universal Transverse Mercator projection, Zone 15N, North American Datum of 1983. North American Vertical Datum of 1988.

DEPARTMENT OF NATURAL RESOURCES

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Minnesota Department of Natural Resources (DNR)
Groundwater Atlas Program
mndnr.gov/groundwatermapping

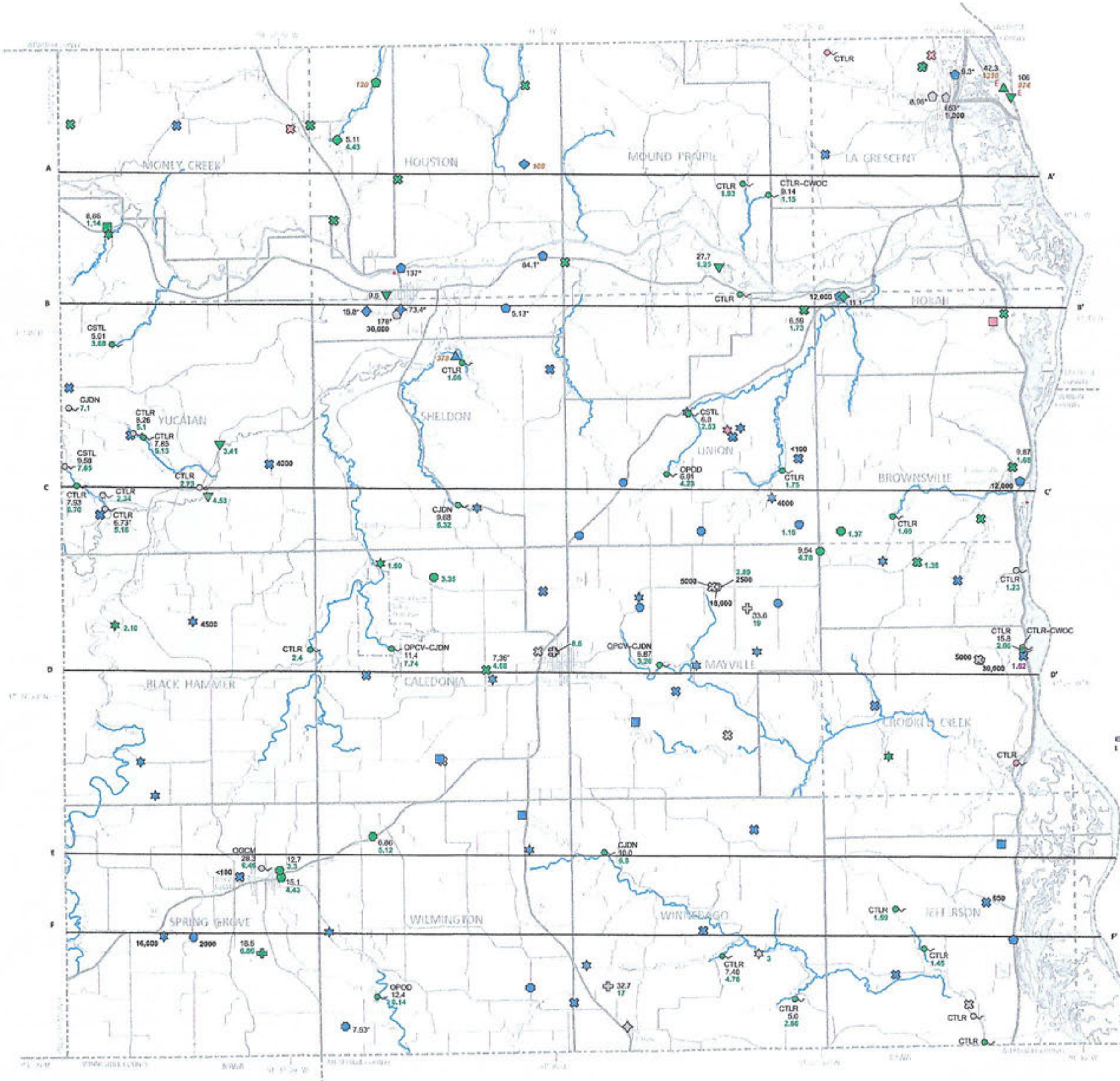
# Water Chemistry

By John D. Barry

2025

Groundwater Atlas of Houston County
Water Chemistry, Plate 5
County Atlas Series C-33, Part B

To accompany atlas Report and Plate 6.




**Map Explanation**

**Water sample and aquifer symbols**

Symbol color indicates tritium age of water sample.
See Figure 3 in the report for geologic unit correlation.

- Water table
- Buried sand
- Prairie du Chien, Prairie du Chien/Oneota
- Prairie du Chien–Jordan
- Jordan
- St. Lawrence
- Tunnel City/Lone Rock
- Tunnel City–Wonewoc
- Wonewoc, Wonewoc–Eau Claire
- Wonewoc–Mt. Simon
- Eau Claire
- Eau Claire–Mt. Simon, Mt. Simon
- Spring (label indicates aquifer code)

**Tritium age**

Symbol color indicates tritium age of water sample.

- Recent: water entered the ground since about 1953 (greater than or equal to 8 tritium units [TU] to 15 TU).
- Mixed: water is a mixture of recent and vintage (greater than 1 TU to less than 8 TU).
- Vintage: water entered the ground before 1953 (less than or equal to 1 TU).
- Not sampled for tritium.

**Symbols and labels**

- 5.8 Chloride: if shown, concentration is ≥5 ppm. (* naturally elevated, ⁺ source unknown)
- 1.82 Arsenic: if shown, concentration is ≥1 ppb.
- 120 Manganese: if shown, concentration is ≥100 ppb.
- 3.35 Nitrate: if shown, concentration is ≥1 ppm.
- 5000 Carbon-14 ($^{14}C$): estimated groundwater residence time in years.
- • Surface-water sample
- E Groundwater sample with evaporative signature
- B—B' Line of cross section (Part B)
- Designated trout stream
- Body of water

SCALE 1:100 000

1 0 1 2 3 4 5 MILES

1 0 1 2 3 4 5 KILOMETERS

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## 2. Proximity to Trout Streams and Surface Waters

- Silica Sand Mining Trout Stream Setback Permit/Fact Sheet
- DNR letter notifying adjoining Erickson Mine that it requires Trout Stream Setback Permit
- Jordan sandstone = 99% Silica Sand "The Stone That Turns To Sand"
- Formation Graph showing location of Jordan
- Beacon Maps of nearby trout streams, hatchery, watershed with distances
- Citizen Letter to DNR
- Letter from Owner/Operator of Ferndale Fish Hatchery

Minnesota Department of Natural Resources Fact Sheet

# *Silica Sand Mining Trout Stream Setback Permit*

MN Statutes, section 103G.217

## Background

Groundwater discharge from natural springs and seeps in southeast Minnesota is vital to sustaining the region's trout streams and recreational, commercial, agricultural, environmental, aesthetic, and economic values. Recognizing this, the 2013 Legislature prohibited the excavation or mining of silica sand in this region within one mile of any designated trout stream unless a silica sand mining trout stream setback permit has been issued by the DNR commissioner. The Legislature thus provided DNR permitting authority for any silica sand mining activities that occur within one mile of a designated trout stream.

As a result, DNR is now developing the process to administer these permits. The permit application process will require a mine proposer to complete a hydrogeologic evaluation and collect any other information necessary to assess potential impacts to trout streams, springs, seeps, and fens and other hydrogeologic features. Based upon the evaluation, the DNR will identify appropriate setbacks from designated trout streams, springs, and other hydrogeologic features, such as water tables, and any other restrictions necessary to safeguard these resources.

DNR intends this permit process to complement other existing regulatory programs and not supplant or duplicate them. The permit process is limited to proposals to excavate or mine silica sand within one mile of any designated trout stream in the Paleozoic Plateau Ecological Section of Minnesota. This area includes the southeast tip of the state as shown in the adjacent map.

## Application Process

**Pre-application Meeting**

The permit application process begins with a pre-application meeting and site-visit with the project proposer to review the proposed mining operation and provide direction on the preparation of the remaining application materials.

A two-tier approach will be used in evaluating proposed silica sand mining operations. Tier 1 includes dry mining operations where mining does not extend below the water table and groundwater extraction is limited to less than 10,000 gallons per day or one million gallons per year. Typically, dry mining operations are expected to have less environmental concerns than wet mining. Tier 2 includes wet mining operations where excavation occurs below the water table or where a significant volume of groundwater is extracted. Early in the process the DNR will determine if it will be a Tier 1 (less potential for adverse effects) or Tier 2 (higher

2

potential for adverse impacts; more rigorous information requirements) application. Tier 2 projects, if permitted, are likely to have more stringent restrictions.

The pre-application process will include a quick assessment of the potential issues that a project proposer may face, e.g., an area with numerous springs could be subject to substantial set-backs, buffers, etc. limiting the area that could be mined. Our goal is timely and open communication with the project proposer to facilitate compliance and well-informed decision making.

**Pre-application spring monitoring**

Springs and other significant water features in the area of concern are to be monitored for at least one year prior to application. The area of concern will often extend beyond the boundaries of the mine operation. When an Environmental Assessment Worksheet (20 acres and up) is required, the collection of data, such as spring monitoring, will also be required as part of the environmental review.

**Application**

Following the pre-application meeting and adequate monitoring, an application will be submitted to the DNR. Upon determination that the application is complete, the DNR will forward the application to the local zoning authority, soil and water conservation district, and watershed district for a 30-day review period.

**Required Permit Application Submittals**

The required technical documents for Tier 1 Dry Mining applications are:

1. *General Mine Location Map with Supporting Information* (This map indicates mine location and footprint, streams, wetlands, watershed and springshed boundaries, roads, developments, and other supporting information.)
2. *Mining Plan* (This includes mine depth, processing, timing, techniques, etc.)
3. *Mine Reclamation Plan* (The final disposition and topography of site, re-vegetation, and schedule are included in this plan.)
4. *Stream and Wetland Resources Report* (Field delineations, mapping and characterization of streams, springs, seeps, calcareous fens and other wetlands are included in this report.)
5. *Hydrogeologic Evaluation Report for Tier 1* (This is a comprehensive report which summarizes the plans and information gathered about the proposed mine, including all of the sections above (maps, mining plan, reclamation plan, spring and wetland resources report, and monitoring plan). This report is for dry mining operations only.)
6. *Groundwater and Stream Monitoring Plan* (This plan includes descriptions of the design, installation, management and operations of the planned monitoring network for the site. The monitoring network will be installed and operated prior to initiation of mining activities to establish baseline conditions.)

Additional technical requirement for Tier 2 Wet Mining application:

7. *Comprehensive Hydrogeologic Investigation Report for Tier 2* (This report includes the Tier 1 Hydrogeologic Evaluation Report information plus additional information needed to assess wet mining proposals. It will include data and information gathered from the more extensive groundwater monitoring and aquifer testing.)

**Mining Limitations**
Parameters that will be used to evaluate proposed silica sand mining operations and determine setback distances include:

1. Trout stream temperature. Does the proposed silica sand mining operation have the potential to increase trout stream temperatures?
2. Stream base flow or stream quantity. Does the proposed silica sand mining operation have the potential to cause a reduction in groundwater base flow recharge to trout streams or a reduction in trout stream flow volumes?
3. Spring water quality. Does the proposed silica sand mining operation have the potential to lessen the quality of spring water, including its temperature, turbidity, or contamination?
4. Surface Water runoff. Is there a threat of negative impacts to streams from increased surface water runoff from silica sand mining operations?
5. Processing, stockpiling. Is there a threat of negative impacts to streams from the processing or stock piling of sand or leachate from those processes?
6. Recreation: Does the proposed silica sand mining operation have the potential to lessen the recreational use or productivity of the trout streams due to the operation of the silica sand mine?

**Mining and Reclamation Plans**
An important part of silica sand mining in relation to trout stream protection is the reclamation of the mined land. Reclamation is a process that results in a safe and non-polluting mine area following the close of the mine and sometimes during mine operation. Reclamation controls potential adverse environmental impacts and safety issues, preserves natural resources, and encourages responsible planning for future land use; while encouraging good mining practices. While much of the reclamation takes place at the end of a mine's operation, reclamation planning occurs before a mine is permitted. Understanding how the land will look after mining helps guide how the mine is opened and developed. The mining and reclamation plans will be based on discussions between the applicant and the DNR at the pre-application conference. The plans will describe the operating life of the mine, including the rate of mining and anticipated changes in that rate, the mining activities to be conducted, as well as the design, methods, sequence, and schedules of reclamation including closure and post-closure maintenance.

**Financial assurance bond**
A financial assurance bond is required to ensure that there is a source of funds to be used by the DNR if the permittee fails to perform reclamation activities or corrective action required by the DNR. This will be required prior to the start of mining.

**Application Fees**
Applicants will be charged an application fee based on billable hours, using a professional services rate model. This is similar to the method used by the DNR for collecting and charging for work required for high-volume water appropriation permits.

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**Anticipated Review Time**

It is the DNR's goal to complete all permit decisions within 150 days of the receipt of complete applications. The actual time will depend on the complexity of the project, the likelihood and number of potential impacts, staff time availability and responsiveness of the applicant to information requirements. Our guidance document requires a year of hydrogeologic monitoring prior to application. If the monitoring is conducted as required, and the data analyzed and incorporated into the project proposer's hydrogeologic conceptual model, the DNR anticipates permit review and decision taking no more than 90 days.

**Annual Report**

If a permit is issued, an annual report will be required that describes actual mining and reclamation completed during the past year, submits and analyzes groundwater and surface water monitoring data, identifies the mining and reclamation activities planned for the upcoming year, and submits a contingency reclamation plan to be implemented if operations cease in the upcoming year.

**Corrective Action**

On the observation of violations of the applicant's permit, immediate action will be taken by the DNR to have the mine operator correct the violation.

**Annual Permit Fee**

Ongoing monitoring and regular inspection of the mining operation will help ensure the protection of the trout stream resource. An annual silica sand mining trout stream setback permit fee will be charged to the mine operator based on our professional services rate and billable hours.

**Existing Silica Sand Mining Operations**

Silica sand mining operations that were operating before May 24, 2013 are not required to obtain the trout stream setback permit.

**Additional Information**

Silica Sand Rulemaking Webpage: http://www.dnr.state.mn.us/input/rules/silica_sand.html
DNR Silica Sand FAQ: http://files.dnr.state.mn.us/lands_minerals/silica_sand_fact_sheet.pdf

**DNR Contact for Silica Sand Mining Trout Stream Setback Permit:**

Tom Hovey, Department of Natural Resources, 500 Lafayette Road, Box 32, St. Paul, MN 55155-4032
Phone number: 651-259-5654
e-mail: tom.hovey@state.mn.us

Rev. 1/4/2014

# Minnesota Department of Natural Resources

Division of Ecological and Water Resources
500 Lafayette Road, St. Paul, MN 55155

Minnesota DEPARTMENT OF NATURAL RESOURCES

July 25, 2014

Tracie Erickson
[redacted]
Rushford, Minnesota 55971

RE: DNR Silica Sand Mining Trout Stream Setback Permit, Ferndale Creek, Erickson Silica Sand Mine, Houston County

Dear Mr. Erickson:

We understand that you have started mining silica sand at your mine in Houston County. As we stated in our letter of April 16, 2014, the 2013 law states that silica sand mining in the region including Houston County is prohibited within one mile of a designated trout stream unless a silica sand mining trout stream setback permit has been issued by the DNR. Since you are within one mile of Ferndale Brook, a designated trout stream, a trout stream setback permit is required.

We have determined that due to the lapse in your conditional use permit, subsequently reinstated by the county, your mining qualifies as a new project and is subject to the setback permit requirement. Therefore, you must cease mining until you apply for and receive a setback permit.

In order to assist you in your application, I have enclosed a document describing the application process for a silica sand mining trout stream setback permit. The key points of this permit process include:

- pre-application meeting and site visit with affected agencies;

- hydrogeological evaluation that will include at least one year of monitoring of springs and other significant water features prior to application;

- permit application including mining and reclamation plans, stream and wetland resources report, hydrogeologic evaluation report, groundwater and stream water monitoring plan; and

- financial assurance bond.

The results of the hydrogeologic evaluation may result in a buffer distance adjacent to the trout stream that cannot be mined, or the denial of a permit to mine within one mile of the trout stream. Please note that these requirements are in addition to applicable environmental review requirements.

Please confirm within five (5) business days that mining operations have ceased and acknowledge the need to obtain a permit before resuming operations at the mine.

Please feel free to contact me if you have further questions. I can be reached at (651) 259-5654, tom.hovey@state.mn.us, or the above address.

Sincerely,

Tom Hovey

Tom Hovey
Water Regulation Unit Supervisor

Enclosure

c: Bob Scanlan, Houston County Planning and Zoning Director
Rick Frank, Houston County Environmental Services Director
Teresa Walter, Chair – Houston County Board of Commissioners
Will Seuffert, Director - Environmental Quality Board
Tom Landwehr, Commissioner – Department of Natural Resources
Scot Johnson, SE Groundwater Specialist – Department of Natural Resources

6

# The Stone That Turns to Sand

## Geological Origin of the Jordan Sandstone

There is another rock resource on the Kasota Prairie which is as equally valuable as its limestone. But this one hardly looks like a rock at all. It is a sandstone that can crumble in your hand. It is the Jordan Sandstone that is found in southern Minnesota. In Runkel's[1] illustration ( see Fig. 10 ), the Jordan Sandstone is part of a complex of sedimentary rocks, consisting of the Jordan, St. Peter, Wonewoc and Mt. Simon layers.

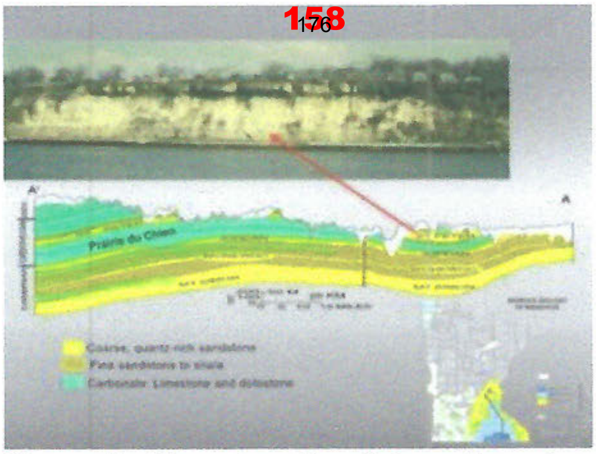



Fig. 10 Sedimentary Sandstone Complex

My research has shown however, that the illustration's rather straight-forward layering is not true in the field. The sequential occurrence of these sandstones, the thickness of their beds, and the quality of the rock is a complicated geologic feature to understand. These formations have risen, sank, or folded into each other over millions of years, producing rock formations at different depths, different thickness, and different qualities in different areas. However, on the Kasota Prairie the Jordan sandstone lies generally below the limestone.

In composition, the Jordan sandstone consists of 99% quartz or silica; hence, the name that is often applied to it, is "silica sand." It has been characterized as having high strength, chemically inert, spherical in form and, compared to "common" sand, has larger grains.[2] I have looked at the Jordan  sandstone grains under a microscope and can confirm that indeed they are mostly round and of uniform size. These characteristics make it a high-quality sand to use in oil and gas mining, as compared to the more irregular size grains of so-called "common" sand. Today, the Jordan sandstone and other sandstones are riding a wave of unprecedented demand for use in an innovative oil and natural gas mining method called fracing or fracking. Fracking has become in the last twenty years the major way to extract oil and natural gas from shale rock. To understand why this is the case, one must know a bit about this method of mining.

## Fracking

Fracking is the process whereby a solution of water, chemicals, and silica sand are forced into shale formations which contain oil and/or natural gas. There are a number of steps involved in this mining method as described in the ProPublica web site.[3] First, large quantities of water and silica sand with added chemicals are trucked to the mining site and combined. Next "pumpers" inject the solution under high pressure into the rock formation. The solution breaks up or “fractures” the rock formation; hence, its name. The natural round, uniform shape and size of the silica sand grains does not clog the wells, but rather moves like a liquid through them. The silica sand also helps keep these fractures open so that the natural gas or oil can flow through the shale deposit into an oil well. The sand is also often called a “proppant,” as it refers to “propping open” the fractured shale. The oil or natural gas then flows out of the well into pipelines. Finally, a recovery of the waste water solution is undertaken.

## Eagle Ford Play

A few years ago, to learn first-hand about this type of mining, I joined a field trip to view fracking operations at the Eagle Ford Shale Play[4] in southeast Texas. This field trip was part of the annual meeting program of the the National Council for Geographic Education held at the University of Texas at San Marcos, Texas. The Eagle Ford covers a wide area, dipping toward the Gulf of Mexico and varies in depth from 4,000 to 14,000 feet. Professor Donald Huber, in his Field Trip Guide[5] explained the process of fracking. Before the actual mining begins, a so-called staging platform is constructed which contains tanks for chemical storage, sand storage units, water tanker trucks, data vans, and the drilling rig itself. A road to the platform also must be constructed, security fences put up, gates installed and holding ponds dug and lined for waste water. Once this is all completed, drilling or “makin’ a hole” in Texas mining parlance, can begin. The drilling rig is a mobile unit that is assembled at each well site. It will drill here for about a week then move on to another platform. Given the gas and oil boom of the last decade, over 3,100 well permits were issued in the Eagle Ford Shale play to 2012.[6] The result is a southeast Texas landscape that is dotted with hundreds of oil rigs and gas wells (see Fig. 11). A typical gas/oil rig consists of a derrick, water tanks, and temporary housing. Roads are constructed to the drilling site and for security, a fence is erected. This platform will remain in place until the oil/gas “plays out” and then is moved to a new site.

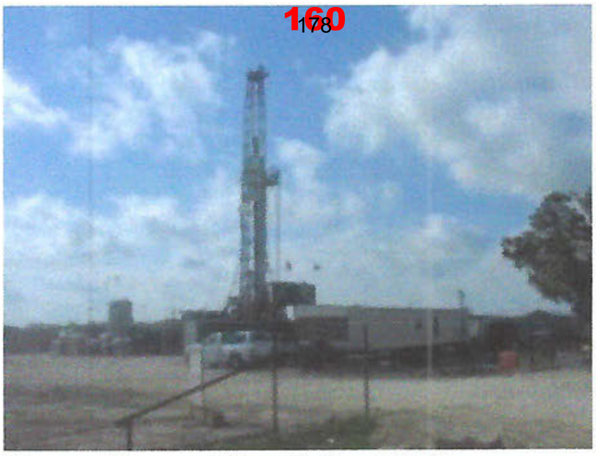


Fig. 11. Texas Oil and Gas Well

## Oil and Gas Benefits

The economic benefits to local communities and individuals in the Eagle Ford Shale Play is difficult to comprehend. Over 47,000 jobs have been added to local communities since the boom began.[7] Workers are needed as drillers, derrick hands, roughnecks, mud engineers, road construction crews, pipe line contractors, supply delivery personnel, security guards, and the most needed: water, oil, gas, and sand truck drivers. The increased work force has created a huge demand for housing. Small town hotel and motel occupancies have risen, along with their rates. Parks have been set up to accommodate RVs and pickup campers. So-called "man camps" with new cabin-like houses have sprung up, offering daily maid service, 32 inch TVs with SAP, freezers and microwaves, with 24-hour security (see Fig. 12).

Fig. 12. Texas Oil Field Man Camp

And the economic benefits extend beyond the local oil/gas rich communities. According to Texas law, school districts reaping oil and gas dollars must share these revenues with poor school districts in the state. This is the so-called Robin Hood Plan.[8] For example, Cotulla, Texas, a small town in the Eagle Ford Shale Play, remitted 1 million dollars to other school districts in 2011. In 2012, it rose to 15 million.

Finally, let me relate a story about a 90 year old woman living in the little town of Luling, Texas. She had recently sold the oil and gas rights on her cattle ranch on the Eagle Ford Play. She went into the local bank to cash her first monthly dividend check. The teller explained to her that the bank did not have enough money on hand that day to cash her check. She exclaimed, "Well, I don't see why not? It's only for $1,500." The tellerreplied, "Ma am, look at that check again; it's for $15,000."[9] That this kind of money is being made in the Eagle Ford is an understatement. However, such riches are not without its problems as well.

## "Not What It's Fracked Up To Be"

There are a host of problems and concerns with fracking. Increased truck use backs up traffic at stop lights and rail crossings. There is concern about methane leakage at gas wells. Speculation is rampant that due to the high pressure used to break up the shale, thousands of small earthquakes occur. But the big problems concern water use, recovery and pollution. A massive amount of water is needed for fracking. In an area like Southeast Texas where surface water is at a premium, most water has to come from underground resources. This raises the question of "whose water is it" and "who should profit by its use"? Another concern is that waste water that comes from the drilling site is supposed to be captured and stored in lined pits to prevent groundwater pollution. Often, it is not.

There is an additional problem that occurs hundreds of miles away from the oil/gas wells on the Eagle Ford. As was discussed earlier, a key ingredient for fracking is silica sand. Given the great demand for cheaper oil and natural gas produced by fracking, the silica sands in Minnesota and Wisconsin can't be mined and shipped out fast enough. One of the major suppliers of this sand is the Jordan sandstone on the Kasota Prairie.

The Unimin Corporation has been mining this sand for over 30 years, primarily being used to free or un-clog oil wells. According to Jeff Jurewicz,[10] the company was started by Bill Woods in 1970 as a small mining operation in Pennsylvania, primarily supplying sand for sand blowing [blasting?] companies. It now has mining sites in 20 states and Mexico and Canada. They own or manage over 100,000 acres and have over 2,400 employees. It is the world's leading producer of silica sand and a major producer of resin coated sand proppants. It is also the largest producer of low-iron nepheline syenite for glass, ceramics, paint, and plastic uses as well as the world's leading producer of high quality quartz.[11]

Fig. 13. Unimin Kasota Plant.

The size of the Unimin sand processing and shipping facilities can be seen on the accompanying photograph (see Fig.13 ). It shows a complex of buildings for cleaning and washing the sand, offices, parking for trucks, railroad spurs for sand cars, and sand storage containers. Nearby, are the active quarries and reservoirs where waste water that had been used to clean the sand has been pumped. All of this is needed for the mining of the Jordan sandstone. And, as we shall see, Unimin has greatly expanded its mining operations.

## Mining the Sandstone

Similar to the limestone deposits which are only a few miles away, the Jordan sandstone formation lies quite near the surface. This makes it accessible to open pit mining methods and thus economical to extract. However, the mining of the sandstone is considerably different than the mining of limestone.

First, cores are made into the ground to test the depth and quality of the sandstone at a particular location. These test cores are made by an auger-like drilling device which brings the core to the surface for testing. If a mining site is suitable, all vegetation must be cleared. Then, the overburden of loose limestone and soil  is removed by bulldozers This overburden can vary from five to ten feet in depth.It is pushed to the side of the site and will later be used as fill to create a berm around the mining pit or, in some cases, also used for mine reclamation. Once the sandstone is exposed, it can be "broken up" by blasting. A small explosive can be inserted into the formation and detonated, It is then a simple matter of front-end loaders to begin scooping up the sandstone from the pit (see Fig. 14), which is now in the form of chunks, and loading it onto trucks or onto what resembles a huge conveyor belt. These chunks are then conveyed to the crusher plant which breaks them up into smaller pieces. The sand is then cleaned with water to remove any unwanted silt and clay particles. These particles make up about 25% of the sandstone that is initially mined. An important next step, involves the drying and sorting of the sand to fit the requirements of fracking. Non-fracking sand can be sold as industrial sand, such as for road construction or stored for possible reclamation. The final step is to load the sand onto rail cars.

Fig .14. Sandstone Mining Pit.

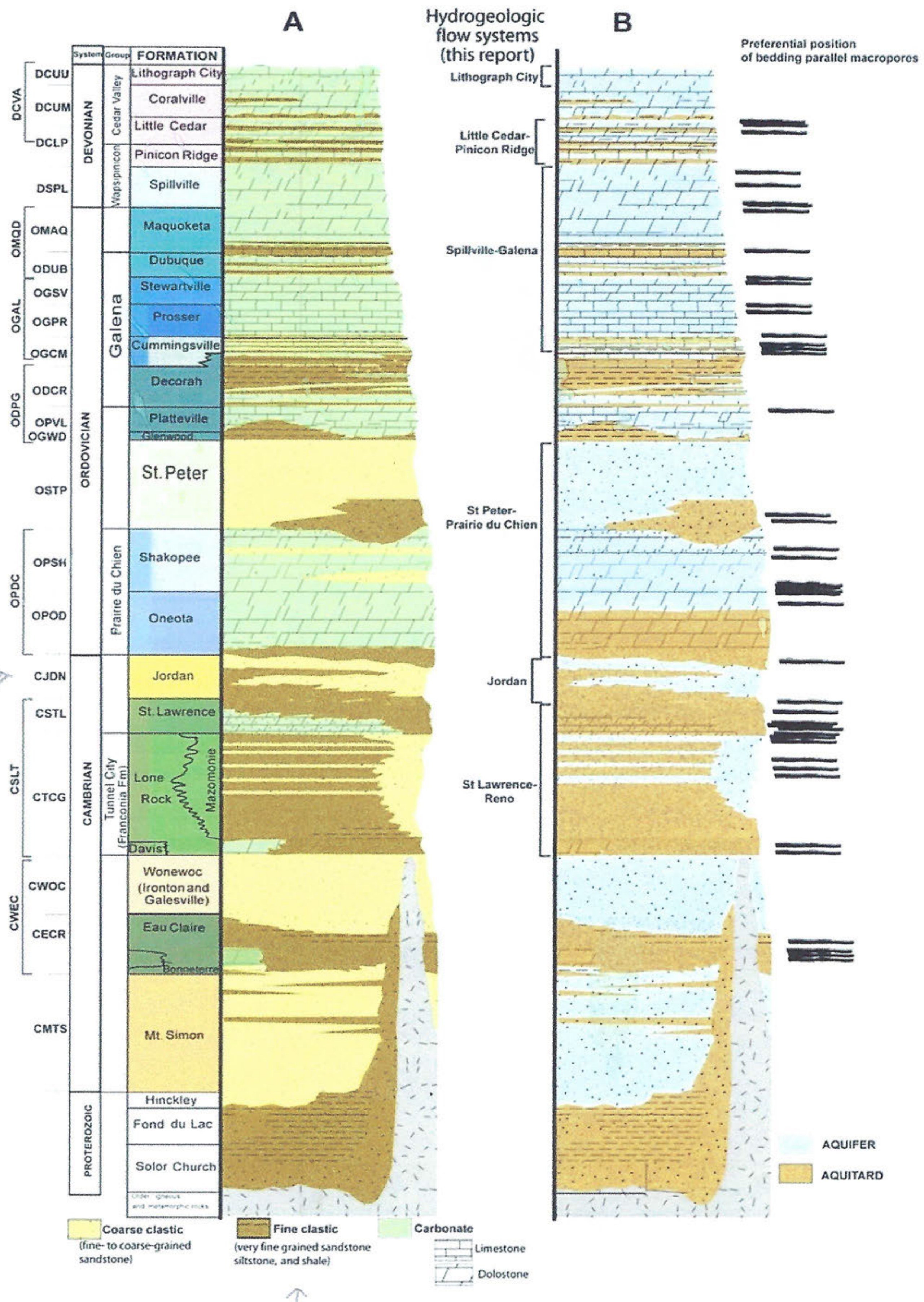
From the railroad adjacent to the plant, the silica sand is then shipped to oil and gas mining locations. Most of the sand from the Kasota Unimin plant is destined for the oil shale deposits in Texas, such as the Eagle Ford, and to the oil shales in North Dakota. To meet the demand for its sand Unimin acquired the load cars of the Winchester and Western Rail Company. John Brotten, an engineer for Unimin,[12] told me to be on the look out for Winchester and Western sand cars when I was on my Texas fracking field trip. Sure enough, our second stop was a sand unloading and storage facility. There were so many Winchester and Western sand cars there that I couldn't count them all. To me, this illustrated that, although the oil and gas fields of Texas and the Kasota Prairie sand are geographically widely separated, they are closely tied to each other economically. Both industries need each other and together are making many formerly unattainable oil and gas deposits feasible to mine. And in the process, making lots of money.

However, like the problems involved in fracking, the mining of silica sand carries its own sets of concerns. How these concerns have raised conflict on the Kasota Prairie will be the subject of the next chapter.

1. Tony Runkel, *Southeastern Minnesota Silica Sand Geologic and Landscape Context*. Minnesota Geological Survey, University of Minnesota, n.d., p.2. ↩
2. Ibid., p.1. ↩
3. "Fracking: Gas Drilling's Environmental Threat" *ProPublica*, https://www.propublica.org/series/fracking. ↩

4. A “Play” is mining term for a shale formation that contains significant amounts of natural gas.
5. Donald J. Huebner, *The Eagle Ford Shale Play Field Trip Guide and Educator Resource*. Department of Geography, Texas State University-San Marcos. 2012.
6. Ibid, p.5.
7. Ibid., p.19.
8. .Ibid, p.19.
9. Ibid., p. 6.
10. Jeff Jurewicz, Lecture at the Department of Geography, Gustavus Adolphus College, St. Peter, Mn., January 18, 2013.
11. "Unimin," Wikipedia, https://en.wikipedia.org/wiki/Unimin.
12. John Brotten Interview at Unimin Corporation office in Kasota, Minnesota, July, 2012.

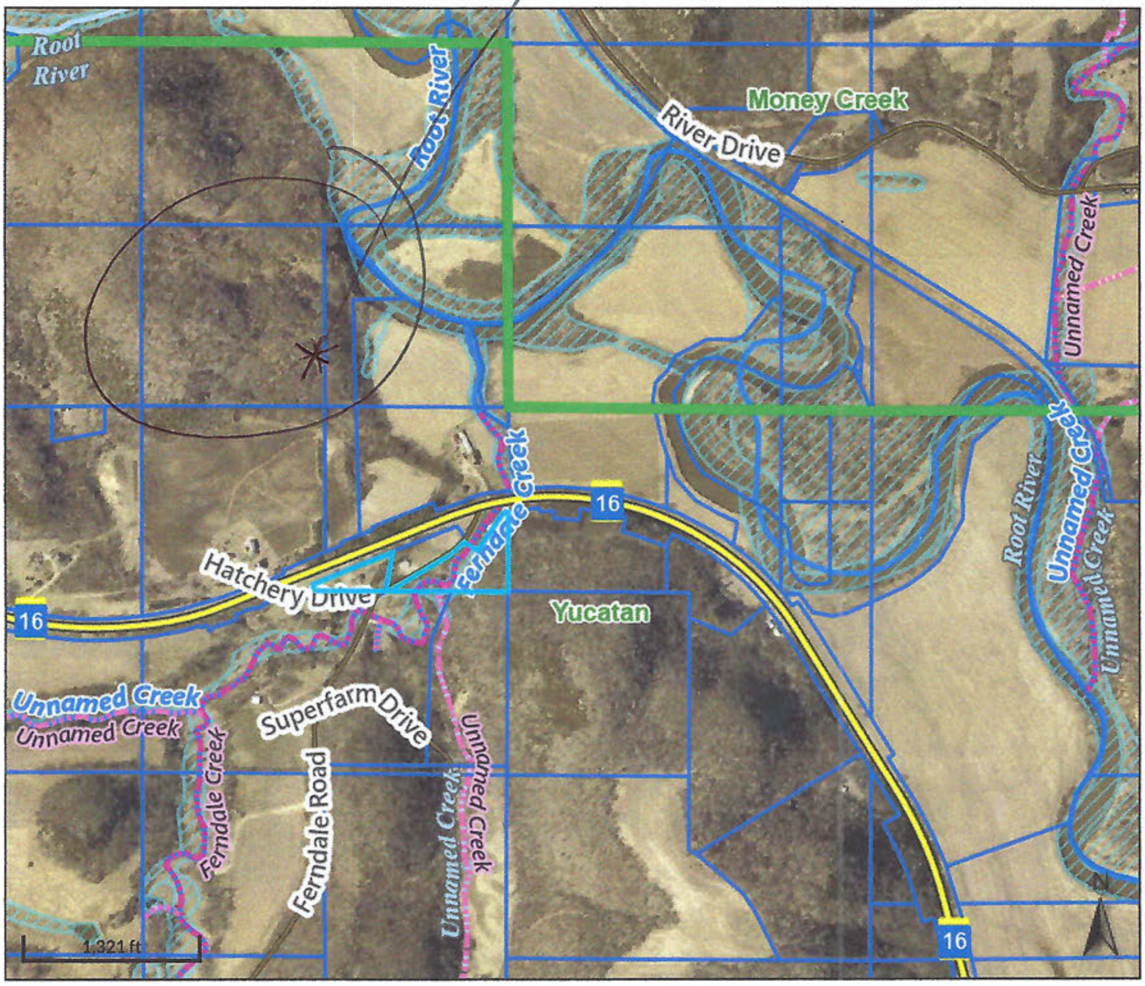
Formation Graph



Trout Stream map

Beacon™ Houston County, MN

Proposed mine




## Overview

## Legend

**Parcels**
- Parcels
- Mobile Home
- Exempt
- Personal Property
- Lease

**Roads**
- US Highway
- State Highway
- County Highway
- Township Road
- Municipal Road

**Trout Streams**
- Designated Trout Stream
- Protected Tributary to Designated Trout Stream

**Public Water Watercourse**

**Rivers and Streams**
- Centerline (River)
- Connector (Lake)
- Connector (River)
- Connector (Wetland)
- Drainage Ditch (Perennial)
- Drainage Ditch (Undifferentiated)
- Interpreted Arc Connector
- Stream (Intermittent)
- Stream (Perennial)
- Stream (Unknown)

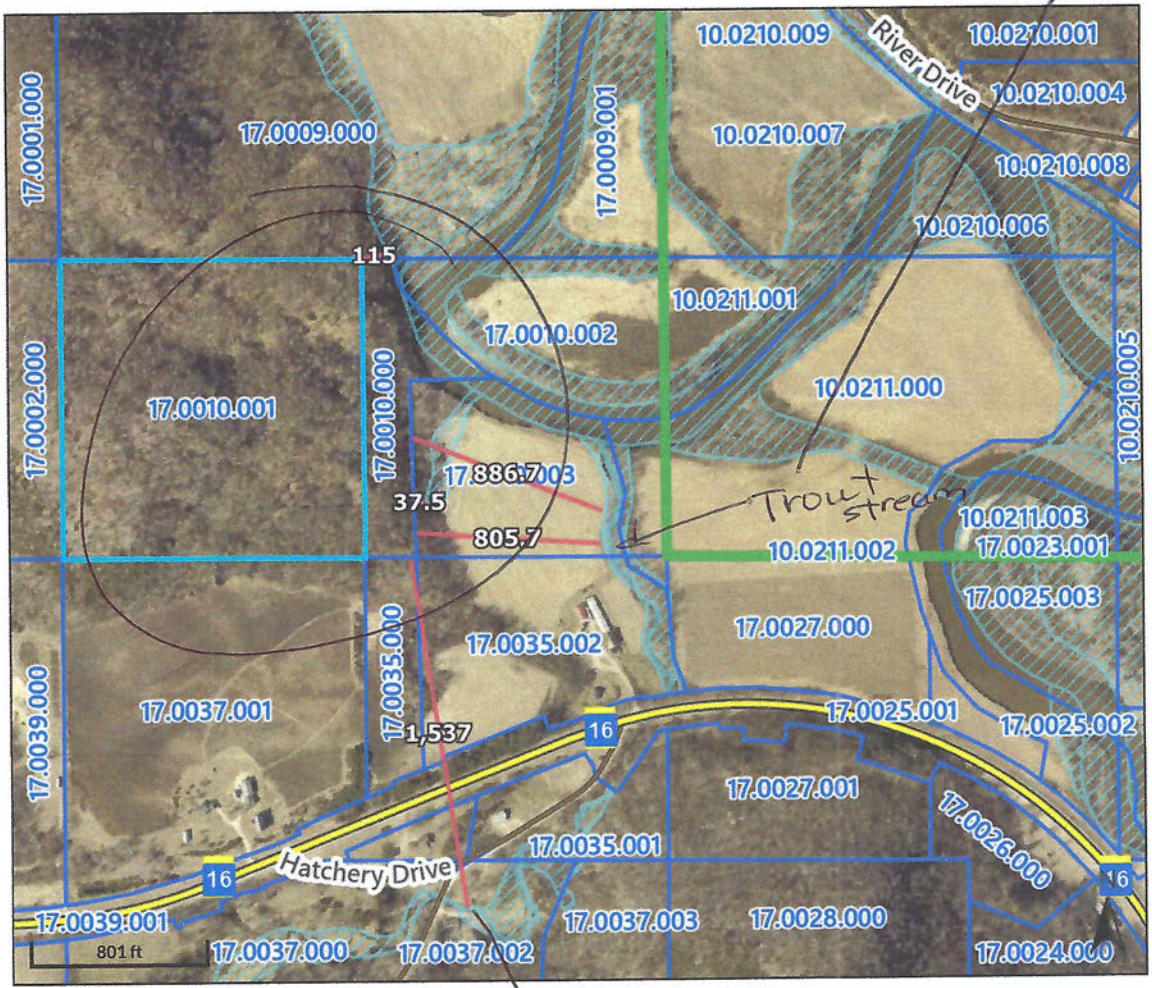
**Wetlands**

**Political Townships**

Distances to trout streams + hatchery

805 ft

**Beacon**™ Houston County, MN




**Overview**

**Legend**

**Parcels**

- Parcels
- Mobile Home
- Exempt
- Personal Property
- Lease
- Corporate Limits

**Roads**

- US Highway
- State Highway
- County Highway
- Township Road
- Municipal Road
- Wetlands
- Political Townships

| | | | | | |
|---|---|---|---|---|---|
| **Parcel ID** | 170010001 | **Alternate ID** | n/a | **Owner Address** | OLSON,CLAIR & JARAD<br>22543 COUNTY 13<br>RUSHFORD, MN 55971 |
| **Sec/Twp/Rng** | 20-104-007 | **Class** | 113 - RURAL PRESERVE | | |
| **Property Address** | | **Acreage** | 40.0 | | |
| **District** | YCTNT/SD239/FD10 | | | | |
| **Brief Tax Description** | SW1/4 SW1/4 B 325 P 221 & B 332 P 451 DOC 310990 & 310991 2 | | | | |

(Note: Not to be used on legal documents)

1,537 ft
Hatchery

Date created: 4/20/2026
Last Data Uploaded: 4/17/2026 10:06:57 PM

Developed by SCHNEIDER GEOSPATIAL

Citizen letter to DNR

Mr. Tom Hovey
Water Regulations Unit
MN Department of Natural Resources
500 Lafayette Road - Box 25
St. Paul, MN 55155-4032

Dear Mr. Hovey,

I am writing to express serious concern regarding the Clair & Jarad Olson proposal for a new silica sand mining operation adjacent to Ferndale Creek and the Ferndale Fish Hatchery. This project raises significant environmental risks to one of southeast Minnesota's most sensitive cold-water resources and to the public investments made to protect them. The proposed mine site is also adjacent to RIM land, associated wetlands and the banks of the Root River. The proposed site borders our property on two sides.

The proposed operators are Bruening Rock Products and G-Cubed, who are currently proposing multiple mines in the area.

Many of us concerned citizens are familiar with silica sand mining and the Trout Stream Setbacks as the Erickson silica sand mine expansion was proposed adjacent to our property on the west side. Thankfully, the required Trout Stream Setback protections were enforced, prohibiting their silica sand operation expansion. Thank you for leading that project. The proposed Olson silica sand mine is located even closer to Ferndale Creek and the Hatchery. We do not want the proposed mine operators to bully their way into a location that is not suitable for mining.

We respectfully urge the Minnesota DNR to:

1. Enforce robust and precautionary trout stream setback distances for this silica sand mining proposal. Prohibit them from opening a silica sand mine on their property.
2. Carefully evaluate cumulative groundwater impacts to Ferndale Creek and the Ferndale Fish Hatchery. The nearby Erickson mine is already going very deep. (They were allowed to continue their mining operation that existed pre-2013 but were not allowed to expand).
3. Prioritize protection of wetlands, RIM land, and groundwater recharge areas that sustain cold-water ecosystem
4. The hill has been identified by the Minnesota DNR as having outstanding biodiversity.

Preventative setbacks and strong environmental safeguards are essential to ensure these resources remain protected for future generations. Thank you for your time and consideration of these concerns. If we can be of any help please let me know.

Sincerely,
Jackie Baker
[redacted]
Rushford MN 55971
[redacted]

Letter From Owner of Ferndale Fish Hatchery

To Whom It May Concern,

I am writing to express concern regarding the potential impact of proposed sand mining activity near my fish hatchery, Ferndale Hatchery, located in Yucatan Township in Houston County. I understand that a permit application has been submitted to operate a quarry for mineral extraction within an Agricultural Protection District.

My primary concern is the potential effect this activity may have on the quality and quantity of the spring water that supplies my hatchery. Ferndale Hatchery has been in operation for many years and is licensed with the Minnesota Department of Natural Resources on the Aquaculture License Approved Waters List (License No. 102241). In recent years, the hatchery has expanded production from eggs to fingerlings, raising approximately 40,000 to 60,000 trout annually.

The hatchery depends entirely on a clean and consistent spring water source. As such, any disruption to groundwater flow, sediment introduction, or contamination could have serious and potentially long-term consequences for both hatchery operations and the surrounding ecosystem.

Given these concerns, I respectfully request that a formal environmental assessment be conducted to evaluate any potential impacts of the proposed quarry on local groundwater resources. Ensuring the protection of this water source is critical not only to my operation but also to the broader environmental health of the area.

Additionally, I would appreciate guidance on any other agencies or entities I should contact regarding this matter.

Thank you for your attention to this issue. I would welcome any updates or information you can provide.

Sincerely,

Wade Anderson

[redacted]

**3. Wildlife Habitat, Ecological Impacts, Outstanding Biodiversity**

- National Heritage Review of Proposed Bluff - March 23, 2026
- Minnesota Natural Resource Atlas Map showing “Outstanding Biodiversity Significance”
- Property Evaluation for Native Plant Communities and Wildlife of proposed bluff adjoining property owned by RoseMary Iversonn- September 2012
- 6134 - MN Rules Chapter Endangered, Threatened, Special Concern Species

National Heritage Review
& proposed project
area

DEPARTMENT OF NATURAL RESOURCES

**Minnesota Department of Natural Resources**
**Division of Ecological & Water Resources**
**500 Lafayette Road, Box 25**
**St. Paul, MN 55155-4025**

March 23, 2026

Cindy Hatleli

RE: Natural Heritage Review of the proposed Development Project,
T104N R7W Sections 20 and 29; Houston County

Dear Cindy Hatleli,

For all correspondence regarding the Natural Heritage Review of this project please include the project ID **MCE-2026-00247** in the email subject line.

As requested, the Minnesota Natural Heritage Information System has been reviewed to determine if there are any rare features in or near Township 104N Range 7 W Sections 20 and 29. Based on this review, there are many rare features, including state protected species, that have been documented in this area. Any development in the proposed area is likely to take state-listed threatened or endangered species and a permit to take will likely be needed for any development on the property.

The following rare features may be impacted by any development in this area:

***Ecologically Significant Areas***

- The Minnesota Biological Survey (MBS) has identified a Site of *Outstanding* Biodiversity Significance that overlaps nearly all the proposed project. Sites of Biodiversity Significance have varying levels of native biodiversity and are ranked based on the relative significance of this biodiversity at a statewide level. Sites ranked as *Outstanding* contain the best occurrences of the rarest species, the most outstanding examples of the rarest native plant communities, and/or the largest, most intact functional landscapes present in the state. In this specific instance, there are three native plant communities that occupy nearly all of the area of interest. These are, with their state conservation ranks,
    - Dry Barrens Oak Savanna (Southern), Oak Subtype (UPs14a2) – Critically Imperiled (S1)
    - Dry Bedrock Bluff Prairie (Southern) (UPs13c) – Vulnerable to Extirpation (S3)
    - Oak – Shagbark Hickory Woodland (FDs38a) – Vulnerable to Extirpation (S3)

  More than 99% of the prairie and savanna that were present in the state before settlement has been destroyed, and more than one-third of Minnesota's endangered, threatened, and special concern species are now dependent on the remaining small fragments of Minnesota's prairie and savanna ecosystem. Therefore, we feel that all prairie and savanna remnants merit protection. A 2012 report by a DNR ecologist noted that similar sites on an adjoining property had high ecological integrity with several rare species noted. The DNR recommends avoidance of any area identified as a Site of Outstanding Biodiversity Significance.

MBS Sites of Biodiversity Significance and DNR Native Plant Communities can be viewed using the Explore page in Minnesota Conservation Explorer (MCE) or their GIS shapefiles can be downloaded from the MN Geospatial Commons. Reference the MBS Site Biodiversity Significance and Native Plant Community websites for information on interpreting the data. The attached Conservation Planning Report has a list of MBS Sites of Biodiversity Significance and DNR Native Plant Communities in the vicinity of your project.

- If the Wetland Conservation Act (WCA) is applicable to this project, please note that native plant communities with a Conservation Status Rank of S1 through S3 or wetlands within *High* or *Outstanding* MBS Sites of Biodiversity Significance may qualify as Rare Natural Communities (RNC) under WCA. Minnesota Rules, part 8420.0515, subpart 3 states that a wetland replacement plan for activities that modify a RNC must be denied if the local government unit determines the proposed activities will permanently adversely affect the RNC. If the proposed project includes a wetland replacement plan under WCA, please contact your DNR Regional Ecologist for further evaluation. Please visit WCA Program Guidance and Information for additional information, including the RNC Technical Guidance.

***State-listed Species***

- Several state-listed plant species have been documented within the vicinity of the area of interest and there are known occurrences of state-listed threatened plants within the area of interest. These species are listed in the table below; the species documented in the proposed project area is noted with an asterisk. Minnesota's Endangered Species Statute (Minnesota Statutes, section 84.0895) and associated Rules (Minnesota Rules, part 6212.1800 to 6212.2300 and 6134) prohibit the take of endangered or threatened plants or animals, including their parts or seeds, without a permit. Further consultation with the DNR will be needed before any disturbance occurs on this site.

| State status | Common Name | Scientific Name | Habitat |
|---|---|---|---|
| Endangered | Canada Forked Chickweed | *Paronychia canadensis* | Savanna, Upland Prairie |
| Threatened | Seaside Three-awn | *Aristida tuberculosa* | Upland Prairie, Savanna |
| Threatened | Clasping Milkweed* | *Asclepias amplexicaulis** | Savanna, Upland Prairie |
| Threatened | Witch-hazel | *Hamamelis virginiana* | Mesic Hardwood Forest |
| Threatened | Three-flowered Melic | *Melica nitens* | Mesic Hardwood Forest, Upland Prairie |
| Threatened | Silverleaf Grape | *Vitis aestivalis* | Mesic Hardwood Forest |
| Special Concern | Plains Wild Indigo | *Baptisia leucophaea* | Savanna, Upland Prairie |
| Special Concern | Canada Frostweed | *Crocanthemum canadense* | Savanna, Upland Prairie |
| Special Concern | Old Field Toadflax | *Nuttallanthus canadensis* | Savanna, Upland Prairie |
| Special Concern | Goat's Rue | *Tephrosia virginiana* | Savanna, Upland Prairie |

- Timber rattlesnakes (*Crotalus horridus)*, a state-listed threatened species, and North American racer (*Coluber constrictor*) and gophersnake (*Pituophis catenifer*), both state-listed species of special concern, have been reported in the vicinity of the proposed project and may be encountered on site. In Minnesota, the ideal habitat for timber rattlesnakes and North American racers is forested bluffs, south-facing rock outcrops, and bluff prairies, particularly in the Mississippi River Valley while gophersnakes prefer open, sandy-soiled habitats. Nearby forests, prairies, and agricultural lands are used as summer feeding grounds. Timber rattlesnake mortality in Minnesota is most commonly caused by poaching, vehicle collisions, and habitat destruction. The loss of a single adult, especially a female, can impact the population significantly. Minnesota's Endangered Species Statute (Minnesota Statutes, section 84.0895) and associated Rules (Minnesota Rules, part 6212.1800 to 6212.2300 and 6134) prohibit the take of threatened or endangered species without a permit. There may be take associated with any development of the area. Additional consultation with the DNR will be needed before any development occurs in the area.

- The area of interest overlaps with a U.S Fish and Wildlife Service (USFWS) Rusty Patched Bumble Bee High Potential Zone. The rusty patched bumble bee *(Bombus affinis)* is federally listed as endangered and is anticipated to be listed as an endangered species in Minnesota in 2026. This species is likely to be present in suitable habitat (shrub/tree cover and the surrounding 100 feet of vegetation) within High Potential Zones and may be impacted by a variety of land management activities including, but not limited to, prescribed fire, tree-removal, haying, grazing, herbicide use, pesticide use, land-clearing, soil disturbance or compaction, or use of non-native bees. Minnesota's Endangered Species Statute (Minnesota Statutes, section 84.0895) and associated Rules (Minnesota Rules, part 6212.1800 to 6212.2300 and 6134) prohibit the take of threatened or endangered species without a permit. **A permit to take may be needed when the endangered status becomes effective.** Updates to the status of this species will be posted at Endangered and Threatened Species Permits. Additional consultation with the DNR will be needed before any development occurs in the area.

- Please visit the DNR Rare Species Guide for more information on the habitat use of state-listed species and recommended measures to avoid or minimize impacts.

***Federally Protected Species***

- The rusty patched bumblebee is also federally listed as endangered.

- To ensure compliance with federal law, conduct a federal regulatory review using the U.S. Fish and Wildlife Service's (USFWS) online Information for Planning and Consultation (IPaC) tool.

***Natural Heritage Review***

- The best way for project proposers to do their due diligence in regard to state endangered species laws is to request a Natural Heritage Review from the DNR. Requests can be made through the Minnesota Conservation Explorer website. More information about the process can be found at the Natural Heritage Review Program website.

The Natural Heritage Information System (NHIS), a collection of databases that contains information about Minnesota's rare natural features, is maintained by the Division of Ecological and Water Resources, Department of Natural Resources. The NHIS is continually updated as new information becomes available and is the most complete source of data on Minnesota's native plant communities, rare species, and other rare features. However, the NHIS is not an exhaustive inventory and does not contain the locations of all rare features in the state. Therefore, ecologically significant features for which we have no records may exist within the project area. If additional information becomes available regarding rare features in the vicinity of the project, further review may be necessary.

This letter identifies issues regarding known occurrences of rare features and potential impacts to these rare features. Visit Natural Heritage Review for additional information regarding this process, survey guidance, and other related information. For information on the environmental review process or other natural resource concerns, please contact your DNR Regional Environmental Assessment Ecologist.

Thank you for consulting us on this matter and for your interest in the conservation of Minnesota's rare natural resources.

Sincerely,

James Drake Digitally signed by James Drake
Date: 2026.03.23 17:02:14 -05'00'

Natural Heritage Review Specialist
james.f.drake@state.mn.us

Cc: Melissa Collins

# Proposed Development Area

USA Topo Basemap With Locator Map



Project Boundary

Project Type: Mining, Sand / Gravel / Crushed Stone

Project Size (acres): 51.65

County(s): Houston

TRS: T104 R7 S19, T104 R7 S20, T104 R7 S29

3/18/2026 04:12 PM

Minnesota Natural Resource Atlas



Driven to Discover®

Search Data Catalog Search

NATURAL RESOURCES RESEARCH INSTITUTE

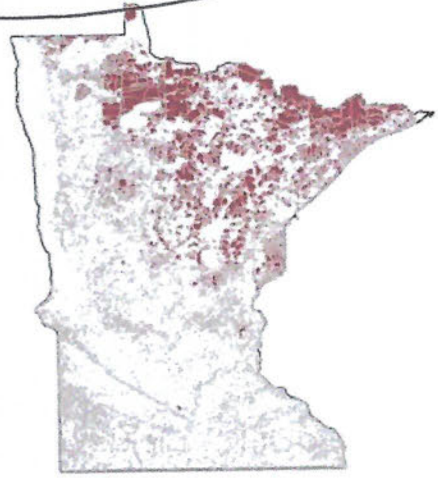
# Minnesota Natural Resource Atlas

Home | Using the Atlas | Mapping Tool | Data Catalog | About the Atlas

## Biodiversity Significance

Outstanding Biodiversity

**Data Categories:** Biota
**Data Source:** MN Dept. of Natural Resources
**Update Fequency:** As Needed
**Date Acquired:** 12/23/2025
**Data Available:** Yes
**Metadata Available:** Yes
**Tags:** biological surveys, Native Plant Communities, Rare Plants



Extent of available data.

This data layer identifies areas of biodiversity significance. It was developed by the Minnesota Department of Natural Resources. Aerial photography interpretation and field investigations were used to assign a native biodiversity significance ranking to sites within the landscape. The ranking is determined based on the number of rare species, the quality of the native plant communities, the size of the site, and the site's context within the landscape. These areas that may contain high quality native plant communities, rare plants, rare animals, and/or animal aggregations can be given priority for preservation.

**Launch Map** **Get Data** **Get Metadata**

nrriinfo@d.umn.edu
(800) 234-0054
(218) 788-2694
5013 Miller Trunk Highway
Duluth, MN 55811



## About the Project

The Natural Resource Atlas of Minnesota is a collaborative project led by the Natural Resources Research Institute – University of Minnesota Duluth with contributions from the College of Food, Agriculture and Natural Resources – University of Minnesota and Minnesota Sea Grant. Funding has been provided by the Minnesota State Legislature, the Legislative-Citizen Commission on Minnesota Resources, and the Department of Iron Range Resources and Rehabilitation.

Updated 02/03/2026

# Property Evaluation for Native Plant Communities

**Rosemary Iverson**
**T104, R7, S19**
**Houston County**

2

**Prepared by:**
**Jaime Edwards**
**Nongame Wildlife Specialist**
**MN Department of Natural Resources**
**Nongame Wildlife Program**
**September 2012**

## Property Location

The Iverson property consists of 41.9 acres located in Houston County, Yucatan Township, off Highway 16. The property is on rolling terrain with a steeper southwest facing slope. The property is south and west of the Root River by approximately ½ mile or less. The legal description is T104N, R7W, SE ¼ of the SE ¼ of Section 19.

## Property Use

The Iverson property is used recreationally, with no permanent residence on site. There is a small cabin on the property, but the remainder of the property is left in its natural state. No formal or significant trails occur on the property.

It is likely that portions of the property were lightly grazed at one time, but no grazing has occurred in at least the last 20 years. The property does not exhibit signs of having a significant grazing history. The oak-shagbark hickory portion of the property shows signs of select harvest of a few trees, but it doesn't appear to have been heavily logged, and the landowner has no knowledge of previous logging activity.

## Property Background

The Iverson property lies within the **Eastern Broadleaf Forest Province** (EBF) of Minnesota, which covers nearly 12 million acres of the central and southeastern parts of the state and serves as a transition, or ecotone, between semiarid portions of the state that were historically prairie and semihumid mixed conifer-deciduous forests to the northeast. The western boundary of the province in Minnesota is sharply defined along much of its length as an abrupt transition from forest and woodland to open grassland.

The land surface of the province is largely the product of Pleistocene glacial processes. The northwestern and central portions of the province were covered by ice in the last glaciation and are characterized by thick (100–300 feet [30–90 meters]) deposits of glacial drift that is highly calcareous and of Wisconsin Age at its surface. Glacial lakes associated with the last glacial advance contributed large volumes of meltwater to rivers that cut deep valleys along the present course of the Minnesota, St. Croix, and lower Mississippi rivers. In the southeastern part of the province, which was not covered by ice in the last glaciation, headward erosion of streams draining into the deepening Mississippi valley dissected the flanking uplands, exposing Paleozoic bedrock and pre-Wisconsin drift. The waning stages of the glacial lakes contributed massive amounts of sediment to the river valleys and provided a source of silt that was redeposited by wind as a mantle of loess over the eroded lands in the southeastern part of the province.

The EBF Province coincides roughly with the part of Minnesota where precipitation approximately equals evapotranspiration; it seems likely that this aspect of climate has an important influence on plants, as many forest species reach their western range limits and several prairie species reach their eastern range limits within the province.

This Province is divided into sections, of which the Iverson property lies within the **Blufflands Subsection.** This area is a rugged region of bluffs and valleys that is quite different from the rest of the state.

The **Blufflands Subsection** is a loess-capped plateau, deeply dissected by river valleys. The greatest relief occurs along the Mississippi River, where relief is up to 600 feet. In the east, loess lies directly on bedrock. In the southeast, loess overlies red clayey residuum that was formed directly from limestone or sandstone. Paleozoic sedimentary rocks are exposed in valley walls, but are generally mantled with colluvium or loess. Topography is controlled by underlying glacial till along the western edge of the subsection, where loess is several feet thick. As glacial drift thins to the east, topography is largely bedrock controlled (Dept. of Soil Science, Univ. of Minnesota 1973). Sinkholes are common in the southwestern portion of the subsection.


Depth of drift over bedrock varies from 0 to 50 feet. Bedrock is exposed in river and stream valleys. In general, sediment thickness varies by landscape position. Large exposures of bedrock occur in the steep ravines. These exposures are primarily Ordovician dolomite, limestone, and sandstone with Cambrian sandstone, shale, and dolomite exposed along the valley walls of the Mississippi River (Morey 1981, Sims et al. 1966). Devonian dolomite and limestone are more locally exposed along the western edge of the subsection.

Loess thickness is variable; loess deposits range from 30 feet thick on broad ridgetops, to less than a foot on valley walls. The predominant soils are Udalfs, with localized Aquents along the floodplains of major rivers (Cummins and Grigal 1981). Cambrian siltstones, sandstones, and shales influence soil properties.

There are no natural lakes in this subsection. The drainage network is well developed and dendritic in nature. Major rivers include the Mississippi (which forms the eastern boundary), Root, Whitewater, Zumbro, and Canon. There are numerous coldwater trout streams throughout the subsection.

Tallgrass prairie and bur oak savanna were major vegetation types on ridge tops and dry upper slopes. Red oak-white oak-shagbark hickory-basswood forests were present on moister slopes, and red oak-basswood-black walnut forests in protected valleys. Prairie was restricted primarily to broader ridge tops, where fires could spread, but also occurred on steep slopes with south or southwest aspect. Sand prairies also occurred in areas with outwash sands associated with rivers.

The Blufflands Subsection has the rarest habitat types remaining in Minnesota, including prairie and oak savanna (oak openings). This subsection also harbors the highest number of wildlife species that are of greatest conservation concern by the State of Minnesota.

(Source: Tomorrow's Habitat for the Wildlife and Rare, MN DNR)

**Pre-settlement Vegetation**

Based on Marschner's pre-settlement vegetation map of Minnesota, the Iverson property was dominated by prairie and oak openings/barrens. The pre-settlement map also indicates the presence of river bottom forest. Marschner's data is generalized over a broader area, so the presence of river bottom forest may not be reflective of the portion of the Iverson property that has forest, which is higher in elevation and likely never was what we typically associate with a bottomland forest.

Pre-settlement bearing trees found in the immediate area of the Iverson property include black oak (*Quercus nigra*), and northern pin oak (*Quercus ellipsoidalis*). Both species are commonly associated with barrens habitat. Hackberry (*Celtis* occidentalis) was found south and east of the property. This tree can grow in bottomland conditions, as well as in dry, upland conditions; therefore, its presence doesn't lend much insight to the pre-settlement habitat conditions. No other bearing trees were noted that indicate the presence of river bottom forest.

**Current Vegetation**

The Iverson property has three rare plant communities including: dry barrens oak savanna (oak subtype), dry barrens prairie (southern), and dry bedrock bluff prairie (southern). The property also has an oak-shagbark hickory woodland and a red oak-white oak (sugar maple) forest, which are more common plant communities. Overall, the property lies within a larger complex of oak barrens/savanna and oak forest. It is one of the few larger barrens complexes remaining in Minnesota.

The following is a description of the native plant communities found on the Iverson property. The community name and category (ex. UPs14) are derived from the Field Guide to Native Plant Communities of Minnesota, Eastern Broadleaf Forest, developed by the MN DNR.

**Dry barrens oak savanna (southern - oak) – UPs14a2**

Once common on the landscape in Minnesota, dry barrens oak savanna is currently a very rare plant community, with less than 1% of intact barrens savanna remaining statewide. The majority of the Iverson property has this plant community on it (See appendix for native plant community map). This native plant community is characterized by having sparse trees on very sandy soils. Sand blow-outs are often present, and topsoil formation is uncommon. Organic matter can be found in the top soil/sand layer where the substrate has been stabilized by vegetation. The herbaceous vegetation is dominated by native grasses but rarely covers 100% of the surface. Black oak is the dominant tree, with occasional pin oaks when fire has been suppressed. In the absence of fire, this plant community is susceptible to cedar encroachment and succession to woodland and forest. Dry barrens oak savanna is a fire-dependent native plant community.

Native grasses typically associated with this plant community include little bluestem (*Schizachyrium scoparium*), porcupine grass (*Stipa spartea*), and June grass (*Koeleria pyramidata*). Because of the very dry, sandy nature of this plant community, several species tend to be more restricted to this habitat type including sand dropseed (*Sporobolus cryptandrus*) and base-branched three-awn grass (*Aristida basiramea*). Flowers commonly found on barrens oak savannas include western ragweed (*Ambrosia psilostachya*), Virginia ground cherry (*Physalis virginiana*), gray goldenrod (*Solidago nemoralis*), and hoary frostweed (*Helianthemum bicknelli*).

(For the sake of easier reading, scientific names will not be included, please refer to appendix for scientific names)

During site visits in 1988 and 1993, MN DNR Plant Ecologists observed a sand savanna dominated by black oak with some northern pin oak and Eastern red cedar. There were many open sandy areas. Species commonly encountered included western ragweed, cotton grass, bracken fern, horsemint, hairy puccoon, Canadian forked chickweed, little bluestem, black-eyed Susan, bird's foot coreopsis, false Solomon's seal, Indian pipe, and clasping milkweed. Quality of the barrens was rated as good to excellent and no evidence of grazing was present.

During my August 7, 2012 site visit, I observed several of the same species. The lack of fire has lead to an increase in black oak, pin oak and red cedar, among other tree and shrub species. The overall character of the site still remains a black oak dominated barrens savanna, but succession is changing this plant community. The very dry sandy soil is helping slow the progression into woodland, and eventually forest, but without reintroduction of fire, this oak barrens savanna will be lost. The herbaceous species observed are indicative of a barrens oak savanna and the quality remains good despite the increased canopy. Restoration potential is high for this plant community.

The main plant species I observed in the oak barrens savanna include:

| **Trees/shrubs** | **Flowers** |
|---|---|
| Black oak | Bird's foot coreopsis |
| Northern pin oak | False Solomon's seal |
| Red cedar | figwort |
| Smooth sumac | gray goldenrod |
| American hazelnut | horsemint |
| | rattlesnake plantain |
| Grasses | western ragweed - dominant |
| June grass | Western sunflower |
| Little bluestem | wood betony |
| purple lovegrass - dominant | |
| a species of panic grass | |
| Pennsylvania sedge - dominant | |
| Other sedges | |

** This was not an exhaustive list of species present, but rather includes a list of species commonly observed during the site evaluation, and considered to be indicative of this native plant community.

**Dry Bedrock Bluff Prairie (Southern) - UPs13c**

In Southeastern Minnesota, dry bedrock bluff prairies are typically restricted to steep south- or west-facing slopes. Soil cover is thin with a considerable amount of rock, often exposed as outcrops, ledges or cliffs. Similar dry prairies occur throughout the state, but are not always associated with the dolomite or sandstone bedrock found in SE MN. Bluff prairie is the second dominant native plant community on the Iverson property. This plant community is characterized by having very few trees (historically), and being dominated by native grasses, flowers and some shrubs. Herbaceous cover can vary from as little as 25% to as much as 100% depending on the soil composition, slope aspect, and tree canopy of the site. Herbaceous vegetation can range from tall native grasses to mid-height native grasses; however, mid-height is more common with a few bunches of tall grasses. This plant community is susceptible to cedar and brush encroachment, especially with the lack of fire. Bluff prairies are fire dependent native plant communities.

Native grasses typically associated with this plant community for SE MN include side-oats grama (*Bouteloua curtipendula*), plains muhly grass (*Muhlenbergia cuspidata*), and Kalm's brome (*Bromus kalmia*). Flowers commonly found on bedrock bluff prairies include flowering spurge (*Euphorbia corollata*), skyblue aster (*Aster oolentangiensis*), and bird's foot coreopsis. Some species found more commonly on bluff prairies than other types of dry prairies include false boneset (*Kuhnia eupatorioides*), cylindric blazing star (*Lisatris cylindracea*), and beardless birdfoot violet (*Viola pedata*).

(For the sake of easier reading, scientific names will not be included, please refer to appendix for scientific names)

During site visits in 1988 and 1993, MN DNR Plant Ecologists observed a bluff prairie that was starting to get significant cedar encroachment, but open prairie areas were persistent throughout, with good plant diversity. Open-grown oaks were observed, indicating the historical openness of the site and also the transition of bluff prairie to oak savanna. This transition is common for SE MN bluff prairies, which often grade from bluff prairie into oak savanna. Plant species commonly encountered included black oak, Eastern red cedar, and little bluestem. Not a lot of plant data was collected for the bluff prairie.

During my site visit on 7 August 2012, I observed a degraded bedrock bluff prairie suffering from severe Eastern red cedar encroachment. Prairie openings still occur, but are small and isolated. Plant diversity is still good, indicating some level of restorability. However, a large portion of the bluff has little to no vegetative understory due to dense cedar cover. Pennsylvania sedge is becoming dominant in some areas, which is common for degraded bluff prairies. Rocky outcrops are present including small to large outcrops and/or exposed limestone. Most rocky areas are completely shaded by cedars, oaks and other tree and shrub species. The invasive species, buckthorn, is also present, which can pose a significant threat over time. Despite the degraded quality of the bluff, many native plants were still found on the site, just not in great abundance.

The following species were observed on the Iverson bluff prairie:

| **Trees/shrubs** | **Flowers** |
|---|---|
| Black oak | Bergamot |
| Bur oak | Bird's foot coreopsis |
| Grey dogwood | False boneset |
| Leadplant | Flowering spurge |
| Ninebark | Gray goldenrod |
| Red cedar - dominant | Green milkweed |
| Smooth sumac | Hoary puccoon |
| | Long-headed thimbleweed |
| Grasses | Prairie ragwort |
| June grass | Purple prairie clover |
| Indiangrass | Pussy toes |
| Little bluestem | Silky aster |
| purple lovegrass | Sky blue aster |
| a species of panic grass | Western sunflower |
| Pennsylvania sedge - dominant | Whorled milkweed |
| Prairie dropseed | Wild flax |
| Side-oats grama | Wood betony |
| Switchgrass | Yellow coneflower |

** This was not an exhaustive list of species present, but rather includes a list of species commonly observed during the site evaluation, and considered to be indicative of this native plant community.

**Dry Barrens Prairie (South) – UPs13a**

This native plant community occurs on a small section of the Iverson property, surrounded by barrens oak savanna. While not comprising a significant portion of the property, this plant community is rather rare in SE MN. Dry barrens are dominated by native grasses on wind-reworked sand. Exposed sand and blow-outs are common, and dunes form occasionally in more expansive barrens. There is little or no soil formation. Plants more characteristically found in this plant community compared to other dry prairies include silky prairie clover (*Dalea villosa*), long-leaved panic grass (*Panicum perlongum*),

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seaside three-awn grass (*Aristida tuberculosa*), sand dropseed (*Sporobolus crytandrus*) and hairy puccoon (*Lithospermum carolinense*). This plant community is susceptible to some cedar encroachment, but due to the dry, unstable soil, it takes a long time for tree species to become dense. Without fire, black oaks can become dense and Northern pin oak can also become established. Dry barrens prairie is a fire-dependent native plant community.

(For the sake of easier reading, scientific names will not be included, please refer to appendix for scientific names)

During site visits in 1988 and 1993, MN DNR Plant Ecologists observed an excellent quality sand barrens prairie grading into a dry barrens oak savanna. Scattered black and pin oak were present, but open sandy expanses were also found. Several rare plant species ( all State-listed) were found in this plant community, including goat's rue, Canada forked chickweed, plains wild indigo, cliff goldenrod, clasping milkweed, and sea-beach three-awn grass. Other, more common species, found in association with the rare plants include Canada frostweed, tall blazing star, horsemint, western ragweed, cotton grass, old field toadflax, hairy puccoon, and little bluestem.

During my 7 August 2012 site visit, I observed several of the sand barrens species observed in the early 1990s. The overall size of the sand barrens appears to be smaller, with some of it converting into black oak savanna. However, there are still expanses of open sand. Herbaceous cover was in pockets with bare sand pockets also present. Goat's rue dominated the site. Purple lovegrass was also present. I observed several of the listed species found previously on the property, including goat's rue, Canada forked chickweed, and sea-beach three-awn grass. The weather in 2012 has been extremely dry, so plants such as milkweed have not fared well. It is likely this species is still present, but was not visible or may have been browsed by deer. Overall, the quality of the sand prairie remains excellent.

In addition to observing a higher quality barrens plant community, I observed at least one six-lined racerunner, a lizard typically associated with dry sandy habitats in SE MN. This lizard is considered to be a species in greatest conservation need.

The following is a list of plant species I observed on the Iverson sand barrens:

| **Trees/shrubs** | **Flowers** |
|---|---|
| Black oak | Bergamot |
| Northern pin oak | Bird's foot violet |
| Leadplant | Blue vervain |
| | Canada forked chickweed |
| **Grasses** | Canada frostweed |
| June grass | Earthstar |
| purple lovegrass - dominant | Evening primrose |
| a species of panic grass | Flowering spurge |
| Pennsylvania sedge | Goat's rue - dominant |
| Sea-beach thee-awn grass | Gray goldenrod |
| Switch grass | Horsemint |
| | Hoary puccoon |
| | Pussy toes |
| | Round-headed bushclover |
| | Rough blazing star |
| | Showy goldenrod |
| | Sweet everlasting |
| | Tall cinquefoil |

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|---|---|
| | Western sunflower |
| | Virginia ground cherry |

** This was not an exhaustive list of species present, but rather includes a list of species commonly observed during the site evaluation, and considered to be indicative of this native plant community.

**Southern Oak-Shagbark Hickory Woodland – FDs38a**

This native plant community comprises a relatively small portion in the north east corner of the Iverson property. This native plant community is unique to Southeastern Minnesota because shagbark hickory reaches its northern-most range. Oak-hickory woods commonly occur on dissected bedrock terrain. Many of these woodlands have prairie soils in their profile, indicating they were formerly occupied by open woodlands (savannas) or prairie. This is a fire-dependent native plant community with an average historical fire cycle of 11 years. There are commonly three growth stages to this native plant community: young forests recovering from fire (0-55 years), mature forests (55-135 years), and old forests (>135 years).

Based on the 1993 site evaluation by MN DNR Plant Ecologists, the oak-hickory woodland section of the Iverson property appeared to have been selectively logged. It was categorized as a dry-mesic forest dominated by red and white oak, with hackberry, black oak and birch. Canopy cover approximated 70% with many dense, straight-trunked trees. The typical diameter at breast height (dbh) of the trees ranged from 10" – 15", but larger trees were also occasionally present ranging from 2' – 3' in dbh. Most of these larger trees were observed on the upper slopes. The size of these trees indicates the woodland was in the mature forest stage, with a few trees reaching the old forest stage. The majority of the subcanopy (50% – 75%)was dominated by ironwood, American elm, hackberry, and maple. The shrub layer was 50% – 75% choke cherry, hazelnut, and round-leaved dogwood. Tree seedlings represented approximately 5% of the herbaceous layer with a diversity of herbaceous plants primarily on the northern aspect of the property. A list of herbaceous plants was not included in the evaluation.

During my site visit on 7 August 2012, I did not spend a lot of time in this portion of the property. However, one thing that I did notice and is important is the lack of invasive brush such as buckthorn and honeysuckle. There also weren't large patches of prickly ash or gooseberry, which would indicate a significant grazing history. It is very uncommon to find woodland sites in SE MN that are not heavily inundated with invasive brush. There are some invasive plants present, but not at any significant level at this time. However, monitoring should occur to ensure invasives don't increase significantly, especially since buckthorn is present in larger amounts on the bluff prairie and could be a potential source. Unfortunately, I did find some garlic mustard. There wasn't a significant amount and it appeared to be all first-year plants, but this non-native invasive can very quickly overtake the understory of woodlands and should be considered a significant threat. We pulled much of what we found, but the woods should be monitored for additional plants. Overall, I would consider this plant community to still be in the mature growth stage. Canopy cover remains at roughly 60% - 70%.

The following is a list of plant species I observed on the Iverson oak-hickory woodland:

| **Trees/shrubs/vines** | **Flowers** |
|---|---|
| American elm | Bergamot |
| American hazelnut | False Solomon's seal |
| Black cherry | Hog peanut |
| Chokecherry | Honewort |
| Grey dogwood | Horse gentian (tinkerweed) |
| Gooseberry | Lopseed |
| Greenbrier | Pointed-leaved tick trefoil |
| Hackberry | Sweet cicely |
| Ironwood | Side-flowering aster |
| Poison ivy | White snakeroot |
| Prickly ash | |

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|---|---|
| Red/Black oak | **Grasses** |
| Rubus sp. (brambles/briars) | Pennsylvania sedge |
| Shagbark hickory | Other sedges |
| Smooth sumac | Other grass species |
| White oak | |
| Virginia creeper | |
| | |

** This was not an exhaustive list of species present, but rather includes a list of species commonly observed during the site evaluation, and considered to be indicative of this native plant community.

**Red Oak – White Oak – (Sugar Maple) Forest - MHs37b**

This native plant community comprises a small portion of the NW corner of the Iverson property. Red and white

oak are the dominant canopy trees in this plant community, but sugar maple, basswood, and other trees are also commonly found. Depending on the age of the forest, the maples and basswoods can be larger, especially if fire or other disturbance has retained the higher percentage of oak, and the forest is starting to transition to a maple-basswood dominated forest. Fire occurs much less frequently in this plant community type, often on a 20 year or more rotation. This forest type is most commonly found on north slopes, which are moister with richer soil (thus the decreased frequency of fire). However, they can also be found on upper east and west slopes. Soil profiles are richer than other plant communities found on the Iverson property, and indicate a history of oak woodland rather than prairie.

The plant composition, particularly the tree and shrub species, of red oak-white oak forests is very similar to the oak-hickory woodland. These two plant communities can be differentiated by the herbaceous layer. Red oak-white oak forests (MHs37b) tend to have fewer prairie associated herbaceous plants than the oak-hickory forests. MHs37b indicator species include Jacob's ladder (*Polemonium reptans*), bloodroot (*Sanguinaria Canadensis*), American spikenard (*Aralia racemosa*), and Virginia waterleaf (*Hydrophyllum virginianum*). It would also be more common to find an increased abundance of spring ephemerals in this plant community as soil moisture is typically higher, especially on north slopes.

No plant data from the plant ecologists exists for this community. I also did not walk this corner of the property.

**Minnesota County Biological Survey (MCBS)**

The MCBS evaluated the Iverson property and surrounding area in 1988 and 1993. Several rare plant species were noted on the Iverson property, including:

Canada forked chickweed (*Paronychia Canadensis*) – threatened
Plains wild indigo (*Baptisia bracteata var. leucophaea*) – special concern
Cliff goldenrod (*Solidago sciaphila*) – special concern
Goat's rue (*Tephrosia virginiana*) – special concern
Clasping milkweed (*Asclepias amplexicaulis*) – special concern
Sea-beach needlegrass (*Aristida tuberculosa*) – special concern

In addition to finding rare species and rare plant communities, MCBS ranked the habitat found on the Iverson property and surrounding area as having outstanding biodiversity. Very few areas with this ranking, the highest level, remain in Minnesota. The ranking of outstanding indicates the habitat still contains the main characteristics and floristic composition associated with that native plant community, and often has limited to no invasive species.

**Management Recommendations**

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The ***dry barrens*** prairie is still relatively intact on the Iverson property. It is slowly decreasing in size, shifting over to dry oak barrens, but the floristic diversity is still excellent. Management in this plant community can consist of some oak removal as well as some shrub removal as shrubs move in. A periodic prescribed burn will help keep the sand prairie open. However, the open sandy nature of this plant community will result in patchy burning, which is just fine. This community is very dry by nature, so fire should not be used on a frequent basis. It is recommended that fire be used as a management tool every 5-10 years, based on the encroachment of trees and shrubs. No significant invasive species occur in this community at this point, which is great. Things to watch for in this community include spotted knapweed, cow vetch and crown vetch. Vetches are often used for soil stabilization, so if either of these two species is planted in the vicinity, especially along roads, monitoring should be done to ensure they don't get established on the sand barrens. The most common route for knapweed and vetches to reach a site are from transport by mowing equipment, vehicles and ATVs. All equipment and vehicles should be cleaned with a power washer prior to entering the site, especially if the equipment or vehicles were in areas known to have these invasives.

The ***barrens oak savanna*** is also still in good shape. However, tree density is increasing and the presence of pin oak indicates the habitat has lacked fire for some time. This is a fire dependent community, so fire is an important management tool that can, and should, be used for this community. Larger black oaks will withstand fire, but the pin oaks will be set back to some degree by a hot fire. Fire will also set back some of the brush such as hazelnut and sumac. The presence of Pennsylvania sedge indicates some woodland plants are starting to establish in the savanna. This isn't all that bad, but if the area continues its succession, this community will be lost. Because it is such a rare plant community in Minnesota, it is important to retain. Selective harvest of oaks to reduce the overall canopy will help keep the open nature of the savanna, and allow for drier prairie plants to continue and expand. Fire cycle can be every 3-8 years, with more frequent fire recommended early on to reduce some of the woody vegetation. Because the soil substrate of this plant community is sand, the same herbaceous invasives species as the dry barrens should be watched for. Additionally, woody invasives that can be a problem in this plant community include red cedar, buckthorn, honeysuckle, and Japanese barberry. Birds and other wildlife can bring in seeds for these tree/shrub species. Also buckthorn is present in the bluff prairie area and can serve as a source. Burning will help keep these species out, but anything larger than 1" diameter should be removed, or cut and treated with a brush specific herbicide such as Garlon 4.

Both of the above communities are very sandy, and thus, are excessively drained. Because of this, no herbicide containing picloram (such as Pathway or Tordon) should be used to treat brush or trees. This chemical easily leeches in the soil and can spread to other non-target plants and trees. It also has a higher soil residency time, so it is not recommended for these sites. Chemicals including glyphosate and triclopyr would be fine in this environment if chemical treatment is pursued for brush control.

The ***dry bedrock bluff prairie*** is getting severely overgrow with red cedar. The density of trees is significant enough that not much vegetation is growing on the ground. There are still pockets of prairie and signs of stunted, stressed prairie plants under the cedars. This indicates the site is still salvageable around the open pockets. It is highly recommended that cedars be cut and either removed from site, or piled and burned during the winter. Tree cutting should progress outward from existing prairie openings. Because the cedar density is significant, cedar removal should occur incrementally over time if possible – meaning remove a few acres at a time rather than restoring the entire bluff at once. While the latter can be done if funding dictates a one-time visit, it can make the site a little more susceptible to weed species becoming established. The site also has buckthorn as part of the understory. Existing trees should be treated to prevent further spread. As the bluff gets opened up, the buckthorn seedlings and seeds will express themselves. Small seedlings will die in hot fire, but right now there isn't enough grass to carry a good fire, so invasive brush will most likely need to be pulled or sprayed as it appears. Fire should be reintroduced as a management technique. Early fires will be spotty and not very hot, but as the prairie expands, fire will become more expansive and effective at retaining the openness of the bluff. Early on, fires should be conducted every 2-3 years, and then every 5-8 years once the prairie has expanded. The biggest threat to this plant community is already present - red cedar invasion. Buckthorn is also present and is considered a serious threat. Other woody invasives to be on the look-out for include honeysuckle, Japanese barberry and multiflora rose.

The **oak-shagbark hickory woodland** is still in relatively good condition. I did not see a lot of invasive brush, which would be the primary concern for this habitat type. The one exception is the presence of small pockets of garlic mustard. This is a non-native herbaceous invasive that can have a significant impact on a variety of woodland habitats. This plant is a biennial, so the first year it doesn't produce seed (which is what I saw), but the second year plant produces a substantial amount of seed and has an exploding seed pod. Birds and mammals also spread the seed. See appendix for ways to get rid of garlic mustard.

As for tree management, it depends on goals. If the goal is simply to have the plant community retained, little management is required other than to ensure invasives don't get a stronghold and that you are seeing new seedlings. If deer numbers are high, they can browse seedlings and saplings, preventing forest regeneration. This plant community is fire dependent, so periodic fire could be used. Without fire, this plant community could transition into a maple basswood forest. That is occurring in a lot of oak woodlands in SE MN. Fire will help retain the oak-hickory combination in this woodland.

If a goal is harvest, I recommend having a DNR forester assess the site and make recommendations on management. They likely will recommend some timber stand improvement practices that would reduce competitive trees such as ironwood, and selective management of specific trees that have the highest potential market value. They can also recommend the best harvest techniques. Oaks like sunlight, so harvest in this community may consist of removing larger patches of trees to allow for sufficient light for oak and hickory regeneration.

The ***red oak-white oak forest*** is a small portion of the Iverson property. Managing this small area will not have a significant impact on the overall quality of this forest since the majority of this plant community occurs on surrounding land. Invasive species is the biggest area of potential management. The same species that can impact the oak-shagbark hickory woodland can impact this forest community. Monitoring their presence and taking early action will be the best line of defense for maintaining the plant community structure.

While this plant community is not fire dependent , periodic use of fire can help retain the oaks. The tree diversity in this community is typically greater than the oak-shagbark community, so it is common and natural to have maple and basswood, as well as cherry and hackberry. If the goal is to retain a larger portion of oak, selective harvest of non-oak trees is probably going to be the best approach for management. Also, because this community is so small on the Iverson property, harvest is unlikely to provide a significant financial yield. Therefore, it is recommended to manage select trees for potential harvest, rather than the entire community.

**Wildlife Species on the Iverson Property**

The MCBS did not note any wildlife species on the Iverson property or surrounding area. It is likely that the MCBS animal staff did not survey this property given the total lack of animal information. During my site visit, I observed at least one six-lined racerunner (*Aspidoscelis sexlineata*) on the sand barrens area of the property. This animal is not a State-listed species, but it is recognized by the MN DNR as a species in greatest conservation need. I did not observe other wildlife species.

Given the high quality and complexity of the larger plant communities on and in the vicinity of the Iverson property, it is reasonable to expect the habitat supports a diversity of animal and insect species. Species that could potentially be found on or around the Iverson property that depend on the habitats present include (but are not limited to) the following key species:

Timber rattlesnake (which has been reported in the area, but not confirmed) - threatened
Bullsnake – special concern
Northern racer – special concern
Foxsnake – species in greatest conservation need
Milksnake – species in greatest conservation need
Eastern hog-nosed snake – species in greatest conservation need
Leonard's skipper butterfly – special concern
Prairie vole – special concern
Cerulean warber – special concern

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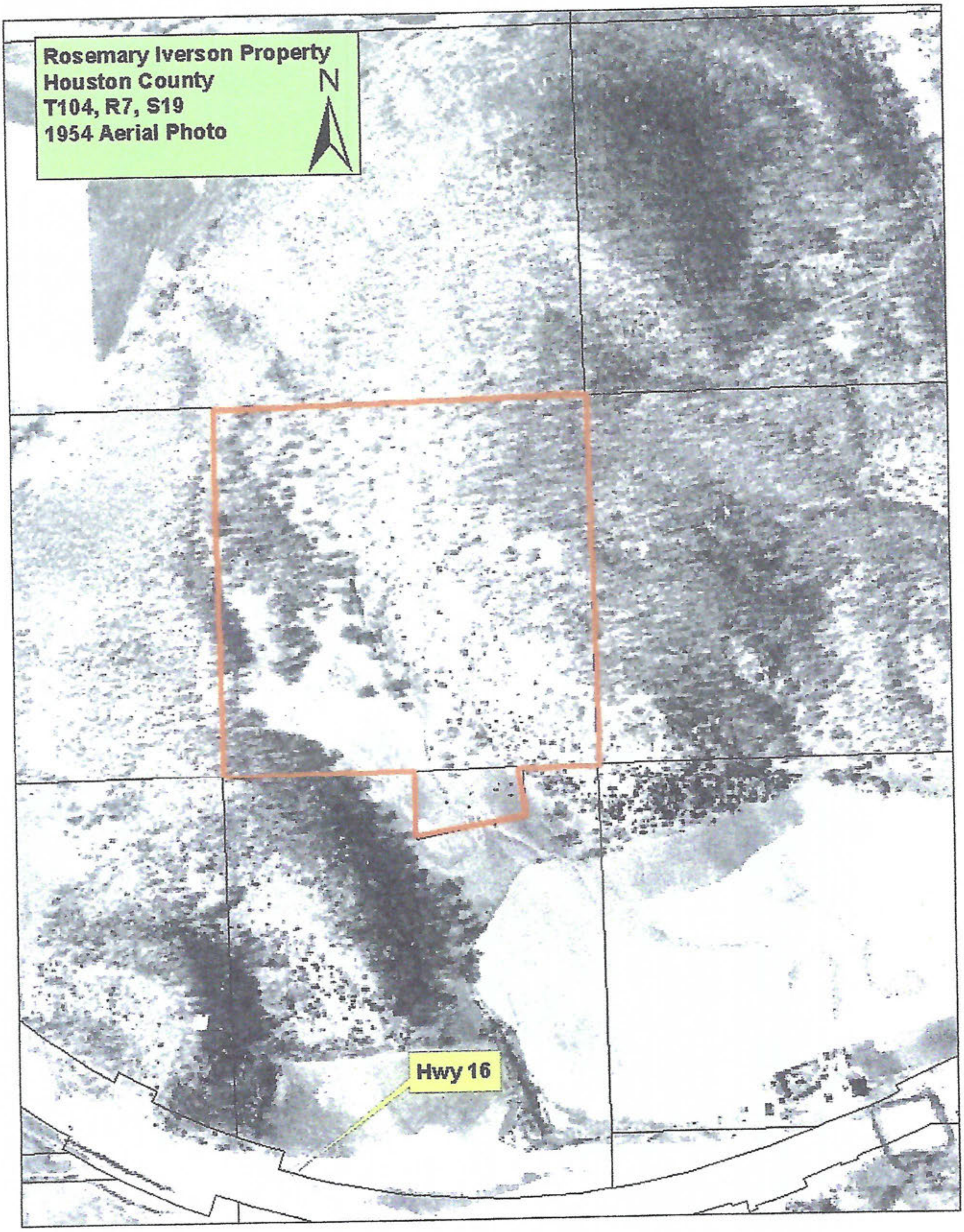
**Iverson Property 1954 Aerial Photo**

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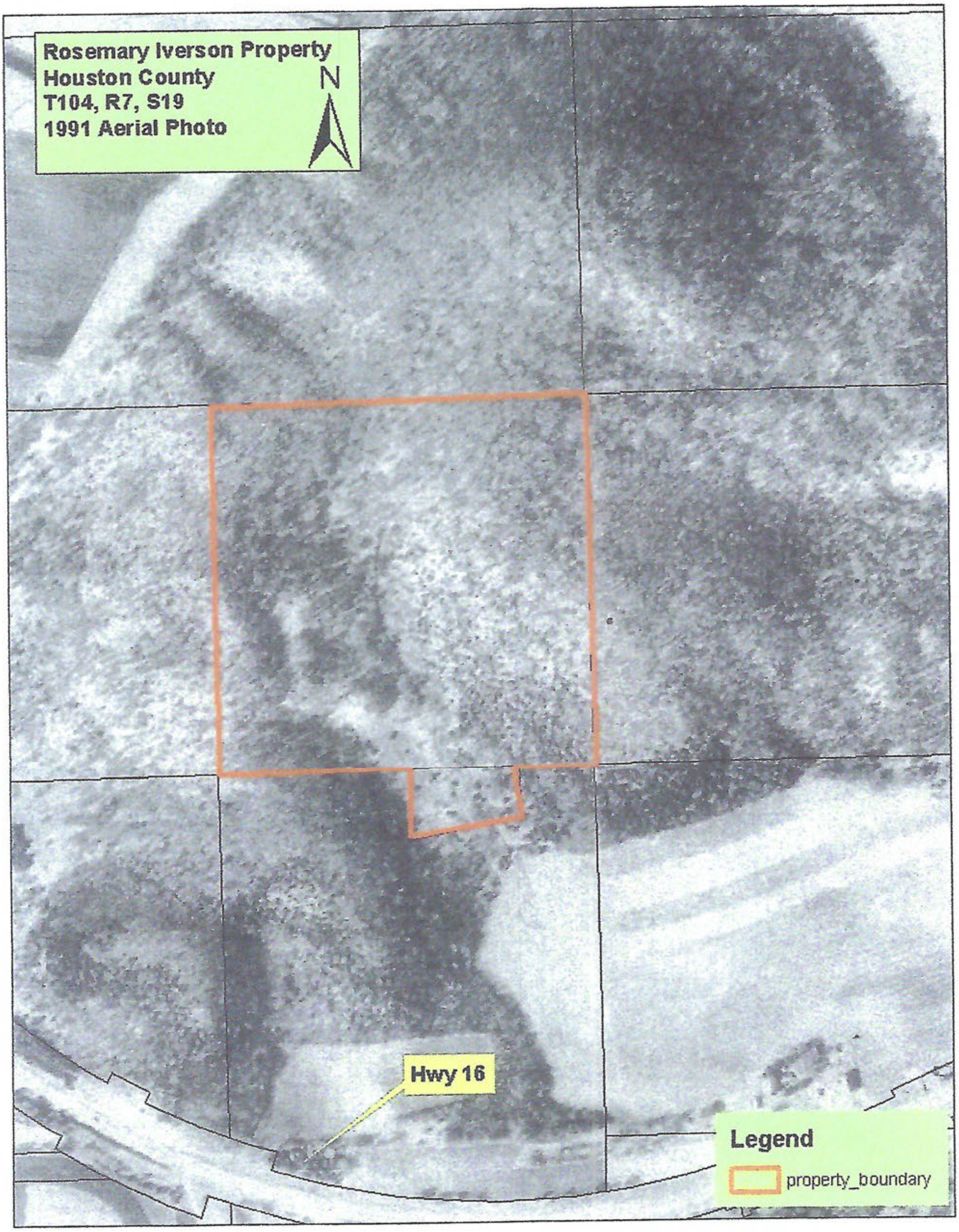
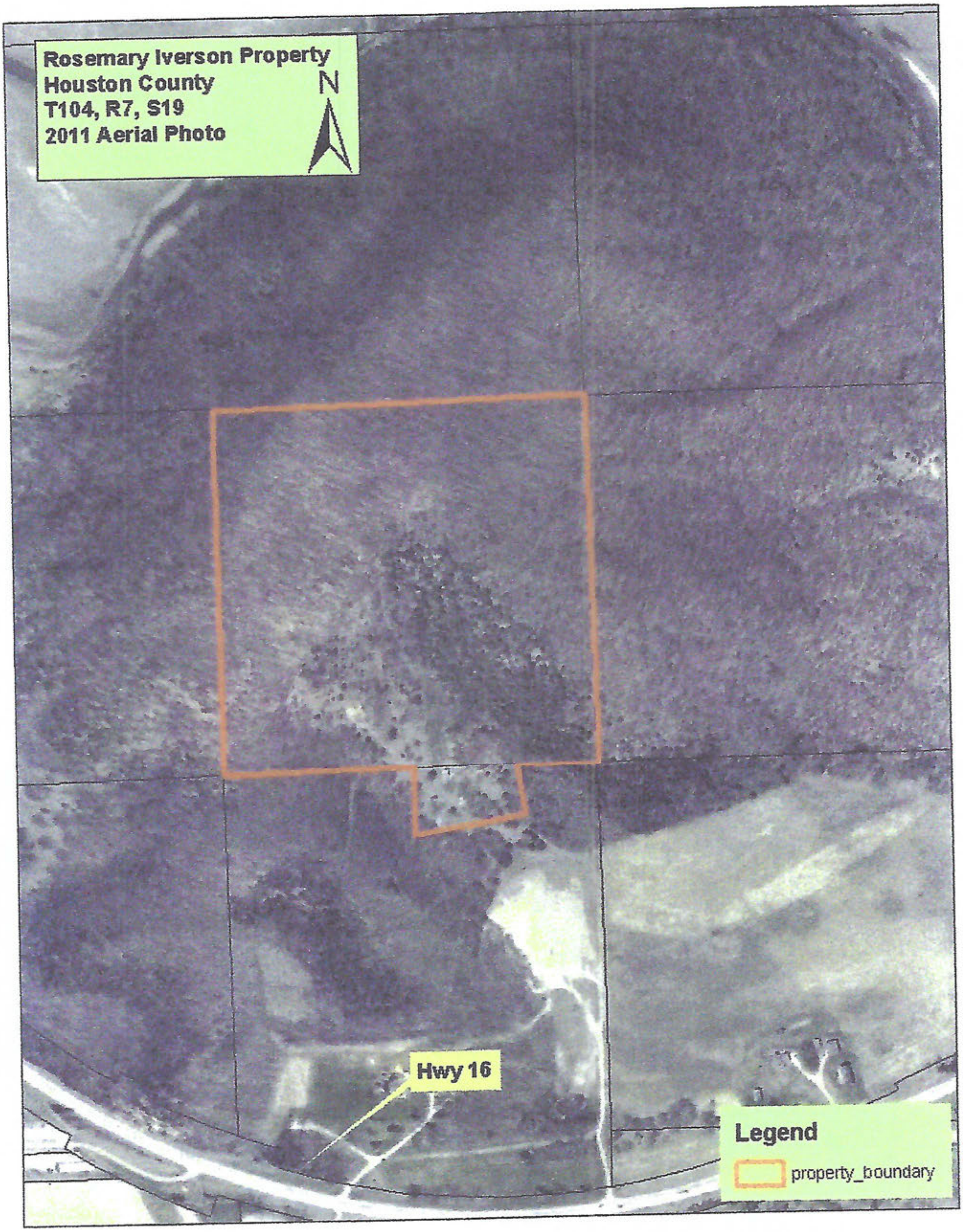

Rosemary Iverson Property
Houston County
T104, R7, S19
1991 Aerial Photo
N
Hwy 16
Legend
property_boundary


Rosemary Iverson Property
Houston County
T104, R7, S19
2011 Aerial Photo
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**MNDNR Native Plant Community Classification for Iverson Property**

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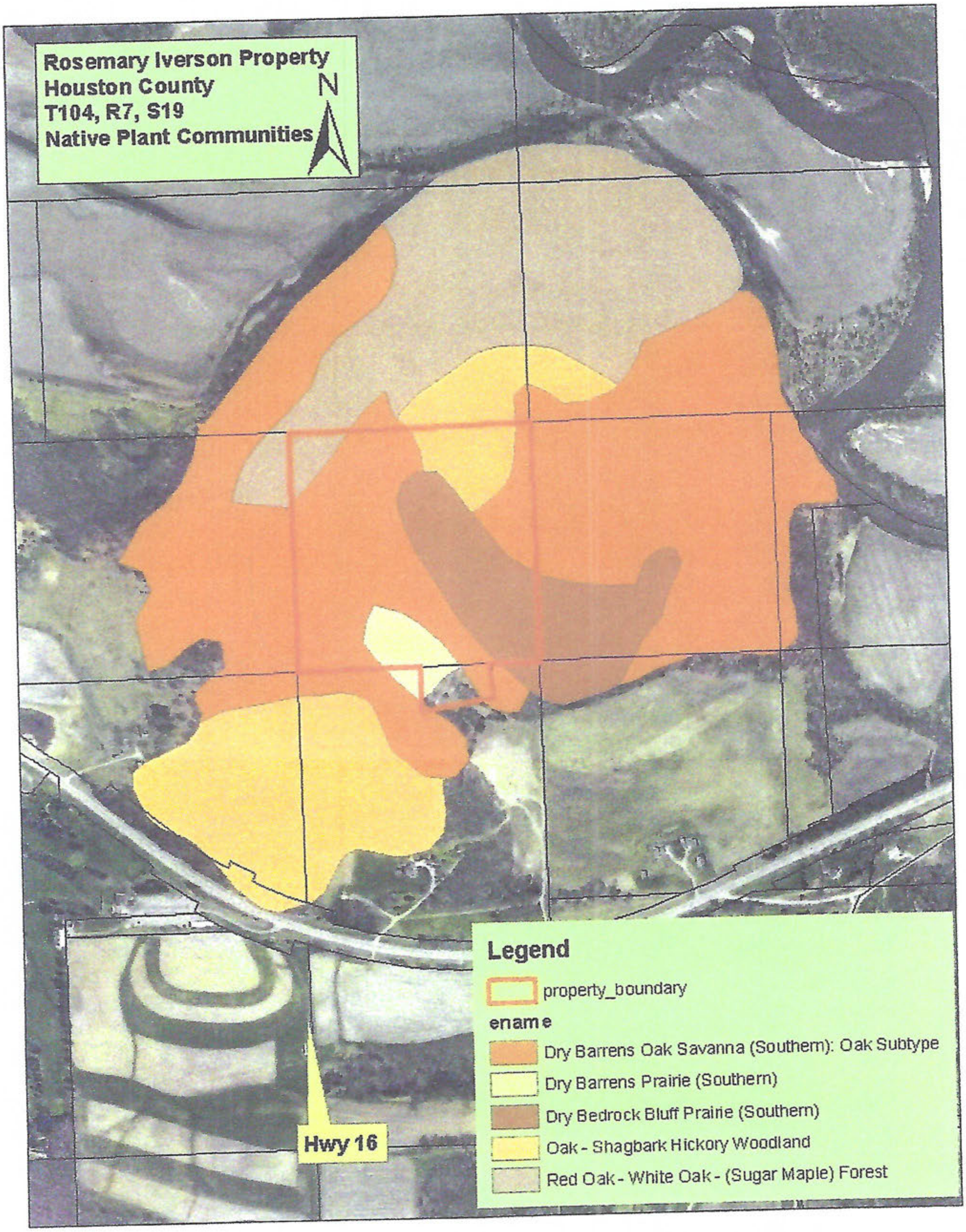


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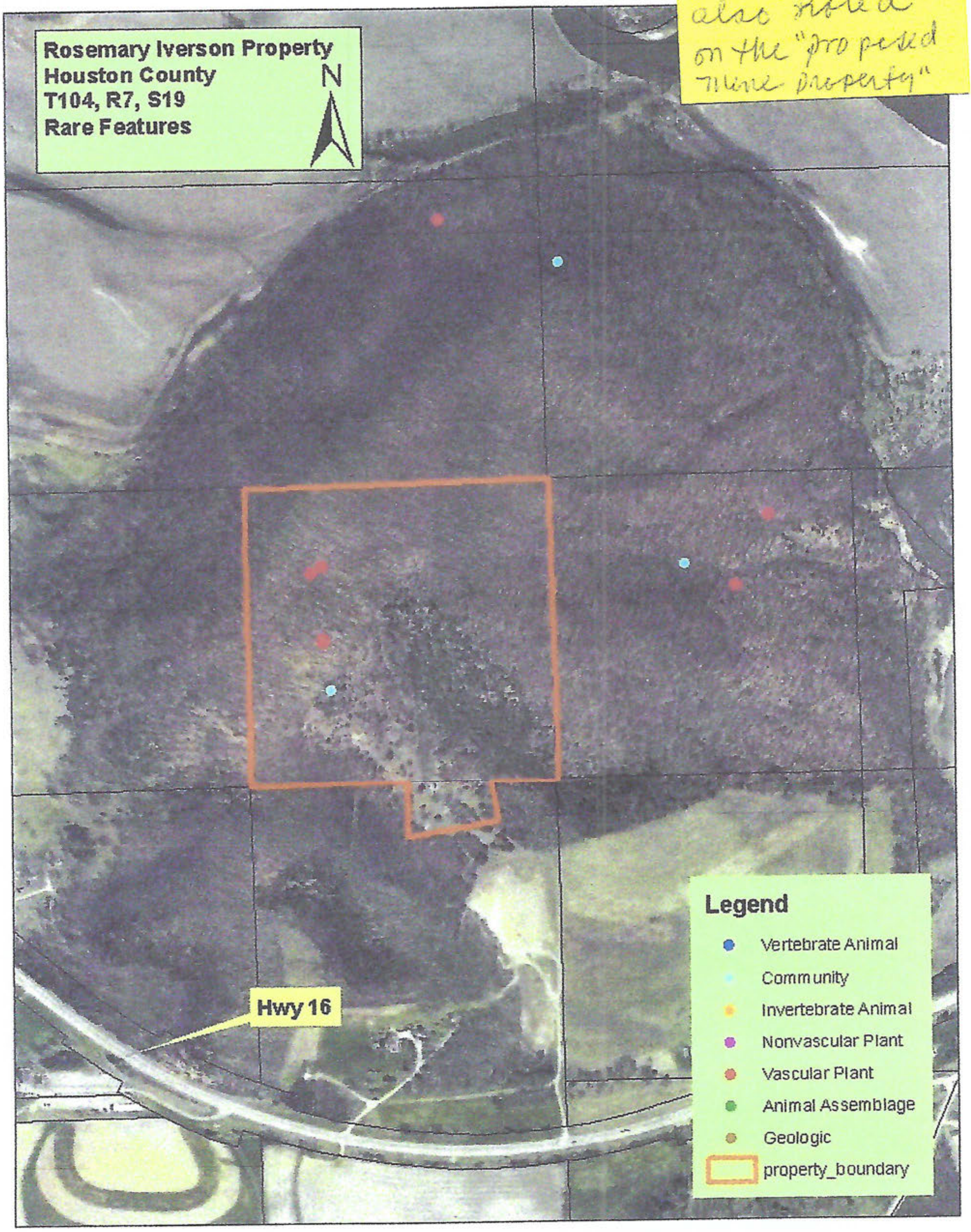
**MCBS Rare Features found on Iverson property**

Note
Rare features also noted on the "proposed mine property"



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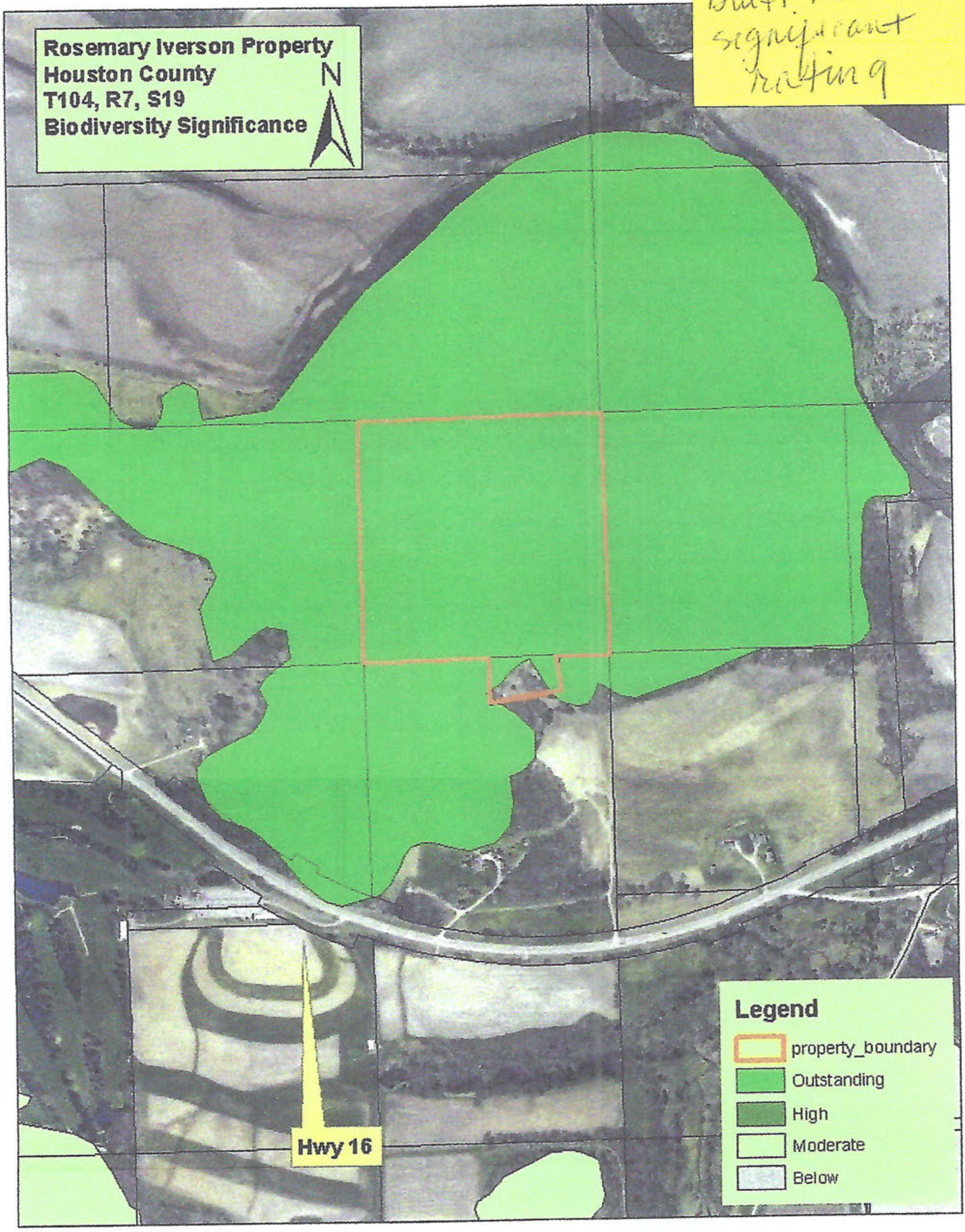
## MNDNR Biological Significance Ranking for Iverson property

Note
Most of the Bluff has a significant rating

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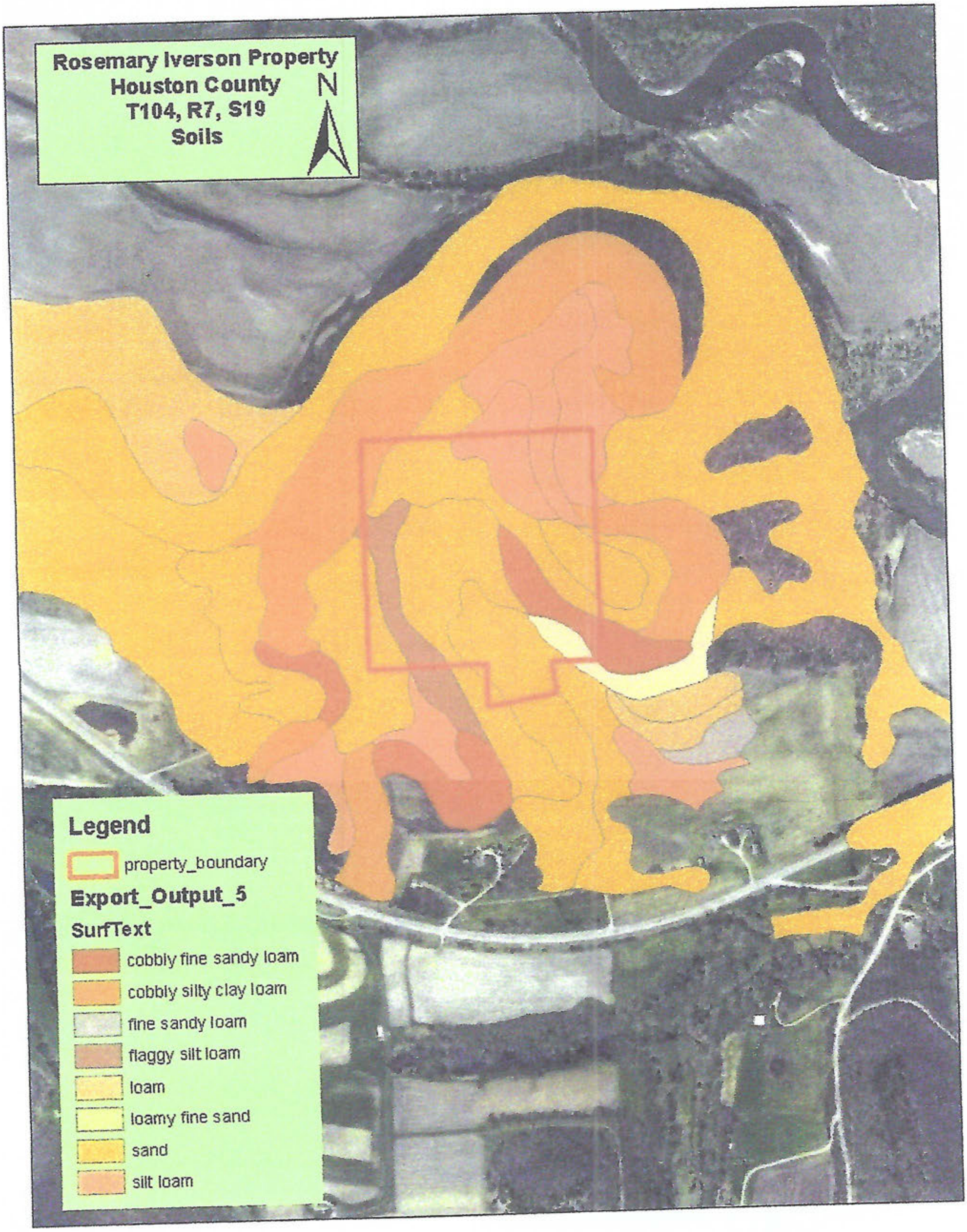
Rosemary Iverson Property
Houston County
T104, R7, S19
Soils
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fine sandy loam
flaggy silt loam
loam
loamy fine sand
sand
silt loam

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## Pre-settlement Vegetation Map



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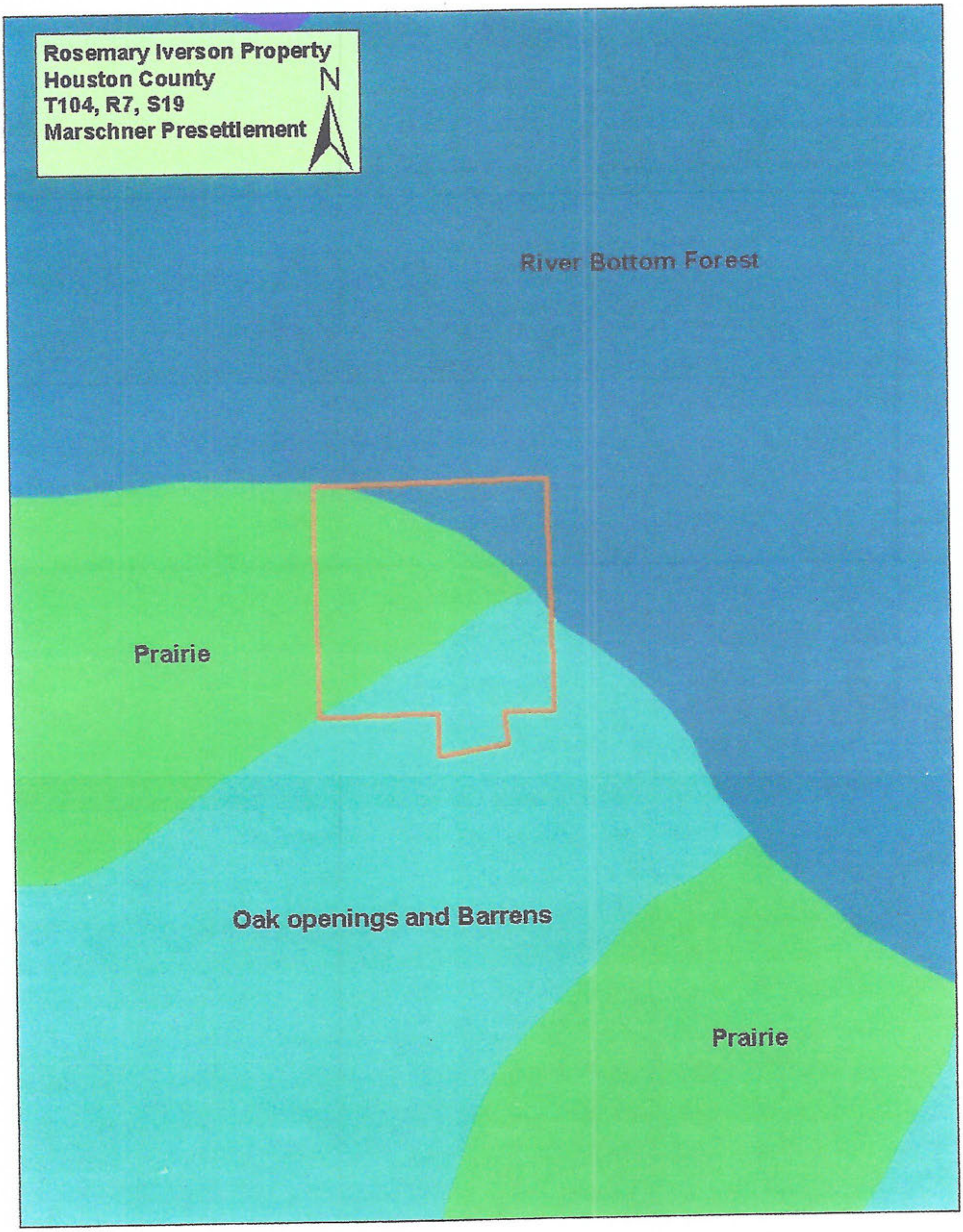


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**Iverson Property plant list from 7 August 2012**

Plant observation by Jaime Edwards, MNDNR Nongame Wildlife Specialist

List includes common name and scientific name. Alphabetized by common name.

| **Flowers** | **Grasses** |
|---|---|
| Bergamot (*Monarda fistulosa*) | June grass (*Koeleria pyramidata*) |
| bird's foot violet (*Viola pedata*) | Kalm's brome (*Bromus kalmia*) |
| bird's foot coreopsis (*Coreopsis palmata*) | little bluestem (*Schizachyrium scoparium*) |
| black-eyed Susan (*Rudbeckia hirta*) | Panic grass (*Panicum sp.*) |
| Blue vervain (*Verbena hastate*) | Pennsylvania sedge (*Carex pennsylvanica*) |
| bracken fern (*Pteridium aquilinum*) | plains muhly grass (*Muhlenbergia cuspidata*) |
| Canada frostweed (*Helianthemum canadense*) | porcupine grass (*Stipa spartea*) |
| Canadian forked chickweed (*Paronychia Canadensis*) | Prairie dropseed (*Sporobolus heterolepis*) |
| clasping milkweed (*Asclepias amplexicaulis*) | purple lovegrass (*Eragrostis spectabilis*) |
| Cliff goldenrod (*Solidago sciaphila*) | sand dropseed (*Sporobolus cryptandrus*) |
| cotton grass (*Froelichia floridana*) | Sea-beach three-awn grass (*Aristida basiramea*) |
| cylindric blazing star (*Lisatris cylindracea*) | side-oats grama (*Bouteloua curtipendula*) |
| bird's foot coreopsis (*Coreopsis palmate*) | |
| Earthstar (*Astraeus hygrometricus*) | **Shrubs/Vines** |
| Evening primrose(*Oenothera biennis*) | American hazelnut (*Corylus Americana*) |
| false solomon's seal (*Smilacina stellata*) | Choke cherry (*Prunus virginiana*) |
| figwort (*Schrophularia lanceolata*) | Grey dogwood(*Cornus racemosa*) |
| flowering spurge (*Euphorbia corollata*) | Greenbrier (*Smilax tamnoides*) |
| Goat's rue (*Tephrosia virginiana*) | Leadplant (*Amorpha canescens*) |
| gray goldenrod (*Solidago nemoralis*) | Ninebark (*Physocarpus opulifolius*) |
| Green milkweed (*Asclepias viridiflora*) | Prickly ash (*Zanthoxylum americanum*) |
| hairy puccoon (*Lithospermum caroliniense*) | Raspberry species (*Rubus sps.*) |
| Hog peanut (*Amphicarpaea bracteata*) | Smooth sumac (*Rhus glabra*) |
| Honewort (*Cryptotaenia canadensis*) | Virginia creeper (*Parthenocissus spp.*) |
| Horse gentian (*Tristeum perfoliatum*) | |
| horsemint (*Monarda punctata*) | **Trees** |
| hoary frostweed (*Helianthemum bicknelli*) | American elm (*Ulmus Americana*) |
| Indian pipe (*Monotropa uniflora*) | Black cherry (*Prunus serotina*) |
| Long-headed thimbleweed (*Anemone cylindrical*) | Black oak (*Quercus velutina*) |
| Lopseed (*Phryma leptostachya*) | Eastern red cedar (*Juniperus virginata*) |
| Old-field toadflax (*Comandra umbellate*) | Hackberry (*Celtis occidentalis*) |
| Plains wild indigo (*Baptisia bracteata* var. *leucophaea*) | Ironwood (*Ostrya virginiana*) |
| Pointed-leaved tick trefoil (*Desmodium glutinosum*) | Pin oak (*Quercus ellipsoidalis*) |
| Prairie cinquefoil (*Potentilla arguta*) | Red oak (*Quercus rubra*) |
| Prairie ragwort (*Senecio plattensis*) | Shagbark hickory (*Carya ovata*) |
| Purple prairie clover (*Dalea purpurea*) | Sugar maple (*Acer saccharum*) |
| Pussy toes (*Antennaria neglecta*) | White oak (*Quercus alba*) |
| Rattlesnake plantain (*Goodyera pubescens*) | |

| | | |
|---|---|---|
| Rough blazing star(*Liatris aspera*) | | |
| Round-headed bushclover (*Lespedeza capitatal)* | | |
| Showy goldenrod (*Solidago speciosa*) | | |
| Side-flowering aster (*Aster laterifolus*) | | |
| Silky aster (*Aster sericeus*) | | |
| skyblue aster (*Aster oolentangiensis*) | | |
| Sweet cicely (*Osmorhiza claytonia*) | | |
| Sweet everlasting (*Pseudognaphalium obtusifolium*) | | |
| western ragweed (*Ambrosia psilostachya*) | | |
| Western sunflower (*Helianthus occidentalis*) | | |
| White snakeroot (*Eupatorium rugosum*) | | |
| Whorled milkweed (*Asclepias verticillata)* | | |
| wood betony (*Pedicularis Canadensis*) | | |
| Virginia ground cherry (*Physalis virginiana*) | | |
| Yellow coneflower (*Ratibida pinnata*) | | |
| Yellow flax(*Linum sulcatum*) | | |

## Crown Vetch (*Coronilla varia*)

**DESCRIPTION:** Crown vetch is an herbaceous perennial legume with creeping stems 2-6 feet long, and leaves consisting of 15-25 pairs of oblong leaflets. This species has a reclining growth habit and rhizomes that can grow up to ten feet long, thus contributing to rapid and extensive

vegetative spread. Flower clusters range in color from pinkish-lavender to white, occur in umbels on long, extended stalks, and bloom from May through August. Flowers produce long, narrow pods containing slender seeds.

**DISTRIBUTION AND HABITAT:** Crown vetch (also known as "trailing crown vetch") is an exotic perennial frequently used as a ground cover for erosion control and as a green fertilizer crop. It is used as a bank stabilizer along roads and waterways. The plant's original habitat includes Europe, southeast Asia and northern Africa. The plant's distribution in the U.S. encompasses most of the northern U.S. east of South Dakota.

Crown vetch has been planted extensively in the northern two-thirds of the United States on road banks and other areas prone to erosion. This plant readily escapes cultivation; it may be found invading remnant prairies, woodland edges, agricultural fields, hayfields, pastures, and the banks and gravel bars of streams. It has typically been planted along roadsides and other right-of-ways, but quickly spreads into adjacent prairies and open fields. Crown vetch prefers full sunlight, but healthy populations have been found in partial shade.

**LIFE HISTORY AND EFFECTS OF INVASION:** Crown vetch is a serious management threat to

natural areas due to its seeding ability and rapid vegetative spreading by creeping roots. Flowers appear from May to August and produce few to several seeds. Seeds can remain dormant and viable for over fifteen years.

## CONTROLLING CROWN VETCH:

Very little research information is currently available regarding the control of crown vetch. Research has largely been restricted to the establishment and management of this perennial legume. As a result, a limited number of control measures have become available from the unpublished notes of active natural resource managers. Further field research is needed to adequately address this species. However, preventative measures can and should be implemented: do not use crown vetch for erosion control, and encourage your local highway department to stop using it.

Crown Vetch
(c) John M. Randall/The Nature Conservancy

### Mechanical Methods:

In fire-adapted communities, **prescribed burning** in late spring can be an effective control. Burns may need to be repeated for several years to achieve adequate control.

Where feasible, late spring **mowing** for several successive years can control this species. Also, mowing twice every year: in June and in late August, corresponding with successive leaf-out periods.

### Chemical Control:

The herbicide **2,4-D amine** (dimethylamine salt of 2,4--D) is a low volatility formulation that can be foliar-applied in early spring when crown vetch is growing actively. 2,4-D amine should be applied by hand sprayer at the recommended application rate on the label for spot application. Phenoxy herbicides are broadleaf-selective plant growth regulators that will not harm grasses, but precautions must be taken in the vicinity of non-target broad-leaved plants. To reduce vapor drift, use an amine rather than an ester formulation of 2,4-D.

A 2% active ingredient (a.i.) solution of **triclopyr** in water has also been successful in controlling large infestations. Like 2,4-D, triclopyr is advantageous because it is dicot-specific and does not affect grasses beyond some temporary browning.

**Glyphosate** is a broad-spectrum, translocated herbicide that can be foliar-applied as a 1 or 2% a.i. solution during early spring when the plant is actively growing. Glyphosate is nonselective, and care should be taken to avoid non-target plants. To insure good foliar coverage, the previous year's growth should be burned to eliminate duff accumulation and to expose new growth. A follow-up application of glyphosate may be necessary the following fall or early spring to combat regeneration from underground parts or seed.

The herbicide **clopyralid** has been used successfully to treat roadside populations of crown vetch. This herbicide shows promise because it is even more specific than triclopyr in the plant families it affects; specifically, this herbicide kills leguminous species but does not affect grasses and most other plant families. However, further research is needed.

When applying any of the herbicides described above, spot applications should be done uniformly with a hand sprayer to ensure that the entire leaf is wetted. Do not spray so heavily that herbicide drips off the target species. Native plants, left unharmed, will be important in recolonizing the site after crown vetch is controlled. Reseeding of native plants may be necessary where infestations of crown vetch are severe. Planting an intermediate cover crop may be appropriate.

All of these methods may need repeated applications over several years to effectively eradicate populations of crown vetch that are well established.

This fact sheet was modified from http://www.dnr.state.wi.us/invasives/fact/crown_vetch.htm

## Tartarian Honeysuckle

**(*Lonicera tatarica*)**

## Morrow's Honeysuckle (*Lonicera*

***morrowii*)**

## Bella Honeysuckle

**(*Lonicera x bella*)**

**DESCRIPTION:** Exotic bush honeysuckles are dense, upright deciduous shrubs (3 to 10 feet in height) with shallow roots; opposite, simple, and oval or oblong leaves; and yellow, orange, or red berries. Tartarian honeysuckle has smooth, hairless, bluish-green leaves. Morrow's honeysuckle has downy leaves, and bella honeysuckle is a hybrid between the Tartarian and Morrow's varieties. The shaggy-barked older stems and branches of the shrubs are often hollow. Flowering occurs during May and June, and produces fragrant, tubular flowers arranges in pairs. Flowers of the Tartarian honeysuckle are generally pink to crimson in color. Flowers of the other honeysuckle species are white and become yellow as they age.

**SIMILAR SPECIES:** *Lonicera maakii* is another invasive species that is troublesome in states to the south, and may become a problem in Minnesota. The exotic bush honeysuckles are easily separated from native *Lonicera* species. All native honeysuckles of the *Lonicera* genera--grape honeysuckle (*Lonicera reticulata*), yellow honeysuckle (*Lonicera flava*), and red honeysuckle (*Lonicera dioica*)--are woody vine-like twining species. The exotics are stout, erect shrubs. *Diervilla* species are native bush honeysuckles with yellow flowers found in dry or rocky sites.

Bush honeysuckles are easy to find in early spring when they begin leaf development one to two weeks before native shrubs. Similarly, they hold their leaves later into the fall than native species. These species can be discerned from a distance during their flower and fruit periods in late spring and midsummer.

**DISTRIBUTION AND HABITAT:** Bush honeysuckles can live in a broad range of plant communities with varying moisture and shade levels. Most natural communities are susceptible to invasion by one or more of the species, with or without previous invasions. Woodlands are most affected, and are particularly vulnerable if the habitat is already disturbed. Bush honeysuckles thrive in sunny, upland habitats, including forest edges, roadsides, pastures, and abandoned fields. They can also be found in fens, bogs, and along lakeshores.

Bush honeysuckles are native to Asia and Western Europe. Tartarian honeysuckle was introduced to North America as an ornamental in 1752. The others were introduced in the late 1800's. Distribution is typically near large urban areas, but rural infestations have occurred where the species were introduced to provide wildlife with cover and a food source. Bush honeysuckles have naturalized from New England south to North Carolina and west to Iowa. Exotic honeysuckles have become widespread in Wisconsin and Minnesota. Their proliferation is due largely to horticultural plantings, especially in urban areas. However, there are pockets of infestation in rural areas where honeysuckles were planted to improve wildlife habitat.

**LIFE HISTORY AND EFFECTS OF INVASION:** The widespread distribution of bush honeysuckle is aided by birds, which consume the ripened fruit in summer and disperse the seeds over long distances. The seeds appear to require a cold stratification period to break dormancy. Seedlings establish in sparse vegetation, and are usually found growing under tall shrubs or trees. Their vigorous growth inhibits development of native shrub and ground layer species; eventually they may entirely replace native species by shading and depleting soil moisture and nutrients. The early leafing of these species is particularly injurious to spring ephemerals, which have evolved to bloom before trees and shrubs have leafed out.

## CONTROLLING EXOTIC BUSH HONEYSUCKLES

**Mechanical Control:** Since honeysuckle roots are fairly shallow, small- to medium-sized plants can often be dug or pulled. Plants are particularly easy to remove in spring when the soil is moist. A shovel or grubbing hoe will often loosen the roots enough to allow a fairly large plant to be pulled. A mattock or weed wrench can also be used. In sensitive areas, this type of physical removal may disturb the soil and lead to more invasions, in which case it should be avoided. Soil should be tamped down to discourage further establishment of honeysuckle seedlings.

In fire-adapted communities, spring prescribed burning may kill seedlings and top-kill larger plants, although results have been mixed. Resprouts may occur, so repeated prescribed burning annually or biennially for several years may be necessary.

**Chemical Control:** Bush Honeysuckles can be controlled by cutting the stems at the base with brush saws, chain saws or other tools. After cutting, stumps should be treated immediately with a 20% active ingredient (a.i.) of glyphosate solution using a low-pressure, hand-held sprayer, sponge applicator, or contact solution bottles. Stumps can be treated later after cutting with the same herbicide solution, although it may not be as effective because the stumps scab over to protect the plant. Two cuts per year--the first in early spring followed by one in early autumn--are recommended. If not followed by herbicide treatment, cuts made in winter will encourage vigorous resprouting when the plant comes out of dormancy. Triclopyr formulated for water dilution is not effective on this species: triclopyr formulated for dilution in diesel fuel can be used for applications on cut stumps throughout the year, although winter application has in some cases proven to be 100% effective, whereas spring treatment has shown 70-80% effectiveness. If stump treatment is not done at the time of cutting, foliage on the resprouts may be sprayed, taking care of non-target plants.

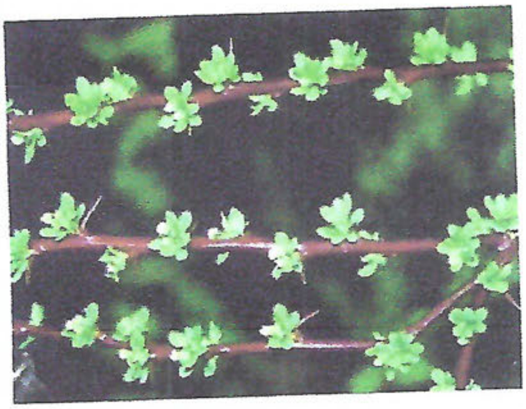
Where burning is not possible, a 1.5% a.i. glyphosate solution can be sprayed to cover the foliage. Spraying after the plant blooms may kill mature and seedling plants. Spraying prior to the emergence of native shrubs and ground flora is the safest time to spray without impacting native species. In wetlands, glyphosate formulated for use over water must be used.

Both mechanical and chemical control methods must be repeated for at least three to five years in order to stop new plants emerging from the seed bank.

This fact sheet was modified from http://www.dnr.state.wi.us/org/land/er/invasive/factsheets/redcedar.htm

## Japanese Barberry
## (*Berberis thunbergii*)

**DESCRIPTION:** Japanese barberry is a compact, spiny shrub that commonly grows from two to three feet tall (although it can grow up to six feet in height). Roots are shallow but tough, and have a distinct yellow color when broken. The smooth-edged leaves range from oval to spatulate in shape and are clustered in tight bunches close to the branches. The single spines bear small leaves in their axils. Yellow flowers bloom in May, are about one third of an inch wide, and are solitary or in small clusters of 2-4 blossoms. The bright-red fruits mature in mid-summer and hang from the bush during autumn and into winter. The berries are small, oblong, and found singly or in clusters. Several cultivars of this species are sold as ornamentals. A similar species, European barberry (*Berberis vulgaris*) is also an invasive non-native. It can be distinguished from the Japanese barberry by its spiny toothed leaves and flowers in a long raceme. Both species can be controlled using the techniques discussed below.



**DISTRIBUTION AND HABITAT:** Japanese barberry prefers well-drained soils, although it has been found in wet, calcareous situations, (specifically in a black ash swamp). It is typically found in locations of partial sunlight such as a woodland's edge; it can survive well under the shade of an oak canopy. It is also found along roadsides, fences, old fields, and open woods.

**LIFE HISTORY AND EFFECTS OF INVASION:** Japanese barberry was introduced from Japan around 1875. It is commonly planted for ornamental reasons (its scarlet fruit and autumnal foliage in shades of orange, red, and crimson make it an attractive hedge), as well as for wildlife and erosion control. It easily naturalizes because its fruit is often eaten by birds, which subsequently disperse the seed. Its range in North America extends from Nova Scotia south to North Carolina, and westward to Montana.

Japanese barberry can be found invading oak woodlands and oak savannas; it is becoming more widespread in Minnesota woodlands in the southern part of the state, particularly near urban areas. A related non-native species, *B. vulgaris*, was widely planted for similar purposes, but has been exterminated because it is the alternate host of black rust, a disease that affects wheat crops.
The plant regenerates by seed and creeping roots. Birds and rabbits are known to eat the seeds and distribute the species. Branches root freely when they touch the ground; thus allowing single plants to become quite large. Japanese barberry competes poorly with grasses and may succumb to drought conditions.

**CONTROLLING JAPANESE BARBERRY**
Very little is known about the control of Japanese barberry. What information is available has been gathered from the notes of natural resource managers.

**Mechanical Control:** Mechanical removal of the plant is recommended in early spring because barberry is one of the first shrubs to leaf out, thereby making identification easier. Cutting, pulling or digging are effective in areas where there are only a few plants. A hoe, weed wrench, or mattock should be used to uproot the bush and all connected roots. Thick gloves are recommended for protection from the shrub's spines.
Japanese barberry may be relatively easy to control in fire-adapted communities. Fire is thought to kill these plants and prevent future establishment.

**Chemical Control:** Triclopyr has been used as a cut-stump treatment with success. Other herbicides labeled for brush control, such as glyphosate, may prove to be effective. Care in application is essential because glyphosate is a non-selective herbicide that can kill native species as well. Herbicides are suggested only for plants that are difficult to remove mechanically.

This fact sheet was modified from http://www.dnr.state.wi.us/invasives/fact/rose.htm

## Multiflora Rose
## (*Rosa multiflora*)

Multiflora Rose

**DESCRIPTION:** A member of the rose family, multiflora rose is a dense spreading shrub with wide, arching canes and stiff curved thorns. Older plants may have a root crown diameter of 8 inches or more and can reach a height of 15 feet. Its pinnately compound leaves grow alternately and usually consist of seven to nine small (1/2 to 1 inch) oval leaflets with toothed margins. The leaflets are nearly smooth on the upper surface and paler with short hairs on the underside. Blossoming in late spring, its numerous white flowers form a panicle from 1/2 to 11/2 inches across. Native roses usually have pink flowers. The flowers develop into small, hard, nearly round red fruits (called hips) that are 1/4 inch in size. They remain on the plant throughout the winter. The seeds are angular achenes.

By law, multiflora rose is considered a nuisance weed, and cannot be sold or propagated.

**DISTRIBUTION AND HABITAT:** Introduced from Japan in 1886 as rootstock for cultivated roses, planting of multiflora rose was encouraged by the U.S. Soil Conservation Service beginning in the 1930's to curb soil erosion. The nursery industry also touted the shrub as a "living fence," to control livestock and create snow barriers along highways. It was promoted by wildlife managers as late as the 1960's as an excellent source of food and cover for wildlife. Due to its dense growing habits, it has become a serious problem in the eastern United States and occurs throughout the U.S.
Multiflora rose has naturalized in most of the northeastern and midwestern United States. Although abundant throughout Illinois, multiflora rose is currently only become a problem in southernmost tier of counties in Wisconsin. Presumably, its northern range is limited by an inability to tolerate winter temperatures below -28°F. The plant is found in old fields, pastures, roadsides and forests. It can live in a wide range of soil and environmental conditions, but thrives in sunny areas with well-drained soils. It is not found in standing water or extremely dry habitats.

Multiflora Rose
(c) John M. Randall/The Nature Conservancy

**LIFE HISTORY AND EFFECTS OF INVASION:**
Multiflora rose blooms in May or June. Individual plants may produce up to 500,000 seeds per year. The majority of seedlings emerge near the parent plant from which the seeds fell. In addition, many species of birds and mammals feed on the hips, dispersing the seeds widely. The canes are also capable of rooting

when in contact with soil.
Multiflora rose readily invades prairies, savannas, open woodlands, and forest edges. Where it grows in dense thickets, it replaces the surrounding vegetation.

## CONTROLLING MULTIFLORA ROSE

**Mechanical Control:** In areas where multiflora rose is just beginning to invade, fire can limit its establishment. Scattered populations in high-quality areas can be effectively controlled by complete removal of the plants. All roots must be removed because new plants can grow from severed roots. Mowing with heavy equipment has proven effective, although non-selective. However, the strong thorns have been known to puncture rubber tires--filling tires with foam may help. Mowing or cutting should be repeated 3-6 times during the growing season for at least 2-4 years. Follow-up monitoring is necessary because new plants may arise from root fragments or previously dormant seeds.
**Chemical Control:** Manual application of herbicides on freshly cut stems has proven an effective means of control as it can destroy the root system and prevent re-sprouting. After the stem is cut, herbicide should be applied. Glyphosate can be used effectively as a 10-20 % active ingredient (a.i.) solution if applied to the cut stems or canes in the growing season (between July and September) or during dormancy. Application during dormancy is preferable because it reduces the likelihood of damaging other species. A foliar spray of 1% a.i. glyphosate solution applied to flowering or budding plants is also effective, especially when the flowers are in full bloom. However, it is non-selective and should not be used in high-quality natural areas.

Multiflora Rose

Triclopyr formulated for water dilution can be applied to cut stems or canes with a hand-held sprayer. Triclopyr must be applied within a few hours of cutting. Dormant season is the best time for application to ensure non-target species are not damaged by run-off.
A foliar spray of 2% a.i. fosamine solution in water can be effectively used from July to September if the foliage is well covered. Do not spray so heavily that herbicide drips off the target species. Die-back will not be apparent until the following summer. Fosamine is the preferred folier spray treatment because it is non-volatile and will only affect woody species.
A 1% a.i. solution of dicamba can be applied as a foliar spray. Dicamba is selective against broadleaf and should never be used if desirable broadleaf vegetation is present. Application is most effective when administrating during May or June when plants have achieved full leaf-out and are actively flowering. When treating dense foliage, one-half ounce of surfactant should be added per gallon of water for maximum effectiveness.
A handful of water softener salt place at the base of the plant has apparently proven effective, but will remain in the soil for many years.

**Biological Control:** Biological methods exist to kill or damage multiflora rose. Rose rosette disease, a native virus vectored by a eriophyid mite (*Phyllocoptes frutiphilus*), can be fatal. However, it may infect native roses and plums as well as commercially important members of the rose family like apples, some berries, and ornamental roses. The disease spreads from infected canes to the roots and then to other canes. Plants usually die within 1-2 years. Pruning may be practical in areas where the disease is present because it encourages succulent growth, increasing plant susceptibility to mite infestation.

Two insects also feed on multiflora rose; the larva of the rose stem girdler beetle girdles and kills individual canes and the other, the rose seed chalid wasp (*Megastigmus aculeastus* var. *nigroflavus*) reduces seed viability. The U.S Department of Agriculture should be contacted for more information on biological control methods.

This fact sheet was modified from http://www.dnr.state.wi.us/invasives/fact/rose.htm

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Bald eagle – special concern
Red-shouldered hawk – special concern
Northern myotis (bat)– special concern

**Links for additional information**
Tomorrow's Habitat for the Wild and Rare, MN DNR Publication:
http://www.dnr.state.mn.us/cwcs/index.html
Rare Species Guide, web-based reference, MN DNR:
http://www.dnr.state.mn.us/rsg/index.html
Invasive species: http://dnr.wi.gov/invasives/index.htm
Weed ID website: http://weedid.wisc.edu/weedid.php
Invasives Control Handbook: http://www.invasive.org/gist/handbook.html
Eastern Broadleaf Native Plant Community Field Guide:
http://www.dnr.state.mn.us/npc/classification.html

**Appendices:**
1. Topographic map
2. Aerial photos of 1954, 1991 and 2011
3. Marschner's pre-settlement vegetation map
4. Native plant communities map
5. Rare features map
6. Biodiversity significance map
7. Soils map
8. Iverson property plant list
9. Native plant community descriptions
10. Invasive species fact sheets

**Iverson Property Topographic Map**

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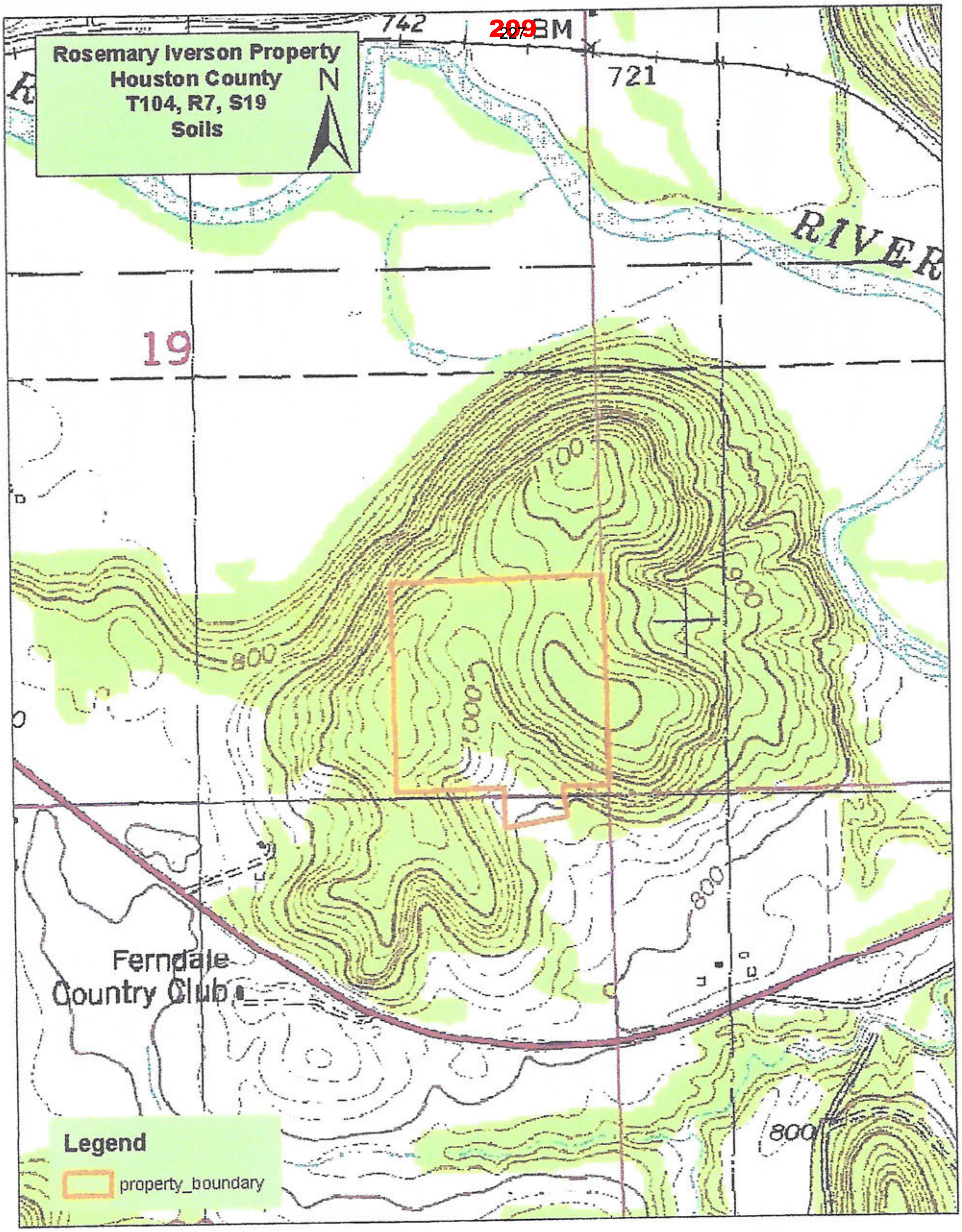
Rosemary Iverson Property
Houston County
T104, R7, S19
Soils
N
742
BM
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# CHAPTER 6134

# DEPARTMENT OF NATURAL RESOURCES

# ENDANGERED, THREATENED, SPECIAL CONCERN SPECIES



## 6134.0100 STATUTORY AUTHORITY.

Pursuant to Minnesota Statutes, section 84.0895, the species of wild animals and plants listed in parts 6134.0200 to 6134.0400 are designated as endangered, threatened, or of special concern, as indicated in those parts.

**Statutory Authority:** *MS s 84.0895*

**History:** *8 SR 1921; L 1986 c 386 art 4 s 9*

**Published Electronically:** *June 11, 2008*

## 6134.0150 PURPOSE AND SCOPE.

Minnesota Statutes, section 84.0895, subdivision 3, requires the commissioner of natural resources to adopt rules designating species meeting the statutory definitions of endangered, threatened, or species of special concern. Minnesota Statutes, section 84.0895, subdivision 5, authorizes the commissioner to adopt rules that regulate treatment of species designated as endangered or threatened. Thus, two different sets of rules have been adopted: parts 6134.0100 to 6134.0400 designate species in the three statutory categories; and parts 6212.1800 to 6212.2300 create regulations for species designated as endangered or threatened.

Species designated as species of special concern are not protected by Minnesota Statutes, section 84.0895 or rules adopted under that section. Parts 6212.1800 to 6212.2300 and Minnesota Statutes, section 84.0895, impose a variety of restrictions, a permit program, and several exemptions pertaining to species designated as endangered or threatened. Among these are that acts otherwise prohibited may be allowed by permit issued by the commissioner; plants on certain agricultural lands and plants destroyed in consequence of certain agricultural practices are exempt; and the accidental, unknowing destruction of designated plants is exempt. Parts 6134.0100 to 6134.0400 do not address protection of habitat for species designated as endangered, threatened, or species of special concern, nor do they obligate anyone to survey lands for the presence of designated species.

Persons are advised to read the full text of parts 6134.0100 to 6134.0400 and 6212.1800 to 6212.2300 and Minnesota Statutes, section 84.0895, in order to understand all Department of Natural Resources regulations pertaining to species that are designated as endangered, threatened, or species of special concern.

**Statutory Authority:** *MS s 84.0895*

**History:** *20 SR 2782*

**Published Electronically:** *June 11, 2008*

**6134.0170 SPECIES NAMES.**

Species designated as endangered, threatened, or of special concern in this chapter are identified by the species' scientific (Latin) names. Common (English) names, when available, follow the scientific names and are included for the convenience of the reader, but do not reliably identify the species so designated.

**Statutory Authority:** *MS s 84.0895*

**History:** *38 SR 217*

**Published Electronically:** *August 19, 2013*

**6134.0200 ANIMAL SPECIES.**

Subpart 1. **Mammals.** The following species of mammals are designated as:

A. Endangered: none.

B. Threatened:

(1) *Spilogale putorius*, eastern spotted skunk; and

(2) *Thomomys talpoides*, northern pocket gopher.

C. Of special concern:

(1) *Alces americanus*, moose;

(2) *Cervus canadensis*, elk;

(3) *Cryptotis parva*, North American least shrew;

(4) *Eptesicus fuscus*, big brown bat;

(5) *Lynx canadensis*, Canada lynx;

(6) *Microtus ochrogaster*, prairie vole;

(7) *Microtus pinetorum*, woodland vole;

(8) *Mustela nivalis*, least weasel;

(9) *Myotis lucifugus*, little brown myotis;

(10) *Myotis septentrionalis*, northern myotis;

(11) *Onychomys leucogaster*, northern grasshopper mouse;

(12) *Perimyotis subflavus*, tri-colored bat;

(13) *Perognathus flavescens*, plains pocket mouse;

(14) *Phenacomys ungava*, eastern heather vole;

(15) *Puma concolor*, mountain lion;

(16) *Reithrodontomys megalotis*, western harvest mouse;

(17) *Sorex fumeus*, smoky shrew;

(18) *Synaptomys borealis*, northern bog lemming; and

(19) *Urocitellus richardsonii*, Richardson's ground squirrel.

Subp. 2. **Birds.** The following species of birds are designated as:

A. Endangered:

(1) *Ammodramus bairdii*, Baird's sparrow;

(2) *Ammodramus henslowii*, Henslow's sparrow;

(3) *Anthus spragueii*, Sprague's pipit;

(4) *Athene cunicularia*, burrowing owl;

(5) *Calcarius ornatus*, chestnut-collared longspur;

(6) *Charadrius melodus*, piping plover;

(7) *Lanius ludovicianus*, loggerhead shrike;

(8) *Podiceps auritus*, horned grebe; and

(9) *Rallus elegans*, king rail.

B. Threatened:

(1) *Phalaropus tricolor*, Wilson's phalarope; and

(2) *Sterna hirundo*, common tern.

C. Of special concern:

(1) *Accipiter gentilis*, northern goshawk;

(2) *Aegolius funereus*, boreal owl;

(3) *Ammodramus nelsoni*, Nelson's sparrow;

(4) *Asio flammeus*, short-eared owl;

(5) *Buteo lineatus*, red-shouldered hawk;

(6) *Chondestes grammacus*, lark sparrow;

(7) *Coturnicops noveboracensis*, yellow rail;

(8) *Cygnus buccinator*, trumpeter swan;

(9) *Empidonax virescens*, acadian flycatcher;

(10) *Falco peregrinus*, peregrine falcon;

(11) *Gallinula galeata*, common gallinule;

(12) *Leucophaeus pipixcan*, Franklin's gull;

(13) *Limosa fedoa*, marbled godwit;

(14) *Parkesia motacilla*, Louisiana waterthrush;

(15) *Pelecanus erythrorhynchos*, American white pelican;

(16) *Progne subis*, purple martin;

(17) *Setophaga cerulea*, cerulean warbler

(18) *Setophaga citrina*, hooded warbler;

(19) *Sterna forsteri*, Forster's tern;

(20) *Tympanuchus cupido*, greater prairie-chicken; and

(21) *Vireo bellii*, Bell's vireo.

Subp. 3. **Amphibians and reptiles.** The following species of amphibians and reptiles are designated as:

A. Endangered:

(1) *Acris blanchardi*, Blanchard's cricket frog; and

(2) *Sistrurus catenatus*, massasauga.

B. Threatened:

(1) *Crotalus horridus*, timber rattlesnake;

(2) *Emydoidea blandingii*, Blanding's turtle;

(3) *Glyptemys insculpta*, wood turtle; and

(4) *Pantherophis obsoletus*, western ratsnake.

C. Of special concern:

(1) *Ambystoma maculatum*, spotted salamander;

(2) *Anaxyrus cognatus*, Great Plains toad;

(3) *Apalone mutica*, smooth softshell;

(4) *Coluber constrictor*, North American racer;

(5) *Hemidactylium scutatum*, four-toed salamander;

(6) *Heterodon nasicus*, plains hog-nosed snake;

(7) *Necturus maculosus*, mudpuppy;

(8) *Pituophis catenifer*, gopher snake;

(9) *Plestiodon fasciatus*, common five-lined skink; and

(10) *Tropidoclonion lineatum*, lined snake.

Subp. 4. **Fish.** The following species of fish are designated as:

A. Endangered:

(1) *Alosa chrysochloris*, skipjack herring;

(2) *Crystallaria asprella*, crystal darter;

(3) *Hybopsis amnis*, pallid shiner; and

(4) *Noturus exilis*, slender madtom.

B. Threatened:

(1) *Erimystax x-punctatus*, gravel chub;

(2) *Fundulus sciadicus*, plains topminnow;

(3) *Ictiobus niger*, black buffalo;

(4) *Notropis anogenus*, pugnose shiner; and

(5) *Polyodon spathula*, paddlefish.

C. Of special concern:

(1) *Acipenser fulvescens*, lake sturgeon;

(2) *Anguilla rostrata*, American eel;

(3) *Aphredoderus sayanus*, pirate perch;

(4) *Clinostomus elongatus*, redside dace;

(5) *Coregonus kiyi*, kiyi;

(6) *Coregonus Nipigon*, Nipigon cisco;

(7) *Coregonus zenithicus*, shortjaw cisco;

(8) *Couesius plumbeus*, lake chub;

(9) *Cycleptus elongatus*, blue sucker;

(10) *Etheostoma chlorosoma*, bluntnose darter;

(11) *Etheostoma microperca*, least darter;

(12) *Hybognathus nuchalis*, Mississippi silvery minnow;

(13) *Ichthyomyzon fossor*, northern brook lamprey;

(14) *Ichthyomyzon gagei*, southern brook lamprey;

(15) *Lepomis gulosus*, warmouth;

(16) *Lepomis peltastes*, northern longear sunfish;

(17) *Lythrurus umbratilis*, redfin shiner;

(18) *Morone mississippiensis*, yellow bass;

(19) *Moxostoma duquesnei*, black redhorse;

(20) *Notropis nubilus*, Ozark minnow;

(21) *Notropis topeka*, Topeka shiner;

(22) *Percina evides*, gilt darter;

(23) *Phenacobius mirabilis*, suckermouth minnow;

(24) *Platygobio gracilis*, flathead chub; and

(25) *Prosopium coulterii*, pygmy whitefish.

Subp. 5. [Repealed, 20 SR 2782]

Subp. 6. **Mollusks.** The following species of mollusks are designated as:

A. Endangered:

(1) *Arcidens confragosus*, rock pocketbook;

(2) *Cumberlandia monodonta*, spectaclecase;

(3) *Cyclonaias tuberculata*, purple wartyback;

(4) *Elliptio crassidens*, elephant-ear;

(5) *Epioblasma triquetra*, snuffbox;

(6) *Fusconaia ebena*, ebonyshell;

(7) *Lampsilis higginsii*, Higgins eye;

(8) *Lampsilis teres*, yellow sandshell;

(9) *Megalonaias nervosa*, washboard;

(10) *Plethobasus cyphyus*, sheepnose;

(11) *Quadrula fragosa*, winged mapleleaf;

(12) *Simpsonaias ambigua*, salamander mussel; and

(13) *Tritogonia verrucosa*, pistolgrip.

B. Threatened:

(1) *Actinonaias ligamentina*, mucket;

(2) *Alasmidonta marginata*, elktoe;

(3) *Ellipsaria lineolata*, butterfly;

(4) *Elliptio dilatata*, spike;

(5) *Lasmigona costata*, fluted-shell;

(6) *Ligumia subrostrata*, pondmussel;

(7) *Quadrula metanevra*, monkeyface;

(8) *Quadrula nodulata*, wartyback;

(9) *Striatura ferrea*, black striate snail;

(10) *Truncilla donaciformis*, fawnsfoot;

(11) *Venustaconcha ellipsiformis*, ellipse; and

(12) *Vertigo meramecensis*, bluff vertigo.

C. Of special concern:

(1) *Anodonta suborbiculata*, flat floater;

(2) *Elliptio complanata*, eastern elliptio;

(3) *Gastrocopta rogersensis*, Rogers' snaggletooth snail;

(4) *Lasmigona compressa*, creek heelsplitter;

(5) *Ligumia recta*, black sandshell;

(6) *Planogyra asteriscus*, eastern flat-whorl snail;

(7) *Pleurobema sintoxia*, round pigtoe;

(8) *Striatura ferrea*, black striate snail; and

(9) *Zonitoides limatulus*, dull gloss.

Subp. 7. **Jumping spiders.** The following species of jumping spiders are designated as:

A. Endangered: none.

B. Threatened: *Tutelina formicaria*.

C. Of special concern:

(1) *Habronattus calcaratus maddisoni*;

(2) *Habronattus texanus*;

(3) *Habronattus viridipes*;

(4) *Marpissa formosa*;

(5) *Paradamoetas fontana*;

(6) *Pelegrina arizonensis*;

(7) *Phidippus apacheanus*;

(8) *Phidippus pius*; and

(9) *Sassacus papenhoei*.

Subp. 8. **Butterflies and moths.** The following species of butterflies and moths are designated as:

A. Endangered:

(1) *Erynnis persius persius*, persius dusky wing;

(2) *Hesperia assiniboia*, assiniboia skipper;

(3) *Hesperia dacotae*, Dakota skipper;

(4) *Hesperia ottoe*, ottoe skipper

(5) *Hesperia uncas*, uncas skipper;

(6) *Lycaeides melissa samuelis*, Karner blue;

(7) *Oarisma poweshiek*, poweshiek skipperling; and

(8) *Oeneis uhleri varuna*, Uhler's arctic.

B. Threatened: *Oarisma gratia*, gratia skipper.

C. Of special concern:

(1) *Atrytone arogos iowa*, arogos skipper;

(2) *Catocala abbreviatella*, abbreviated underwing;

(3) *Catocala whitneyi*, Whitney's underwing;

(4) *Erebia mancinus*, disa alpine;

(5) *Hesperia leonardus*, leonardus skipper;

(6) *Lycaeides idas nabokovi*, Nabokov's blue;

(7) *Pyrgus centaureae freija*, grizzled skipper;

(8) *Schinia indiana*, phlox moth;

(9) *Schinia lucens*, leadplant flower moth; and

(10) *Speyeria idalia*, regal fritillary.

Subp. 9. **Caddisflies.** The following species of caddisflies are designated as:

A. Endangered:

(1) *Hydroptila waskesia*, a species of purse casemaker caddisfly;

(2) *Limnephilus janus*, a species of northern caddisfly;

(3) *Limnephilus secludens*, a species of northern caddisfly;

(4) *Ochrotrichia spinosa*, a species of purse casemaker caddisfly; and

(5) *Polycentropus milaca*, a species of tube casemaker caddisfly.

B. Threatened:

(1) *Chilostigma itascae*, headwaters chilostigman caddisfly

(2) *Goera stylata*;

(3) *Hydroptila rono*, a species of purse casemaker caddisfly;

(4) *Ironoquia punctatissima*, a species of northern caddisfly;

(5) *Lepidostoma libum*;

(6) *Limnephilus rossi*, a species of northern caddisfly;

(7) *Oecetis ditissa*, a species of long-horned caddisfly;

(8) *Oxyethira ecornuta*, a species of purse casemaker caddisfly;

(9) *Parapsyche apicalis*, a species of nestspinning caddisfly;

(10) *Polycentropus glacialis*, a species of tube casemaker caddisfly; and

(11) *Ylodes frontalis*, a species of long-horned caddisfly.

C. Of special concern:

(1) *Agapetus tomus*;

(2) *Anabolia ozburni*, a species of northern caddisfly;

(3) *Hydroptila metoeca*, a species of purse casemaker caddisfly;

(4) *Hydroptila quinola*, a species of purse casemaker caddisfly;

(5) *Hydroptila tortosa*, a species of purse casemaker caddisfly;

(6) *Oxyethira itascae*, a species of purse casemaker caddisfly;

(7) *Protoptila erotica*, a species of saddle casemaker caddisfly; and

(8) *Triaenodes flavescens*, a species of long-horned caddisfly.

Subp. 10. **Tiger beetles.** The following species of tiger beetles are designated as:

A. Endangered:

(1) *Cicindela fulgida fulgida*, crimson saltflat tiger beetle, fulgida subspecies;

(2) *Cicindela hirticollis rhodensis*, hairy-necked tiger beetle; and

(3) *Cicindela limbata nympha*, sandy tiger beetle.

B. Threatened:

(1) *Cincindela fulgida westbournei*, crimson saltflat tiger beetle, westbournei subspecies; and

(2) *Cicindela lepida*, ghost tiger beetle.

C. Of special concern:

(1) *Cicindela denikei*, Laurentian tiger beetle;

(2) *Cicindela macra macra*, sandy stream tiger beetle;

(3) *Cicindela patruela patruela*, northern barrens tiger beetle; and

(4) *Cicindela splendida cyanocephalata*, splendid tiger beetle.

Subp. 11. **Leafhoppers.** The following species of leafhoppers are designated as:

A. Endangered: none.

B. Threatened: none.

C. Of special concern:

(1) *Aflexia rubranura*, red-tailed leafhopper;

(2) *Attenuipyga vanduzeei*, hill prairie shovelhead leafhopper; and

(3) *Macrosteles clavatus*, caped leafhopper.

Subp. 12. **Dragonflies.** The following species of dragonflies are designated as:

A. Endangered: none.

B. Threatened: *Ophiogomphus susbehcha*, St. Croix snaketail.

C. Of special concern:

(1) *Aeshna sitchensis*, zigzag darner;

(2) *Aeshna subarctica*, subarctic darner;

(3) *Boyeria grafiana*, ocellated darner;

(4) *Ophiogomphus anomalus*, extra-striped snaketail;

(5) *Ophiogomphus howei*, pygmy snaketail;

(6) *Somatochlora brevicincta*, Quebec emerald; and

(7) *Somatochlora forcipata*, forcipate emerald.

**Statutory Authority:** *MS s 84.0895*

**History:** *8 SR 1921; 20 SR 2782; L 2012 c 277 art 1 s 90; 38 SR 217*

**Published Electronically:** *October 8, 2013*

## 6134.0300 VASCULAR PLANTS.

The following species of vascular plants are designated as:

A. Endangered:

(1) *Achnatherum hymenoides*, Indian rice grass;

(2) *Agalinis auriculata*, eared false foxglove;

(3) *Agalinis gattingeri*, round-stemmed false foxglove;

(4) *Agrostis hyemalis*, winter bentgrass;

(5) *Allium schoenoprasum*, wild chives;

(6) *Aristida longespica* var. *geniculata*, slimspike three-awn;

(7) *Asclepias stenophylla*, narrow-leaved milkweed;

(8) *Astragalus alpinus* var. *alpinus*, alpine milk-vetch;

(9) *Bartonia virginica*, yellow bartonia;

(10) *Botrychium ascendens*, upswept moonwort;

(11) *Botrychium gallicomontanum*, Frenchman's bluff moonwort;

(12) *Botrychium lineare*, slender moonwort;

(13) *Botrychium spathulatum*, spatulate moonwort;

(14) *Calamagrostis purpurascens*, purple reedgrass;

(15) *Caltha natans*, floating marsh marigold;

(16) *Carex careyana*, Carey's sedge;

(17) *Carex formosa*, handsome sedge;

(18) *Carex pallescens*, pale sedge;

(19) *Carex plantaginea*, plantain-leaved sedge;

(20) *Carex supina* ssp. *spaniocarpa*, weak arctic sedge;

(21) *Castilleja septentrionalis*, northern paintbrush;

(22) *Chrysosplenium iowense*, Iowa golden saxifrage;

(23) *Commelina erecta*, slender dayflower;

(24) *Diarrhena obovata*, obovate beakgrain;

(25) *Dodecatheon meadia*, prairie shooting star;

(26) *Draba cana*, hoary whitlow grass;

(27) *Draba norvegica*, Norwegian whitlow grass;

(28) *Dryopteris marginalis*, marginal shield fern;

(29) *Eleocharis wolfii*, Wolf's spikerush;

(30) *Elodea bifoliata*, two leaf waterweed;

(31) *Empetrum atropurpureum*, purple crowberry;

(32) *Empetrum nigrum*, black crowberry;

(33) *Erigeron acris* var. *kamtschaticus*, bitter fleabane;

(34) *Erythronium propullans*, dwarf trout lily;

(35) *Escobaria vivipara*, ball cactus;

(36) *Fimbristylis puberula* var. *interior*, hairy fimbry;

(37) *Hasteola suaveolens*, sweet-smelling Indian plantain;

(38) *Hybanthus concolor*, eastern green-violet;

(39) *Hydrastis canadensis*, goldenseal;

(40) *Iodanthus pinnatifidus*, purple rocket;

(41) *Isoetes melanopoda*, prairie quillwort;

(42) *Juglans cinerea*, butternut;

(43) *Juncus articulatus*, jointed rush;

(44) *Juncus marginatus*, marginated rush;

(45) *Juncus subtilis*, slender rush;

(46) *Lechea tenuifolia* var. *tenuifolia*, narrow-leaved pinweed;

(47) *Listera auriculata*, auricled twayblade;

(48) *Lysimachia maritima*, sea milkwort;

(49) *Malaxis paludosa*, bog adder's mouth;

(50) *Marsilea vestita*, hairy waterclover;

(51) *Montia chamissoi*, montia;

(52) *Osmorhiza berteroi*, Chilean sweet cicely;

(53) *Oxytropis viscida*, sticky locoweed;

(54) *Packera cana*, gray ragwort;

(55) *Packera indecora*, elegant groundsel;

(56) *Paronychia canadensis*, Canada forked chickweed;

(57) *Paronychia fastigiata* var. *fastigiata*, forked chickweed;

(58) *Parthenium integrifolium*, wild quinine;

(59) *Phegopteris hexagonoptera*, broad beech fern;

(60) *Physaria ludoviciana*, bladderpod;

(61) *Platanthera praeclara*, western prairie fringed orchid;

(62) *Polanisia jamesii*, James' polanisia;

(63) *Polemonium occidentale* ssp. *lacustre*, western Jacob's ladder;

(64) *Polygala cruciata*, cross-leaved milkwort;

(65) *Polystichum acrostichoides*, Christmas fern;

(66) *Potamogeton bicupulatus*, snailseed pondweed;

(67) *Potamogeton confervoides*, algae-like pondweed;

(68) *Potamogeton diversifolius*, diverse-leaved pondweed;

(69) *Potamogeton oakesianus*, Oake's pondweed;

(70) *Potamogeton pulcher*, spotted pondweed;

(71) *Prosartes trachycarpa*, rough-fruited fairybells;

(72) *Psoralidium tenuiflorum*, slender-leaved scurfpea;

(73) *Rhodiola integrifolia* ssp. *leedyi*, Leedy's roseroot;

(74) *Rubus missouricus*, Missouri dewberry;

(75) *Rubus stipulatus*, bristle-berry;

(76) *Sagina nodosa* ssp. *borealis*, knotty pearlwort;

(77) *Sagittaria brevirostra*, short-beaked arrowhead;

(78) *Saxifraga cernua*, nodding saxifrage;

(79) *Scleria triglomerata*, tall nutrush;

(80) *Selaginella selaginoides*, northern spikemoss;

(81) *Stuckenia vaginata*, sheathed pondweed;

(82) *Tofieldia pusilla*, small false asphodel;

(83) *Tsuga canadensis*, eastern hemlock;

(84) *Utricularia purpurea*, purple-flowered bladderwort;

(85) *Vaccinium uliginosum*, alpine bilberry; and

(86) *Xyris torta*, twisted yellow-eyed grass.

B. Threatened:

(1) *Achillea alpina*, Siberian yarrow;

(2) *Ammophila breviligulata* ssp. *breviligulata*, beachgrass;

(3) *Aristida tuberculosa*, seaside three-awn;

(4) *Arnica lonchophylla*, long-leaved arnica;

(5) *Arnoglossum plantagineum*, tuberous Indian plantain;

(6) *Arnoglossum reniforme*, great Indian plaintain;

(7) *Asclepias amplexicaulis*, clasping milkweed;

(8) *Asclepias hirtella*, prairie milkweed;

(9) *Asclepias sullivantii*, Sullivant's milkweed;

(10) *Asplenium trichomanes* ssp. *trichomanes*, maidenhair spleenwort;

(11) *Aureolaria pedicularia*, fernleaf false foxglove;

(12) *Bacopa rotundifolia*, water hyssop;

(13) *Berula erecta*, stream parsnip;

(14) *Besseya bullii*, kitten-tails;

(15) *Bistorta vivipara*, alpine bistort;

(16) *Boechera retrofracta*, Holboell's rock cress;

(17) *Botrychium lanceolatum* ssp. *angustisegmentum*, narrow triangle moonwort;

(18) *Botrychium lunaria*, common moonwort;

(19) *Botrychium mormo*, goblin fern;

(20) *Botrychium oneidense*, blunt-lobed grapefern;

(21) *Callitriche heterophylla*, larger water starwort;

(22) *Cardamine pratensis*, cuckoo flower;

(23) *Carex conjuncta*, jointed sedge;

(24) *Carex davisii*, Davis' sedge;

(25) *Carex festucacea*, fescue sedge;

(26) *Carex garberi*, Garber's sedge;

(27) *Carex jamesii*, James' sedge;

(28) *Carex laevivaginata*, smooth-sheathed sedge;

(29) *Carex laxiculmis*, loose-culmed sedge;

(30) *Carex novae-angliae*, New England sedge;

(31) *Carex rossii*, Ross' sedge;

(32) *Carex sterilis*, sterile sedge;

(33) *Crassula aquatica*, pygmyweed;

(34) *Cyperus acuminatus*, short-pointed umbrella sedge;

(35) *Cypripedium arietinum*, ram's head orchid;

(36) *Deschampsia flexuosa*, slender hair grass;

(37) *Desmodium cuspidatum* var. *longifolium*, big tick trefoil;

(38) *Desmodium nudiflorum*, stemless tick trefoil;

(39) *Diplazium pycnocarpon*, narrow-leaved spleenwort;

(40) *Eleocharis flavescens* var. *olivacea*, olivaceous spikerush;

(41) *Eleocharis robbinsii*, Robbins' spikerush;

(42) *Eleocharis rostellata*, beaked spikerush;

(43) *Erigeron lonchophyllus*, short ray fleabane;

(44) *Eupatorium sessilifolium*, upland boneset;

(45) *Floerkea proserpinacoides*, false mermaid;

(46) *Gaylussacia baccata*, black huckleberry

(47) *Hamamelis virginiana*, witch-hazel;

(48) *Heteranthera limosa*, mud plantain;

(49) *Hudsonia tomentosa*, beach heather;

(50) *Huperzia porophila*, rock fir moss;

(51) *Leersia lenticularis*, catchfly grass;

(52) *Lespedeza leptostachya*, prairie bush clover;

(53) *Luzula parviflora*, small-flowered woodrush;

(54) *Melica nitens*, three-flowered melic;

(55) *Minuartia dawsonensis*, rock sandwort;

(56) *Moehringia macrophylla*, large-leaved sandwort;

(57) *Napaea dioica*, glade mallow;

(58) *Nymphaea leibergii*, small white waterlily;

(59) *Orobanche fasciculata*, clustered broomrape;

(60) *Orobanche ludoviciana* var. *ludoviciana*, Louisiana broomrape;

(61) *Orobanche uniflora*, one-flowered broomrape;

(62) *Phacelia franklinii*, Franklin's phacelia;

(63) *Phemeranthus rugospermus*, rough-seeded fameflower;

(64) *Piptatherum canadense*, Canadian ricegrass;

(65) *Platanthera flava* var. *herbiola*, tubercled rein orchid;

(66) *Poa paludigena*, bog bluegrass;

(67) *Polystichum braunii*, Braun's holly fern;

(68) *Rhynchospora capillacea*, hair-like beak rush;

(69) *Rotala ramosior*, toothcup;

(70) *Rubus chamaemorus*, cloudberry;

(71) *Rubus fulleri*, bristle-berry;

(72) *Rubus semisetosus*, swamp blackberry;

(73) *Rudbeckia triloba* var. *triloba*, three-leaved coneflower;

(74) *Sagittaria calycina* var. *calycina*, hooded arrowhead;

(75) *Salicornia rubra*, red saltwort;

(76) *Salix pellita*, satiny willow;

(77) *Scleria verticillata*, whorled nutrush;

(78) *Scutellaria ovata* var. *versicolor*, ovate-leaved skullcap;

(79) *Shinnersoseris rostrata*, annual skeletonweed;

(80) *Silene nivea*, snowy campion;

(81) *Spiranthes casei* var. *casei*, Case's ladies' tresses;

(82) *Subularia aquatica* ssp. *americana*, awlwort;

(83) *Sullivantia sullivantii*, reniform sullivantia;

(84) *Trichophorum clintonii*, Clinton's bullrush;

(85) *Utricularia geminiscapa*, hidden-fruit bladderwort;

(86) *Utricularia resupinata*, lavender bladderwort;

(87) *Valeriana edulis* var. *ciliata*, edible valerian;

(88) *Viola lanceolata* var. *lanceolata*, lance-leaf violet;

(89) *Viola nuttallii*, yellow prairie violet;

(90) *Vitis aestivalis* var. *bicolor*, silverleaf grape;

(91) *Woodsia alpina*, alpine woodsia;

(92) *Woodsia glabella*, smooth woodsia; and

(93) *Woodsia scopulina* ssp. *laurentiana*, Rocky Mountain woodsia.

C. Of special concern:

(1) *Adlumia fungosa*, Allegheny vine;

(2) *Alisma gramineum*, narrow-leaved water plantain;

(3) *Allium cernuum*, nodding wild onion;

(4) *Androsace septentrionalis*, northern androsace;

(5) *Antennaria parvifolia*, small-leaved pussytoes;

(6) *Arabis laevigata* var. *laevigata*, smooth rock cress;

(7) *Arisaema dracontium*, green dragon;

(8) *Aristida purpurea* var. *longiseta*, red three-awn;

(9) *Asplenium platyneuron*, ebony spleenwort;

(10) *Astragalus flexuosus* var. *flexuosus*, slender milk-vetch;

(11) *Astragalus missouriensis* var. *missouriensis*, Missouri milk-vetch;

(12) *Avenula hookeri*, spike oat;

(13) *Baptisia bracteata* var. *glabrescens*, plains wild indigo;

(14) *Baptisia lactea* var. *lactea*, white wild indigo;

(15) *Bidens discoidea*, discoid beggarticks;

(16) *Botrychium acuminatum*, tailed grapefern;

(17) *Botrychium campestre*, prairie moonwort;

(18) *Botrychium minganense*, Mingan moonwort;

(19) *Botrychium pallidum*, pale moonwort;

(20) *Botrychium rugulosum*, St. Lawrence grapefern;

(21) *Botrychium simplex*, least moonwort;

(22) *Buchloe dactyloides*, buffalo grass;

(23) *Calamagrostis lacustris*, narrow reedgrass;

(24) *Calamagrostis montanensis*, Plains reedgrass;

(25) *Carex annectens*, yellow-fruit sedge;

(26) *Carex exilis*, coastal sedge;

(27) *Carex flava*, yellow sedge;

(28) *Carex grayi*, Gray's sedge;

(29) *Carex hallii*, Hall's sedge;

(30) *Carex hookerana*, Hooker's sedge;

(31) *Carex media*, intermediate sedge;

(32) *Carex michauxiana*, Michaux's sedge;

(33) *Carex muskingumensis*, Muskingum sedge;

(34) *Carex obtusata*, blunt sedge;

(35) *Carex ormostachya*, necklace sedge;

(36) *Carex praticola*, prairie-dweller sedge;

(37) *Carex scirpoidea*, northern single-spike sedge;

(38) *Carex typhina*, cattail sedge;

(39) *Carex xerantica*, dry sedge;

(40) *Chamaesyce missurica*, Missouri spurge;

(41) *Cirsium pumilum* var. *hillii*, Hill's thistle;

(42) *Cladium mariscoides*, twig rush;

(43) *Crataegus calpodendron*, late hawthorn;

(44) *Crataegus douglasii*, black hawthorn;

(45) *Crotalaria sagittalis*, rattlebox;

(46) *Cymopterus glomeratus*, plains spring parsley;

(47) *Cypripedium candidum*, small white lady's slipper;

(48) *Dalea candida* var. *oligophylla*, western white prairie clover;

(49) *Decodon verticillatus*, water willow;

(50) *Deparia acrostichoides*, silvery spleenwort;

(51) *Desmanthus illinoensis*, prairie mimosa;

(52) *Dicentra canadensis*, squirrel corn;

(53) *Draba arabisans*, Arabian whitlow grass;

(54) *Drosera anglica*, English sundew;

(55) *Drosera linearis*, linear-leaved sundew;

(56) *Dryopteris goldiana*, Goldie's fern;

(57) *Elatine triandra*, three-stamened waterwort;

(58) *Eleocharis coloradoensis*, dwarf spikerush;

(59) *Eleocharis nitida*, neat spikerush;

(60) *Eleocharis quinqueflora*, few-flowered spikerush;

(61) *Eryngium yuccifolium*, rattlesnake master;

(62) *Euphrasia hudsoniana* var. *ramosior*, Hudson Bay eyebright;

(63) *Fimbristylis autumnalis*, autumn fimbry;

(64) *Gaillardia aristata*, blanket flower;

(65) *Gentiana affinis*, northern gentian;

(66) *Gentianella amarella*, felwort;

(67) *Gymnocarpium robertianum*, northern oak fern;

(68) *Gymnocladus dioica*, Kentucky coffee tree;

(69) *Helianthemum canadense*, Canada frostweed;

(70) *Helianthus nuttallii* ssp. *rydbergii*, Nuttall's sunflower;

(71) *Huperzia appalachiana*, Appalachian fir moss;

(72) *Hydrocotyle americana*, American water-pennywort;

(73) *Jeffersonia diphylla*, twinleaf;

(74) *Juncus stygius* var. *americanus*, bog rush;

(75) *Juniperus horizontalis*, creeping juniper;

(76) *Limosella aquatica*, mudwort;

(77) *Listera convallarioides*, broad-leaved twayblade;

(78) *Littorella americana*, American shore plantain;

(79) *Lysimachia quadrifolia*, whorled loosestrife;

(80) *Malaxis monophyllos* var. *brachypoda*, white adder's mouth;

(81) *Muhlenbergia uniflora*, one-flowered muhly;

(82) *Myriophyllum heterophyllum*, broadleaf watermilfoil;

(83) *Najas gracillima*, slender naiad;

(84) *Najas guadalupensis* ssp. *olivacea*, southern naiad;

(85) *Najas marina*, sea naiad;

(86) *Nuttallanthus canadensis*, old field toadflax;

(87) *Oenothera rhombipetala*, rhombic evening primrose;

(88) *Opuntia macrorhiza*, devil's tongue;

(89) *Osmorhiza depauperata*, blunt-fruited sweet cicely;

(90) *Panax quinquefolius*, American ginseng;

(91) *Pellaea atropurpurea*, purple cliff brake;

(92) *Persicaria careyi*, Carey's smartweed;

(93) *Phlox maculata*, wild sweet William;

(94) *Pinguicula vulgaris*, butterwort;

(95) *Plagiobothrys scouleri* var. *penicillatus*, Scouler's popcornflower;

(96) *Plantago elongata*, slender plantain;

(97) *Platanthera clavellata*, small green wood orchid;

(98) *Poa wolfii*, Wolf's bluegrass;

(99) *Polytaenia nuttallii*, prairie parsley;

(100) *Pyrola minor*, small shinleaf;

(101) *Quercus bicolor*, swamp white oak;

(102) *Ranunculus lapponicus*, Lapland buttercup;

(103) *Rorippa sessiliflora*, sessile-flowered yellow cress;

(104) *Rubus multifer*, Kinnickinnick dewberry;

(105) *Rubus quaesitus*, Prince Edward Island blackberry;

(106) *Rubus vermontanus*, Vermont blackberry;

(107) *Ruellia humilis*, wild petunia;

(108) *Ruppia cirrhosa*, spiral ditchgrass;

(109) *Salix maccalliana*, McCalla's willow;

(110) *Salix pseudomonticola*, false mountain willow;

(111) *Sanicula trifoliata*, beaked snakeroot;

(112) *Saxifraga paniculata*, encrusted saxifrage;

(113) *Schedonnardus paniculatus*, tumble grass;

(114) *Shepherdia canadensis*, soapberry;

(115) *Silene drummondii* ssp. *drummondii*, Drummond's campion;

(116) *Solidago mollis*, soft goldenrod;

(117) *Stellaria longipes* ssp. *longipes*, long-stalked chickweed;

(118) *Symphyotrichum shortii*, Short's aster;

(119) *Taenidia integerrima*, yellow pimpernel;

(120) *Tephrosia virginiana*, goat's rue;

(121) *Thaspium barbinode*, hairy-jointed meadow-parsnip;

(122) *Torreyochloa pallida*, Torrey's mannagrass;

(123) *Trillium nivale*, snow trillium;

(124) *Triplasis purpurea* var. *purpurea*, purple sandgrass;

(125) *Trisetum spicatum*, spike trisetum;

(126) *Verbena simplex*, narrow-leaved vervain;

(127) *Waldsteinia fragarioides* var. *fragarioides*, barren strawberry;

(128) *Woodsia oregana* ssp. *cathcartiana*, Oregon woodsia;

(129) *Xanthisma spinulosum* var. *spinulosum*, cutleaf ironplant; and

(130) *Xyris montana*, montane yellow-eyed grass.

**Statutory Authority:** *MS s 84.0895*

**History:** *8 SR 1921; 20 SR 2782; 38 SR 217*

**Published Electronically:** *October 12, 2015*

**6134.0400 LICHENS; MOSSES; LIVERWORTS; FUNGI.**

Subpart 1. **Lichens.** The following species of lichens are designated as:

A. Endangered:

(1) *Caloplaca parvula*;

(2) *Dermatocarpon moulinsii*;

(3) *Leptogium apalachense*;

(4) *Lobaria scrobiculata*;

(5) *Parmelia stictica*;

(6) *Pseudocyphellaria crocata*; and

(7) *Umbilicaria torrefacta*.

B. Threatened:

(1) *Allocetraria oakesiana*;

(2) *Arthrorhaphis citronella*, golden-dot lichen;

(3) *Coccocarpia palmicola*;

(4) *Lecanora epanora*, a species of rim lichen;

(5) *Parmelia stuppea*;

(6) *Peltula bolanderi*, Bolander's peltula lichen;

(7) *Protopannaria pezizoides*, brown-gray moss-shingle lichen;

(8) *Ramalina roesleri*, frayed ramalina lichen; and

(9) *Usnea mutabilis*, bloody beard lichen.

C. Of special concern:

(1) *Ahtiana aurescens*;

(2) *Amygdalaria panaeola*, powdery almond lichen;

(3) *Anaptychia crinalis*;

(4) *Arctoparmelia centrifuga*, concentric ring lichen;

(5) *Arctoparmelia subcentrifuga*, a species of ring lichen;

(6) *Bryoria fuscescens*, pale-footed horsehair lichen;

(7) *Buellia nigra*, black disk lichen;

(8) *Caloplaca stellata*, a species of firedot lichen;

(9) *Cladonia pseudorangiformis*;

(10) *Heterodermia obscurata*, orange-tinted fringe lichen;

(11) *Melanelia subolivacea*, brown-eyed camouflage lichen;

(12) *Menegazzia terebrata*, port-hole lichen;

(13) *Ochrolechia androgyna*, powdery saucer lichen;

(14) *Peltigera venosa*;

(15) *Platismatia glauca*, ragbag lichen;

(16) *Ramalina thrausta*, Angel's hair lichen;

(17) *Stereocaulon pileatum*, pixie foam lichen;

(18) *Sticta fuliginosa*;

(19) *Thelocarpon epibolum*, a species of thelocarpon lichen;

(20) *Usnea longissima*, Methusela's beard lichen; and

(21) *Usnea rubicunda*, red beard lichen.

Subp. 2. **Mosses and liverworts.** The following species of mosses and liverworts are designated as:

A. Endangered:

(1) *Bryoxiphium norvegicum*, sword moss;

(2) *Schistostega pennata*, luminous moss; and

(3) *Splachnum rubrum*, red parasol moss.

B. Threatened:

(1) *Cirriphyllum piliferum*, hair-pointed feather moss;

(2) *Cryptocolea imbricata*, hidden perianth liverwort;

(3) *Cynodontium schisti*, mowed mosquito moss;

(4) *Lescuraea saxicola*, lustrous bow moss;

(5) *Sphagnum compactum*, cushion peat moss;

(6) *Sphagnum lescurii*, red twisted peat moss; and

(7) *Trichocolea tomentella*, down liverwort.

C. Of special concern:

(1) *Aphanorrhegma serratum*, lidden earth moss;

(2) *Atrichum crispum*, wave-leaved crane's-bill moss;

(3) *Atrichum tenellum*, little saw moss;

(4) *Aulacomnium androgynum*, bud-headed thread moss;

(5) *Aulacomnium heterostichum*, differential branched crease capsule moss;

(6) *Bryum cyclophyllum*, egg-leaf true moss;

(7) *Buxbaumia aphylla*, bug-on-stick moss;

(8) *Cyrto-hypnum pygmaeum*, pygmy plume moss;

(9) *Encalypta procera*, tall extinguisher moss;

(10) *Frullania selwyniana*, Selwyn's ear-leaf liverwort;

(11) *Heterocladium dimorphum*, spaced-out tangle moss;

(12) *Hyophila involuta*, rolled-leaf wet-ground moss;

(13) *Jaffueliobryum wrightii*, Wright's blunt-leaved true moss;

(14) *Meesia uliginosa*, swan moss;

(15) *Pogonatum urnigerum*, urn-bearing hair moss;

(16) *Thelia hirtella*, nipple moss; and

(17) *Tortella inclinata*, shortleaf chalk moss.

Subp. 3. **Fungi.** The following species of fungi are designated as:

A. Endangered:

(1) *Psathyrella cystidiosa*;

(2) *Psathyrella rhodospora*; and

(3) *Suillus weaverae*.

B. Threatened: none.

C. Of special concern:

(1) *Boletus subcaerulescens*, a species of Porcini mushroom;

(2) *Laccaria trullisata*;

(3) *Lactarius fuliginellus*;

(4) *Lysurus cruciatus*; and

(5) *Sarcosoma globosum*, a species of cup fungus.

**Statutory Authority:** *MS s 84.0895*

**History:** *8 SR 1921; 20 SR 2782; 38 SR 217*

**Published Electronically:** *August 19, 2013*

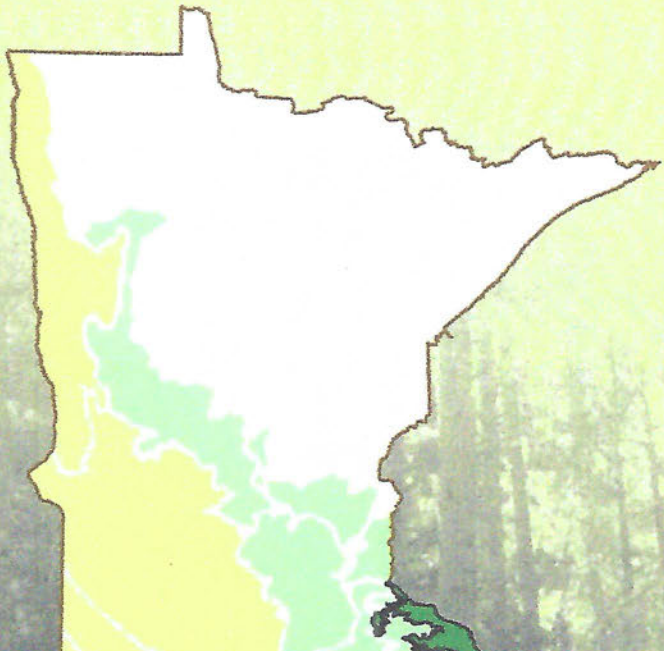
# 4. Wetlands, Shoreland, Bluffland, Reinvest In Minnesota (RIM) Land

- Bluffland Subsection Profile
- Ecological Subsections Map - Division of Forestry
- Beacon Shoreland Map
- Beacon Wetlands Map
- Minnesota Natural Resource Atlas Map showing Adjoining RIM Easements
- Citizen letter regarding his RIM Land

# Tomorrow's Habitat for the Wild & Rare

An Action Plan for Minnesota Wildlife

# Blufflands
## Subsection Profile



Minnesota's Comprehensive Wildlife Conservation Strategy

## SUBSECTION OVERVIEW

The Blufflands Subsection in southeastern Minnesota, dominated by the Mississippi River, is characterized by bluff prairies, steep bluffs, and stream valleys, often 500 to 600 feet deep. Numerous cold-water trout streams feed major rivers such as the Root, Whitewater, Zumbro, and Cannon. Rich hardwood forests grow along the river valleys, and river-bottom forests grow along major streams and backwaters. There are few lakes.

Agriculture, both row crops and pastures, takes place in former savanna and prairie areas and is the most prominent land use in this subsection. Forestry is also an important land use, and outdoor recreational opportunities abound, with significant amounts of public lands along the river corridor. Retaining or restoring the health of stream systems is an important conservation objective in this subsection.

### Quick facts

**Acres:** 1,287,434 (2.4% of state)

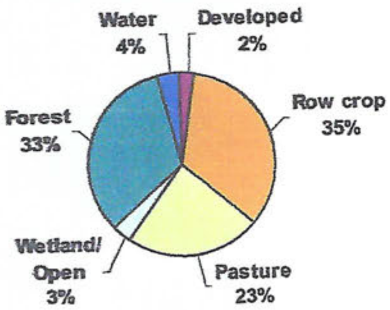
**Ownership**

| Public | Private | Tribal |
|---|---|---|
| 11.2% | 88.8% | 0.0% |

**Population density (people/sq. mi.)**

| Current | Change (2000-2010) |
|---|---|
| 58.7 | +3.1 |

**Current Land Use/Land Cover**




## SPECIES IN GREATEST CONSERVATION NEED

**156 Species in Greatest Conservation Need (SGCN)** are known or predicted to occur within the Blufflands – the most of all the subsections in Minnesota. These SGCN include 82 species that are federal or state endangered, threatened, or of special concern. The table, SGCN by Taxonomic Group, displays by taxonomic group the number of SGCN that occur in the subsection, as well as the percentage of the total SGCN set represented by each taxon. For example, 9 mammal SGCN are known or predicted to occur in the Blufflands, approximately 41% of all mammal SGCN in the state.

### SGCN BY TAXONOMIC GROUP

| Taxa | # of SGCN | Percentage of SGCN Set by Taxon | Examples of SGCN |
|---|---|---|---|
| Amphibians | 3 | 50.0 | Pickerel frog |
| Birds | 53 | 54.6 | Blue-winged warbler |
| Fishes | 26 | 55.3 | Crystal darter |
| Insects | 14 | 25.0 | Karner blue butterfly |
| Mammals | 9 | 40.9 | Northern myotis |
| Mollusks | 32 | 82.1 | Hubricht's vertigo |
| Reptiles | 16 | 94.1 | Timber rattlesnake |
| Spiders | 3 | 37.5 | *P. apacheanus* |

## HIGHLIGHTS

- The Blufflands provides a critical migratory corridor for forest songbirds, raptors, and waterfowl. It is the most important subsection for reptiles and one of the most important subsections for mollusks.
- It is an important area for birds such as Henslow's sparrows, prothonotary warblers, red-shouldered hawks, Louisiana waterthrushes, and peregrine falcons. It is also an important area for Karner blue butterflies and Blanding's turtles.
- Reptiles, amphibians, snails, mussels, and fish are special features of this landscape, including timber rattlesnakes, milk snakes, paddlefish, shovelnose sturgeon, pallid shiners, American eels, pirate perch, skipjack herrings, and several Pleistocene snails.
- Areas important for SGCN include the Whitewater, Gores Pool, and McCarthy Lake WMAs; Upper Mississippi River NWR; Kellogg-Weaver Dunes, Great River Bluffs, John Latsch, Whitewater, and Frontenac SPs; and Cannon River Turtle Preserve and Mound Prairie SNAs.

## SPECIES SPOTLIGHT


Photo by Barney Oldfield

**Timber rattlesnake *(Crotalus horridus)***

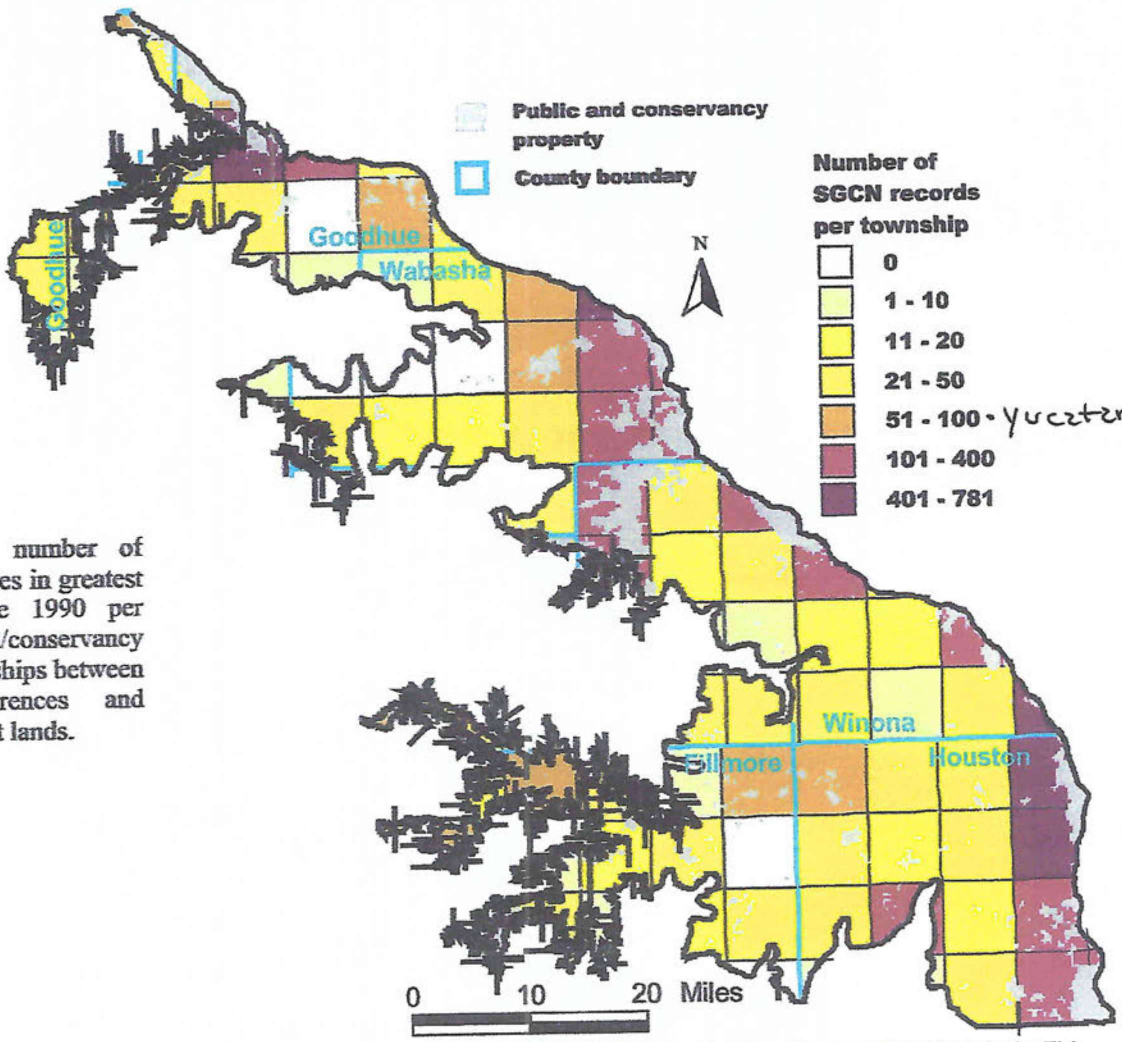
**Distribution** Blufflands of SE Minnesota along the Mississippi River and its tributaries.

**Abundance** Uncommon, with spotty distribution in some DNR state parks, WMAs, and private lands.

**Legal Status** State list-Threatened.

**Comments** This snake is benefiting from legal protection, DNR education workshops for landowners and law enforcement officials, and the federal Landowner Incentive Program, a state-administered voluntary program that provides funding to private landowners to implement habitat management projects benefiting "at-risk" species.

## SGCN ELEMENT OCCURRENCES BY TOWNSHIP




This map depicts the number of validated records of species in greatest conservation need since 1990 per township and public land/conservancy land. It suggests relationships between known SGCN occurrences and conservation management lands.

*Sources*: MN DNR Natural Heritage database, MN DNR County Biological Survey (MCBS), MN DNR Statewide Mussel Survey, MN DNR Fisheries Fish database. Areas with no MCBS animal surveys may have had mussel and fish surveys, as well as reports of other species occurrences recorded in the MN DNR Natural Heritage database.

## SPECIES PROBLEM ANALYSIS

The species problem analysis provides information on the factors influencing the vulnerability or decline of SGCN that are known or predicted to occur in the subsection. The table lists the nine problems, or factors, used in the analysis, and the percentage of SGCN in the subsection for which each factor influences species vulnerability or decline. The results of the species problem analysis indicate that habitat loss and degradation in the subsection are the most significant challenges facing SGCN populations.

NOTE: The inverse of the percentages for each problem does not necessarily represent the percentage of SGCN for which the factor is not a problem, but instead may indicate that there is not sufficient information available to determine the level of influence the factor has on SGCN in the subsection.

| Problem | Percentage of SGCN in the Subsection for Which This Is a Problem |
|---|---|
| Habitat Loss in MN | 82 |
| Habitat Degradation in MN | 88 |
| Habitat Loss/Degradation Outside of MN | 27 |
| Invasive Species and Competition | 29 |
| Pollution | 35 |
| Social Tolerance/Persecution/Exploitation | 23 |
| Disease | 1 |
| Food Source Limitations | 4 |
| Other | 21 |

## KEY HABITATS - For Species in Greatest Conservation Need

The CWCS identified key habitats for SGCN within the subsection using a combination of five analyses, labeled A-E below. The table depicts the five analyses, and under which analyses the key habitats qualified. To qualify as a key habitat for the subsection, the habitat had to meet the criteria used in at least one of the five analyses, as specified in the descriptions to the right of the table. The graphs below depict results from four (A-D) of the five analyses used in determining key habitats. Those habitats that meet the criteria are highlighted in RED in the graph for that analysis. Those habitats that do not meet the criteria are shaded in GOLD. Analysis E is not represented by a graph; the results of this analysis are presented as a list of key rivers/streams in Appendix I. For a more detailed explanation of the five analyses used, see Chapter 7, Methods and Analyses.

| KEY HABITATS | ANALYSIS A | B | C | D | E |
|---|---|---|---|---|---|
| Oak Savanna | X | | X | | |
| Prairie | X | X | X | | |
| Wetland-Nonforest | | | * | | |
| Shoreline-dunes-cliff/talus | | X | | | |
| River-Headwater to Large | | | | X | X |
| River-Very Large (Mississippi River) | | | | X | X |

*Wetlands do not represent more than 5% of the 1890s or 1990s landcover, but the 1984 Anderson & Craig study indicates wetlands have declined by greater than 50% in this subsection.

**Description of Analyses**

A: Terrestrial habitat use analysis - terrestrial habitats that represent more than 5% of 1890s or 1990s landcover and are modeled to have the most SGCN using them based on a z-test with p<0.01.

Note: A Z-test helps determine the significance of the set of data p<0.01 is good

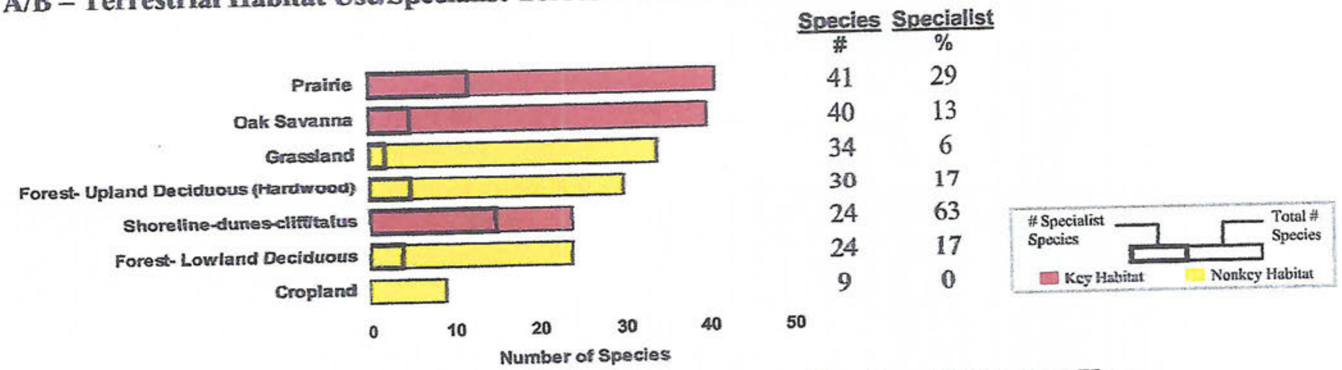
B: Specialist terrestrial habitat use analysis - terrestrial habitats that represent more than 5% of 1890s or 1990s landcover and have more than 15 species, 20% of which use 2 or fewer habitats (specialist species).

C: Terrestrial habitat change analysis - terrestrial habitats that represent more than 5% of the 1890s landcover and have declined by more than 50% in the 1990s landcover. For wetlands this change was based on an analysis done by Anderson & Craig in *Growing Energy Crops on Minnesota's Wetlands: The Land Use Perspective* (1984).

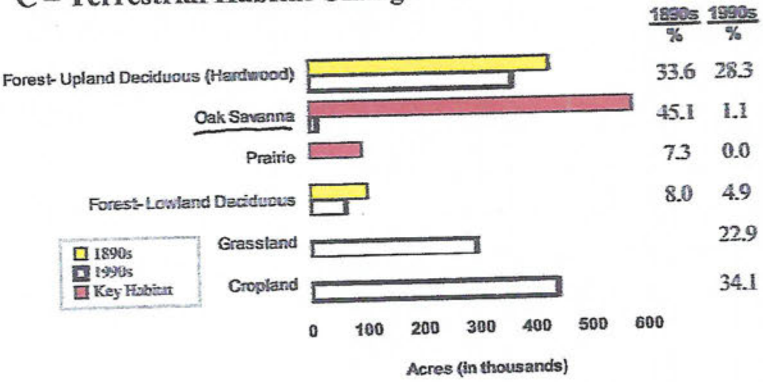
D: Aquatic habitat use analysis - lake or stream habitats that have the most SGCN use based on a z-test with p<0.01 of all subsections.

E: The Nature Conservancy/SGCN occurrence analysis - stream reaches identified in the Areas of Aquatic Biodiversity Significance in the four TNC Ecoregional Assessments and reaches with high SGCN occurrences (see Appendix I for list of stream reaches).

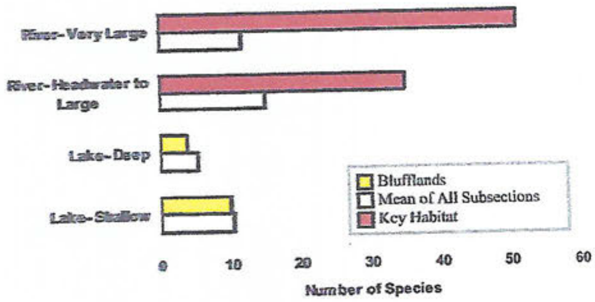
### A/B – Terrestrial Habitat Use/Specialist Terrestrial Habitat Use




### C – Terrestrial Habitat Change




### D – Aquatic Habitat Use




### E – The Nature Conservancy/SGCN Occurrence

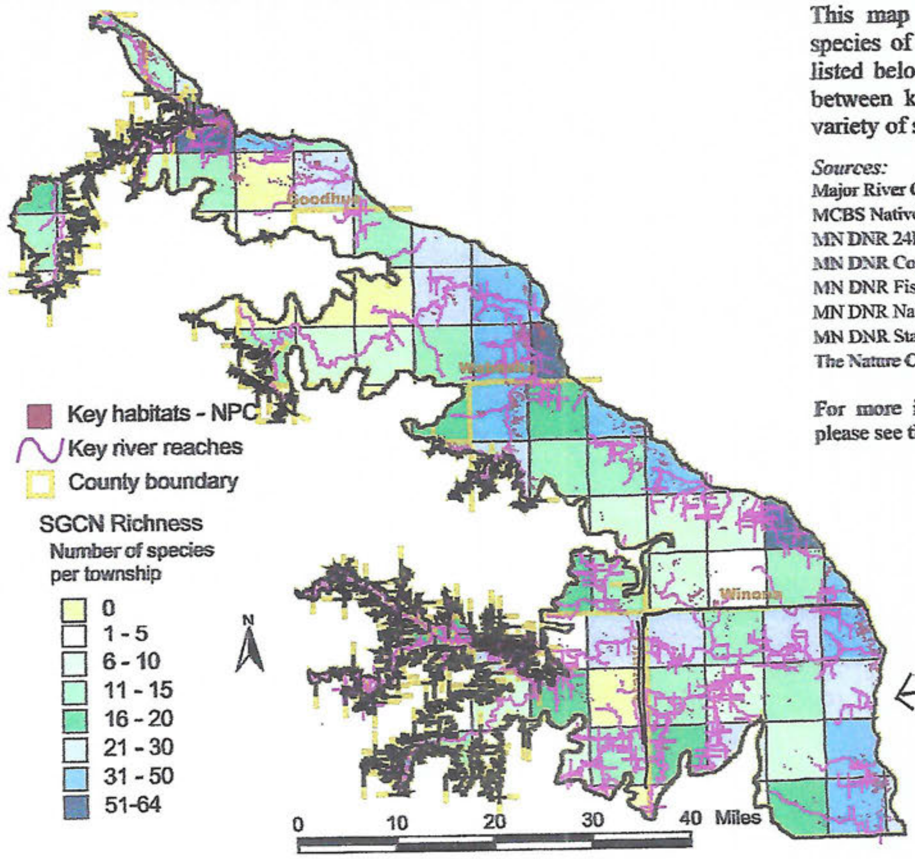
To reference the key rivers and streams for the subsection, see Appendix I.

## DISTRIBUTION OF KEY HABITATS AND SPECIES RICHNESS BY TOWNSHIP

This map depicts key habitats and the number of species of SGCN per township based on the sources listed below. It suggests there is often a relationship between key habitats and species richness (i.e., the variety of species of SGCN in a township).

*Sources:*
Major River Centerline Traces in Minnesota, 1984
MCBS Native Plant Communities (NPC), 2005
MN DNR 24K Rivers and Streams, 2005
MN DNR County Biological Survey (MCBS), 2005
MN DNR Fish database, 2005
MN DNR Natural Heritage database, 2005
MN DNR Statewide Mussel Survey, 2005
The Nature Conservancy Rivers and Streams combined dataset, 2005

For more information on how this map was constructed, please see the Subsection Profile Overview in Chapter 5.




← Houston County

## SUBSECTION HABITAT PERCENTAGES AND HABITAT USE BY SGCN TAXA

This table presents information on the percentages for each habitat in the subsection (showing changes in coverage between the mid- to late 1800s and the 1990s), as well as habitat use by SGCN taxonomic group. Habitats are listed in ranked order for percent coverage within the subsection in the 1990s. Key habitats for the subsection (as identified on previous page) are listed in **BOLD**. SGCN habitat use is broken down by taxonomic group, with a total number of species for all taxonomic groups listed at the far right of the table.

| | | | SGCN BY TAXONOMIC GROUP | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HABITAT | Percentage of Subsection (1890s) | Percentage of Subsection (1990s) | Amphibians | Birds | Fishes | Insects | Mammals | Mollusks | Reptiles | Spiders | Total Number of Species |
| Cropland | N/A | 34.0 | | 5 | | | 3 | | 1 | | 9 |
| Forest-Upland Deciduous (Hardwood) | 33.6 | 28.3 | | 15 | | 3 | 5 | 1 | 6 | | 30 |
| Grassland | N/A | 22.9 | | 15 | | | 8 | | 11 | | 34 |
| Forest-Lowland Deciduous | 8.0 | 4.9 | 1 | 15 | | | 4 | | 3 | 1 | 24 |
| Developed | N/A | 2.4 | | 5 | | 2 | 5 | | 1 | | 13 |
| Lake-Deep | N/A | 2.3 | 1 | 1 | 1 | | | | 1 | | 4 |
| Lake-Shallow | N/A | 1.4 | | 7 | 1 | | | | 2 | | 10 |
| **Oak Savanna** → | 45.1 | 1.1 | | 16 | | 5 | 8 | | 11 | | 40 ← |
| **Wetland-Nonforest** | 1.1 | 1.1 | 2 | 23 | | 1 | 2 | | 3 | | 31 |
| Forest-Lowland Coniferous | 0.0 | 0.8 | | 7 | | | 1 | | | | 8 |
| Forest-Upland Coniferous | 0.0 | 0.8 | | 13 | | 2 | 3 | | 7 | | 25 |
| Forest-Upland Deciduous (Aspen-oak) | 1.6 | 0.0 | | 13 | | | 3 | | | | 16 |
| **Prairie** | 7.3 | 0.0 | | 13 | | 7 | 7 | | 11 | 3 | 41 |
| **Shoreline-dunes-cliff/talus** | N/A | N/A | 1 | 11 | | 1 | | 5 | 6 | | 24 |
| Shrub-Lowland | N/A | N/A | 1 | 14 | | | 2 | | 2 | | 19 |
| **River-Headwater to Large** | N/A | N/A | 2 | 3 | 14 | 3 | | 9 | 4 | | 35 |
| **River-Very Large (Mississippi River)** | N/A | N/A | 2 | 2 | 19 | | | 24 | 4 | | 51 |

N/A: Insufficient data available to determine percent coverage within subsection. We have no data to indicate the existence of cropland, grassland, or developed land prior to settlement by people of European descent, although these land uses likely did occur at very low levels.
NOTE: 0.0 indicates less than 0.05 percent coverage.

## Ten-Year Goals, Management Challenges, Strategies, and Priority Conservation Actions

### Goal I: Stabilize and increase SGCN populations

*Management Challenge 1 – There has been significant loss and degradation of SGCN habitat*
*Strategy I A – Identify key SGCN habitats and focus management efforts on them*

**Priority Conservation Actions to Maintain, Enhance, and Protect the Key Habitats**

1. Oak savanna habitats, actions include:
    a. Manage invasive species
    b. Use prescribed fire and other practices to maintain savanna
    c. Encourage oak savanna restoration efforts
    d. Provide technical assistance and protection opportunities to interested individuals and organizations
2. Native prairie habitats, actions include:
    a. Manage invasive species
    b. Use prescribed fire and other practices to maintain prairie
    c. Manage grasslands adjacent to native prairie to enhance SGCN habitat
    d. Encourage prairie restoration efforts
    e. Provide technical assistance and protection opportunities to interested individuals and organizations
3. Nonforested wetlands, actions include:
    a. Enforce the Wetlands Conservation Act
    b. Manage habitats adjacent to wetlands to enhance SGCN values
    c. Provide technical assistance and protection opportunities to interested individuals and organizations
4. Cliff and bluff habitats, actions include:
    a. Support the protection of cliff and bluff habitats from damaging development
    b. Enhance cliff and bluff habitats to support SGCN
    c. Provide technical assistance and protection opportunities to interested individuals and organizations
5. Stream habitats, actions include:
    a. Maintain good-water quality, hydrology, geomorphology, and connectivity in priority stream reaches
    b. Maintain and enhance riparian areas along priority stream reaches
    c. Provide technical assistance and protection opportunities to interested individuals and organizations

*Management Challenge 2 – Some SGCN populations require specific management actions*
*Strategy I B – Manage federal and state listed species effectively*

**Priority Conservation Actions for Specific SGCN**

1. Implement existing federal recovery plans
2. Develop and implement additional recovery plans
3. Provide technical assistance to managers, officials, and interested individuals related to listed species
4. Enforce federal and state endangered species laws, as well as other wildlife laws and regulations

*Strategy I C – Manage emerging issues affecting specific SGCN populations*

**Priority Conservation Actions for Specific SGCN**

1. Work with partners to effectively address emerging issues affecting SGCN populations
2. Enforce federal and state wildlife laws and regulations

### Goal II: Improve knowledge about SGCN

*Management Challenge 1 – More information about SGCN and SGCN management is needed*
*Strategy II A – Survey SGCN populations and habitats*

**Priority Conservation Actions for Surveys**

1. Survey SGCN populations within the subsection, actions include:
    a. Continue MCBS rare animal surveys
    b. Survey SGCN populations related to key habitats
    c. Survey wildlife taxa underrepresented by MCBS animal surveys
2. Survey SGCN habitats within the subsection, actions include:
    a. Assess the amount and quality of key habitats and map their locations

*Strategy II B – Research populations, habitats, and human attitudes/activities*

**Priority Conservation Actions for Research**

1. Research important aspects of species populations within the subsection, actions include:
   a. Better understand the life history and habitat requirements of important SGCN
2. Research important aspects of SGCN habitats within the subsection, actions include:
   a. Identify best management practices for maintaining and enhancing key habitats
   b. Identify important patterns and distributions of key habitats to better support SGCN populations
   c. Identify important functional components within key habitats to support specific SGCN
   d. Explore important, emerging SGCN habitat management issues
3. Research important aspects of people's understanding of SGCN within the subsection, actions include:
   a. Identify people's attitudes and values regarding SGCN
   b. Identify places and ways people can enjoy and appreciate SGCN

*Strategy II C – Monitor long-term changes in SGCN populations and habitats*

**Priority Conservation Actions for Monitoring**

1. Monitor long-term trends in SGCN populations, actions include:
   a. Continue existing population monitoring activities
   b. Develop additional monitoring activities for specific SGCN populations
2. Monitor long-term trends in SGCN habitats, actions include:
   a. Develop long-term monitoring activities for important SGCN habitats

*Strategy II D – Create performance measures and maintain information systems*

**Priority Conservation Actions for Performance Measures and Information Systems**

1. Create and use performance measures, actions include:
   a. Develop partner-specific performance measures within the subsection
   b. Develop project-specific performance measures for SWG-funded projects
   c. Actively incorporate monitoring and performance measure information to enhance adaptive management
2. Maintain and update information management systems

## Goal III: Enhance people's appreciation and enjoyment of SGCN

*Management Challenge 1 – Need for greater appreciation of SGCN by people*

*Strategy III A – Develop outreach and recreation actions*

**Priority Conservation Actions for Outreach and Recreation**

1. Create new information and communicate with people to enhance their appreciation of SGCN
2. Create opportunities for people to appropriately enjoy SGCN-based recreation

## How to use this subsection profile

### Intended audience: Natural resource professionals and interested stakeholders

- Identify how the priority conservation actions and key habitats intersect and inform your current and future priorities.
- Using your additional insights and local knowledge, "step-down" the priority conservation actions into more detailed actions and practical on-ground tasks.
- Use it to understand species in greatest conservation need priorities and tell a story about the subsection (its history, biology, ecology, demography) to other natural resource professionals, managers, decision makers and land owners.
- Visit our website, or give us a call, and tell us how you're using it, how others are using it, and ideas that "step-down" the priority conservation actions.

**Website:**

www.dnr.state.mn.us/cwcs

### For more information, please contact:

Emmett Mullin, Project Manager, MN DNR, phone: 651-259-5566, email: emmett.mullin@dnr.state.mn.us

Daren Carlson, Ecologist/GIS Analyst, MN DNR, phone: 651-259-5079, email: daren.carlson@dnr.state.mn.us

Brian Stenquist, Strategic Planner, MN DNR, phone: 651-259-5144, email: brian.stenquist@dnr.state.mn.us

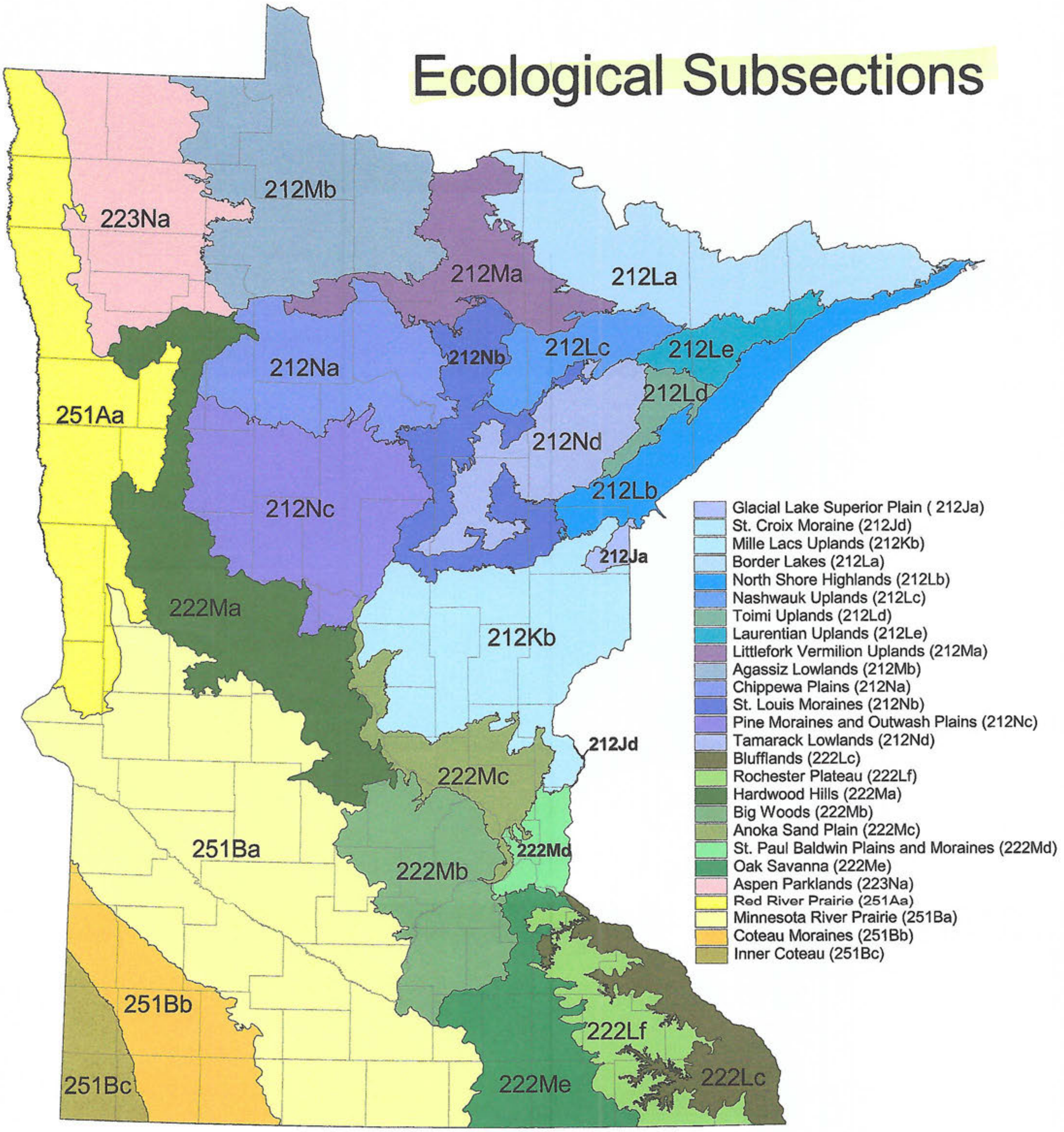
### How to cite this document:

Minnesota Department of Natural Resources, 2006. *Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife*, Comprehensive Wildlife Conservation Strategy. Division of Ecological Services, Minnesota Department of Natural Resources.



Department of Natural Resources
500 Lafayette Road
St. Paul, MN 55155-4040
(651) 296-6157 (Metro Area)
1-888-MINNDNR (646-6367) (MN Toll Free)

# Ecological Subsections



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Beltrami County
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MN Center for Environmental Advocacy
MN Department of Agriculture
MN Department of Natural Resources
Natural Resources Conservation Service
Potlatch Corporation
USDA Forest Service
U.S. Fish and Wildlife Service

For more information contact:
ECS Specialist
MN DNR, Division of Forestry
Resource Assessment Program
413 SE 13 Street
Grand Rapids, MN 55744
(218) 327-4449 ext 239

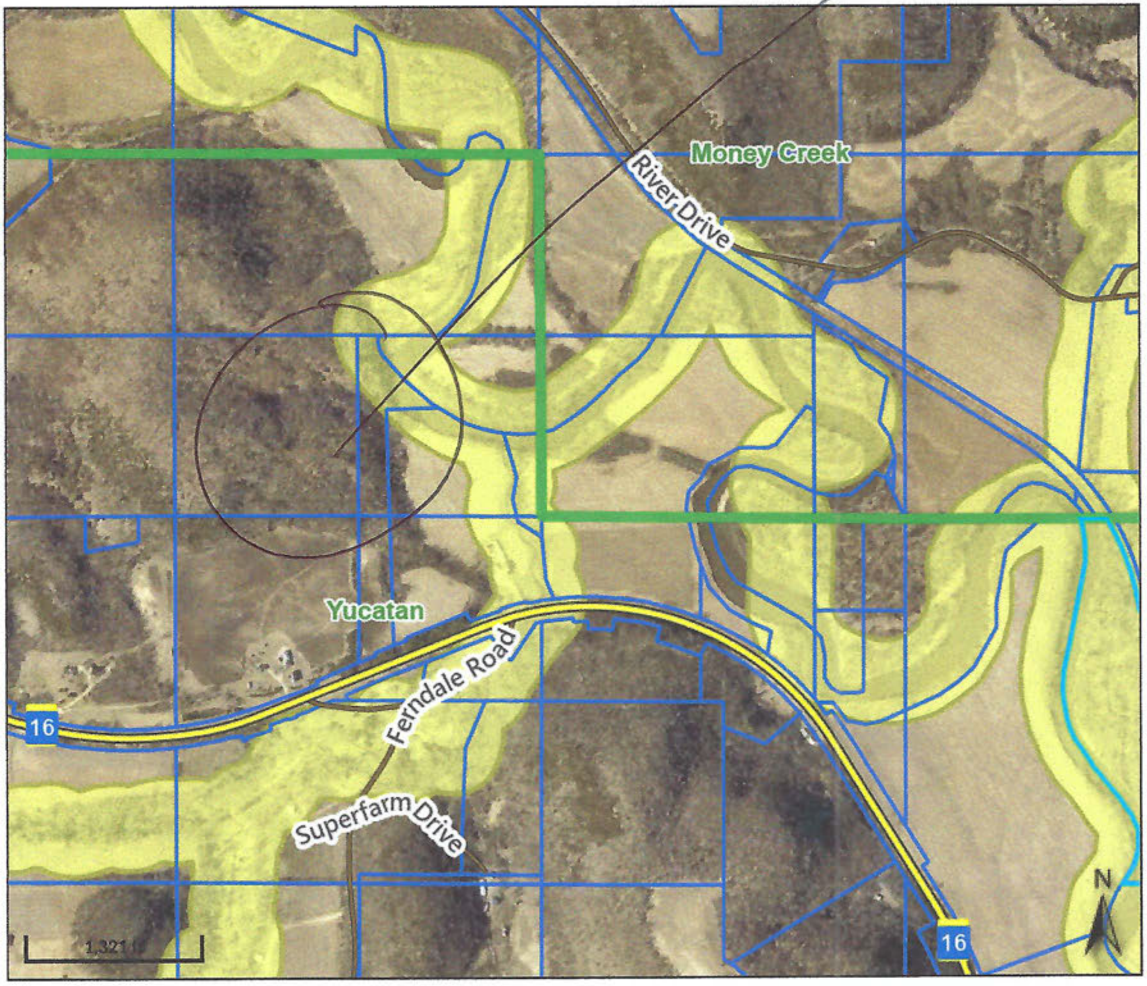
September, 2000

Division of Forestry
Ecological Land
Classification Program

Shoreland map

# Beacon™ Houston County, MN

proposed mine site




**Overview**

**Legend**

**Parcels**
- Parcels
- Mobile Home
- Exempt
- Personal Property
- Lease
- **Corporate Limits**

**Roads**
- US Highway
- State Highway
- County Highway
- Township Road
- Municipal Road
- **Shoreland**
- **Political Townships**

| | | | | | |
|---|---|---|---|---|---|
| **Parcel ID** | 170018000 | **Alternate ID** | n/a | **Owner Address** | STATE OF MN DNR |
| **Sec/Twp/Rng** | 08-104-007 | **Class** | 981 - STATE ACQUIRED | | 500 LAFAYETTE RD BOX 45 |
| **Property Address** | | **Acreage** | 63.58 | | ST PAUL, MN 55155 |

**District** YCTNT/SD239/FD10

**Brief Tax Description** EX PT NW1/4 LY N & E OF ROOT RIVER EX PT N1/2 NE1/4 NW1/4 4

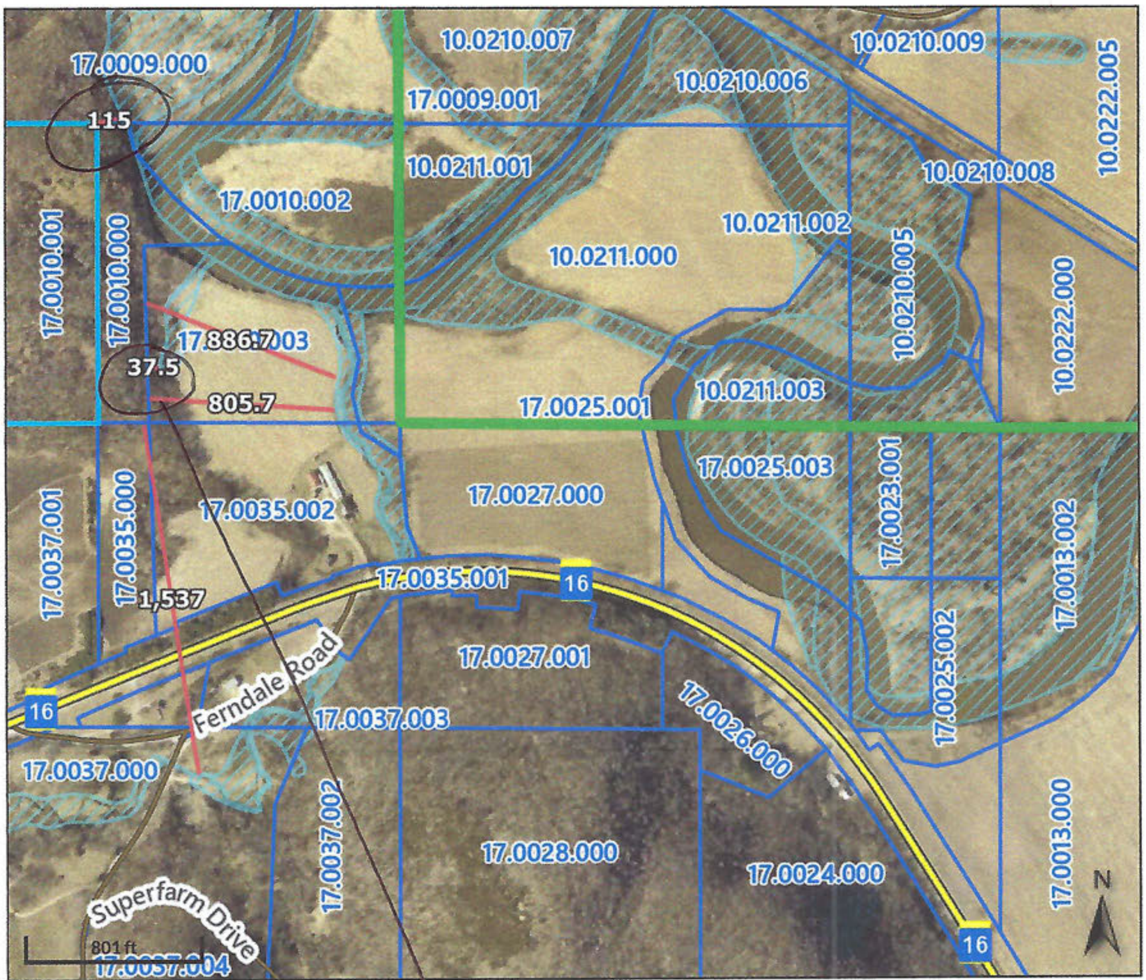
(Note: Not to be used on legal documents)

Date created: 4/10/2026
Last Data Uploaded: 4/10/2026 9:29:38 AM

Developed by SCHNEIDER GEOSPATIAL

# Beacon™ Houston County, MN

Wetlands map




## Overview

## Legend

**Parcels**

- Parcels
- Mobile Home
- Exempt
- Personal Property
- Lease
- Corporate Limits

**Roads**

- US Highway
- State Highway
- County Highway
- Township Road
- Municipal Road
- Wetlands
- Political Townships

| | | | | | |
|---|---|---|---|---|---|
| **Parcel ID** | 170010001 | **Alternate ID** | n/a | **Owner Address** | OLSON,CLAIR & JARAD |
| **Sec/Twp/Rng** | 20-104-007 | **Class** | 113 - RURAL PRESERVE | | 22543 COUNTY 13 |
| **Property Address** | | **Acreage** | 40.0 | | RUSHFORD, MN 55971 |

**District** YCTNT/SD239/FD10

**Brief Tax Description** SW1/4 SW1/4 B 325 P 221 & B 332 P 451 DOC 310990 & 310991 2
(Note: Not to be used on legal documents)

Date created: 4/20/2026
Last Data Uploaded: 4/17/2026 10:06:57 PM

Developed by SCHNEIDER GEOSPATIAL

37.5 ft to nearest wetland

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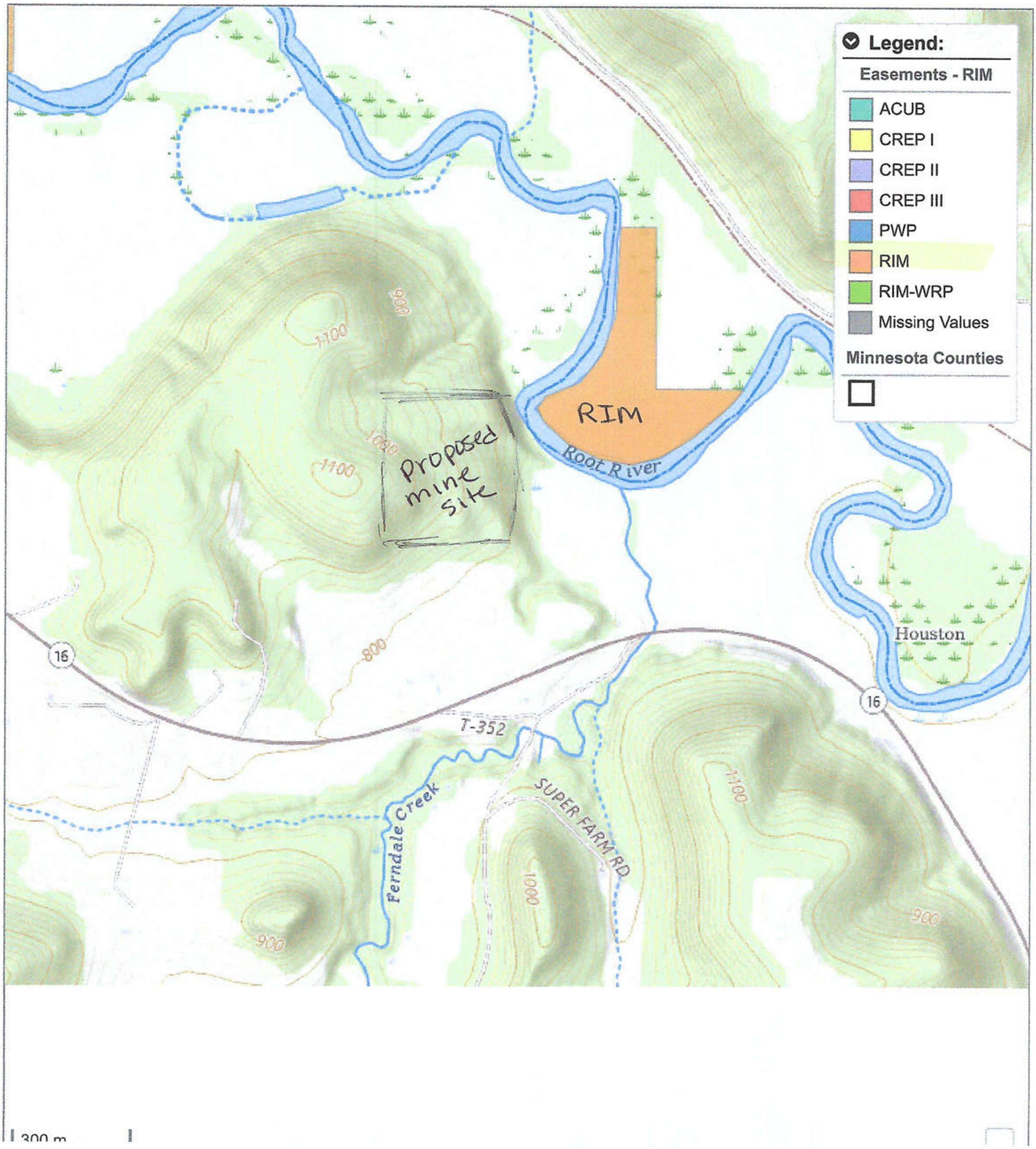
# Minnesota Natural Resource Atlas

RIM Easement

Home | Using the Atlas | Mapping Tool | Data Catalog | About the Atlas



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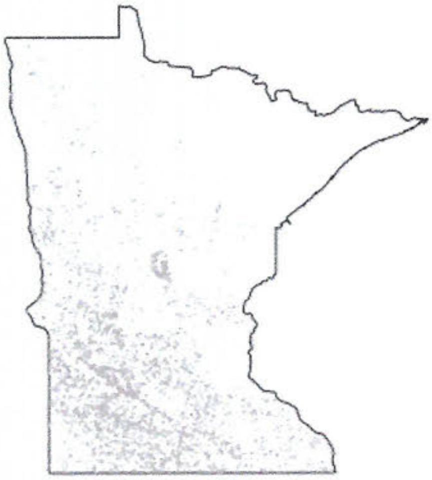
## Easements – RIM

**Data Categories:** Environment
**Data Source:** MN Board of Water & Soil Resources
**Update Fequency:** As Needed
**Date Acquired:** 12/23/2025
**Data Available:** Yes
**Metadata Available:** Yes
**Tags:** Conservation, Easements, Grasslands, habitat, Water Quality, Wetlands



Extent of available data.

This data layer indicates the location of conservation easements that were created through the Reinvest in Minnesota (RIM) program. It was developed by the Minnesota Board of Water and Soil Resources. RIM creates conservation easements that establish riparian buffers or permanently restore wetlands and/or land adjacent to wetlands. It is funded by the Board of Water and Soil Resources (BWSR) and implemented by Soil and Water Conservation Districts. The program seeks to improve water quality and wildlife habitat throughout the state by protecting economically marginal, flood-prone, and environmentally sensitive areas and enhancing their ecological value. Wetlands and riparian buffers can serve to improve water quality and decrease erosion by reducing the overland flow of water and the pollutants and sediment it can transport.

**Launch Map** **Get Data** **Get Metadata**

nrriinfo@d.umn.edu
(800) 234-0054
(218) 788-2694
5013 Miller Trunk Highway
Duluth, MN 55811



Privacy Statement

## About the Project

The Natural Resource Atlas of Minnesota is a collaborative project led by the Natural Resources Research Institute – University of Minnesota Duluth with contributions from the College of Food, Agriculture and Natural Resources – University of Minnesota and Minnesota Sea Grant. Funding has been provided by the Minnesota State Legislature, the Legislative-Citizen Commission on Minnesota Resources, and the Department of Iron Range Resources and Rehabilitation.

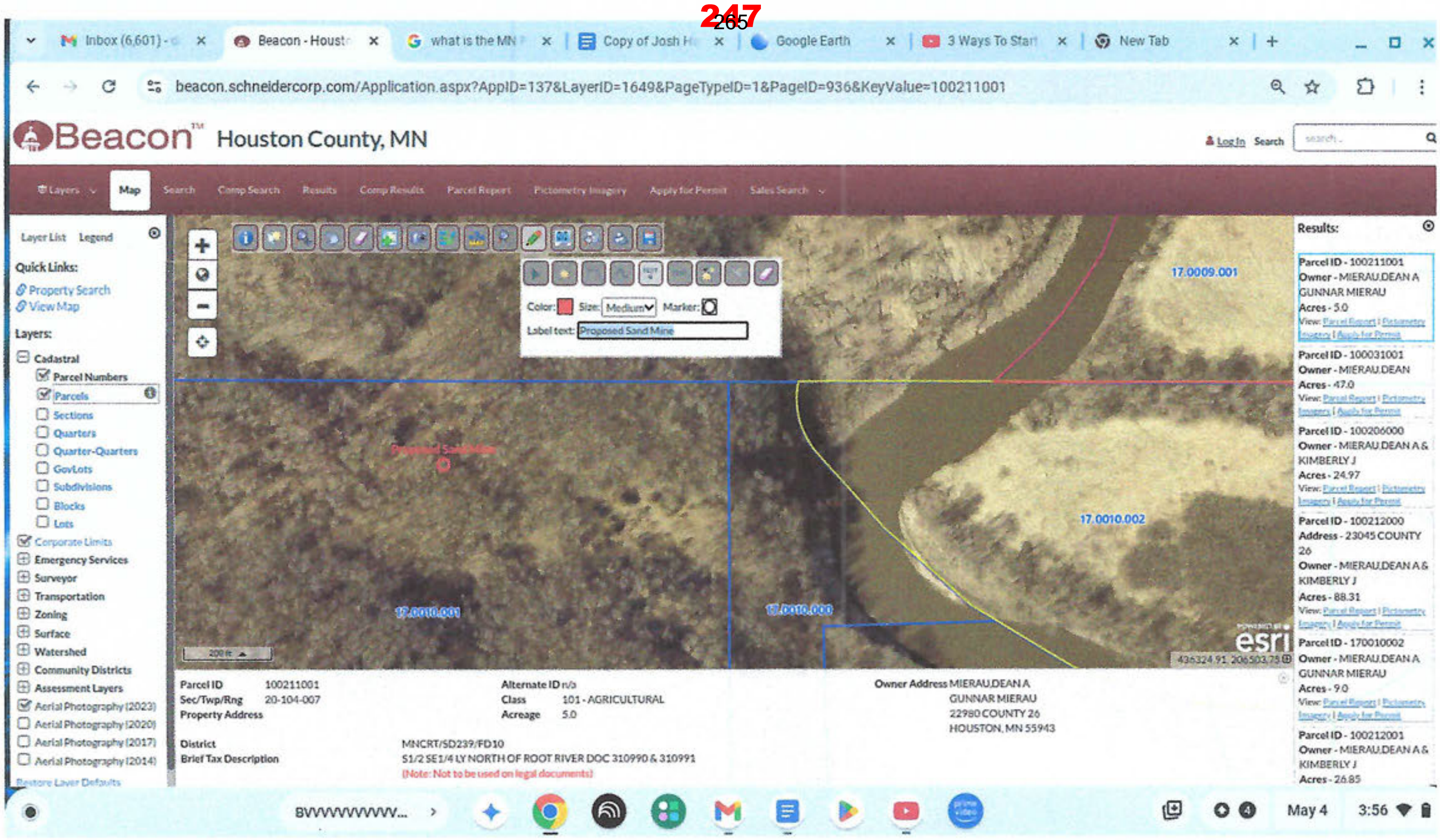
Updated 02/03/2026

To Whom it May Concern,

I wanted to take a brief moment to point out that the proposed Olson Sand Mine is adjoining my property, a Reinvest In Minnesota (RIM) perpetual easement. This is relevant since in order to enroll land in this program it undergoes an extensive review because the land is deemed critically necessary to ensure water quality issues are preserved, threatened and endangered species are protected, as well as ensuring other environmental factors are preserved. The State of MN utilized an extensive enrollment and criteria process to secure perpetual easement on the land which can not be reversed. It would be irresponsible for Houston County to ignore the aforementioned reasons why adjoining land is in the program and allow adjoining land to become a sand mine. Water Quality, threatened and endangered species as well as other environmental factors do not adhere to county derived property lines. The adjoining land of the Olson's bears the same environmental sensitivities as the adjoining RIM easement land and the proposed sand mine should not be approved based on environmental and cultural impacts.

Sincerely,

Dean Mierau
Houston County


Beacon - Houston
beacon.schneidercorp.com/Application.aspx?AppID=137&LayerID=1649&PageTypeID=1&PageID=936&KeyValue=100211001
Beacon Houston County, MN
Layers
Map
Search
Comp Search
Results
Comp Results
Parcel Report
Pictometry Imagery
Apply for Permit
Sales Search
Layer List
Legend
Quick Links:
Property Search
View Map
Layers:
Cadastral
Parcel Numbers
Parcels
Sections
Quarters
Quarter-Quarters
GovLots
Subdivisions
Blocks
Lots
Corporate Limits
Emergency Services
Surveyor
Transportation
Zoning
Surface
Watershed
Community Districts
Assessment Layers
Aerial Photography (2023)
Aerial Photography (2020)
Aerial Photography (2017)
Aerial Photography (2014)
Restore Layer Defaults
Color:
Size: Medium
Marker:
Label text: Proposed Sand Mine
Proposed Sand Mine
17.0009.001
17.0010.002
17.0010.001
17.0010.000
esri
Results:
Parcel ID - 100211001
Owner - MIERAU,DEAN A GUNNAR MIERAU
Acres - 5.0
Parcel ID - 100031001
Owner - MIERAU,DEAN
Acres - 47.0
Parcel ID - 100206000
Owner - MIERAU,DEAN A & KIMBERLY J
Acres - 24.97
Parcel ID - 100212000
Address - 23045 COUNTY 26
Owner - MIERAU,DEAN A & KIMBERLY J
Acres - 88.31
Parcel ID - 170010002
Owner - MIERAU,DEAN A GUNNAR MIERAU
Acres - 9.0
Parcel ID - 100212001
Owner - MIERAU,DEAN A & KIMBERLY J
Acres - 26.85
View: Parcel Report | Pictometry Imagery | Apply for Permit
Parcel ID 100211001
Sec/Twp/Rng 20-104-007
Property Address
Alternate ID n/a
Class 101 - AGRICULTURAL
Acreage 5.0
Owner Address MIERAU,DEAN A
GUNNAR MIERAU
22980 COUNTY 26
HOUSTON, MN 55943
District MNCRT/SD239/FD10
Brief Tax Description S1/2 SE1/4 LY NORTH OF ROOT RIVER DOC 310990 & 310991
(Note: Not to be used on legal documents)
May 4
3:56

## 5. Erosion

- Minnesota Natural Resource Atlas - Soil Erosion Risk of Proposed Mine
- Stabilizing shoreland property to prevent erosion | UMN Extension
- Neighbor witnessing existing and ongoing erosion, wildlife, trout streams and wetland
- Citizen conversation with Lanesboro Fish Hatchery

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# Minnesota Natural Resource Atlas

Soil Erosion Risk

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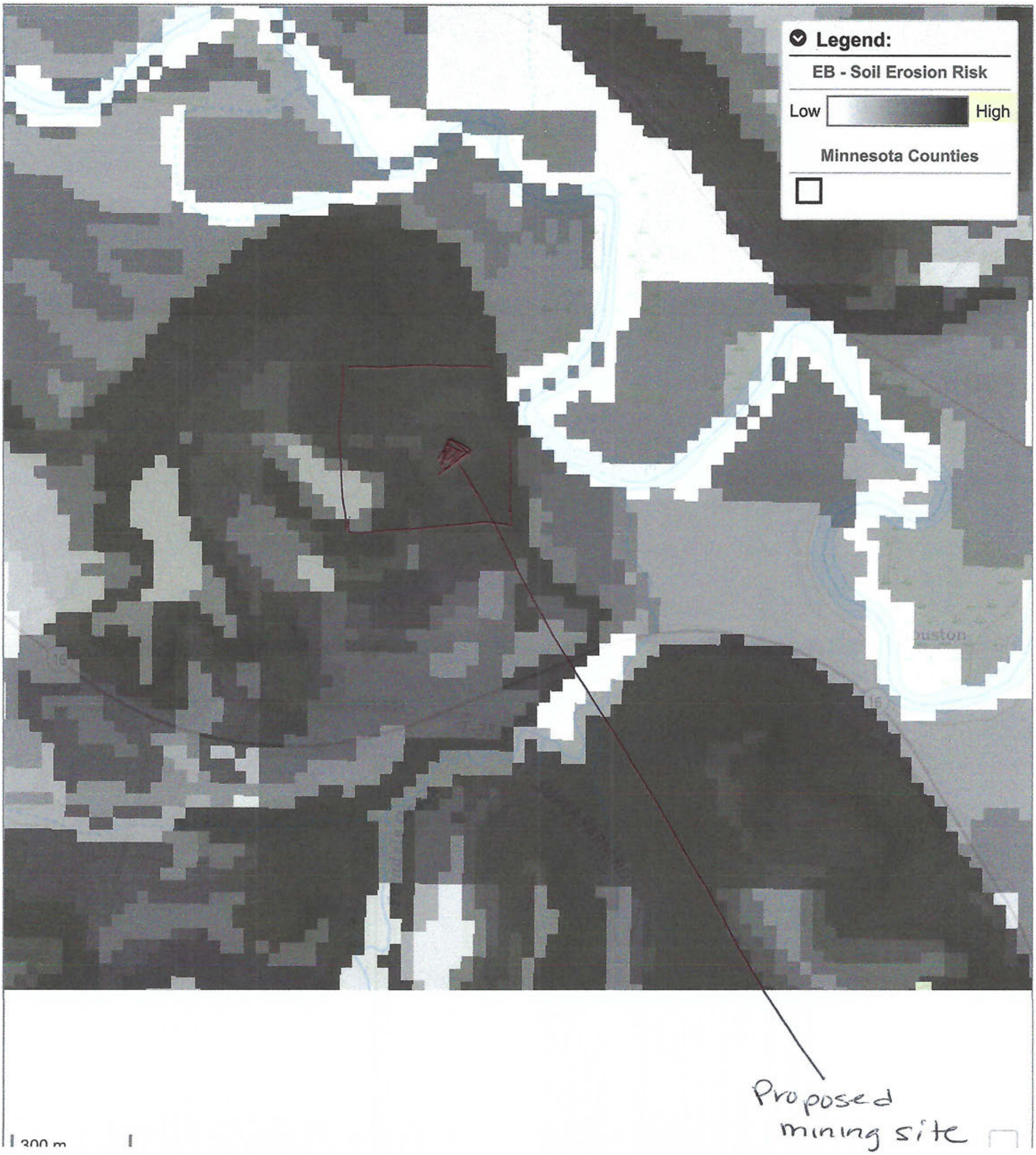

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# EB – Soil Erosion Risk

**Data Categories:** Environment
**Data Source:** MN Board of Water & Soil Resources, Natural Resources Research Institute
**Update Fequency:** None Planned
**Date Acquired:** 07/01/2018
**Data Available:** No
**Metadata Available:** Yes
**Tags:** erosion, soil, Water Quality

Extent of available data.

This data layer is the Environmental Benefits (EB) Soil Erosion Risk map. It was developed by the Minnesota Board of Water and Soil Resources and the Natural Resources Research Institute. The EB Soil Erosion Risk represents the potential for soil erosion. It is based on a number of factors, including climate, soil type, and slope. The risk is calculated using a subset of the Universal Soil Loss Equation. Erosion is one of the major contributors to water quality impairment. The soil that enters a body of water decreases clarity and can also carry pollutants and nutrients. The scores are a relative ranking across most of the state. Although it was developed to help identify and rank areas for conservation efforts, the EB Soil Erosion Risk is useful for many purposes.

**Launch Map** **Get Metadata**

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(218) 788-2694
5013 Miller Trunk Highway
Duluth, MN 55811



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Updated 02/03/2026

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# Stabilizing shoreland property to prevent erosion

With more shoreline than California, Florida and Hawaii combined, Minnesota is bound to have areas where shoreland erosion is a problem. It's obvious that wave-pounded properties lose soil and ultimately their value. What isn't as obvious is that your practices can accelerate or slow erosion. Slow erosion by diverting water runoff away from hills and bluffs. Use drain pipes or French drains to create a safe route for water that can't be diverted.
Leave natural shoreland vegetation and beach rocks undisturbed. The shore edge can be further protected by installing rip-rap (big rocks).

## Bluffs and erosion

Shoreland properties often slope toward the water. Some hills are gradual, but some are extreme, like bluffs. Erosion is a big problem for bluffs. Increased runoff is especially damaging to high bluffs.

Slumping of bluffs can be caused by:

- Unstable soil caused by surface or ground water reaching the bluff.
- On lakes, waves can erode supporting soil at the bottom of the bluff.
- Along river bluffs, river currents can erode the supporting soil.

### Preventing bluff erosion

Prevent erosion of higher shoreline bluffs by:

- Retaining moisture-absorbing vegetation on the bluff.
- Diverting surface runoff away from the bluff (including rain gutter outlets).
- Reducing runoff rate toward the bluff.
- Minimizing paved areas that increase runoff.
- Limiting ground water flow toward the bluff.
- Installing septic systems and drainfields away from the bluff.
- Avoiding additional weight on the bluff edge, such as pools, buildings or storage sheds.

### Create safe routes for water you can't divert

On property with steep slopes or bluffs, reducing the amount of water reaching the bluff will help with stabilization. Sometimes, diverting water away from the bluff is impractical. In these cases, create a safe route for the water to travel.

1. **Use a drain pipe that reaches the very bottom of the bluff.**

Use a non-perforated plastic drain pipe that outlets at the very bottom of the bluff. Rock should be placed around the outlet to prevent erosion at the bottom of the drain.

2. **Install a "French drain" to catch surface water.**

Surface water and some ground water can be drained before it reaches the bluff by installing a "French drain". A French drain is a narrow trench set back from, but parallel to, the top of the bluff and filled with free-draining sand or gravel.

A perforated, corrugated plastic pipe at the bottom collects water and should drain away from the bluff. The entire perforated length of pipe must be wrapped with fabric or a filter sock. Installing deeper drains will intercept more ground water and provide better protection for the bluff.

### Keep extra weight off of the top of the bluff

No additional weight should be placed near the top of the bluff.

- NO buildings.
- NO garage slabs.
- NO vehicles.

These are especially inappropriate near the top of a bluff because they add weight and water:

- NO septic systems.
- NO swimming pools.

## Shoreland and erosion

### Leave the shore undisturbed

For most property that slopes toward water, leaving the natural shoreland undisturbed is often the best and least expensive protection against erosion. A filter strip of thriving vegetation should be left on and near the shore. This binds the soil and minimizes soil loss from surface runoff and waves, and from use by people (Figure 3). Existing vegetation can be enhanced by planting woody or aquatic plants.

Natural shoreline features provide natural protection. While swimmers may not enjoy walking on cobblestones, and an ice-pushed ridge may block some of the view from your lawn chair, these features help "nourish" your beach by reducing erosion and trapping sand. Even driftwood absorbs a certain amount of wave energy that otherwise erodes soil.

## Additional shore protection

Regardless of the natural protection on your shore, the right combination of conditions (such as high lake level and wind direction) can result in a severe wave pounding, and shoreland soil may need additional protection.

Placement of large rock, usually referred to as rip-rap, is the preferred and most common form of shore protection. There are technical methods available to determine rock size, placement geometry and elevations to ensure the best protection. Your county Soil and Water Conservation District (SWCD), the MN Board of Water and Soil Resources (BWSR) and the federal Natural Resources Conservation Service (NRCS) can provide technical assistance.

The above agencies will also have information on other types or remedies that may be appropriate for your particular situation. Potential shore protection alternatives include:

- Bulkheads (retaining walls).
- Gabions (rock-filled wire baskets).
- Articulating blocks (cable-connected concrete blocks).
- Geoweb matrix (thick, open-cell plastic grid).

A few of the alternatives can be placed by hand. Some other alternatives, such as railroad ties, are often tried but rarely work. If you have your own idea for a solution, you should seek technical advice first.

### Rip-rap (large rocks)

Planting native aquatic vegetation will usually stabilize a shoreline if done properly. In the rare cases when that is not possible, rip-rap may be used as a last resort. If rip-rap is used, crushed or blasted rocks lock together better than rounded boulders. However, this method can be very expensive unless rip-rap is readily available.

### Use geotextile fabric

Geotextile fabric is usually placed beneath the rock rip-rap to prevent soil loss through the rock openings. It's easy to place and provides an excellent filter barrier.

- **Prevent punctures:** In order to prevent punctures, plenty of slack should be provided over protruding objects that cannot be removed. A layer of sand or fine gravel can be placed on the fabric for extra protection against puncture.

- **Wrap together as one unit:** Enough fabric should be laid out so that the rip-rap periphery can be "wrapped" by bringing the fabric up and back down into the rip-rap. This will help hold the rip-rap together as one structural unit. Keep in mind that sunlight will degrade exposed fabric.
- **Graded filter layer:** As an alternative to the fabric, a graded filter layer can be used beneath rip-rap to prevent soil loss through the rip-rap openings.

### Toe protection

Sufficient rock must be placed at the base of the rip-rap for toe protection. Excavated toe material must be removed from the lakebed and placed in a non-wetland area.

## Hiring help

### Rip-rap installation

The price of rip-rap placement depends on local contractors, distance to the nearest rock source and access to the project site. It also depends on how much other work, such as clearing or earthwork, is required.

Protection for Lake Superior shoreline typically costs more than for inland lake shoreline. Inquire at the county SWCD office about cost-share assistance.

A project cost can also be estimated by calling earthwork contractors in your area. A big savings can be realized if you can install these items yourself.

### Stabilizing a slumping bluff

#### Find out about soil types and ground water level

If you want to stabilize a slumping bluff, find out about soil types and ground water level. The record from when your well was drilled may be a good information source. You can obtain this record from the state or county health department or from your well driller. Contact your county SWCD for information on soils.

#### Get technical assistance

Effective bluff stabilization will require technical assistance.

You can:

1. Request an engineer from the BWSR, SWCD or NRCS to inspect your site.
2. Consider hiring a geotechnical engineering firm. They can take soil borings, analyze soil properties and recommend a remedy.

## Regulations often apply

All erosion protection projects that alter the lakebed or riverbed require a **protected waters permit** from the Department of Natural Resources (DNR).

Contact the DNR Area Hydrologist for:

- Permit guidelines.
- Other agencies that might require a permit.
- For assistance in planning your erosion prevention project.

Some rip-rap projects may not need a permit.

## For more information

Local government offices:

- Soil and Water Conservation District (SWCD).
- Planning and zoning department.
- Watershed Districts.

Minnesota state agency regional offices:

- Minnesota Board of Water and Soil Resources (BWSR).
- Minnesota Department of Natural Resources (DNR) Area Hydrologist.

Federal agencies:

- Natural Resources Conservation Service (NRCS).
- U.S. Army Corps of Engineers (USACE).

*Reviewed in 2018*

Erosion reported by neighbor

April 20, 2026

Rebecca Christensen
[redacted]
Rushford, MN 55971

Minnesota Environmental Quality Board
520 Lafayette Road N
Saint Paul, MN 55155

Re: Request for Discretionary Environmental Worksheet (EAW) for the Proposed Mining Project in Houston County

I am writing today to not only make this request, but to voice my concerns for not only our property, but our neighborhood and our ecosystem in general.

As far as our property goes, it is somewhat unique in that we are bordered by the highway, the river and a protected trout stream (Ferndale Creek), as well as a wetland at the base of the hill being proposed for the sand mine. It is because of this that I have numerous fears for the amount of cumulative damage that could be done here. We are downhill from the proposed mine, and as we know, everything runs downhill.

Over the years, without any activity uphill at all, we have noticed a creeping of the sand coming across our north field. Plainly visible on google earth. This leaves us with a sandy spot which will not grow a healthy crop. With disturbance it is my fear we will lose the field for planting.

The wetland is at the north end of that same field. It isn't large, but it is a vital part of our land and for our wildlife. Just to the west of the wetland on the river side is a sheared sand wall, which we have watched slough sand into the river for years.

To the east of this field is Ferndale Creek (a protected Trout Stream) which has been a watering hole to the wildlife as well. The river and creek as well as our surrounding vegetation have attracted many animals, including bear, and especially during drought. Family members have even caught Northerns at the point the creek meets the river.

Upstream from us on Ferndale Creek is a trout hatchery. Trout are highly susceptible to temperature changes in their waters, and will die if that changes even a few degrees. It is my fear that flocculants and Suractants may be used to keep the dust down, etc. at the mine site. That could over time have many effects on the water temperature and quality.

In 30 years of living here, we have seen every kind of wildlife that Minnesota has to offer. Some I didn't even think lived here. There is nothing quite as thrilling or scary than hearing a noise on your porch you believe to be an opossum, only to nearly open the front door to a large mama black bear eating your oriole jelly and just checking out your home. Or having a mama bear and her babies wandering the property eating berries, your compost pile, and going for a swim after.

We have enjoyed having a quiet, restful place to call home, and I know our wildlife doesn't consider us a threat, so I fear the added activity alone, with all the noise, disturbance and vibration will drive our wildlife away from our neighborhood. Our bald and golden eagles will no longer nest nearby and train the babies to fly and hunt here, and the deer and turkeys may move on also.

As for the neighborhood, will we all stay? Or will we be driven out by the noise and pollution as well as dropping property values? I have already been approached by a realtor looking to make a quick buck. Coincidentally the same realtor who sold the property proposed for the mine.

Even the angle of the proposed mine wall to mine floor (2:1) and the scant distance to the next property line is worrisome for the land to the north of the mine. The DNR wont allow anything less than a 3:1 pitch for anything you would want to do at the waters' edge, but this sand, which just rolls without stopping, is expected to not slough back at a 2:1 ratio? Foolhardy.

I believe the people in our neighborhood all have a healthy respect of our land enough to know what we have and appreciate it. I would hate to find out in a few years that the cumulative effects of everything this mine would do, actually had an ill effect on any one of us. Whether it be our health, our livelihoods, our air and water, or our wildlife.

Will the sand wall which is already sloughing off into the river increase and change the flow of the river? Will that in turn change the ability for the creek to empty out, or possibly back up?

In all, I can see nothing good can come of having this mine, which is practically on top of the existing mine. With the changing agricultural scene, fewer farms every year it seems, I have to question its very need. Ag sand can and probably should be found elsewhere. We have at least one shale mine in our county, and because of a lack of data on the subject, I am sure there are other sand/shale mines in the county which could be utilized if need is so great.

I think sacrificing a protected trout stream, a wetland, wildlife and the homes, peace and beauty of our neighborhood is just not a good trade for a mine which has such a limited scope and need.

I don't believe the average person has any idea how quickly mother nature can change our emvironment, even in a few short hours, much less what the proven long term effects of what a man-made disturbance can do to the environment over the course of many years.

Thank you for your time and attention to this matter. Please let our dwindling resources be your guide. When in doubt, do without is a motto I live by, please consider it.

Humbly,

Rebecca L. Christensen

Citizen conversation with Laneboro Fish Hatchery

Erosion

Dear EQB Staff,

I just got off the phone speaking to Scott from the Lanesboro Fish Hatchery where I informed him of the proposed sand mine just off of the Root River between the cities of Rushford and Houston. I asked him to look up the property on Beacon so that he could see why I am concerned. I expressed my concern over the close proximity to the river and especially how it will be located 300' west of the outer edge of a bend in the river.

I voiced my concern over what would happen if we received another flood event comparable to the 2007 flooding in the area. We both agreed that another flood like the 2007 flood would spread into the proposed mine operation and move any unprotected sand into the river.

The parcel number is 17.0010.001 in Houston County where the last proposal that we have been made aware of is to extract 17 acres of sand over the next thirty years.

I felt that Scott understood my reason for concern over the proposed site being so close to the Root River especially on the outer edge of the river since erosion happens on the outer edge of a river bend and deposits on the inner portion of a river bend.

Cindy Hatleli
Houston County

## 6. Air Quality, Silica Dust, and Public Health

- Crystalline Silica in Air andamp; Water, and Health Effects - MN Dept. of Health
- Silicosis: Causes, Symptoms, Diagnosis & Treatment
- Beacon maps of nearby residences (with distances) and Ferndale Public Golf Course

DEPARTMENT OF HEALTH

I am searching for...

DEPARTMENT OF HEALTH

# Crystalline Silica in Air & Water, and Health Effects

Crystalline silica is a substance of concern for human health. Dust sized silica particles, invisible to the naked eye, are generated during a variety of activities and can be breathed into the body where they reach deep into the lungs. Once in the lungs, these particles can be coughed up, or pass from the lungs to other organs in the body through the blood stream, or stay stuck in the lungs. Breathing crystalline silica repeatedly over many years is a well-known cause of health problems.

Silica is a "building block" material that forms rocks, soil, sand, and other parts of the earth. A large amount of the earth is made up of silica. Silica occurs in either a crystalline or an amorphous structure. Over many years, silica in the soil can form into crystalline silica due to natural heat and pressure. Crystalline silica is very commonly found throughout the Midwest, and is more toxic to human health than amorphous silica.

Many industrial and commercial processes require crystalline silica. Some of the more notable uses for crystalline silica include glassmaking, road-building, molds for molten metals poured at foundries, hydraulic fracturing, or "fracking," for oil and gas production, water filtration, and even electronics. Crystalline silica can be released into the air from cutting, grinding, drilling, crushing, sanding, or breaking apart many different materials. Silica is a well-known occupational hazard and has also been recently examined for its environmental concentrations near silica sand mines and transport terminals.

## Health Effects

Disease risk is related to both the levels and duration of crystalline silica exposure. The onset of disease may occur long after the exposure has stopped. Silicosis, lung cancer, chronic bronchitis, and several autoimmune diseases have been linked to long term or very high exposures to crystalline silica.

Expand All

### At High Concentrations in the Air

Health effects of crystalline silica have been well studied in workers. Occupational exposures are associated with serious health effects at higher concentrations in the air, and new rules have recently been implemented to better control worker exposures.

### At Low Concentrations in the Air

We do not currently know what impacts silica has at lower concentrations such as those typically found in air. At this time, there is no evidence that exposure to low-levels of breathable crystalline silica in air has adverse health effects. This continues to be an area of on-going research.



# Air Monitoring

A few years ago, concern mounted surrounding silica sand mining activities and the potential release of large amounts of crystalline silica into the air. In response, MDH developed a health-based guidance [LINK http://www.health.state.mn.us/communities/environment/hazardous/topics/silica.html#healthbase] value for crystalline silica in the air and the Minnesota Pollution Control Agency (MPCA) received air quality monitoring data from silica sand facilities in Minnesota between 2012 and 2017. For more information, contact the MPCA at 651-296-6300 or 800-657-3864.

# Water and Silica Sand Mining

Any mine may create a pathway for chemicals and/or bacteria to more easily reach the groundwater.

Expand All

### Silica Sand Mining or Processing and Groundwater

- The risks to drinking water depend on:
  - How close the mining operations are to the upper surface of the groundwater
  - The use of heavy equipment
  - Leaks and spills of fuel, engine oil, or other chemicals
  - Runoff from contaminant sources
  - Waste illegally dumped in the mine
- Some frac sand mines (mines that extract silica sand to be used for hydraulic fracturing) use products called flocculants to remove silt and clay in the sand washing process. These products are generally considered to be environmentally safe; however, they often contain low concentrations of chemicals (acrylamide and DADMAC) that are of potential concern. The Minnesota Pollution Control Agency sets limits in the mine's permit for the amount of flocculants that can be used and MDH recommends monitoring of the groundwater at facilities where the chemicals are used to ensure safe drinking water levels are not exceeded.
- Groundwater near frac sand mines may become slightly more acidic (lower in pH). This may cause minerals (like iron and manganese) to more easily dissolve, which can cause water to have unpleasant taste and odor, and may cause staining. MDH recommends monitoring pH of groundwater near frac sand mining operations.

### Silica Sand Mining and Wells

Mining can remove large volumes of groundwater and has the potential to impact nearby wells. Impacts could include the lowering of water levels, possibly even causing a nearby well to go dry.

- The Minnesota Department of Natural Resources reviews large water removal activities to ensure that groundwater use will not harm wells in the area.
- MDH evaluates whether there are any potential risks to community water supply wells.
- MDH recommends a number of actions to prevent or reduce the potential for pollutants to enter the groundwater and water quality monitoring to protect nearby drinking water wells.

For more information, see: Wellhead Protection Issues Related to Mining Activities (PDF) [LINK http://www.health.state.mn.us/communities/environment/water/docs/swp/mining.pdf].

# Legislation

In 2013, legislation was passed to update environmental review rules, provide technical assistance, and develop model standards and criteria to support local units of government as they consider permits for silica sand mining, processing, and transportation in Minnesota. For more information, see the Minnesota Environmental Quality Board's website Silica Sand Projects [LINK https://www.eqb.state.mn.us/content/silica-sand-projects].

# Health-Based Guidance

MDH was directed to adopt an air quality health-based value for silica sand (See: Chapter 114, Article 4, Section 105 (c) [LINK https://www.revisor.mn.gov/laws/2013/0/114/]). MDH completed a review of breathable (respirable) crystalline silica and released an air quality chronic health-based value (HBV) of 3 micrograms per cubic meter (μg/m$^3$) in July 2013. MDH developed this guidance because there are no federal or state guidelines or standards for respirable crystalline silica in ambient air.

Expand All

### Guidance is Focused on Human Health

The focus of MDH's health-based guidance is on crystalline silica that is found in the air, and may be breathed into the lungs. Crystalline silica is toxic to humans when inhaled because of how it damages tissues in the lungs. Crystalline silica in other places in the environment, such as surface water or groundwater, is not a concern for human health because it is not breathed in from these sources.

### Basis for MDH Guidance

Guidance values already exist for occupational exposures to breathable silica particles in the workplace. These guidance values are based on workplace silica exposures that took place over many decades. MDH used these studies to determine a level of silica in air that would not be expected to harm human health based on current scientific understanding. The 3 μg/m$^3$ chronic HBV is many times lower than occupational guidelines or standards due to adjustments for continuous exposure and consideration of uncertainty factors to protect sensitive subpopulations in the general population. The HBV protects even the most sensitive people exposed to crystalline silica at any time during their life.

Sufficient data is not available to support development of quantitative health-based guidance for shorter duration exposures (1 - 30 days) to respirable crystalline silica. Extremely high levels of respirable crystalline silica are needed to cause short-term health effects in occupationally-exposed individuals and are far higher than what the general public would be expected to encounter in ambient air. Existing ambient air standards for particulate matter (which includes crystalline silica) provide protection against health effects in these short-term exposure timeframes.

The concentration of breathable crystalline silica in air can vary considerably from day to day. Air monitoring may show that values are greater than 3 μg/m$^3$ on occasion. Daily or weekly values greater than 3 μg/m$^3$ are not cause for concern. The health-based value is a yearly average concentration because long term exposure to crystalline silica is the primary health risk.

For technical information, refer to the Crystalline Silica Toxicological Summary Sheet (PDF) [LINK http://www.health.state.mn.us/communities/environment/risk/docs/guidance/air/silicasumm.pdf]

# Resources



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Expand All

## MDH Resources

Addressing Community Concerns: Health Impact Assessment [LINK http://www.health.state.mn.us/communities/environment/hia/index.html]

Community concerns related to general mining activities include increased traffic,noise, and risk of accidents. Health Impact Assessment (HIA) is a process that could lead to a more complete evaluation of all of the risks associated with the frac sand mining process.

Crystalline Silica Toxicological Summary Sheet (PDF) [LINK http://www.health.state.mn.us/communities/environment/risk/docs/guidance/air/silicasumm.pdf]

A summary of health based values for crystalline silica in ambient air.

Wellhead Protection Issues Related to Mining Activities (PDF) [LINK http://www.health.state.mn.us/communities/environment/water/docs/swp/mining.pdf]

Guidance for revising local government land use comprehensive plans, rules or regulations as they may apply to aggregate mining in drinking water supply management areas in Minnesota.

## Other Resources

Silica Sand Projects [LINK https://www.eqb.state.mn.us/content/silica-sand-projects]

The Minnesota Environmental Quality Board is a resource for coordinating and connecting state agencies that work on issues related to Silica Sand Mining in Minnesota.

Particulate Matter (PM) Pollution [LINK https://www.epa.gov/pm-pollution]

The US Environmental Protection Agency provides further information about particulate matter—like crystalline silica.

Silica sand mining [LINK https://www.pca.state.mn.us/regulations/silica-sand-mining]

The Minnesota Pollution Control Agency activities related to silica sand mining.

Mining in Minnesota [LINK https://www.dnr.state.mn.us/education/geology/digging/mining.html]

The Minnesota Department of Natural Resources provides addition information about silica sand projects and silica sand mining.

**Last Updated:** 09/27/2024

Cleveland Clinic

# Silicosis

Silicosis is a lung disease that can develop from breathing in silica dust, usually around mining and construction sites. Symptoms include a long-lasting cough, problems breathing, inflammation in your airways and scarring in your lung tissue. There's no cure. But there are ways to manage your symptoms.

## What Is Silicosis?

**Image content:** This image is available to view online.

View image online (https://my.clevelandclinic.org/-/scassets/images/org/health/articles/silicosis)

Silicosis causes permanent damage to your lungs. It affects people who breathe in silica dust over a long period of time.

Silicosis (sil-eh-KOH-sis) is a type of interstitial lung disease that can occur from breathing in very tiny silicon dioxide particles (silica dust). Silica is a natural compound that's in things like:

- Plants, including dark, leafy greens, bell peppers and other vegetables
- Rocks, including quartz and granite
- Sand
- Soil
- Water

Manufacturers often include silicon dioxide (silica gel) packets in packages to absorb moisture.

Silica is nontoxic if you drink it or eat it. But inhaling certain kinds of silica dust can cause problems with your respiratory system. It damages the immune cells in the tiny air sacs in your lungs (alveolar macrophages). Alveolar macrophages (al-VEE-uh-ler MAK-ruh-feyj-es) are part of your immune system — they're part of your respiratory system's core line of defense.

Most people get silicosis because they breathe in silica dust at their jobs. Symptoms aren't usually noticeable right away. But over time, silica can damage your lungs. For some kinds of silica, this can take about 10 years of regular exposure. With higher levels of exposure, lung damage can happen faster. Silicosis rates have improved with safety regulations. But in the past five years, a large number of people have developed silicosis from working with engineered stone products.

You can't cure or reverse silicosis. But healthcare providers can help you manage symptoms. Severe cases can affect your ability to do daily activities. It can also be fatal.

### Types of silicosis

Silicosis may develop in three ways:

- **Acute (sudden) silicosis**: You can get this type by having an intense silica dust exposure — the dust you breathe in consists of a lot of silica. It usually takes five years or less to develop. But you may develop acute silicosis within several months.

- **Chronic (long-term) silicosis**: This is the most common type. It usually develops after exposure to breathable dust for more than 10 years. The amount of silica in the dust is also a factor. Simple silicosis is the most common type of chronic silicosis. Progressive massive silicosis is another type that causes a lot of scarring.
- **Subacute silicosis (accelerated silicosis)**: This type typically develops over two to five years. It develops faster because of heavier exposure to silica dust.

## Symptoms and Causes

### What are the symptoms of silicosis?

The main silicosis symptoms include:

- Long-lasting (persistent) cough, especially coughing up phlegm
- Inflammation in your lung tissue
- Scarring in your lung tissue (pulmonary fibrosis)

These symptoms can also cause:

- Fatigue
- Muscle weakness
- Shortness of breath
- Unexplained weight loss

### What is the main cause of silicosis?

Damage to your lungs from breathing in silica dust causes silicosis. This usually happens in a work-related setting.

### Risk factors

Silicosis is a work-related lung disease. You're at greater risk of developing silicosis if you work in the following industries:

- Construction, building and demolition
- Foundry work
- Mining and quarrying
- Pottery, ceramics and glassmaking
- Sandblasting
- Stone work, including making stone countertops

### What are the long-term effects of silicosis?

People who have silicosis are at an increased risk of the following:

- Autoimmune diseases like scleroderma, rheumatoid arthritis and lupus
- Chronic bronchitis
- Chronic kidney disease (CKD)
- Lung cancer

- Tuberculosis and other lung infections

## Diagnosis and Tests

### How doctors diagnose silicosis

A healthcare provider will:

- Review your medical history
- Ask about your symptoms
- Perform a physical exam, including listening to your lungs with a stethoscope (auscultation)

They may also ask about your job history. If they suspect silicosis or another lung condition, they'll recommend additional testing.

### Tests that are used

Healthcare providers may recommend the following tests to help diagnose silicosis:

- **Bronchoalveolar lavage**: This test "washes" your lungs and examines the fluid they pull out.
- **Imaging tests**: Chest X-rays and CT scans can provide detailed images of your lungs.
- **Lab tests**: Lab tests can't diagnose silicosis. But they can help providers rule out other conditions, like some types of infections. One test may include a tuberculosis skin test.
- **Lung biopsy**: Providers remove a small piece of your lung tissue for examination. Providers rarely recommend a lung biopsy to help diagnose silicosis.
- **Pulmonary function tests**: These tests evaluate how well your lungs work.
- **Sputum culture**: A sputum culture examines mucus that you cough up.

## Management and Treatment

### Can lungs recover from silica dust?

No. There's no cure for silicosis. Healthcare providers can't reverse lung damage from silica dust. They can only help manage your symptoms.

### What are the treatment options for silicosis?

You can't treat silicosis. But you can help manage your symptoms by:

- Changing jobs
- Doing pulmonary rehab
- Quitting smoking, vaping and using tobacco products
- Taking a bronchodilator to improve airflow
- Using supplemental oxygen

In severe cases, healthcare providers may recommend a lung transplant.

### Are there silicosis clinical trials?

Yes, there are ongoing clinical trials for silicosis treatments. Researchers use antifibrotic drugs to treat some forms of silicosis. Some of these drugs are experimental. But one drug — nintedanib (OFEV®) — has approval from the U.S. Food and Drug Administration (FDA) to treat pulmonary fibrosis.

If your healthcare providers think you're a good candidate, they may suggest that you participate.

### When should I see my healthcare provider?

You should have regular checkups with a healthcare provider if you work around silica dust. Schedule an appointment right away if you have a cough or trouble breathing.

Call a provider right away if you have silicosis and notice new symptoms that concern you.

During your appointment, you may wish to ask your provider:

- Will my condition get worse?
- What can I do to feel better?
- How can I protect my lungs?
- Am I a good candidate for a silicosis clinical trial?
- Can you recommend a silicosis support group?
- Do I need to think about a lung transplant, and what does this process look like?

## Outlook / Prognosis

### What can I expect if I have silicosis?

Your outlook depends on many factors, including:

- How much silica you've been exposed to
- How long you've been exposed to silica dust
- Whether you're still exposed to silica dust
- Your age
- Any other conditions you may have

Your healthcare providers will give you a better idea of what to expect, according to your situation. But in general, your outlook is better if your symptoms don't get worse.

If silicosis causes progressive massive fibrosis, your outlook is poor. You're more likely to have permanent breathing problems and a reduced quality of life. It's also more likely to cause premature death.

### What is the life expectancy?

It depends on the severity of your condition, your age and your overall health. Some people can live 10-20 years or longer after receiving a silicosis diagnosis. Your healthcare provider will give you a better idea of what to expect.

## Prevention

### Can silicosis be prevented?

Yes, you can prevent silicosis. If you work around respirable crystalline silica dust, you can help lower your risk of developing silicosis by:

- Changing out of dusty clothes

- Making sure job sites have air-monitoring equipment
- Using equipment that helps reduce the amount of dust in the air, including exhaust ventilation, dust-collecting systems, spraying water on surfaces and using "wet drills" to keep dust down
- Using vacuums with high-efficiency particulate air (HEPA) filters or wet mops to clean worksites instead of a dry broom
- Wearing the proper PPE, including a tight-fitting respirator

It's also a good idea to get regular silicosis screenings through your employer. Screenings are tests that check for signs of silicosis before you have symptoms. Early detection is key to preventing severe symptoms.

## Additional Common Questions

### Is silicosis the same as cancer?

No, silicosis isn't cancer. It doesn't cause your cells to grow out of control. But silicosis may be a factor in developing lung cancer.

### Can exercise help?

Exercise may be helpful if you have silicosis. Discuss your exercise plans with a healthcare provider. They may suggest pulmonary rehab, which includes exercises that can help improve your breathing.

### A note from Cleveland Clinic

It's common to write off a cough and other symptoms of silicosis as a common respiratory infection. But if you work around silica and have symptoms, it's a good idea to schedule an appointment with a healthcare provider to figure out exactly what's going on with your respiratory system.

There's no cure for silicosis. Some cases are mild while others are very serious. Only a provider can tell you what to expect in your specific situation. They'll work with you to create a plan to manage your symptoms and protect your airways from further damage.

### Experts You Can Trust

**Medically Reviewed.** Last updated on 09/05/2025.

### References

Cleveland Clinic's health articles are based on evidence-backed information and review by medical professionals to ensure accuracy, reliability and up-to-date clinical standards.


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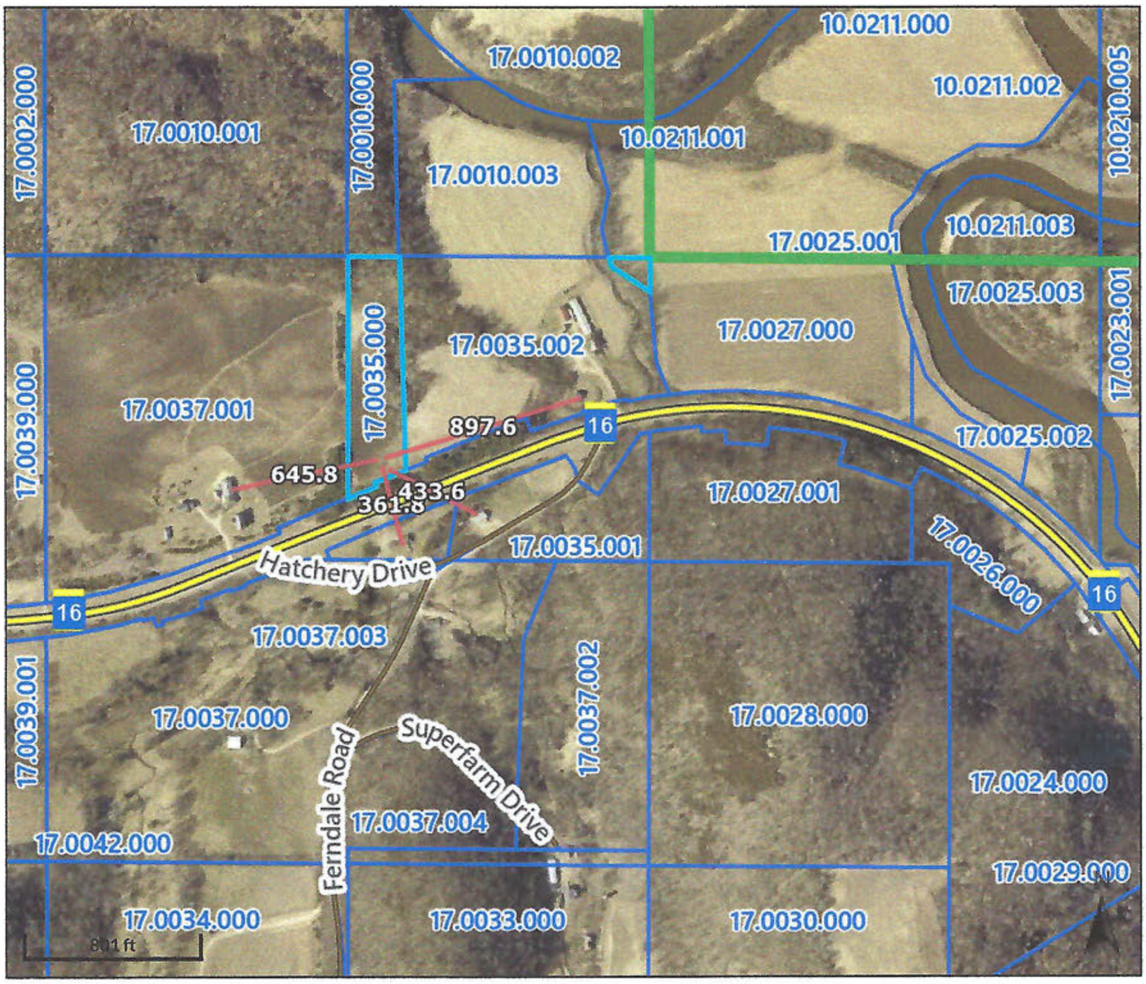
Beacon™ Houston County, MN

Nearby residences




**Overview**

**Legend**

**Parcels**

- Parcels
- Mobile Home
- Exempt
- Personal Property
- Lease
- **Corporate Limits**

**Roads**

- US Highway
- State Highway
- County Highway
- Township Road
- Municipal Road
- **Political Townships**

| | | | | | |
|---|---|---|---|---|---|
| **Parcel ID** | 170035000 | **Alternate ID** | n/a | **Owner Address** | OLSON,CLAIR & JARAD |
| **Sec/Twp/Rng** | 29-104-007 | **Class** | 101 - AGRICULTURAL | | 22543 COUNTY 13 |
| **Property Address** | | **Acreage** | 5.77 | | RUSHFORD, MN 55971 |

**District** YCTNT/SD239/FD10

**Brief Tax Description** NE1/4 NW1/4 EX PIECES SOLD; DOC 310990 & 310991

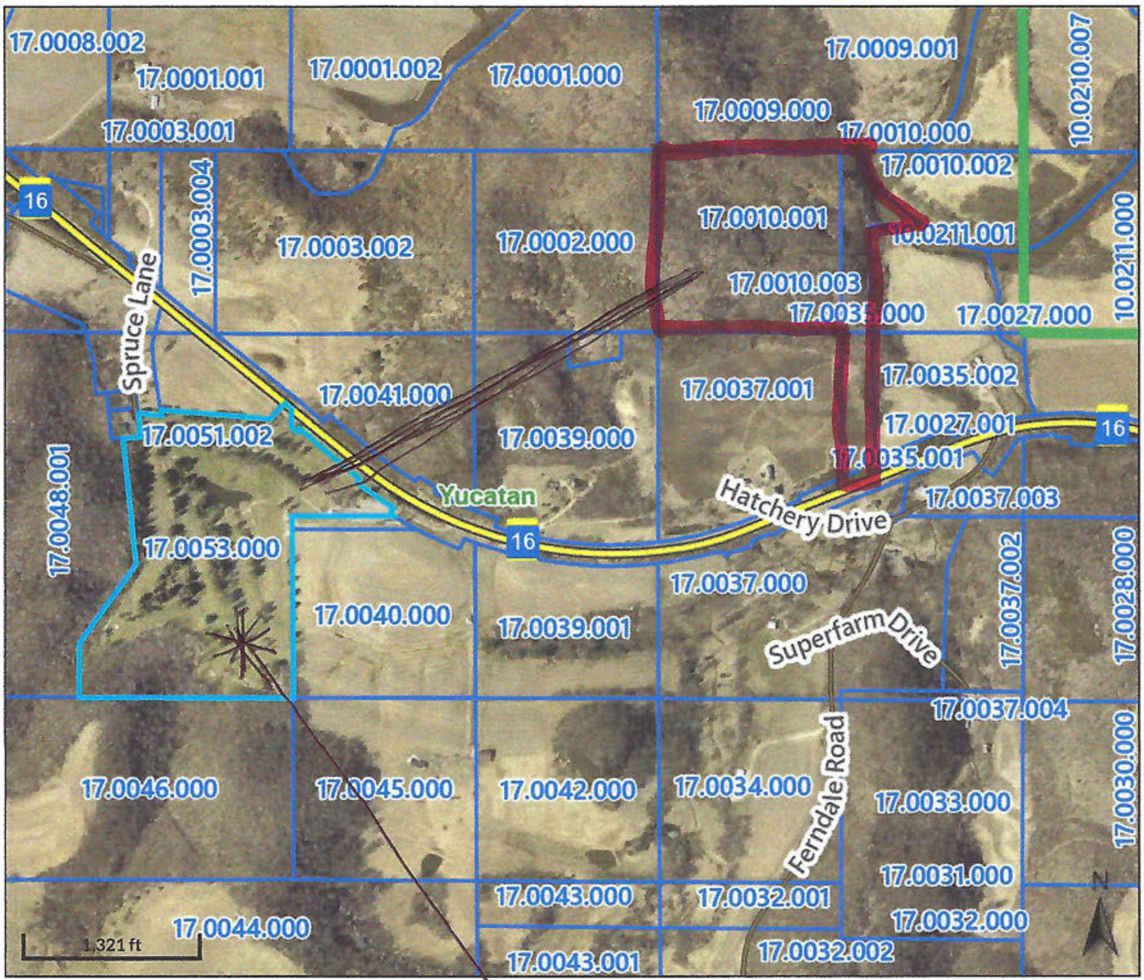
(Note: Not to be used on legal documents)

Date created: 5/2/2026
Last Data Uploaded: 5/1/2026 10:08:07 PM

Developed by SCHNEIDER GEOSPATIAL

# Beacon™ Houston County, MN

Nearby Golf course




## Overview

## Legend

**Parcels**
- Parcels
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- Exempt
- Personal Property
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- **Corporate Limits**

**Roads**
- US Highway
- State Highway
- County Highway
- Township Road
- Municipal Road
- **Political Townships**

| | | | | | |
|---|---|---|---|---|---|
| **Parcel ID** | 170053000 | **Alternate ID** | n/a | **Owner Address** | FERNDALE GOLF LLC |
| **Sec/Twp/Rng** | 30-104-007 | **Class** | 247 - QUALIFY GOLF COURSES | | 23239 STATE HWY 16 |
| **Property Address** | 23239 STATE 16<br>RUSHFORD | **Acreage** | 67.8 | | RUSHFORD, MN 55971 |

**District** YCTNT/SD239/FD10

**Brief Tax Description** PT NW1/4 (59A) & PT NW1/4 NE1/4 (4.7A) & PT NW1/4 (3A) DOC 234770; DOC 297152 3

(Note: Not to be used on legal documents)

Golf course

Date created: 5/2/2026
Last Data Uploaded: 5/1/2026 10:08:07 PM

Developed by SCHNEIDER GEOSPATIAL

### 7. Noise and Light Pollution

- A Guide to Noise Control in Minnesota MPCA
- Noise, Light & Vibration | Environmental Health Project

1

# A Guide to Noise Control in Minnesota

Acoustical Properties, Measurement, Analysis, and Regulation

Minnesota Pollution Control Agency

November 2015

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# Foreword

The Minnesota Pollution Control Agency (MPCA) is empowered to enforce the State of Minnesota noise rules. These rules and supporting acoustical information can be viewed in the document, "A Guide to Noise Control in Minnesota." This publication is intended to provide information on the basics of sound and noise regulation.

Revised 2015

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# Introduction

Noise is a pollutant. While its physical and emotional effects are difficult to define quantitatively, the noise level itself can be measured.

**Sound:** An alteration of pressure that propagates through an elastic medium such as air and produces an auditory sensation.

**Noise:** Any undesired sound.

The Minnesota Pollution Control Agency (MPCA) is empowered to enforce the State of Minnesota noise rules (Minn. Rules Ch. 7030). Minnesota's primary noise limits are set by "noise area classifications" (NACs) based on the land use at the location of the person that hears the noise. They are also based on the sound level in decibels (dBA) over ten percent ($L_{10}$), or six minutes, and fifty percent ($L_{50}$), or thirty minutes, of an hour.

For residential locations (NAC 1), the limits are $L_{10}$ = 65 dBA and $L_{50}$ = 60 dBA during the daytime (7:00 a.m. – 10:00 p.m.) and $L_{10}$ = 55 dBA and $L_{50}$ = 50 dBA during the nighttime (10:00 p.m. – 7:00 a.m.) (Minn. R. 7030.0040). This means that during a one-hour period of monitoring, daytime noise levels cannot exceed 65 dBA for more than 10 percent of the time (six minutes) and cannot exceed 60 dBA more than 50 percent of the time (30 minutes).

# 1. Noise rules in Minnesota

## 1.1 The basics

Minnesota's noise pollution rules are based on statistical calculations that quantify noise levels over a one-hour monitoring period. The $L_{10}$ calculation is the noise level that is exceeded for 10 percent, or six minutes, of the hour, and the $L_{50}$ calculation is the noise level exceeded for 50 percent, or 30 minutes, of the hour. There is not a limit on maximum noise.

The statutory limits for a residential location are $L_{10}$ = 65 dBA and $L_{50}$ = 60 dBA during the daytime (7:00 a.m. – 10:00 p.m.) and $L_{10}$ = 55 dBA and $L_{50}$ = 50 dBA during the nighttime (10:00 p.m. – 7:00 a.m.) (Minn. R. 7030.0040). This means that during the one-hour period of monitoring, daytime noise levels cannot exceed 65 dBA for more than 10 percent of the time or 60 dBA more than 50 percent of the time.

The basic noise rules for other noise area classifications are:

| Noise Area Classification | Daytime | | Nighttime | |
|---|---|---|---|---|
| | $L_{10}$ | $L_{50}$ | $L_{10}$ | $L_{50}$ |
| 1 | 65 | 60 | 55 | 50 |
| 2 | 70 | 65 | 70 | 65 |
| 3 | 80 | 75 | 80 | 75 |

## 1.2 Noise area classifications

Noise area classifications (NAC) are based on the land use at the location of the person who hears the noise, which does not always correspond with the zoning of an area. Therefore, noise from an industrial facility near a residential area is held to the NAC 1 standards if it can be heard on a residential property.

Some common land uses associated with the NACs include:

NAC 1: Residential housing, religious activities, camping and picnicking areas, health services, hotels, educational services

NAC 2: Retail, business and government services, recreational activities, transit passenger terminals

NAC 3: Manufacturing, fairgrounds and amusement parks, agricultural and forestry activities

NAC 4: Undeveloped and unused land

Note that, although there is a NAC 4, there are no noise standards for these areas. The full list of NAC land uses can be found starting on page 21 of this guide or in Minnesota Rule 7030.0050.

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## 1.3 Common noise concerns

By Minnesota law, the MPCA is empowered to enforce the state's noise rules. Many other agencies and levels of government, however, have an important role to play in upholding the noise standards. Depending on the source and location of the noise, some agencies may be in a better position than others to help citizens with noise concerns.

### Industrial facilities

The MPCA enforces noise standards at facilities for which it has issued an air permit. For complaints about noise at one of these facilities, please use the Online Citizen Complaints Form. If you prefer, you may call the MPCA to make your complaint: 651-296-6300 within the Twin Cities metropolitan area or 1-800-657-3864 if you are outside of this area.

### Local land uses

Local law enforcement agencies are empowered to enforce Minnesota state rules and laws relating to the prevention and control of pollution (Minn. Stat. 115.071). Many local governments also have nuisance noise ordinances or general public nuisance ordinances that can be used to enforce local noise concerns.

Local governments are required to take reasonable measures to prevent the approval of land use activities that will violate the state noise standard immediately upon establishment of the land use (Minn. R. 7030.0030). Municipalities should consider the state noise standard when reviewing and approving new projects in their jurisdiction. The MPCA can provide some expertise to support this review process. Please contact noise.pca@state.mn.us.

### Roads and highways

The Minnesota Department of Transportation (MnDOT) handles complaints about noise on highways and other roads it manages. According to Minn. Stat. 116.07.2a, most roads are exempt from Minnesota's state noise rules. MnDOT does, however, have policies, agreed on with the MPCA, for providing noise mitigation when it is determined to be both feasible and reasonable. MPCA reviews some MnDOT projects and noise mitigation decisions. For further information on MnDOT's noise policies, please visit its website.

### Vehicles

Minn. R.7030.1000-1060 outlines Minnesota's state rules relating to motor vehicle noise. In addition to the state rules, local governments may have nuisance sound ordinances, which are often easier to enforce than the state rule. As with noise relating to local land-use decisions, contacting your local government or law enforcement is your best course of action.

### Airplanes

The Metropolitan Airports Commission (MAC) responds to all concerns regarding noise relating to aircraft or the airports. For more information, please see its website.

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## Snowmobiles, off-highway vehicles, and motor boats

The Minnesota Department of Natural Resources (MDNR) has source-specific noise rules for snowmobiles (Minn. R. 6100.5700.5), off-highway vehicles (Minn. R. 6102.0040.4), and motor boats (Minn. Stat. 86B.321), requiring them to be equipped with proper mufflers and conform to certain noise standards. For more information on MDNR regulations for snowmobiles, off-highway vehicles, and boats, please visit its website.

## Mining

The MDNR also has source-specific rules to restrict noise and vibrations from different types of metallic mining operations (Minn. R. 6130.3900 and 6132.2900). Local governments are relied upon to consider noise when approving and permitting sand and gravel mining operations. The MPCA enforces noise standards at mining facilities for which it has issued an air permit. For complaints about noise at one of these facilities, please use the Online Citizen Complaints Form. If you prefer, you may call the MPCA to make your complaint: 651-296-6300 within the Twin Cities metropolitan area or 1-800-657-3864 if you are outside of this area.

## Gun clubs

Minn. Stat. 116.07.2a exempts gun clubs from the receiver-based noise standards administered by the MPCA. However, Minn. Stat. 87A includes some standards regarding gun club noise. Through this statute, the MDNR is authorized to regulate gun club noise. For further information, please visit its website.

## Motor vehicle race track

Minn. Stat. 116.07.2a exempts motor vehicle race tracks built before July 1, 1996 from Minnesota's noise standards. All tracks built since that date must comply with the noise rules. Local governments have often been successful in working with exempt tracks to mitigate noise concerns by establishing time and date restrictions, muffler requirements, and noise barriers.

# 1.4 Regulatory agencies

Several agencies have noise regulations for different noise sources. Noise rules either set standards based on the source of the noise (source standards) or based on who hears the noise (receiver-based standards).

**Minnesota Pollution Control Agency** - The MPCA has a receiver-based standard intended to limit noise levels and protect the health and welfare of the general public. The MPCA enforces the standard at facilities for which the agency issues air quality permits. The MPCA also works with other agencies and levels of government to enforce noise standards and reduce violations through pre-construction project reviews.

**Local Agencies** - Local governing agencies, such as a cities and counties, are relied upon to enforce noise standards relating to local land use and often have ordinances regulating noise levels. They are also responsible for not allowing land uses that would immediately violate the state noise standard. For instance, local governments should be cautious of allowing a loud local utility facility to locate in a residential area.

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**Minnesota Department of Natural Resources** - The MDNR has source standards for snowmobiles, motorboats, personal watercraft, off-highway vehicles, and gun clubs. MDNR also has source standards for metallic mining operations. For more information, see its website.

**Metropolitan Airport Commission** - The MAC is responsible for all noise issues related to the Minneapolis-St. Paul International Airport and reliever airports. For more information, see its website.

**Federal Aviation Administration** - The FAA has source regulations for commercial jet engines. All commercial jet engines must meet noise emission criteria prior to being certified for flight. However, the Metropolitan Airport Commission is the best contact for noise concerns related to its airports. Additional information on the FAA's noise standards can be found on its website.

**Minnesota Department of Transportation** – MnDOT is responsible for state highway noise mitigation. It works with the Federal Highway Administration (FHWA) and the MPCA to evaluate road projects for noise impacts and possible mitigation measures. For more information see the Department's website.

**Federal Highway Administration (FHWA)** - The FHWA does not have actual noise standards, but has a 70 dBA $L_{10}$ guideline that is used to determine federal funding for noise abatement on highway projects. New highway projects must go through a noise impact analysis and be considered for abatement measures. Information on FHWA's noise policies can be found on its website.

**Federal Railroad Administration (FRA)** - Regulation of railroad-related noise is the responsibility of the FRA. For more information see the Administration's website and to contact them about a noise concern, call 1-800-724-5040.

**Occupational Safety and Health Administration (OSHA)** - OSHA has regulations to protect against hearing loss in the workplace. These are "dose standards" that restrict the amount of noise an employee receives over a period of time, such as eight hours. For additional information, visit OSHA's website.

**Housing and Urban Development (HUD)** - HUD has noise regulations that establish acceptable noise zones for HUD housing projects. More information can be found on HUD's website.

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# 2. Basics of how sound works

## 2.1 Waves and sound pressure level

Sound travels in a wave motion through the air to our ears. A good way to imagine wave motion is with a weight hanging from a spring. Picture the following diagram (Figure 1) as a single weight and spring combination varying as time progresses along the horizontal axis.

In Figure 1 the first position of the weight on the spring is at rest with no forces exerted upon the system. If the weight is raised above its point of rest and the progression of the weight moving down and up again is observed over a period of time, a wave form is produced.

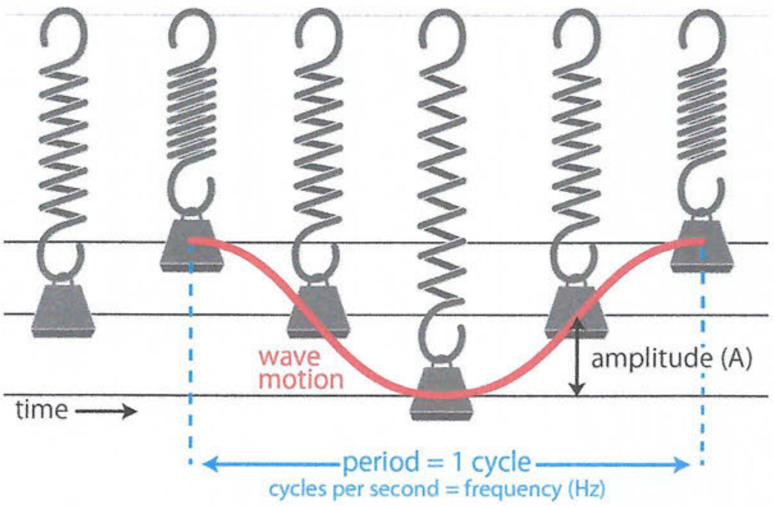


**Figure 1. Weight on a spring – example of periodic motion**

The *amplitude* of the moving weight is labeled as "A" in Figure 1 and corresponds with the maximum movement of the weight from its "at rest" position to the peak of the wave form either up or down. We hear changes in amplitude as changes in volume.

The *period* of the vibration is the amount of time taken to produce one complete cycle or, in this example, how quickly the weight moves from top to bottom and back. The number of cycles per second defines the *frequency* of the periodic (up and down) motion, which is given the unit of *hertz,* or *Hz*. We hear different frequencies as higher or lower pitched sounds.

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Figure 2 shows how the weight on a string (two-dimensional) example of sound waves compares to the compression and expansion of sound waves through space (three-dimensional).

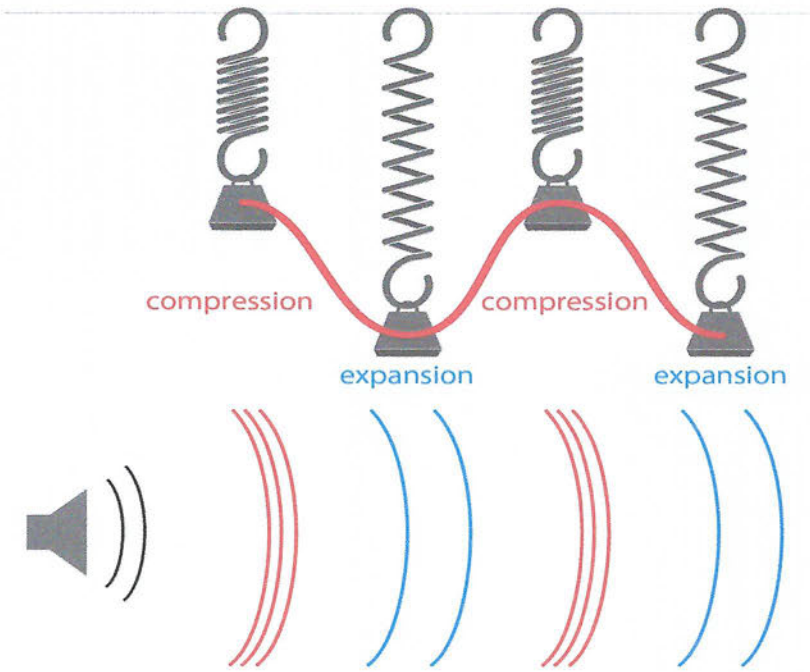


**Figure 2. Comparison of periodic motion to sound waves**

The graphical representation of sound waves in Figure 2 is of *pure tones*, which are sounds made up of a single frequency. A familiar example of a pure tone is the sound produced when a single key of a piano is pressed. For instance, the middle C key on a piano vibrates the associated wire at a rate of approximately 260 times per second or 260 Hertz. The vibration of the wire transfers its motion to the sound board of the piano, which then vibrates at the same frequency, causing the air adjacent to the sound board to form compression and expansion waves in the air emitting outward from the sound board. When received by the human ear, this is regarded as sound. Most sounds are not pure tones, but a mixture of tones of varying amplitude, frequency, and duration.

The *intensity* of a sound is the amount of sound energy at a given moment in a given area. The *sound pressure level*, measured in a unit called the *decibel,* or *dB*, is the ratio between the intensity of a sound and that of a reference pressure, which is the threshold of perception. The decibel is a logarithmic measurement which can accommodate a large range of values. The human ear can detect sounds more than a million times quieter than a jet aircraft during take-off; therefore, to have a system with a manageable range of numbers, the logarithm is used.

Sound pressure level = 20 $\text{Log}_{10}$ * (Measured Sound Pressure / Reference Pressure)

Reference Pressure = 0.00002 Newtons / $(\text{meter})^2$

Many different properties affect the noise level of a specific source type. For example, three lawn mowers may have three different noise levels because of differences in each specific piece of equipment. Noise level also depends on the distance from the noise source and features of the surrounding environment.

Figure 3 provides a rough estimate of decibel levels of some common noise sources.

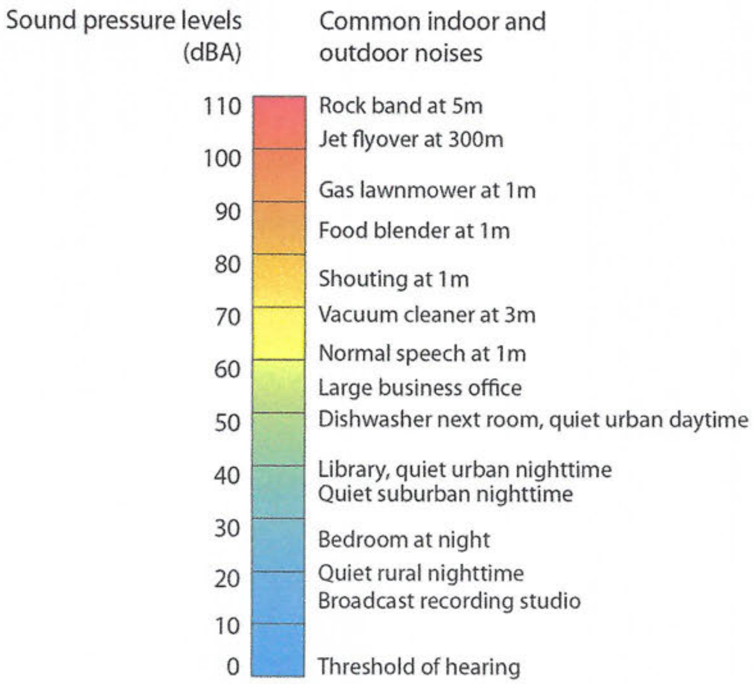


**Figure 3. Decibel levels of common noise sources**

## 2.2 Sound weighting networks

Sound level meters (SLM) used for monitoring can pick up sounds as a perfect computer, but the human ear is not as precise. The human ear cannot hear very low frequencies or very high frequencies. Weighting networks are used in noise monitors to adjust specific frequencies in the audio spectrum to attempt to duplicate the response of the human ear.

The C-weighting network represents the actual sound pressure level that is received by the sound level meter, and does not noticeably vary in its amount of compensation throughout the audio spectrum. C-weighting is used during the calibration of sound level meters to ensure that the sound level displayed on the meter is accurate and the same as the frequency of the calibrator.

The A-weighting network is used to duplicate the sensitivity of the human ear. At 100 Hertz, the A-weighting network filters out approximately 20 dB from the incoming signal before it is combined with the levels from the other frequency ranges to produce an A-weighted sound level.

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The graph in Figure 4 represents the sensitivity of the human ear in comparison to the compensation of a C-weighting network and an A-weighting network. This illustration is useful in understanding how the ear is inefficient in the detection of lower frequencies and is very sensitive to higher frequencies.

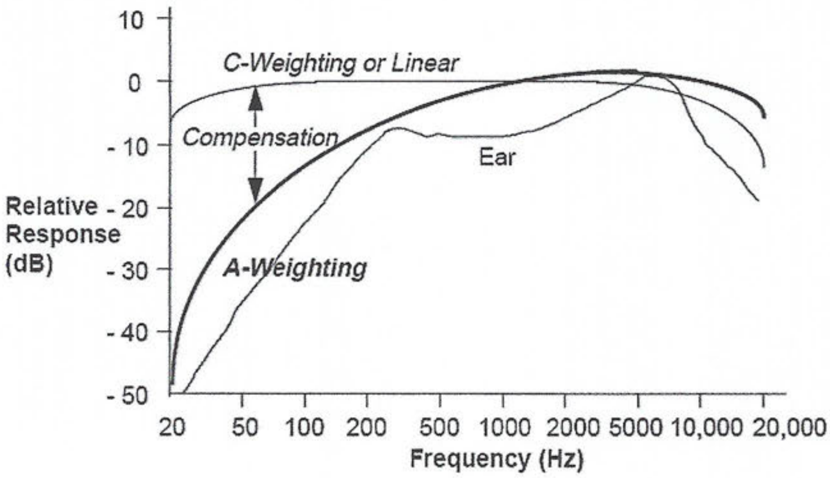


**Figure 4. Weighting networks with sound measurements done in the A-weighting network are reported with the unit dBA**

## 2.3 Human perception of sound

Sound has qualitative aspects that can be described with adjectives and quantitative aspects that can be described with measurements. Sound can be qualitatively perceived as pleasant or annoying, and quantitatively (as loudness) measured in terms of decibels.

Changes in loudness are described on a logarithmic scale because the human ear can hear such a wide range of sound levels. The human ear can usually tell the difference when sound changes by 3 dBA and a 5 dBA change is clearly noticeable. Because of how the logarithmic scale functions in compressing the measurements associated with sounds, an increase of 10 dBA sounds twice as loud.

| | |
|---|---|
| ± 1 dBA.......................... | Not Noticeable |
| ± 3 dBA.......................... | Threshold of Perception |
| ± 5 dBA.......................... | Noticeable Change |
| ± 10 dBA........................ | Twice (Half) As Loud |
| ± 20 dBA........................ | Four Times (One Fourth) As |

**Figure 5. Change in decibel level and perceived change in loudness**

## 2.4 Using decibel measurements

Addition and subtraction of decibels is often necessary for estimating total noise levels or background noise. Because decibels are measured using a logarithmic scale, conventional linear mathematics cannot be used. The following rules of thumb provide a good estimate of the effect that type, distance, and number of sources have on measured sound pressure level.

### Sound propagation and sources

Sources of sound can be defined as *point* or *line* sources, based on the way sound pressure waves spread away from the source. Sound waves move out from sources in a way similar to waves traveling away from a rock dropped in a pond. A *point* source, like a factory, emits sound that spreads out in a sphere. A *line* source, like a busy highway, emits sound that spreads out in a cylinder. Knowing the sources of sounds makes it possible to make assumptions about how the sound behaves.

### Distance attenuation

Over distance, sound *attenuates*, or is reduced in amplitude, and is perceived as becoming quieter. This occurs as the sound travels outward to an increasingly larger sphere or cylinder, and the energy per unit of area decreases. These basic principles allow us to make generalized assumptions about sound.

When the distance is doubled from a *line* source, the sound level decreases three decibels.

**Example:** **If a sound level is:** **70 decibels at 50 feet it will be**
**67 decibels at 100 feet, and**
**64 decibels at 200 feet**

When the distance is doubled from a *point* source, the sound level decreases six decibels (Figure 6).

**Example:** **If a sound level is:** **70 decibels at 50 feet it will be**
**64 decibels at 100 feet, and**
**58 decibels at 200 feet**

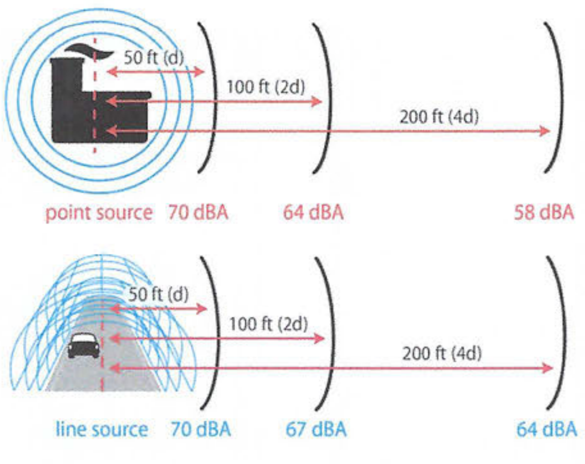


**Figure 6. Distance attenuation of noise levels from a point source (top) and a line source (bottom)**

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## Number of sources

In many situations pertaining to noise control and monitoring, it is very useful to be able to add and subtract multiple sources of sound. This can be done with principles similar to how sound attenuation over distance is estimated.

A doubling of sound energy yields an increase of three decibels. For example, each generator at a factory produces sound that is measured at 70 decibels, so running one generator would create sound measured at 70 dBA, turning on a second generator would increase sound by 3 dBA to 73 dBA, and doubling again to four generators would increase sound levels to 76 dBA. Figure 7 illustrates this principle.

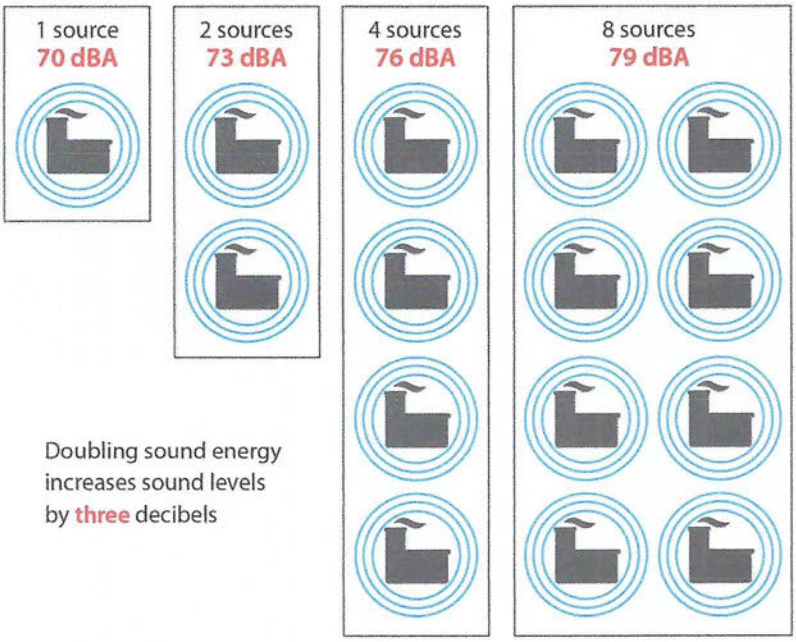


**Figure 7. Addition and subtraction of decibel levels**

In the same way, reducing the number of sources by half will reduce the sound pressure by 3 dBA.

Consider the perception of changes in decibel levels (Figure 5) compared to the example of addition or subtraction of sources (Figure 7). Doubling sources yields an increase of 3 dBA, which is a change that is just perceptible.

## Background noise

Background, or ambient, noise consists of all noise sources other than the noise source of concern. This can include traffic, animals, machinery, voices, and other sounds.

Wind is often a major source of ambient noise and can frequently be a problem when trying to monitor a specific source of noise. The MPCA's noise test procedures state that measurements should not be made when noise from wind or precipitation results in a difference of less than 10 dBA between the background sound level and noise source being measured. In practice, this means that wind speeds must be below 11 mph when making noise measurements and rainy weather conditions should be avoided. When background noise is less than 10 dBA from the decibel level of the noise source to be measured, confidence in the accuracy of the measurement decreases.

In certain instances, when a single noise source is analyzed along with other noise sources, correction factors can be used to isolate the noise source being monitored and calculate its individual noise level. This is done by measuring and recording the total noise level of all sources. Next, the noise source to be isolated is turned off and a noise level reading is taken with all the other existing noise sources in operation. The background noise level is then subtracted from the total noise level. The result is used in conjunction with the following background noise correction chart (Figure 8) to find the approximate noise level of the source.

Figure 8 is a graph used to estimate the amount of background noise influencing a measurement. Based on the measured background noise it gives the corresponding decibel level to be subtracted from the total measurement to determine the decibel level of the noise source being monitored.

For example, if the total noise level is 74 dBA, and then falls to 70 dBA when the source of interest is turned off, the difference of four decibels between the total noise level and background noise indicates that two decibels should be subtracted from the total. This means that a 72 dBA noise level can be attributed to the monitored source in the absence of background noise.

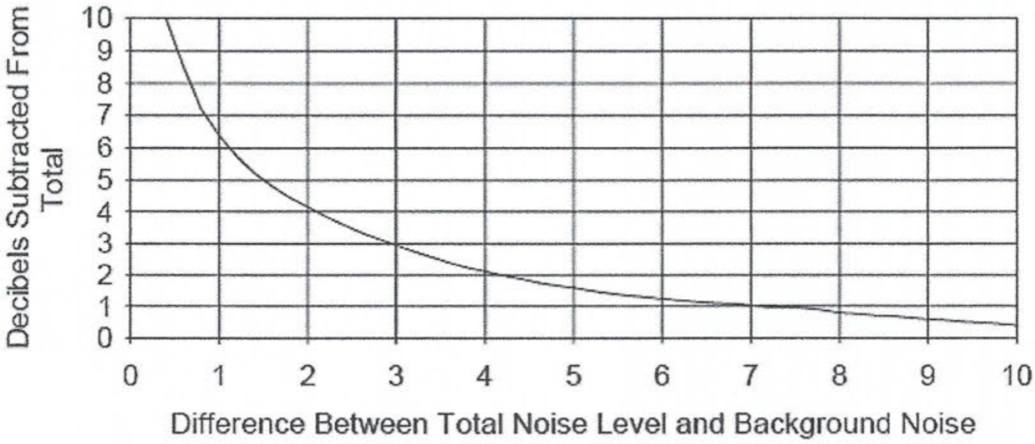


**Figure 8. Background noise correction**

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# 3. Measurement procedures

This guide contains two measurement procedures. The general protocols remain the same, but your choice of procedure depends on the capabilities of your sound level meter (SLM). Noise Test Procedure 1 (NTP-1) should be used if your SLM is capable of calculating monitoring results and Noise Test Procedure 2 (NTP-2) should be used if your SLM only displays instantaneous readings.

## 3.1 General procedures

### Sound level meter

Your sound level meter and microphone must comply with the specifications for ANSI S1.4-1983 Type 0, 1, 2, or S.

### Calibration

You must also have a calibrator of a known frequency and sound level. Calibrators should be compared to a lab standard periodically. Calibration must be performed before and after the monitoring period. Adjustments should be made if necessary.

### Weather conditions

Measurements should not be made when noise from wind or precipitation results in a difference between the background sound level and noise source being measured that is less than 10 dBA. In practice, this means that wind speeds must be below 11 mph and rainy weather conditions should be avoided. Temperature and humidity should be within equipment specifications.

### Background noise

As mentioned in the previous section, background noise is any ambient noise other than the noise to be measured, including wind, precipitation, traffic, etc. The difference between the sound level of the source being monitored and that of the background noise must be less than 10dBA. See page 11 for suggestions on how to correct for background noise.

### Location of measurement

Properly choosing a monitoring location is an important consideration. Measurements should be made in the appropriate NAC, at the area of normal outdoor human activity nearest to the noise source. The monitoring location may not necessarily be at the property line; for instance, if the property of the complainant is large and residential outdoor activity is limited to a backyard patio (possibly such as on a farm).

Measurements must be made outdoors from at least three feet off of the ground (a tripod is helpful for this). Another important part of site selection is the consideration of errors caused by reflecting objects, such as a house or other large manmade or natural structures. Measurements should be made at least as far away from any large reflecting object as from the noise source being measured. If this is not possible, stay at least 30 feet from structures.

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### Documentation of measurement

A survey form must be completed containing date, time, location, noise source, wind speed/direction, temperature, humidity, equipment information (make, model, serial number), site sketch with the location of the noise source and measurement location (including appropriate distances), data and calibration information. A sample survey form can be found on page 16.

## 3.2 Noise Test Procedure 1: Measurement procedure for non-impulsive noise

The following test procedure has been approved by the Commissioner of the MPCA for the measurement of non-impulsive noise. The general procedures described above (3.1 General procedures) should be followed whether you are using the NTP-1 or NTP-2 procedures.

### Instrumentation:

- Sound level meter and a microphone conforming to type 0, 1, 2, or S specifications under ANSI S1.4-1983
- Calibrator of known frequency and level
- Small screwdriver for sensitivity adjustment
- Microphone windscreen
- Noise survey form
- Tripod (optional)

### Monitoring procedure:

Monitoring must be conducted for at least a one hour time period. Sound meter must use the "A" weighting and FAST response characteristics. Follow your manufacturer instructions to obtain the $L_{10}$ and $L_{50}$ results.

## 3.3 Noise Test Procedure 2: Manual measurement procedure for non-impulsive noise

The following test procedure has been approved by the Commissioner of the MPCA for the measurement of non-impulsive noise. The general procedures described above (3.1 General procedures) should be followed whether you are using the NTP-1 or NTP-2 procedures. The NTP-2 procedure is to be used with SLMs that cannot calculate noise statistics and only provide instantaneous readings.

### Instrumentation:

- Sound level meter and a microphone conforming to type 0, 1, 2, or S specifications under ANSI S1.4-1983
- Calibrator of known frequency and level
- Small screwdriver for sensitivity adjustment
- Microphone windscreen
- Noise survey form
- Tripod (optional)

## Manual monitoring procedure:

Using a hand-held SLM, take an instantaneous sound reading every 10 seconds and record on a data sheet. A partner is very helpful.

Continue taking sound readings for one hour, which will give you 360 individual readings. Figure 9 provides an example of a manual monitoring data sheet.

To determine the $L_{10}$, take the 36th loudest (10 percent of 360 = 36) individual sound reading by counting from the loudest to the quietest on the data sheet. For example, in Figure 9, the $L_{10}$ = 63 and is the 36th **X** from the top of the sheet.

To determine the $L_{50}$, take the 180th loudest (50 percent of 360 = 180) individual sound reading. In Figure 9, the $L_{50}$ = 57 and represents the 180th **X** from the top of the sheet.

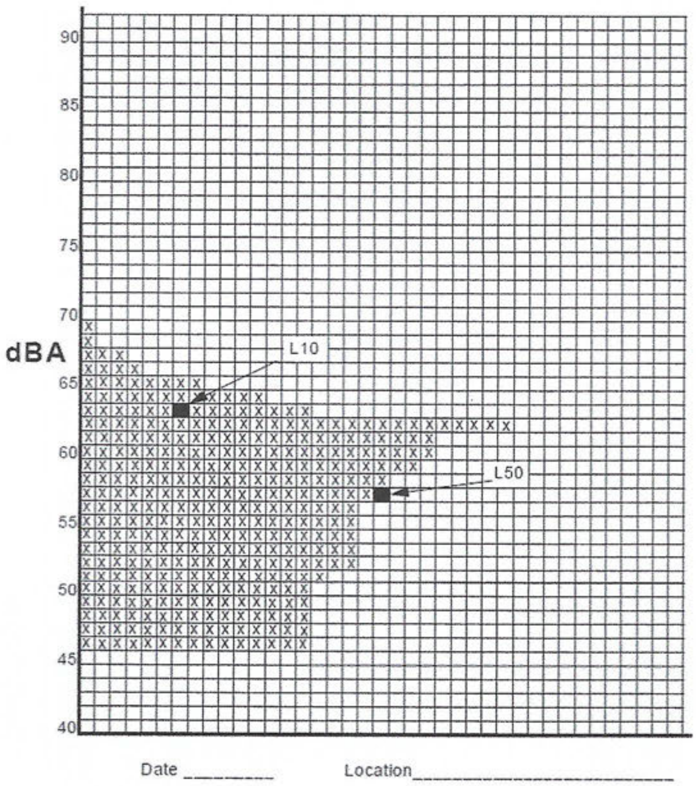
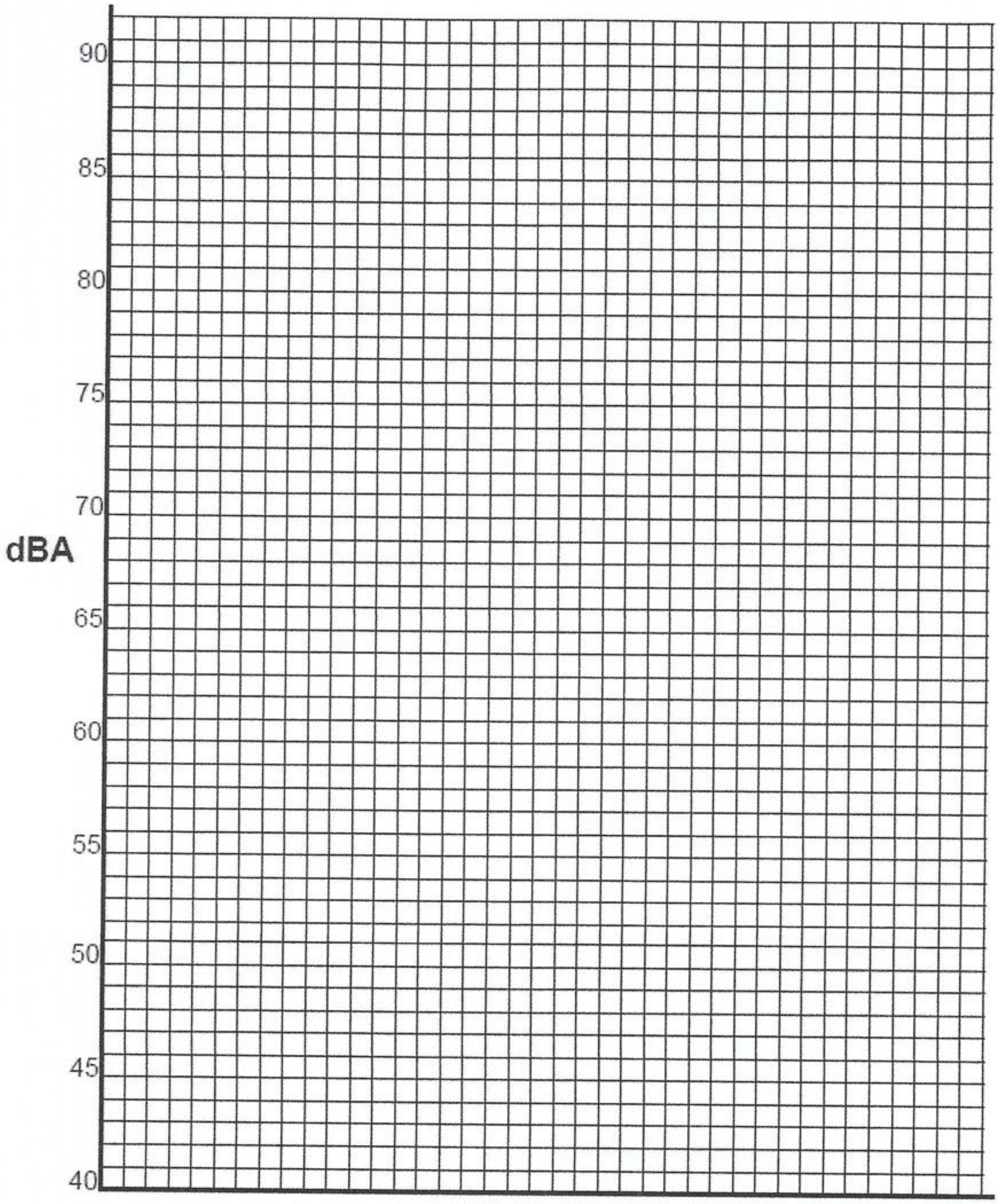



**Figure 9. Example manual monitoring data sheet**

## Manual Monitoring Data Sheet




Date __________ Location ______________________________

## Noise survey

Investigator ______________________________ Date ____________________

SLM Manufacturer and Model __________________ Serial Number______________

Calibrator Manufacturer and Model ________________________________________

Calibrator Serial Number______________________ Calibrator Frequency (Hz) __________

Initial Calibration (dBA) _________ Final Calibration (dBA) _________

Meteorological Conditions: Wind Speed _______ Direction _______ Temperature_______

Source ________________________________________________________________

Monitor Location ________________________________________________________

Time Start ____________ Time End ______________

Results $L_{10}$ ________dBA $L_{50}$ ________dBA

Diagram *(Indicate noise source, receiver, microphone location, reflecting objects, obstructions, landmarks, and distances)*

# 4. Minnesota noise pollution statutes and rules

## Minn. Stat. § 116.07 POWERS AND DUTIES.

Subdivision 1. **Generally.** In addition to any powers or duties otherwise prescribed by law and without limiting the same, the Pollution Control Agency shall have the powers and duties hereinafter specified.

Subd. 2. **Adoption of standards.** (c) The Pollution Control Agency shall also adopt standards describing the maximum levels of noise in terms of sound pressure level which may occur in the outdoor atmosphere, recognizing that due to variable factors no single standard of sound pressure is applicable to all areas of the state. Such standards shall give due consideration to such factors as the intensity of noises, the types of noises, the frequency with which noises recur, the time period for which noises continue, the times of day during which noises occur, and such other factors as could affect the extent to which noises may be injurious to human health or welfare, animal or plant life, or property, or could interfere unreasonably with the enjoyment of life or property. In adopting standards, the Pollution Control Agency shall give due recognition to the fact that the quantity or characteristics of noise or the duration of its presence in the outdoor atmosphere, which may cause noise pollution in one area of the state, may cause less or not cause any noise pollution in another area of the state, and it shall take into consideration in this connection such factors, including others which it may deem proper, as existing physical conditions, zoning classifications, topography, meteorological conditions and the fact that a standard which may be proper in an essentially residential area of the state, may not be proper as to a highly developed industrial area of the state. Such noise standards shall be premised upon scientific knowledge as well as effects based on technically substantiated criteria and commonly accepted practices. No local governing unit shall set standards describing the maximum levels of sound pressure which are more stringent than those set by the Pollution Control Agency.

Subd. 2a. **Exemptions from standards** No standards adopted by any state agency for limiting levels of noise in terms of sound pressure which may occur in the outdoor atmosphere shall apply to (1) segments of trunk highways constructed with federal interstate substitution money, provided that all reasonably available noise mitigation measures are employed to abate noise, (2) an existing or newly constructed segment of a highway, provided that all reasonably available noise mitigation measures, as approved by the commissioners of the Department of Transportation and Pollution Control Agency, are employed to abate noise, (3) except for the cities of Minneapolis and St. Paul, an existing or newly constructed segment of a road, street, or highway under the jurisdiction of a road authority of a town, statutory or home rule charter city, or county, except for roadways for which full control of access has been acquired, (4) skeet, trap or shooting sports clubs, or (5) motor vehicle race events conducted at a facility specifically designed for that purpose that was in operation on or before July 1, 1996. Nothing herein shall prohibit a local unit of government or a public corporation with the power to make rules for the government of its real property from regulating the location and operation of skeet, trap or shooting sports clubs, or motor vehicle race events conducted at a facility specifically designed for that purpose that was in operation on or before July 1, 1996.

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# Minn. Rules § 7030 NOISE POLLUTION CONTROL

## 7030.0010 INCORPORATION BY REFERENCE.

For the purpose of chapter 7030, American National Standards Institute, Specification for Sound Level Meters, S1.4-1983 is incorporated by reference. This publication is available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018 and can be found at: the offices of the Minnesota Pollution Control Agency, 1935 West County Road B-2, Roseville, Minnesota 55113; the Government Documents Section, Room 409, Wilson Library, University of Minnesota, 309 19th Avenue South, Minneapolis, Minnesota 55454; and the State of Minnesota Law Library, 25 Rev. Dr. Martin Luther King Jr. Blvd., Saint Paul, Minnesota 55155. This document is not subject to frequent change.

The Federal Highway Administration publication, Sound Procedures for Measuring Highway Noise: Final Report, FHWA-DP-45-1R (August 1981) is incorporated by reference. This publication is available from the United States Department of Transportation, Federal Highway Administration, 1000 North Globe Road, Arlington, Virginia 22201 and can be found at: the offices of the Minnesota Pollution Control Agency, 1935 West County Road B-2, Roseville, Minnesota 55113; the Government Documents Section, Room 409, Wilson Library, University of Minnesota, 309 19th Avenue South, Minneapolis, Minnesota 55454; and the State of Minnesota Law Library, 25 Rev. Dr. Martin Luther King Jr. Blvd., Saint Paul, Minnesota 55155. This document is not subject to frequent change.

## 7030.0020 DEFINITIONS.

**Subpart 1. Application.** The terms used in this chapter have the meanings given them in this part.

**Subp. 2. A-weighted.** "A-weighted" means a specific weighting of the sound pressure level for the purpose of determining the human response to sound. The specific weighting characteristics and tolerances are those given in American National Standards Institute S1.4-1983, section 5.1.

**Subp. 3. Daytime.** "Daytime" means those hours from 7:00 a.m. to 10:00 p.m.

**Subp. 4. dB(A).** "dB(A)" means a unit of sound level expressed in decibels (dB) and A-weighted.

**Subp. 5. Decibel.** "Decibel" means a unit of sound pressure level, abbreviated as dB.

**Subp. 6. Impulsive noise.** "Impulsive noise" means either a single sound pressure peak (with either a rise time less than 200 milliseconds or total duration less than 200 milliseconds) or multiple sound pressure peaks (with either rise times less than 200 milliseconds or total duration less than 200 milliseconds) spaced at least by 200 millisecond pauses.

**Subp. 7. $L_{10}$.** "$L_{10}$" means the sound level, expressed in dB(A), which is exceeded ten percent of the time for a one hour survey, as measured by test procedures approved by the commissioner.

**Subp. 8. $L_{50}$.** "$L_{50}$" means the sound level, expressed in dB(A), which is exceeded 50 percent of the time for a one hour survey, as measured by test procedures approved by the commissioner.

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**Subp. 9. Municipality.** "Municipality" means a county; a city; a town; a regional planning and development commission established under Minnesota Statutes, chapter 473; the metropolitan council; or other governmental subdivision of the state responsible by law for controlling or restricting land use within its jurisdiction.

**Subp. 10. Nighttime.** "Nighttime" means those hours from 10:00 p.m. to 7:00 a.m.

**Subp. 11. Person.** "Person" means any human being, any municipality or other governmental or political subdivision or other public department or agency, any public or private corporation, any partnership, firm, association, or other organization, any receiver, trustee, assignee, agency, legal entity, other than a court of law, or any legal representative of any of the foregoing, but does not include the agency.

**Subp. 12. Sound pressure level.** "Sound pressure level", in decibels, means 20 times the logarithm to the base 10 of the ratio of the pressure to the reference pressure. The reference pressure shall be 20 micronewtons per square meter.

## 7030.0030 NOISE CONTROL REQUIREMENT.

No person may violate the standards established in part 7030.0040, unless exempted by Minnesota Statutes, section 116.07, subdivision 2a. Any municipality having authority to regulate land use shall take all reasonable measures within its jurisdiction to prevent the establishment of land use activities listed in noise area classification (NAC) 1, 2, or 3 in any location where the standards established in part 7030.0040 will be violated immediately upon establishment of the land use.

## 7030.0040 NOISE STANDARDS.

**Subpart 1. Scope.** These standards describe the limiting levels of sound established on the basis of present knowledge for the preservation of public health and welfare. These standards are consistent with speech, sleep, annoyance, and hearing conservation requirements for receivers within areas grouped according to land activities by the noise area classification (NAC) system established in part 7030.0050. However, these standards do not, by themselves, identify the limiting levels of impulsive noise needed for the preservation of public health and welfare. Noise standards in subpart 2 apply to all sources.

**Subp. 2. Noise standards.**

| Noise Area Classification | Daytime | | Nighttime | |
|---|---|---|---|---|
| | $L_{10}$ | $L_{50}$ | $L_{10}$ | $L_{50}$ |
| 1 | 65 | 60 | 55 | 50 |
| 2 | 70 | 65 | 70 | 65 |
| 3 | 80 | 75 | 80 | 75 |

## 7030.0050 NOISE AREA CLASSIFICATION.

**Subpart 1. Applicability.** The noise area classification is based on the land use activity at the location of the receiver and determines the noise standards applicable to that land use activity unless an exception is applied under subpart 3.

**Subp. 2. Noise area classifications.** The noise area classifications and the activities included in each classification are listed below:

| Noise Area Classification | Land Use Activities | |
|---|---|---|
| 1 | Household Units (includes farm houses) | Transient lodging |
| | Group quarters | Mobile home parks or courts |
| | Residential hotels | Other residential |
| | Cultural activities and nature exhibitions | Medical and other health services |
| | Correctional institutions | Educational services |
| | Religious activities | Motion picture production |
| | Entertainment assembly | Resorts and group camps |
| | Camping and picnicking areas (designated) | Other cultural, entertainment, and recreational activities. |
| 2 | Railroad terminals (passenger) | Bus passenger terminals (intercity) |
| | Railroad terminals (passenger and freight) | Bus passenger terminals (local) |
| | Rapid rail transit and street railway passenger terminals | Bus passenger terminals (intercity and local) |
| | Other motor vehicle transportation | Marine terminals (passenger) |
| | Airport and flying field terminals (passenger) | Marine terminals (passenger and freight) |
| | Airport and flying field terminals (passenger and freight) | Automobile parking |
| | Telegraph message centers | Transportation services and arrangements |
| | Wholesale trade | Retail trade -- apparel and accessories |
| | Retail trade -- building materials, hardware, and farm equipment | Retail trade -- automotive, marine craft, aircraft, and accessories |
| | Retail trade -- general merchandise | Retail trade -- furniture, home furnishings, and equipment |
| | Retail trade -- food | Retail trade -- eating and drinking |
| | Other retail trade | Finance, insurance, and real estate services |

| | | |
|---|---|---|
| | Personal services | Repair services |
| | Business services | Legal services |
| | Other professional services | Contract construction services |
| | Governmental services (except correctional institutions) | Miscellaneous services (except religious activities) |
| | Public assembly (except entertainment assembly and race tracks) | Amusements (except fairgrounds and amusement parks) |
| | Recreational activities (except designated camping and picnicking areas) | Parks. |
| 3 | Food and kindred products -- manufacturing | Textile mill products -- manufacturing |
| | Apparel and other finished products made from fabrics, leather, and similar materials -- manufacturing | Lumber and wood products (except furniture) -- manufacturing |
| | Furniture and fixtures -- manufacturing | Printing, publishing, and allied industries |
| | Paper and allied products -- manufacturing | Chemicals and allied products -- manufacturing |
| | Petroleum refining and related industries | Primary metal industries |
| | Rubber and miscellaneous plastic products -- manufacturing | Stone, clay, and glass products -- manufacturing |
| | Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks -- manufacturing | Railroad, rapid transit, and street railway transportation (except passenger terminals) |
| | Miscellaneous manufacturing (except motion picture production) | Fabricated metal products -- manufacturing |
| | Motor vehicle transportation (except passenger terminals) | Aircraft transportation (except passenger terminals) |
| | Marine craft transportation (except passenger and freight terminals) | Communication (except telegraph message centers) |
| | Highway and street right-of-way | Utilities |
| | Race tracks | |
| | Fairgrounds and amusement parks | Agricultural |
| | Agricultural and related activities | Fishing activities and related services |
| | Other transportation, communication, and utilities (except transportation services and arrangements) | Forestry activities and related services (including commercial forest land, timber production, and other related activities) |
| | All other activities not otherwise listed. | |

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| | | |
|---|---|---|
| 4 | Undeveloped and unused land area (excluding non-commercial forest development) | Non-commercial forest development |
| | Water areas | Vacant floor area |
| | Under construction | Other undeveloped land and water areas. |

**Subp. 3. Exceptions.** The noise area classification for a land use may be changed in the following ways if the applicable conditions are met.

A. The daytime standards for noise area classification 1 shall be applied to noise area classification 1 during the nighttime if the land use activity does not include overnight lodging.

B. The standards for a building in a noise area classification 2 shall be applied to a building in a noise area classification 1 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities

C. The standards for a building in a noise area classification 3 shall be applied to a building in a noise area classification 1 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 40 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities.

D. The standards for a building in a noise area classification 3 shall be applied to a building in a noise area classification 2 if the following conditions are met:

(1) the building is constructed in such a way that the exterior to interior sound level attenuation is at least 30 dB(A);

(2) the building has year-round climate control; and

(3) the building has no areas or accommodations that are intended for outdoor activities.

## 7030.0060 MEASUREMENT METHODOLOGY.

**Subpart 1. Measurement location.** Measurement of sound must be made at or within the applicable NAC at the point of human activity which is nearest to the noise source. All measurements shall be made outdoors.

**Subp. 2. Equipment specifications.** All sound level measuring devices must meet Type O, I, II, or S specifications under American National Standards Institute S1.4-1983.

**Subp. 3. Calibration.** All sound level measuring devices must, at a minimum, be externally field calibrated before and after monitoring using a calibration device of known frequency and sound pressure level.

**Subp. 4. Measurement procedures.** The following procedures must be used to obtain representative sound level measurements:

A. Measurements must be made at least three feet off the ground or surface and away from natural or artificial structures which would prevent an accurate measurement.

B. Measurements must be made using the A-weighting and fast response characteristics of the sound measuring device as specified in American National Standards Institute S1.4-1983.

C. Measurements must not be made in sustained winds or in precipitation which results in a difference of less than ten decibels between the background noise level and the noise source being measured.

D. Measurements must be made using a microphone which is protected from ambient conditions which would prevent an accurate measurement.

**Subp. 5. Data documentation.** A summary sheet for all sound level measurements shall be completed and signed by the person making the measurements. At a minimum, the summary sheet shall include:

A. Date

B. Time

C. Location

D. Noise source

E. Wind speed and direction

F. Temperature

G. Humidity

H. Make, model, and serial number of measuring equipment

I. Field calibration results

J. Monitored levels

K. Site sketch indicating noise source, measurement location, directions, distances, and obstructions.

## 7030.0070 SOUND ATTENUATION MEASUREMENT METHODOLOGY.

**Subpart 1. Purpose.** Sound level measurements made for assessing sound attenuation as specified in part 7030.0050, subpart 3, item B, C, or D, shall be made according to the requirements of this part.

**Subp. 2. Equipment.** The equipment shall meet the requirements specified in part 7030.0060, subpart 2.

**Subp. 3. Calibration.** The equipment must meet the calibration requirements specified in part 7030.0060, subpart 3.

**Subp. 4. Measurement procedure.**

The measurement procedure described in FHWA-DP-45-1R, section 8 must be used for determination of the sound attenuation.

**Subp. 5. Equivalent methods.** Methods equivalent to those described in subpart 4 may be used provided they are approved by the commissioner of the Minnesota Pollution Control Agency. The commissioner shall approve an alternative method if the commissioner finds that the method will produce representative data and results which are as reliable as the methods specified in subpart 4.

## 7030.0080 VARIANCE.

If, upon written application of the responsible person, the agency finds that by reason of exceptional circumstances strict conformity with any provisions of any noise rule would cause undue hardship, would be unreasonable, impractical, or not feasible under the circumstances, the agency may permit a variance upon the conditions and within the time limitations as it may prescribe for the prevention, control, or abatement of noise pollution in harmony with the intent of the state and any applicable federal laws.

## 7030.1000 DEFINITION.

"Motor vehicle" means any self-propelled vehicle not operated exclusively upon railroad tracks and any vehicle propelled or drawn by a self-propelled vehicle and includes vehicles known as trackless trolleys which are propelled by electric power obtained from overhead trolley wires but not operated upon rails, except snowmobiles.

## 7030.1010 PROHIBITIONS.

**Subpart 1. Operation of vehicle.** No person shall operate either a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 at any time or under any condition of grade, load, acceleration, or deceleration in such a manner as to exceed the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner.

**Subp. 2. Sale of vehicle.** No person shall sell or offer for sale a new motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 which when maintained according to the manufacturer's specifications would exceed the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner.

**Subp. 3. Modification of vehicle.** No person shall modify a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 in a manner which will amplify or increase the noise emitted by the vehicle, above the noise limits contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner. No person shall operate a motor vehicle so modified.

**Subp. 4. Sale of parts.** No person shall sell or offer for sale replacement or additional parts for a motor vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 which when installed in the vehicle will amplify or increase the noise emitted by the vehicle, above the noise limits

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contained herein for the category of motor vehicle and speed limits specified, when tested with a measurement procedure approved by the commissioner. No person shall operate a motor vehicle incorporating such parts.

### 7030.1020 SCOPE.

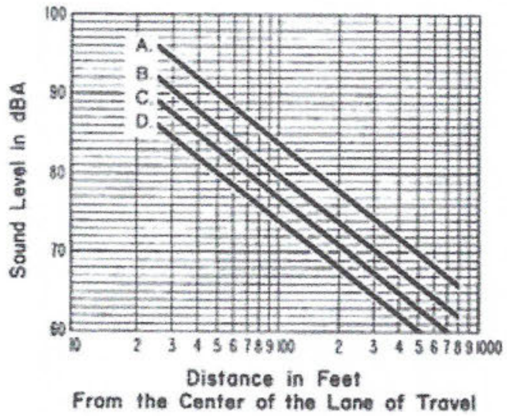
This chapter applies to the total noise from a vehicle or combination of vehicles of a type subject to registration pursuant to Minnesota Statutes, chapter 168 and shall not be construed as limiting or precluding the enforcement of any other provision of law relating to motor vehicle exhaust noise.

### 7030.1030 EXCEPTIONS.

Vehicles under parts 7030.1050 and 7030.1060 are allowed to exceed the noise limits contained herein when performing acceleration maneuvers for safety purposes.

### 7030.1040 NOISE LIMIT FOR VEHICLES OVER 10,000 POUNDS.

Motor vehicle noise limits for vehicles with a manufacturer's gross vehicle weight rating of more than 10,000 pounds and any combination of vehicles towed by such motor vehicle.




Sand Trucks in mining operations, running 360'–645 ft from residences

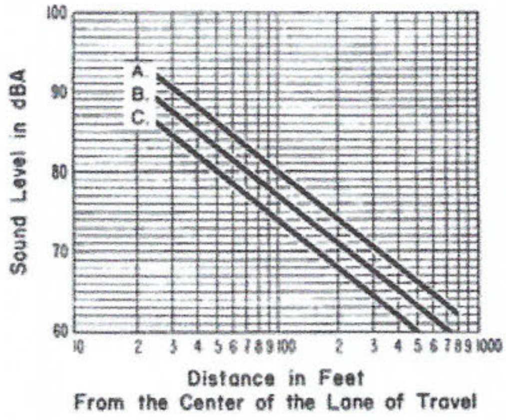
A. Speed limits greater than 35 mph.

B. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines). For stationary run-up tests on all-paved surfaces, add 2 dBA.

C. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines), for vehicles manufactured on or after January 1, 1978. For stationary run-up tests on all-paved surfaces, add 2 dBA.

D. Speed limits equal to or less than 35 mph and stationary run-up tests (for vehicles with governed engines), for vehicles manufactured on or after January 1, 1982. For stationary run-up tests on all-paved surfaces, add 2 dBA.

## 7030.1050 MOTOR VEHICLE NOISE LIMITS FOR MOTORCYCLES.



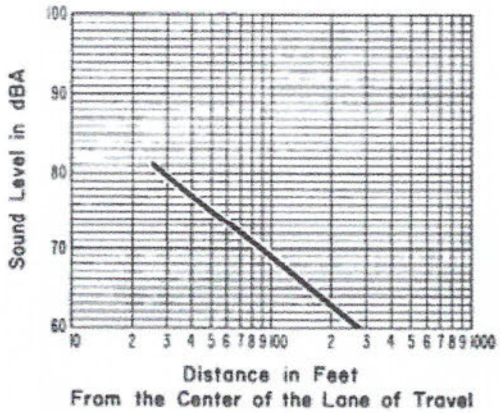

A. For vehicles manufactured before January 1, 1975.

B. Speed limits greater than 35 mph for vehicles manufactured on or after January 1, 1975.

C. Speed limits equal to or less than 35 mph for vehicles manufactured on or after January 1, 1975.

## 7030.1060 NOISE LIMITS FOR OTHER VEHICLES.

Motor vehicle noise limits for any other motor vehicle not included under parts 7030.1040 and 7030.1050 and any combination of vehicles towed by such motor vehicle.




# Minn. Stat. § 86B WATERCRAFT OPERATION

## 86B.321 NOISE LIMITS.

Subdivision 1. **Operation in excess of noise limits prohibited.** A person may not operate a motorboat under any condition of load, acceleration, or deceleration in a manner that exceeds the noise limits contained in subdivision 2.

Subd. 2. **Noise limits.** (a) The noise limits for the total noise from the marine engine or motorboat may not exceed:

(1) for marine engines or motorboats manufactured before January 1, 1982, a noise level of 84 decibels on the A scale measured at a distance of 50 feet from the motorboat or equivalent noise levels at other distances as specified by the commissioner in a pass-by test or 86 decibels on the A scale measured at idle in a stationary test at least four feet above the water and at least four feet behind the transom of the motorboat being tested; and

(2) for marine engines or motorboats manufactured on or after January 1, 1982, a noise level of 82 decibels on the A scale measured at a distance of 50 feet from the motorboat or equivalent noise levels at other distances as specified by the commissioner in a pass-by test or 84 decibels on the A scale measured at idle in a stationary test at least four feet above the water and at least four feet behind the transom of the motorboat being tested.

(b) The noise limits in paragraph (a) do not preclude enforcement of other laws relating to motorboat noise. The officer or deputy doing the testing shall determine which test or tests shall be used. Failure to pass either the pass-by or stationary idle test is a violation of this section.

(c) Equivalent noise levels under paragraph (a) shall be specified by the commissioner by written order and published in the State Register. The noise level determinations are exempt from the rulemaking provisions of chapter 14 and section 14.386 does not apply.

Subd. 3. **Applicability.** The provisions of this section do not apply to motorboats operating under a permit issued under section 86B.121 or a United States Coast Guard marine event permit in a regatta or race while on trial runs or while on official trials for speed records during the time and in the designated area authorized by the permit.

## 86B.521 MOTORBOAT NOISE CONTROL.

Subdivision. 1. **Exhaust muffling system required.** A motor may not be used on a motorboat unless it is equipped with an efficient muffler, underwater exhaust, or other device that adequately muffles or suppresses the sound of the exhaust of the motor so as to prevent excessive or unusual noise. A motor may not be equipped with an altered muffler, muffler cutout, muffler bypass, or any other device designed or installed so that it can be used to continually or intermittently bypass any muffler or muffler system installed in the motorboat or to reduce or eliminate the effectiveness of such a muffler or muffler system.

Subd. 2. **Sale of motor that exceeds noise limits prohibited.**
A person may not sell or offer for sale a marine engine or motorboat that would exceed the noise limits contained in section 86B.321, subdivision 2, under a test procedure approved by the commissioner if the motor is maintained according to the manufacturer's specifications.

Subd. 3. **Modification of engine to exceed noise limits prohibited.** (a) A person may not modify a marine engine or motorboat in a manner that will amplify or increase the noise emitted by the marine engine or motorboat above the noise limits contained in section 86B.321, subdivision 2, under a test procedure approved by the commissioner.

(b) A person may not operate a motorboat with an engine modified to increase noise above the noise limits.

Subd. 4. **Sale of parts that cause excessive noise prohibited.** (a) A person may not sell or offer for sale replacement or additional parts for a marine engine or motorboat which when installed in the marine engine or motorboat will amplify or increase the noise emitted by the marine engine or motorboat above the noise limits contained in section 86B.321, subdivision 2, under a test procedure approved by the commissioner.

(b) A person may not operate a motorboat incorporating parts prohibited to be sold under paragraph (a).

Subd. 5. **Applicability.** The provisions of this section do not apply to motorboats operating under a permit issued under section 86B.121 or a United States Coast Guard marine event permit in a regatta, or race, while on trial runs, or while on official trials for speed records during the time and in the designated area authorized by the permit.

Subd. 6. **Rulemaking exemption.** The test procedures under subdivisions 2, 3, and 4 shall be established by written order by the commissioner and published in the State Register. The establishment of test procedures is exempt from the rulemaking provisions of chapter 14 and section 14.386 does not apply.

# Minn. Stat. § 84.8 SNOWMOBILES

## 84.871 EQUIPMENT REQUIREMENTS.

Subdivision. 1. **Mufflers.** Except as provided in this section, every snowmobile shall be equipped at all times with a muffler in good working order which blends the exhaust noise into the overall snowmobile noise and is in constant operation to prevent excessive or unusual noise. The exhaust system shall not emit or produce a sharp popping or crackling sound. This section does not apply to organized races or similar competitive events held on (1) private lands, with the permission of the owner, lessee, or custodian of the land; (2) public lands and water under the jurisdiction of the commissioner of natural resources, with the commissioner's permission; or (3) other public lands, with the consent of the public agency owning the land. No person shall have for sale, sell, or offer for sale on any new snowmobile any muffler that fails to comply with the specifications required by the rules of the commissioner after the effective date of the rules.

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## 6100.5700 REQUIRED EQUIPMENT.

**Subp. 5. Mufflers.** Mufflers:

A. No person shall operate a snowmobile unless it is equipped with a muffler as required by law and these rules, except that snowmobiles may be operated in organized events as authorized by Minnesota Statutes, section 84.871, without such a muffler.

B. No snowmobile manufactured on or after June 30, 1970, and before February 1, 1972, for sale in Minnesota, except snowmobiles designed for competition purposes only, shall be sold, or offered for sale, unless it is equipped with a muffler that limits engine noise to not more than 86 decibels on the A scale at 50 feet.

C. No snowmobile manufactured on or after February 1, 1972, for sale in Minnesota, except snowmobiles designed for competition purposes only, shall be sold, or offered for sale, unless it is equipped with a muffler that limits engine noise to not more than 82 decibels on the A scale at 50 feet.

D. No snowmobile manufactured on or after April 1, 1975, except a snowmobile designed for competition purposes only, shall be sold, offered for sale, or operated in Minnesota unless it is so equipped and has been certified by the manufacturer to conform to a sound level limitation of not more than 78 decibels on the A scale at 50 feet as originally equipped.

E. In certifying that a new snowmobile complies with the noise limitation requirements of this rule, a manufacturer shall make such a certification based on measurements made in accordance with the SAE Recommended Practice J192(a), as set forth in the Report of the Vehicle Sound Level Committee, as approved by the Society of Automotive Engineers September 1970 and revised November 1973.

F. No snowmobile shall be sold or offered for sale in Minnesota unless its maker has previously furnished the commissioner with a certificate of compliance certifying that all snowmobiles made by that maker meet or exceed the applicable noise level restrictions established by these rules. The certification of compliance shall be in the form of a "Snowmobile Safety Certification Committee" label conspicuously attached to the machine showing certification by the Snowmobile Safety and Certification Committee, Inc., or a label showing compliance with Snowmobile Safety Certification Committee standards accompanied by a letter containing test results of an evaluation of noise levels by a competent independent testing laboratory. Snowmobiles intended for competition purposes only shall be exempt from this part provided a separate placard identifying that such snowmobile is not so equipped is conspicuously and permanently affixed thereto.

G. Except for organized events as authorized by Minnesota Statutes, section 84.871, no snowmobile shall be modified by any person in any manner that shall amplify or otherwise increase total noise level above that emitted by the snowmobile as originally equipped, regardless of date of manufacture.

# Minn. Stat. § 87A. SHOOTING RANGES

## 87A.05 NOISE STANDARDS.

Allowable noise levels for the operation of a shooting range are the levels determined by replacing the steady state noise $L_{10}$ and $L_{50}$ state standards for each period of time within each noise area's classification with a single Leq(h) standard for impulsive noise that is two dBA lower than that of the $L_{10}$ level for steady state noise. The noise level shall be measured outside of the range property at the location of the receiver's activity according to Minnesota Rules, parts 7030.0010 to 7030.0080, as in effect on May 28, 2005. For purposes of this section, "Leq(h)" means the energy level that is equivalent to a steady state level that contains the same amount of sound energy as the time varying sound level for a 60-minute time period.

# Minn. Rules § 6102, RECREATIONAL VEHICLES

## 6102.0002 DEFINITIONS.

**Subpart 1. Scope.** For the purposes of parts 6102.0002 to 6102.0080, the terms defined in this part have the meanings given them.

**Subp. 2. ATV.** "ATV" means an all-terrain vehicle.

**Subp. 3. Commissioner.** "Commissioner" means the commissioner of Natural Resources.

**Subp. 4. Department.** "Department" means the Department of Natural Resources.

**Subp. 5. OHM.** "OHM" means an off-highway motorcycle.

**Subp. 6. ORV.** "ORV" means an off-road vehicle.

**Subp. 7. Vehicle.** "Vehicle" means an OHM, ORV, or ATV.

## 6102.0040 REQUIRED EQUIPMENT.

**Subp. 4. Mufflers.**

A. No person shall operate a vehicle unless it is equipped with a muffler having a spark arrestor approved by the United States Forest Service as described by Code of Federal Regulations, title 36, chapter II, section 261.52, paragraph (j).

B. Vehicles shall not be sold, offered for sale, or operated in this state unless equipped so that overall noise emission does not exceed a sound level limitation of not more than 99 decibels on the A scale from a distance of 20 inches using test procedures and instrumentation as set forth in the Society of Automotive Engineers' Standard, SAE J1287, June 1988, or, if different procedures or instrumentation are used, a noise level equivalent to that level.

C. No noise suppressing system or muffler shall be equipped with a cutout, bypass, or similar device and no person shall modify or alter that system or its operation in any manner which will amplify or increase the noise emitted by the vehicle's motor to exceed the noise limits established in this subpart, except for organized events as authorized by Minnesota Statutes, sections 84.795, subdivision 7; 84.804, subdivision 5; and 84.928, subdivision 5.

# Noise, Light & Vibration

Noise, light, and vibration from truck traffic, drilling, well pumps, compressor stations, processing plants, and other shale gas development (SGD) operations can be disruptive and result in mental and physical health impacts for those living nearby. The impacts may vary depending on the distance from the source and the individual's susceptibility. As with many other exposures, children and other vulnerable populations may experience greater impacts. Those exposed may experience loss of sleep, difficulty concentrating, and stress. These factors may also lead to anxiety, depression, and other mental health impacts, which are further explored here.

## Noise

Noise levels will vary with different SGD activities and infrastructure, and of course the closer you are to the source of the sound, the louder the sound will be.

At well sites, noise may be a result of site preparation, drilling or fracking, and truck traffic. These activities are considered temporary, but that length of time may depend on the number of wells that will be developed on the well pad and how often wells may need to be restimulated.

With facilities like compressor stations and processing plants, noise may be expected for the life of the facility, with louder fluctuations related to events such as blowdowns or flaring. Noise from SGD tends to fluctuate and may involve low-frequency noise, often described as felt more than heard. Noise mitigation techniques that block higher pitch sounds may fail to adequately block low-frequency noise as these sounds use less energy moving through materials than high-frequency sounds. Low-frequency sounds require thicker/denser materials to dampen the sound.

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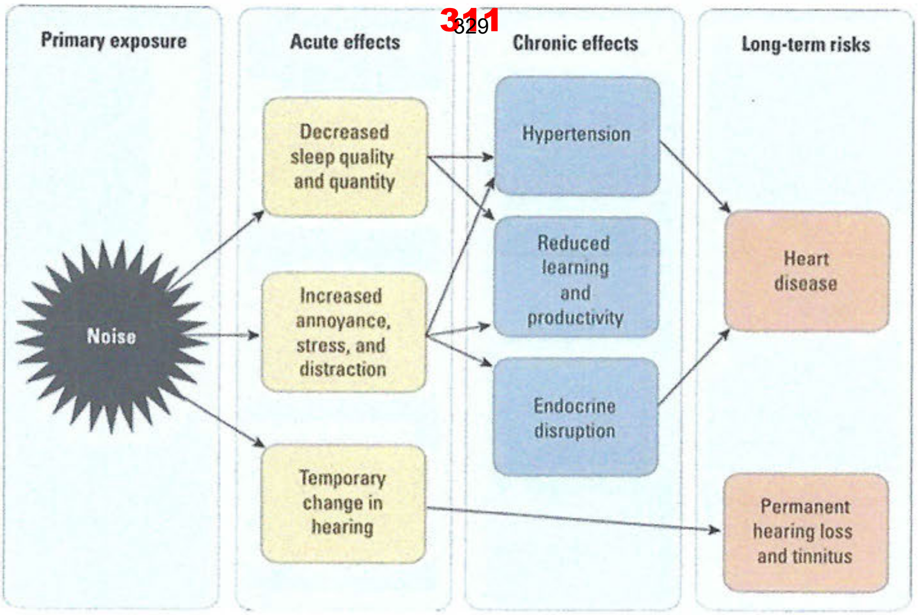



Image courtesy of Hammer, M.S., Swinburn, T.K., Neitzel, R.L., *Environmental Health Perspective*

# Health Impacts from Loud Noises

Loud noise levels are most often associated with hearing loss, but there are other health consequences to consider when noise is frequent or constant, even if it is not loud enough to cause hearing loss. Chronic noise disturbance may contribute to impacts such as stress, disrupted sleep, depression, high blood pressure, cardiovascular disease, diabetes, obesity, and cognitive impairment in children. Hays et al. (2017) suggested that noise levels from SGD primarily cause annoyance, sleep disruptions, and impacted cardiovascular health. They also noted that, according to the World Health Organization, low-frequency noise may make health impacts from noise pollution considerably worse than impacts from higher-frequency sounds and added that, for homeowners, it was particularly bad since house walls do little to dampen low-frequency waves.

Though the Environmental Protection Agency (EPA) and other agencies like the World Health Organization (WHO) suggest noise guidelines, they do not have any regulatory authority to enforce noise pollution problems. Instead, noise control is regulated by state and local governments. Consult with your local health or environmental regulatory agency for more information.

In 1974, the EPA recommended guidelines for acceptable noise levels averaged over 24 hours based on the use of the area in question. An exposure limit of:

- 45 decibels is associated with indoor areas, residences, hospitals, and schools and is meant to prevent activity interference.
- 55 decibels is identified for certain outdoor areas where human activity takes place and is intended to protect against long-term health effects.
- 70 decibels is identified for all areas in order to prevent hearing loss.

According to the National Institute for Occupational Safety and Health (NIOSH), any sound over 85 decibels can lead to hearing damage. Therefore, taking steps to reduce noise by wearing hearing protection or to limit your exposure time by going elsewhere is important for protecting your health.

One way to monitor noise levels from SGD is to install a sound measurement app on your smartphone. Search "Sound Meter" where you access apps to see a list of potential options. These apps will give you a noise level snapshot. Limits recommended by the EPA are for an average over 24 hours, but an app can give you a general idea of levels being reached where you live, work, and play.

Protect PT's (Penn Trafford) Noise Monitoring Program helps residents in Westmoreland and Allegheny counties in Pennsylvania identify baseline ambient noise levels of areas in close proximity to shale gas development. Following a baseline study, Protect PT will conduct studies for each phase of development, including construction, drilling, and hydraulic fracturing. For more information, visit Protect PT's website here.

Be aware of noise levels from adjacent industry and your level of stress. If your ability to concentrate and sleep are compromised, you may need to take action to mitigate the noise levels or to ask for remediation from industry.

# Light

SGD activities and infrastructure may involve dusk to dawn lighting to assist in working around the clock, such as when wells are being drilled and fracked or for constant nighttime lighting at processing plants and compressor stations.

There is a growing body of evidence indicating that excessive artificial light at night (also referred to as ALAN) may result in health impacts.

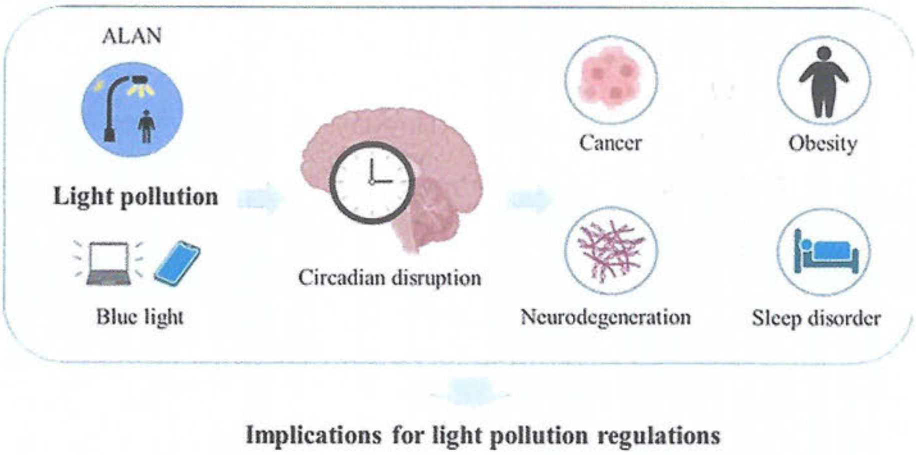



Image courtesy of Cao et al., 2023

Our bodies work within a 24-hour day/night cycle known as the circadian clock. Extended exposure to artificial light at night can interfere with this cycle and alter the normal functioning of the body. Disorders associated with too much light at night can include mental health disorders (such as depression), disrupted sleep, cardiovascular disease, obesity, and cancer.

One possible cause of cancer may be the reduced production of melatonin by the body. Melatonin is produced by a gland in the brain at night when it is dark, and it helps to regulate other hormones in the body. Studies have linked reduced nighttime production of melatonin with increased cancer risk.

4

In addition to turning off lights within your home at night, steps to reduce exposure to artificial light at night from outside the home can be found on the Protecting Your Health page.

# Vibration

SGD may result in vibrations that can be felt in the home during activities such as seismic testing, drilling, and heavy truck traffic. Vibrations are often felt in conjunction with noise. Health impacts related to vibration outside of occupational health have not been well studied. As with noise and light, vibrations that are felt within the home can disrupt sleep and concentration and cause stress and anxiety.

Suggested Next Read: Protecting Your Health

## Learn More

### EHP Resources

- HANDOUT
  - Mental Health in Communities with SGD
  - Protecting Your Health from Shale Gas Development

### Other Resources

- STUDY
  - Cao, M., Xu, T., Yin, D. (2023). Understanding light pollution: Recent advances on its health threats and regulations. *Journal of Environmental Sciences*, 127: 589-602. https://www.sciencedirect.com/science/article/abs/pii/S1001074222003291?via%3Dihub
  - Chepesiuk, R. (2009). Missing the Dark: Health Effects of Light Pollution. *Environmental Health Perspectives*, 117, 1:A20-A27 https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.117-a20
  - Hays, J., McCawley, M., Shonkoff, S. (2017). Public health implication of environmental noise associated with unconventional oil and gas development. *Science of the Total Environment*, 580:448-456. https://www.sciencedirect.com/science/article/abs/pii/S0048969716325724
- ARTICLES
  - Artificial Light at Night May Lower Sleep Quality, Raise Health Risks, *American Academy of Sleep Medicine*
  - EPA Identifies Noise Levels Affecting Health and Welfare, *Environmental Protection Agency*
  - Exposure to Artificial Light at Night Can Harm Your Health, *International Dark Sky Association*
  - How to Block Low Frequency Sound Waves (Bass), *SoundProof Central*
  - Understanding Noise Exposure Limits: Occupational vs. General Environmental Noise, *Center for Disease Control and Prevention, NIOSH*
  - What are the health effects of noise pollution? *Medical News Today*
- REPORT

## 8. Traffic, Road Damage, and Public Safety

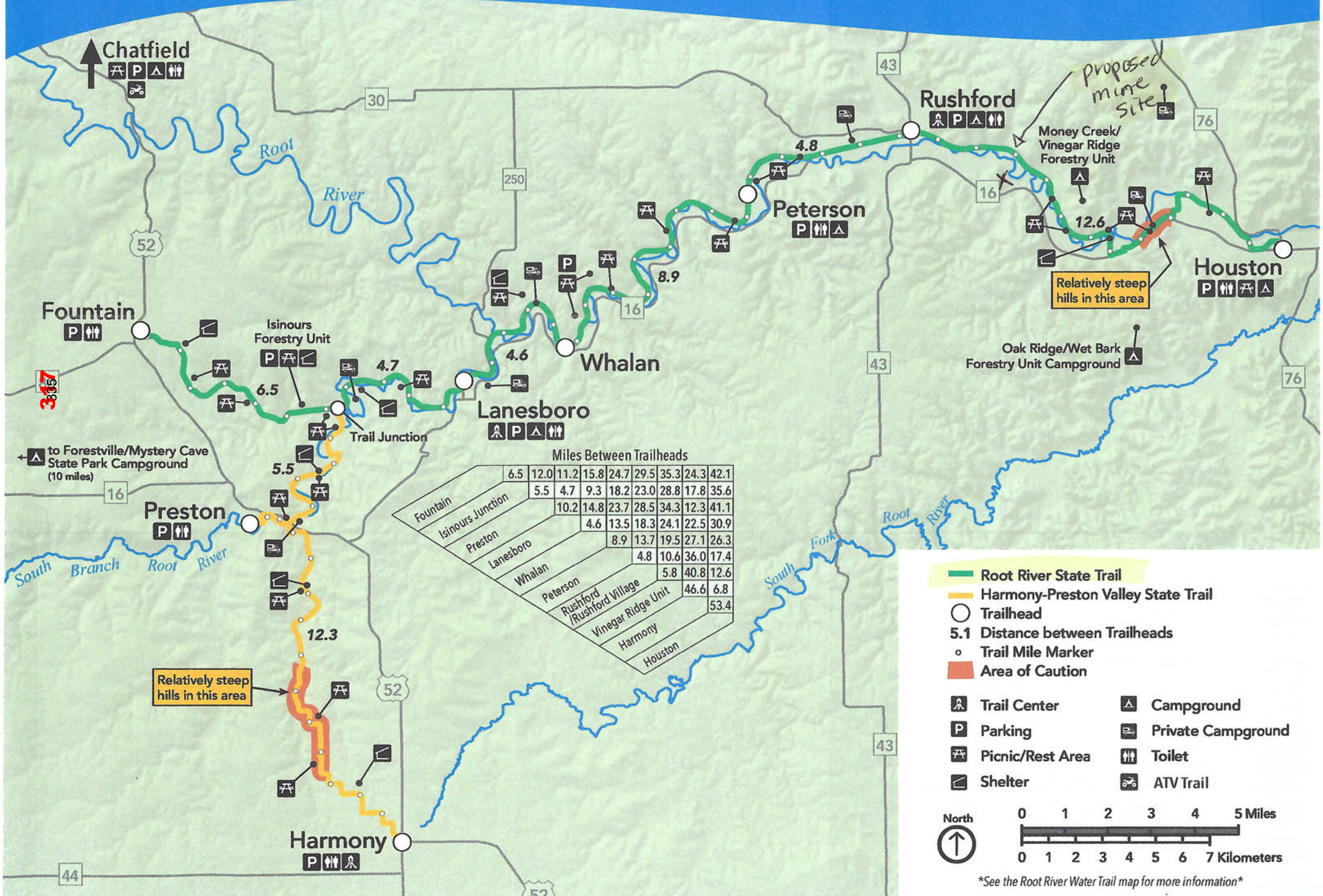
- Map of State Highway 16 showing large curves with small window to pass at ingress/egress point creating safety hazard with trucks entering/exiting


315
10.0190.000 STATE OF MINNESOTA
10.0191.000 FERRO,VENA D
10.0182.002 MIERAU,DEAN A & KIMBERLY J
10.0182.003 HOUSTON COUNTY
10.0180.000 WALTHER TRUST
10.0182.001 PETERSON,RYAN
10.0200.001 VITSE,NATHAN & JUNE
26
10.0183.000 LARSON,KATHLEEN A
10.0212.001 MIERAU,DEAN A & KIMBERLY J
10.0200.003 STATE OF MINNESOTA/DNR
10.0212.002 STATE OF MINNESOTA/DNR
10.0208.000 BENEFICIARY ACRES LLP
RIVER
10.0200.000 CORCORAN, STEVEN E & RENEE L
10.0212.000 MIERAU,DEAN A & KIMBERLY J
10.0213.000 STATE OF MINNESOTA
10.0209.002 BERGLER, CINDY S
10.0201.000 HATLELI,SCOTT
10.0209.003 STATE OF MINNESOTA/DNR
10.0214.000 HATLELI,SCOTT
10.0209.000 JOHNSON, ANDREW P
10.0209.001 STATE OF MINNESOTA
10.0201.001 HOILAND, PHILLIP & MARY
10.0210.002 HOEGH, JOHN R & JACQUELINE
17.0001.002 HOILAND,PHILLIP & MARY
10.0210.007 JOHNSON, ANDREW P
17.0001.000 HATLELI,SCOTT
17.0009.000 HATLELI,SCOTT
10.0210.009 STATE OF MINNESOTA/DNR
17.0003.003 HOILAND,PHILLIP & MARY
17.0009.001 MIERAU,DEAN A & KIMBERLY J
10.0210.008 KOELLER,HEIDI & SCOTT D HOEGH
17.0010.002 MIERAU, DEAN A
10.0211.001 MIERAU, DEAN A
17.0010.000 OLSON,CLAIR & JARAD
10.0210.000 WALLACE,SCOTT D & DARLA K
17.0003.002 PETERSON,JASON L & MICHELE R
17.0002.000 IVERSEN, ROSEMARY C
17.0010.001 OLSON, CLAIR & JARAD
10.0211.000 OLSON,CLAIR & JARAD
17.0010.003 CHRISTENSEN,TONY R & REBECCA
17.0023.000 WALLACE, SCOTT & DARLA
17.0041.000 PETERSON,JASON L & MICHELE R
17.0039.002 IVERSEN, ROSEMARY C
17.0027.000 OLSON,CLAIR & JARAD
17.0035.000 OLSON,CLAIR & JARAD
17.0035.002 CHRISTENSEN, TONY R & REBECCA
17.0025.001 VAN GUNDY, ADAM & LAURA
17.0053.000 FERNDALE GOLF LLC
17.0039.000 ERICKSON,TRACIE & MICHELLE L
17.0037.001 BAKER,CORY R
17.0035.003 HANSON, LARRY
17.0025.000 OLSON,CLAIR R & PATRICIA
17.0025.000 OLSON,CLAIR R & PATRICIA
17.0035.001 HANSON,BEVERLY J
17.0040.001 FERNDALE GOLF LLC
16
HATCHERY
17.0037.003 ANDERSON,LUKAS ANDERSON
17.0026.000 SWEDBERG,BRIAN & DANIELLE
17.0040.000 KJOS,D & C REV TRUST
17.0039.001 KJOS,D & C REV TRUST
State Hwy 16.
A winding road with
a short passing zone
n front of mine access
17.0028.000 ANDERSON,LUKAS ANDERSON & WADE
17.0024.000 ANDERSON,DAVID W & MARILYN E
COYLE,LORI A & TAYLOR R
17.0045.000 KJOS,D & C REV TRUST
17.0042.000 KJOS,D & C REV TRUST
17.0034.000 JOHNSON, MARK
17.0033.000 COYLE,LORI A & TAYLOR R
17.0034.001 MAGIN, ROBERT JOHN & KARI M
17.0030.000 COYLE,LORI A & TAYLOR R
17.0029.000 BAKER, CORY R

## 9. Tourism and Recreation

- Map of Root River State Trail
- Root River STate Water Trails Handout - MN DNR
- State Water Trail Guide And Map To The Root River - MN DNR
- National Historic Bluff Country Scenic Byway Map and Information
- Explore an Ancient Landscape | November–December 2015 | Minnesota Conservation Volunteer | Minnesota DNR
- Business owner letter regarding importance of tourism in the area

# Root River & Harmony-Preston Valley State Trails




Miles Between Trailheads

| | Isinours Junction | Preston | Lanesboro | Whalan | Peterson | Rushford /Rushford Village | Vinegar Ridge Unit | Harmony | Houston |
|---|---|---|---|---|---|---|---|---|---|
| Fountain | 6.5 | 12.0 | 11.2 | 15.8 | 24.7 | 29.5 | 35.3 | 24.3 | 42.1 |
| Isinours Junction | | 5.5 | 4.7 | 9.3 | 18.2 | 23.0 | 28.8 | 17.8 | 35.6 |
| Preston | | | 10.2 | 14.8 | 23.7 | 28.5 | 34.3 | 12.3 | 41.1 |
| Lanesboro | | | | 4.6 | 13.5 | 18.3 | 24.1 | 22.5 | 30.9 |
| Whalan | | | | | 8.9 | 13.7 | 19.5 | 27.1 | 26.3 |
| Peterson | | | | | | 4.8 | 10.6 | 36.0 | 17.4 |
| Rushford /Rushford Village | | | | | | | 5.8 | 40.8 | 12.6 |
| Vinegar Ridge Unit | | | | | | | | 46.6 | 6.8 |
| Harmony | | | | | | | | | 53.4 |

DEPARTMENT OF NATURAL RESOURCES

# Root River State Water Trail

Podcast 741Kb (MP3) (https://files.dnr.state.mn.us/destinations/water_trails/audio-tales/root-audio.mp3)Transcript (PDF) (https://files.d

The Root River represents the timeless scenic and historic qualities characteristic of southeastern Minnesota. Many quaint towns along the river offer historical sights, services and hospitality, making it ideal for family day trips.

From Chatfield to the Mississippi River the river falls 310 feet, for an average drop of 3.4 feet per mile. There is generally a gentle to moderate flow with a few riffles, although water level can vary substantially with rainfall.

(https://www.facebook.com/mnstateparksandtrails) (https://www.instag

## River segments and maps

Get maps and more information (/watertrails/rootriver/segments-maps.html) for this river's two segments:

1. Chatfield to Rushford (/watertrails/rootriver/segments-maps.html#map1)
2. Rushford to the Mississippi River (/watertrails/rootriver/segments-maps.html#map2)

## Landscape

Formed of two branches in the west, the North and the Middle, the Root River winds past towering bluffs topped with oak and hickory. Joined above the town of Whalen by the South Branch - a tributary which flows from Mystery Cave - the river continues its way past bluffs and outcrops until Rushford. There the river straightens as the valley broadens considerably. The scenery then settles into a gentle plain of pastureland and mixed cottonwood and maple, with wooded rolling hills visible in the distance.

Although the watershed has many spring-fed clear water tributaries including the South Branch, the Root River is somewhat cloudy due to erosive soil types in the watershed.

## Fish and wildlife

Eating fish from a Minnesota river or lake? Read the MN Department of Health's fish consumption advisory (http://www.health.state.mn.us/divs/eh/fish/index.html).

### Fish

- Smallmouth bass
- Channel catfish
- Rock bass
- Sunfish
- Crappies

- Rough fish
- Brown trout (western end of the South Branch)

### Wildlife

- White-tailed deer
- Gray and red fox
- Coyotes
- Raccoons
- Woodchucks, weasels and badgers
- River otters and beaver
- Skinks
- Racerunners
- Timber rattlesnake

### Birds

- Great blue herons
- Egrets
- Wood ducks
- Red-tailed hawks
- Osprey
- Turkey vultures
- Bald eagles

## History

Established in 1967 as a state water trail, the Root River's name is a literal translation of the Dakota word Huktan and the French word Racine, which were earlier names given to the river. It is not clear why both the Dakota and French named the river "Root."

This area served as a gateway for cultures moving north. The Mississippian Tradition, - a striking example of cultural development - moved northward about A.D. 900 to 1000. They farmed the fertile bottom land and built terraces above the rivers. The native Dakota Indians continued to inhabit the land until the 1852 Treaty of Traverse de Sioux forced their removal, thus opening the door for further westward expansion of the United States.

Soon hardwood stands were cleared and fields were cultivated. Development of water resources and poor land management led to a negative impact on the area's environment. Catastrophic erosion gradually led the people of southeastern Minnesota to initiate wiser use of the land, and eventually the state established what is now known as the Richard J. Dorer Memorial Hardwood Forest (/state_forests/forest.html?id=sft00033) to restore and prescribe sound multi-use land practices.

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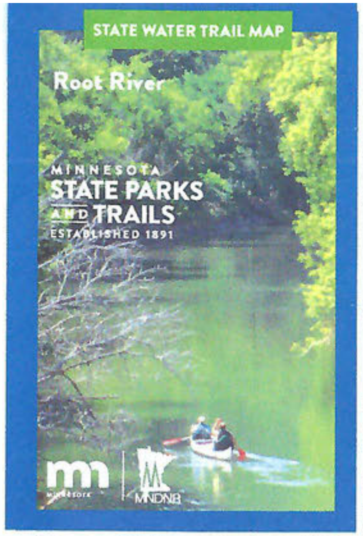
Questions?

Call: 888-646-6367 (MINNDNR) or 651-296-6157

Email: info.dnr@state.mn.us





The Minnesota Department of Natural Resources is an Equal Opportunity Employer.

This information is available in alternative format upon request.

Minnesota State Parks and Trails
Regional Unit
1200 Warner Road
St. Paul, MN 55106
651-772-7900

Online water trail information and maps can be found at mndnr.gov/watertrails

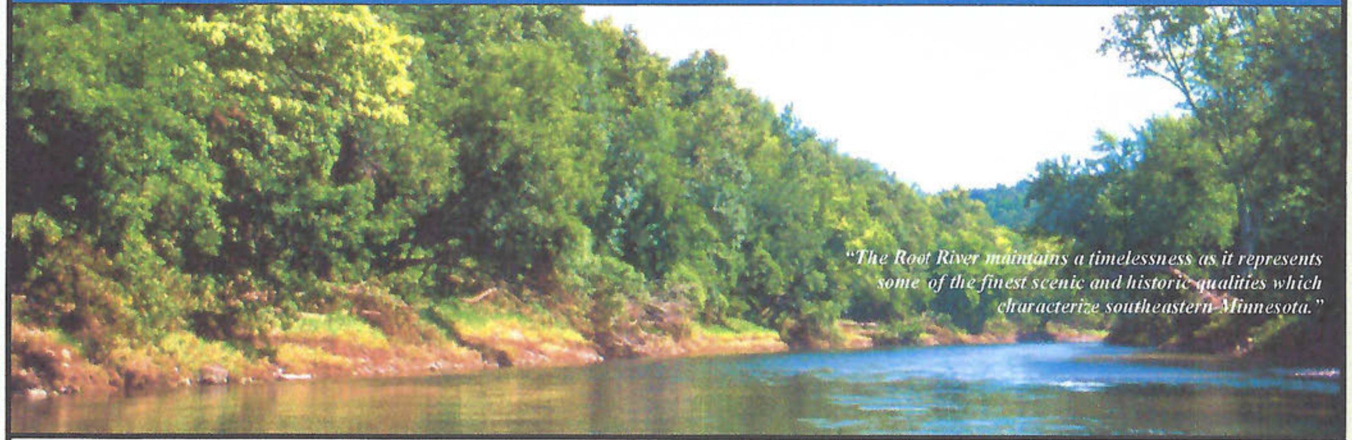
**DNR Information Center**

The DNR's Information Center is available to provide free publications of facilities and services as well as answers questions pertaining to DNR recreational opportunities in Minnesota.

500 Lafayette Road
St. Paul, MN 55155-4040
651-296-6157 Metro Area
1-888-646-6367 MN Toll-Free
mndnr.gov



# A STATE WATER TRAIL GUIDE TO THE ROOT RIVER




## The Root River

The Root River maintains a timelessness as it represents some of the finest scenic and historic qualities which characterize southeastern Minnesota. Formed of two branches in the west, the North and the Middle, the Root River winds past towering bluffs topped with oak and hickory. Joined above Whalan by the South Branch, a tributary which flows from Mystery Cave, the river continues its way past bluffs and outcrops until Rushford.

There the river straightens as the valley broadens considerably. The scenery then settles into a gentle plain of pastureland and mixed cottonwood and maple with wooded rolling hills visible in the distance.

The Root River has a gentle to moderate flow with some riffles at various stretches. From Chatfield to the Mississippi River the river falls 310 feet for an average drop of 3.4 feet per mile. River levels peak in mid-March and once again in early June. Water levels also vary substantially with rainfall. Though the watershed has many spring-fed, clear water tributaries, including the South Branch, the Root River is somewhat cloudy due to erosive soil types in the watershed.

The Root River's superlative scenery and characteristics make it suitable for many types of recreation. Family canoe day trips are very popular. Those more adventurous can take advantage of the canoe campsites for overnight trips. Several towns along the Root River also offer historic sites, services and hospitality to river users (see Towns along the River). Other pastime favorites along the river are bird watching, nature observation, bicycling along the Root River State Trail, and fishing (see River Life).

## River Life

**Wildlife** - Natural life along the Root River is as diverse as anywhere in the state. Wooded shores harbor mammals such as white-tailed deer, gray fox, red fox, coyote, raccoon, woodchucks, squirrels, weasels, and badgers. River otter and beaver can be found in the water.

Lizards such as the skink, racerunner, and many species of snakes, including the timber rattlesnake, can be found along the banks and outcrops.

**Fish** - There are many species inhabiting the river including smallmouth bass, channel catfish, rock bass, sunfish, crappies, and rough fish. Most of these can be found in the active stretches or pooled areas of the river.

Brown trout can be found in the clearer and colder spring-fed streams, as well as the South Branch. All anglers fishing in designated trout waters are required to have a current trout stamp.

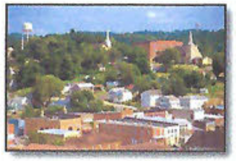
**Birds** - These inhabitants constitute some of the more spectacular river life and can be seen in abundance. The Root River supports over 40 species of birds. While floating, it is quite common to see blue herons, egrets, and wood ducks moving about the river's edge. One might also see wild turkey foraging on the shore or cliff swallows building vase-shaped mud nests on bridge overhead.

**Raptors**- Whether perched high in a tree or soaring majestically above the valley, these magnificent birds of prey provide a visual bounty for those using the Root River.

## Towns Along the River

Nestled among the natural setting, vestiges of culture, past and present, come together in the form of towns. The towns were linked by the Southern Minnesota Railroad, completed in 1870, which was used to carry milled products such as flour and lumber to markets throughout the Midwest. The railroad grade is now the Root River State Trail. These towns represent the development of the valley and offer the visitor a pleasing focus on rural and small town Minnesota as well as a taste of the past.

**Preston** - Settled in 1853 along the South Branch, this community was active in milling. Today the town is the county seat of Fillmore County. It offers a canoe launch, picnic area, campground, lodging, grocery store, and restaurant and connection to the Harmony-Preston Valley Trail.



**Lanesboro**-Platted in 1868 along the South Branch as a railroad town, it flourished as a transportation and mill center. Today Lanesboro offers a historic downtown district. It also offers a campground, a picnic area, a bed and breakfast, a motel, grocery stores, restaurants, and an outfitter.

**Chatfield** - Settled in 1853 on the North Branch, it was a milling and transportation center. It offers a canoe launch, a picnic area, grocery stores, and restaurants and hotel.

**Whalan** - Platted in 1868 as a railroad town, it was once the tobacco center of Fillmore County.

**Peterson** - A railroad village founded in 1867, it was the former site of a mill. The Peterson Trout Farm, founded in 1871, is located a mile south of town (now operated by the Minnesota DNR). There is a canoe launch in town.

**Rushford** - Settled in 1854. It was a major railroad center and mill town. It offers a canoe launch, a motel, a picnic area, grocery stores, restaurants, and an outfitter.

**Houston** - Settled in 1852, it was a steamboat port and the center of railroad transportation. It offers a canoe launch, a motel, a campground, a picnic area, a grocery store and restaurants.

**Hokah** - Settled in 1851, it served as a mill site for railroad machine shops and was serviced by steamboats. It offers a park, grocery store, and restaurant.

## Planning A Safe River Trip

A successful river trip is safe. To enjoy a safe journey, you should be prepared by doing the following:

- Get acquainted with your route. Plan your trip with a map before you depart and advise someone of your plans including planned departure and arrival times.
- Travel with a companion or group.
- Choose a distance that is comfortable for you, most people paddle two to three river miles per hour.
- Wear a U. S. Coast Guard approved personal flotation device that state law requires be on board the boat for each person.
- Bring a first aid kit that includes waterproof matches.
- Bring an extra paddle in your canoe.
- Be cautious of river obstructions, such as overhanging and dead trees in the river.
- You must pack out all trash.
- Leave only footprints; take only photographs!

Water levels can speed you up or slow you down. You can get information about water levels from the regional DNR office, or check the DNR website, or the DNR Information Center.

Remember that much of the shorelands are privately owned. Respect and protect the water and shorelands.

## Boating Information

- Register your watercraft. All watercraft more than 9 feet in length, including nonmotorized canoes and kayaks, must be registered in Minnesota or your state of residence.
- Not all areas of this water trail are suitable for motor use.

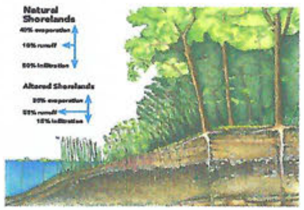
## Rest Areas and Camping Sites

- Public rest areas are available along the route to rest, picnic and explore.
- Camp only in designated campsites, which are available on a first-come, first-served basis
- Bring drinking water. Drinking river water is not recommended, but if you do it must be treated.
- Respect private property. Stop only at designated sites; most of the shoreland is private property.
- Be sanitary! Use designated toilet facilities or bury human waste away from the river.

## Sustainable Ecosystems

Outdoor recreation is dependent on a healthy and attractive natural environment. Sustainable outdoor recreation enables people to enjoy the outdoors without negative impacts on the environment. Communities working together can improve water resources by promoting environmentally sensitive land use practices along rivers and throughout watersheds.

Natural shoreline buffers improve water quality by filtering out pollutants and sediments. Healthy and diverse native shoreline plant communities are attractive and provide important shoreline habitat for birds and wildlife.




*Continued from reverse side*

- **57.9(L)** Confluence with Torkelson Creek, a designated trout stream.
- **56.5(R)** Abandoned Root River Power & Light powerhouse. This structure was one of the first major hydroelectric projects in the Root River Valley. Completed in 1914, its construction was unusual in that it was powered by the dam at river mile 62.0. The water was directed through the bluff behind the power plant via a tunnel. The diversion was necessary to increase the flow gradient enabling the water to reach sufficient force to power the generators.
- **56.1 & 55.9(L)** Power Plant Campsites, DNR facilities with separate landings, picnic tables and pit toilets.
- **54.3** State Highway 250 bridge.
- **53.2** Root River State Trail bridge.
- **53.2(R)** Confluence with South Branch of the Root River.
- **52.5(R)** Highway 16 access. A DNR carry-in landing with pit toilet.
- **51.1(R)** Private Campground.
- **50.1** County Highway 36 bridge.
- **50.1(L)** City of Whalan.
- **49.9(R)** Gribben Valley Management Unit. A DNR forest area. Outfitter located river left.
- **49.9** Old bridge abutments (debris).
- **49.4(R)** Confluence with Gribben Creek, a designated trout stream.
- **49.3(L)** City of Whalan carry-in access. Parking 500' away.
- **47.5(L)** Private Campground.
- **46.4(R)** Confluence with Diamond Creek.
- **44.8(L)** Confluence with Rasen Creek.
- **44.6(R)** Rasen Creek Campsite. A DNR facility which offers two sites, picnic tables and a pit toilet in a wooded, river bottom setting.
- **42.6** Confluence with Big Springs Creek, a designated trout stream.
- **42.0** Township road bridge.
- **39.0** Outfitter off river.
- **38.9(R)** Peterson carry-in access and toilet facility.
- **38.9** County Highway 25 bridge.
- **38.9(L)** City of Peterson.
- **38.0(L)** North Peterson Management Unit. A DNR forest area.
- **33.9** Submerged dam. Use caution when navigating over this structure.
- **33.8(L)** Rushford carry-in access.
- **33.4** State Highway 16 bridge.
- **33.4(L)** City of Rushford.
- **33.1(L)** Confluence with Rush Creek, a designated trout stream.
- **32.3** Outfitter off river.
- **29.7(R)** Confluence with Ferndale Creek.
- **27.9(L)** Money Creek Management Unit, a DNR forest area.
- **26.1(R)** Confluence with Daley Creek, a designated trout stream.
- **24.8(L)** Houston Campsite, a DNR facility which offers two sites and picnic tables.
- **22.5** Abandoned railway bridge abutments (debris).
- **20.4(L)** Confluence with Money Creek.
- **18.8** Dredging operation for sand removal. Use caution when navigating through the area.
- **18.6** State Highway 76 bridge.
- **18.6(R)** City of Houston.
- **18.7(L)** Houston carry-in access.
- **17.9** Powerline crossing.
- **17.3** Township road bridge.
- **17.0(R)** Confluence with South Fork of the Root River.
- **14.8(L)** Confluence with Buell Creek.
- **14.6(L)** Confluence with Silver Creek, a designated trout stream.
- **13.9(L)** Confluence with Storer Creek, a designated trout stream.
- **13.4(R)** Confluence with Crystal Creek.
- **13.1(L)** Mound Prairie Campsite, which offers two sites, picnic tables and a pit toilet in pastured woodland setting.
- **11.9** County Highway 24 bridge.
- **12.0(R)** Mound Prairie carry-in access.
- **10.4(R)** Confluence with Mound Prairie Creek.
- **10.1(L)** Confluence with Day Creek.
- **9.5(L)** Confluence with Brush Valley Creek.
- **6.6(R)** City of Hokah.
- **5.8(R)** Hokah carry-in access. Confluence with Thompson Creek, a designated trout stream.
- **4.0** Abandoned Milwaukee Road Railway bridge.
- **3.2 (L)** Hwy 26 carry-in access. County Highway 26 bridge. Milwaukee Road Railway bridge.
- **0.0** Confluence with Mississippi River. Next available downstream access on the Minnesota side is at Brownsville. The next available upstream access on the Minnesota side is at La Cresent.

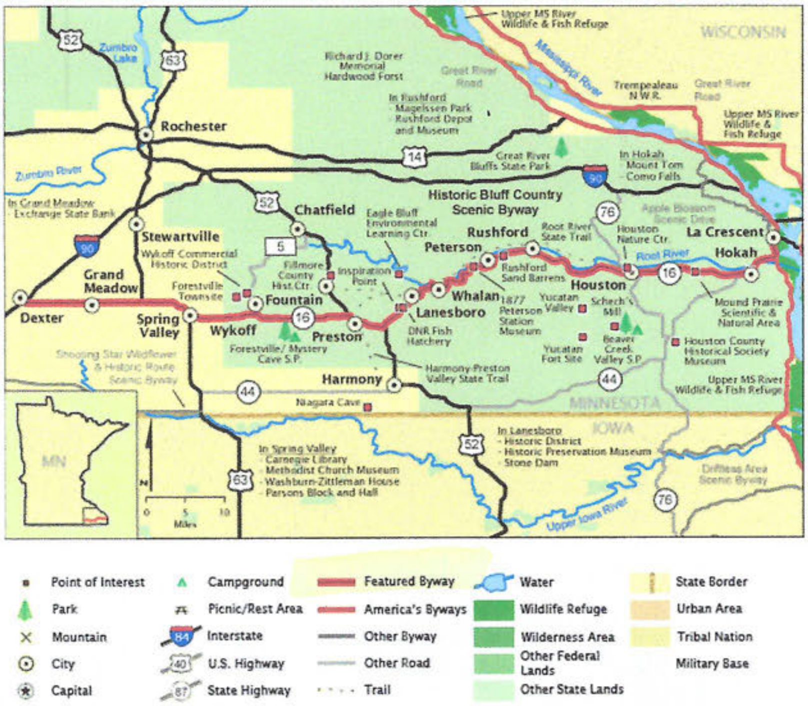
# National Scenic Byways & All-American Roads

MENU

## Historic Bluff Country Scenic Byway

National Scenic Byway • Minnesota

Click on the Map below to view the section of the Byway.



# National Scenic Byways & All-American Roads

MENU

## Historic Bluff Country Scenic Byway

National Scenic Byway • Minnesota

Select a State to View Byways

**Length:** 88 mi (miles) / 141.6 km (kilometers)
**Time to Allow:** Three hours to drive the byway
**Fees:** Some attractions charge fees, but byway travel is free.

In the small communities and scenic beauty of this byway, visitors find art galleries, antique shops, Amish tours, historic sites, cave tours, and museums. Parks, forests and the Root and Mississippi Rivers provide opportunities for many recreation options, including canoeing, cross-country skiing, horseback riding, cycling, wildlife watching, fishing, and photography.

### Local Information

Historic Bluff Country Scenic Byway
**Historic Bluff Country, Inc.**
800-428-2030 or 507-886-2230

DEPARTMENT OF NATURAL RESOURCES

Minnesota DNR (/)

(/mcvmagazine/index.html)

Home (/mcvmagazine/index.html) | Issue Index (/mcvmagazine/issues/2015/nov-dec/index.html)

November–December 2015

# Explore an Ancient Landscape

## To discover the species richness here, look deep into the valleys and high on ridges.

by Hannah Texler

(https://files.dnr.state.mn.us/mcvmagazine/issues/2015/nov-dec/img//blufflands/southeast-minnesota01.jpg)

(https://files.dnr.state.mn.us/mcvmagazine/issues/2015/nov-dec/img//blufflands/southeast-minnesota02.jpg) 

(https://files.dnr.state.mn.us/mcvmagazine/issues/2015/nov-

dec/img//blufflands/southeast-minnesota03.jpg) 

(https://files.dnr.state.mn.us/mcvmagazine/issues/2015/nov-

dec/img//blufflands/southeast-minnesota04.jpg) 

(https://files.dnr.state.mn.us/mcvmagazine/issues/2015/nov-

dec/img//blufflands/southeast-minnesota05.jpg) 

(https://files.dnr.state.mn.us/mcvmagazine/issues/2015/nov-
dec/img//blufflands/southeast-minnesota06.jpg)

When I think about southeastern Minnesota, visions of towering bluffs, valleys filled with spring wildflowers, and winding coldwater streams come to mind. So imagine the disconnect I experienced when I saw a greeting card that showed a cartoonish map with symbols illustrating different parts of the state: All of southern Minnesota was represented with an ear of corn. How could this be?

I am determined to set the record straight. As an ecologist with the Department of Natural Resources, I want to share the beauty, the diversity, and the wonder that I have found during several years of biological surveys in this lovely region.

If geography and ancient history ruled, southeastern Minnesota would probably be a separate state combined with parts of neighboring Wisconsin, Iowa, and Illinois. Together, these 18 million acres are called the Paleozoic Plateau. It is underlain by layers of bedrock that formed over 400 million years ago under a vast sea. After the sea receded, streams—which eventually became the Mississippi River and its tributaries—carved into the bedrock and created a hilly, dissected landscape. Much of the bedrock underlying the landscape is composed of limestone and dolomite. Acidic water, formed when precipitation combines with carbon dioxide, shapes these rocks into caves, sinkholes, and underground drainage, creating a type of landscape known as karst.

The Paleozoic Plateau was largely missed by the last glaciers to move across the state. So instead of being covered by glacial sediments like most of the rest of Minnesota, this rugged, ancient landscape is still visible today.

Also referred to as the blufflands, the driftless area, and coulee country, this is a landscape at once majestic and intimate, ranging from vertical cliffs and wide vistas to narrow valleys, winding creeks, and a myriad of different habitat niches. A walk in the blufflands always offers surprises, and often they are of the faunal or floral variety, because the biological diversity here is higher than in any other part of the state. Minnesota's endangered, threatened, and special concern species list includes 189 plant and animal species that reside here. The region also has the highest number of animal species in greatest conservation need in the state.

## Topography and Geography.

Why is this relatively small region of the state so packed with diversity? Part of the answer lies in its varied topography—steep slopes, floodplains, groundwater discharge areas, high ridgetops, and cliffs. These landscape features support native plant communities specially adapted to thrive under those conditions.

Another factor is Minnesota's position at the northwestern edge of North America's Eastern Broadleaf Forest Province. Many of the rare species found here are rare in the state because they are at the western or northern edge of their range. For example, in Minnesota the timber rattlesnake (*Crotalus horridus*) is found only in the Paleozoic Plateau, but this species ranges more widely throughout eastern North America in appropriate habitats. The blufflands provide the ideal mix of habitats for these snakes—forests and prairies for summer habitat and rock outcrops for winter dens.

Some rare aquatic species are at the northern edge of their range in southeastern Minnesota. One is the crystal darter (*Crystallaria asprella*), a small, pale-yellow fish of large clear streams with moderate to swift currents. For a handful of rare species, the blufflands are key to survival: Seven rare species of flora and fauna have their primary range here in special habitat conditions. For example, glade mallow (*Napaea dioica*) is a tall, summer-blooming floodplain plant that is endemic to the region, meaning it is found nowhere else in the world.

Bedrock bluff prairie is also known as goat prairie because its extreme steepness seems best suited for goats to climb. This unique blufflands habitat occurs on south- to west-facing slopes, where hot, dry conditions slow the growth of trees and shrubs. Fires historically helped to keep these areas open and dominated by more than 200 species of native grasses and wildflowers.

Two rare wildflowers exhibit some of the complexity of blufflands habitats. Plains wild indigo

(*Baptisia bracteata* var. *glabrescens*) is a spring-blooming species adapted to dry conditions. Its pale-yellow flowers attract queen bumblebees, important pollinators on these bluffs. Valerian (*Valeriana edulis* var. *ciliata*), a rare wildflower often found in shallow wetlands on calcium-rich soils, also grows in bedrock bluff prairies. The growing conditions on the blufftops are calcium-rich because of the limestone bedrock and moist in some areas because groundwater is close to the surface.

Wooded slopes and ridgetops surround the goat prairies. Red oak, white oak, bur oak, and shagbark hickory are some of the characteristic trees of these fire-dependent forest communities.

## Shady and Moist.

On cool north- to east-facing slopes and on narrow valley floors along streams and seeps, a variety of forest plant communities endure. Mesic hardwood forests are dominant, with canopies of sugar maple, basswood, red oak, and often white pine, especially on rocky upper slopes. Here, cool, shady conditions make fires much less frequent. Thick layers of leaf litter break down to build up deep, loamy soils rich in nutrients.

Before tree buds unfurl in spring, a visit rewards the hiker with carpets of spring-ephemeral wildflowers, such as white trout lily (*Erythronium albidum*) and spring beauty (*Claytonia virginica*). The diminutive white-flowered squirrel corn (*Dicentra canadensis*) is a spring ephemeral found nowhere else in the state. Look for it in Forestville/Mystery Cave State Park or Frontenac State Park.

By summer, the ground is covered by many of the 40 species of ferns that occur in the blufflands and later-blooming wildflowers such as zigzag goldenrod (*Solidago flexicaulis*), wild geranium (*Geranium maculatum*), and red baneberry (*Actaea rubra*). The floor of mesic hardwood forests features blooming plants from early spring to late fall.

## Cool Crevices in Summer.

Higher up the slopes in the coolest, rockiest valleys, habitat remnants from the last ice age persist. Here, ice from winter lingers in crevices in the limestone bedrock well into summer. Air moving through these fissures in the rocks is cooled and slowly melts the ice. Where cool air and icy water emerge, thick moss carpets and other northern plants grow. Balsam fir, Canada yew, and the endangered Iowa golden saxifrage (*Chrysosplenium iowense*) occur in these places. These northern plants are remnants from 10,000 years ago when the climate was colder and these species were much more common.

Tiny Pleistocene-aged snails, dependent on the continuous presence of cold air, reside on many of these slopes. One federally threatened plant species, Leedy's roseroot (*Rhodiola integrifolia* ssp. *leedyi*), is known from only seven places in the world—four of them on these persistently cold cliffs in Olmsted and Fillmore counties.

These cliffs and slopes are extremely fragile places—one misstep could send rocks and snails and plants tumbling downhill.

Another mosaic of native plant community types resides along the region's big rivers, including the Mississippi and major tributaries such as the Root, Zumbro, Whitewater, Cannon, and Vermillion rivers. Their floodplains hold marshes and sedge meadows, as well as floodplain forests dominated by silver maple, green ash, cottonwood, river birch, and swamp white oak.

More than 150 bird species breed in or migrate through the floodplain habitats. Nearly half of North America's songbirds and 40 percent of its waterfowl spend at least part of their lives in the Mississippi flyway. Bright-blue cerulean warblers (*Setophaga cerulean*), brilliant yellow-orange prothonotary warblers (*Protonotaria citrea*), and soaring red-shouldered hawks (*Buteo lineatus*) are some of the birds at the western edge of their range here.

## Vanished Connections.

The habitat types that once dominated southeastern Minnesota and connected all of the bluffs has today virtually disappeared. A once-continuous mosaic of savanna, forest, and prairie thrived here. Oak savanna and tallgrass prairie covered the uplands above the steep slopes. Deep, rich soils, created by prairie grasses and wildflowers over thousands of years, have nearly all been turned into croplands, leaving fragmented islands of native habitat.

Before European settlement, blufftop fires burned across oak savanna and prairie, often reaching woodlands below. This natural process rejuvenated native grasses and forbs and created openings for oak regeneration. Another impact to bluffs in recent decades came from grazing cattle, sheep, and goats. Now, with fires suppressed, grazing continuing, and row crops prominent, eroding topsoil tumbles down steep slopes, often leaving deep ruts and many feet of sediment on valley floors.

Many floodplains have also been converted to croplands. Perhaps this altered landscape is the reason for the greeting-card artist's perception that the area is all corn. Visitors today must travel deep into the valleys and onto the steep slopes to find the tremendous diversity in this place.

## Today's Challenges.

The diverse, intact native plant communities that still exist in the blufflands are threatened in various ways. Oak forests and woodlands, bluff prairies, and savannas all require fire to thrive and support the plants and animals native to these habitats. Controlled burning on many public and some private lands has helped restore this vital process. However, because most land ownership in this region is private, there are many places without fire. In the absence of fire, invasive species such as nonnative buckthorn (/invasives/terrestrialplants/woody/buckthorn/index.html) and honeysuckle (/invasives/terrestrialplants/woody/exotichoneysuckles.html) displace native species, and much of the native diversity is lost.

Threats to the region's mesic hardwood forests include nonnative earthworms (/invasives/terrestrialanimals/earthworms/index.html) and buckthorn. Garlic mustard (/invasives/terrestrialplants/herbaceous/garlicmustard.html) is a relatively new invasive species that is spreading quickly.

Floodplain forests, emergent marshes, and sedge meadows have been greatly changed by the locks and dams that have removed most of the natural flooding regime in many areas. The latest threat to remaining floodplain forests: Reed canary grass forms dense thickets that seem to prohibit trees from regenerating.

Rivers and streams have been impaired by siltation, pollution, and increased flooding caused by land use changes.

Despite all the pressures and threats, this ancient landscape continues on. Myriad pockets of diverse habitats support many of the plants and animals that evolved over thousands of years to be perfectly adapted to this place.

### Winter Trip.

On a cloudy day this past winter, I traveled along Highway 74, which runs through the middle of the expansive Whitewater Wildlife Management Area (/wmas/detail_report.html?id=WMA0900901) in Winona and Wabasha counties. Light snow covered the bluffs and the floodplain. There wasn't another car in sight or, for that matter, any sign of other humans. I marveled at the expanse of bluffs visible from the valley. Oak forests and bluff prairies, many of them burned in the past year, stretched across successive rows of hills.

As I came to a bend in the road, the sun suddenly came out, warming my face. I felt grateful to be in this beautiful valley that still possesses such natural richness.

To whom it may concern,

As a business owner operating in the Driftless Area, I think it is relevant and worth sharing how people seek out and enjoy the qualities of tranquility and scenery that the driftless area has to offer. For example last year we were researching a new Point of Sale System that would help us with our Credit Card Processing fees and during this process we ran a report for July and were amazed that we had 1100 customers that used a unique credit card to our business which did not include cash, debit or previously used credit cards, totally surprising to us at the Creamery/Nordic Lanes. One of the things I can share is that I obviously showed appreciation for the local customers who supported us but when I would see a table I didn't recognize I would inquire what brought them to the area? I can report that approximately 80% of the time the response would be that we came here to ride the bike trail, we came here to tube or kayak the Root River, we came here to hunt and/or fish, we came here to camp, we came here to golf, we came here to see the fall colors, we came here to purchase recreational land and NEVER once did I hear that we came here to check out OPERATING Sand Mines. So we the community should conclude that people travel here and choose to spend money because they value and enjoy what Houston and surrounding communities have to offer, which is truly a resource and should not go unnoticed and/or ignored!

Thank you,

Dean Mierau
Houston County

## 10. Archaeological Significance and Historical Resources

- Letter from Mississippi Valley Archeology Center - June 18, 2012
- Citizen letter regarding archaeological resources on the bluff

MISSISSIPPI VALLEY ARCHAEOLOGY CENTER

June 18, 2012

To whom it may concern,

We are writing to strongly encourage you to include archaeological resources in your environmental assessment of the proposed sand mine in Houston county along the Root River. The project is located within an area that can be considered very sensitive in terms of archaeological site potential. This is a high hill immediately overlooking the Root River, with a number of level areas on top that provide an outstanding overview of the river valley. The hill would have been an ideal location for both campsites and burial sites. As no archaeological survey has been reported from the area, we do not now know if sites are present, but the area should be surveyed to ensure that sites, particularly burial sites, are not disturbed.

A review of the previously reported sites within two miles of the area indicates that four mound sites and one campsite are known, with many more lining the Root River along its length in Houston and Fillmore Counties. Of the sites known from the immediate area, of most relevance are the Rushford Mounds, a group of six mounds (four conical and two elongated) that are located on a high bluff in Magelssen Bluff Park, in the town of Rushford. This landscape setting is comparable to the hill proposed for a sand mine. The Rushford mounds are unusual in that they were covered with slabs of dolomite within the mounds and as a surface cover. They were excavated in 1935 when human burials were found in each mound.

Another group of 22 mounds is reported on a ridge overlooking the Root River just west of South Rushford. A third group of 9 mounds is on the edge of the terrace overlooking the Root River southwest of Rushford. In Houston County, there is a group of three mounds (two linear, one conical), on a bluff on the north side of the Root River less than a mile to the east of the proposed sand mine. The fifth site is a campsite reported from the bluffs overlooking the Root River just east of the proposed sand mine.

Thus, the hill proposed for the sand mine has a very high likelihood of having archaeological resources, based on the location of previously reported archaeological sites. Furthermore, based on the other sites in the region there may be burial mounds that are protected under the Private Cemeteries Act. The Minnesota Office of State Archaeologist http://www.osa.admin.state.mn.us/mnarch/burials.html) provides information on the laws protecting such burial sites:

> "**Section 307.08 of Minnesota's "Private Cemeteries Act" (MS 307) affords all human burial grounds and remains older than 50 years and located outside of platted or identified cemeteries protection from unauthorized disturbance.** This statute applies to burials on either public or private lands or waters, and includes prehistoric Indian burial mounds as well as historic cemeteries.
>
> "Under provisions of this statute, the Office of the State Archaeologist (OSA) is charged with identifying, authenticating and protecting these burial areas. The OSA maintains a database of such sites.

MVAC at the University of Wisconsin-La Crosse
Office: 608-785-8463
FAX: 608-785-6474
1725 State Street, La Crosse, WI 54601-3788
www.uwlax.edu/mvac

*"Efforts to protect burial sites emphasize "preservation-in-place", that is, maintaining the burial area in its original location and condition.*

"In the event that a burial is either known or suspected to be associated with American Indian peoples, the OSA works in concert with representatives of Minnesota's tribal communities to ensure the integrity of such burial sites.

"**Anyone planning construction activities** who is concerned about the potential for encountering such burials is encouraged to contact the OSA for additional information and assistance. The OSA may be available for on-site visits to identify burial features and areas.

"If such burials are accidently uncovered in the course of construction or other activities:

- excavation should cease
- secure the area
- contact OSA as soon as possible"

We would strongly recommend that prior to any ground disturbance there be an archaeological survey to identify any sites, especially any mounds or burial sites. Such a survey should be included in any environmental assessment.

Sincerely,

Joseph A. Tiffany
Executive Director
[redacted]

Constance Arzigian
Senior Research Associate
[redacted]

Katherine Stevenson
Projects Director
[redacted]

RE: Archeological Resources on the proposed bluff

Shortly after we purchased the 195 acres, just north of the proposed mine, from the Hoiland Estate, Phillip Hoiland had told me that there is a cave on the hill that has residue on the ceiling from fires in the cave. It is believed that this cave had once been used by the Ho Chunk or another native American nation.

Scott Hatleli

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

Bruening Rock Products Inc., of Decorah, Iowa, is proposing a new silica sand mine in Houston County near Rushford, Minnesota. The proposed site is situated along Minnesota's Historic Scenic Byway 16, within the Richard J. Dorer Memorial Hardwood State Forest. It is in close proximity to Ferndale Creek trout stream and state-registered Ferndale Fish Hatchery. It is adjacent to several residential and recreational properties, and includes a significant stretch of Root River shoreline.

The proposed mining operation threatens one of Minnesota's most distinctive regions. Beyond the routine disturbances commonly associated with active mining—including clear-cutting, removal of overburden, blasting, commercial hauling traffic, erosion, water use, noise, dust and light pollution—this proposal raises critical issues due to its location in the Root River Valley. The area's karst topography presents ecological, geological, and hydraulic complexity. Combined with the presence of rare and threatened species and sensitive plant communities on this free standing bluff, this proposal will cause irreparable environmental damage.

Given these considerations, we believe the project warrants careful due diligence, expert evaluation, and thorough examination of the environmental, public health, and economic consequences—both short- and long-term. **Accordingly, we, the undersigned concerned citizens, respectfully request the preparation of an Environmental Assessment Worksheet (EAW).**

NANCY T. MILLER | Nancy T. Miller | 4/9/2026
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | WINONA MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Diane McGonigle | Diane McGonigle | 4/9/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Rick McGonigle | Rick McGonigle | 4/9/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Julie A. Quist | J Quist | 4/9/26
FULL NAME (PRINTED) | SIGNATURE | DATE
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MAILING ADDRESS | CITY / STATE / ZIPCODE

REX E DODSON | Rex E Dodson | 4/9/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | WINONA, MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Mary Dodson | Mary Dodson | 4/9/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE

6

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~~Michelle Mastowski~~ ~~Michelle Mastowski~~ ~~4-9-26~~
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] ~~Ettrick WI 54627~~
MAILING ADDRESS CITY / STATE / ZIPCODE

PATSY GAVIN Patsy Gavin 4-9-26
SIGNATURE DATE
[redacted] Winona, MN 55987
CITY / STATE / ZIPCODE

LORI LISOWSKI Lori Lisowski 4-9-2026
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] WINONA MN 55987
CITY / STATE / ZIPCODE

BARBARA A. BIRKELAND Barbara A. Birkeland 04/9/2026
SIGNATURE DATE
[redacted] Winona MN 55987
CITY / STATE / ZIPCODE

Mary Ellen Erlandson Mary Ellen Erlandson 4/9/26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Winona, MN 55987
CITY / STATE / ZIPCODE

Phyllis Reames Phyllis Reames 4/9/2026
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Winona, MN 55987
MAILING ADDRESS CITY / STATE / ZIPCODE

FULL NAME (PRINTED) SIGNATURE DATE

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Mara Bell — SIGNATURE — 4/1/2026 DATE
[redacted] Winona MN 55987 CITY / STATE / ZIPCODE

Jonah Bell FULL NAME (PRINTED) — SIGNATURE — 4/2/2026 DATE
[redacted] Winona MN 55987 CITY / STATE / ZIPCODE

RICHIE SWANSON FULL NAME (PRINTED) — SIGNATURE — 4-8-26 DATE
[redacted] WINONA MN — MAILING ADDRESS — CITY / STATE / ZIPCODE

Carol Marchant FULL NAME (PRINTED) — Carol Marchant SIGNATURE — 4-9-26 DATE
MAIL [redacted] Winona, mn 55987 CITY / STATE / ZIPCODE

Maria Espadas FULL NAME (PRINTED) — SIGNATURE — 04-09-'26 DATE
[redacted] Winona, MN. 55987 CITY / STATE / ZIPCODE

Alex Espadas FULL NAME (PRINTED) — SIGNATURE — 4/9/26 DATE
[redacted] Winona, MN 55987 CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

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Pamela Kelly — Pamela Kelly — 4/9/2026
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona, MN 55987
MAILING ADDRESS — CITY / STATE / ZIPCODE

Jane Cowgill — Jane Cowgill
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona, MN 55987 — 4/9/26
MAILING ADDRESS — CITY / STATE / ZIPCODE

Susanne Smith — Susanne Smith
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona, MN 55987 — 4/9/26
MAILING ADDRESS — CITY / STATE / ZIPCODE

Mary Kaye Perrin — Mary Kaye Perrin — 4/9/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona, Minn 55987
CITY / STATE / ZIPCODE

Rill Ann Reuter — Rill Ann Reuter — 4/9/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona, MN 55987
CITY / STATE / ZIPCODE

Joan E. McNeil — Joan E. McNeil — 4/9/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona, MN 55987
MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

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JOSEPH MAXEY | [signature] | 4/16/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | WINONA, MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Sarah Maxey | [signature] | 4/16/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona, MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Ariel Barkeim | Ariel Barkeim | 4/16/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona, MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Derek Barkeim | [signature] | 4-16-26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona/MN/55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Kelly Spalding | Kelly Spalding | 4/30/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Samara Losinski | Samara Losinski | 4/30/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

Bruening Rock Products Inc., of Decorah, Iowa, is proposing a new silica sand mine in Houston County near Rushford, Minnesota. The proposed site is situated along Minnesota's Historic Scenic Byway 16, within the Richard J. Dorer Memorial Hardwood State Forest. It is in close proximity to Ferndale Creek trout stream and state-registered Ferndale Fish Hatchery. It is adjacent to several residential and recreational properties, and includes a significant stretch of Root River shoreline.

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David Johnson — David Johnson — 4-20-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Craig Jonsgaard + Eldon Jonsgaard — 4/20/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Mary Ann Carrier — Mary Ann Carrier — 04/20/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Marlin Carrier — Marl Carrier — 04/20/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Dianne Engelhart — Dianne Engelhart — 4-20-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Fred Engelhart — Fred Engelhart — 4-20-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

6

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Sean C. Young | Sean C Young | 4/15/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Spring Grove, MN 55974
MAILING ADDRESS | CITY / STATE / ZIPCODE

Donna Trehar | Donna Treher | 4/15/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Spring Grove Mn 55974
MAILING ADDRESS | CITY / STATE / ZIPCODE

Charlene Meiners | Charlene Meiners | 4-15-26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Caledonia MN 55921
CITY / STATE / ZIPCODE

Patricia Wright | Patricia Wright | April 15, 20
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Brownsville, MN 55919
CITY / STATE / ZIPCODE

Allen Whitesitt | Allen Whitesitt | 4-15-26
SIGNATURE | DATE
[redacted] | Brownsville, MN 55919
CITY / STATE / ZIPCODE

Jeremy Witt | 4/15/2026
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Spring Grove, MN. 55974
MAILING ADDRESS | CITY / STATE / ZIPCODE

Patrick Lang | 4-15-26
FULL NAME (PRINTED) | SIGNATURE | DATE
SG MN 55[illegible]
MAILI[redacted] | CITY / STATE / ZIPCODE

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Corine Handke | Corine Handke | 3/28/26
SIGNATURE | DATE
[redacted] | Caledonia MN 55921
MAILING ADDRESS | CITY / STATE / ZIPCODE

Walter Dames | Walter Dames | 3/28/26
SIGNATURE | DATE
(La Crescent)
[redacted] | La Crescent MN 55947
CITY / STATE / ZIPCODE

Pamela Roland | Pamela Roland
SIGNATURE | DATE
[redacted] | Caledonia MN 55921
CITY / STATE / ZIPCODE

Ellyn Roland | Ellyn Roland | 3/28/26
SIGNATURE | DATE
[redacted] | Caledonia MN 55921
CITY / STATE / ZIPCODE

Debra L. Marsden | Debra L Marsden | 3-28-26
SIGNATURE | DATE
[redacted] | Mabel MN 55954
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
Jane Haist | Jane Haist | 3/28/26
[redacted] | Spring Grove mn 55974
CITY / STATE / ZIPCODE

Steven Handke | Steven J Handke | 3-28-2026
SIGNATURE | DATE
[redacted]
CITY / STATE / ZIPCODE

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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LEE HOCKSTRA | Lee Hoekstra | 3/28/26
SIGNATURE | DATE
[redacted] | Spring Grove, MN 55974
CITY / STATE / ZIPCODE

Joy Moen | Joy Moen
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Spring Grove MN 3/28/26
CITY / STATE / ZIPCODE

Audrey Almo. | Audrey Almo
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Caledonia, MN 55921 | 3/28
CITY / STATE / ZIPCODE

Megan A. Jones | Megan A. Jones | 3/28/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Spring Grove MN 55974
CITY / STATE / ZIPCODE

Joanne L. Griffin | Joanne Griffin
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Spring Grove, Mn. | 3/28/26
CITY / STATE / ZIPCODE

Jean Baty Young | Jean Baty Young | 3/28/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Spring Grove, MN 55974
CITY / STATE / ZIPCODE

Ashley Dress | Ashley Dress | 3/28/26
SIGNATURE | DATE
[redacted] | Caledonia, MN 55921
MAILING ADDRESS | CITY / STATE / ZIPCODE

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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KAREN BINGHAM — Ken Byz — 3/28/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — SPRING GROVE MN
MAILING ADDRESS — CITY / STATE / ZIPCODE

George Legnar — George A. Legnar — 3-28-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Spring Grove MN 55974
MAILING ADDRESS — CITY / STATE / ZIPCODE

Patricia McManimon-Moe — Patty McManimon-Moe — 3/28/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Caledonia MN 55921
MAILING ADDRESS — CITY / STATE / ZIPCODE

Kathy Sundet Rosdahl — Kathy S Rosdahl — 3/28/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Spring Grove MN 55974
MAILING ADDRESS — CITY / STATE / ZIPCODE

Rebecca Burland — R Burland — 3/28/26
SIGNATURE — DATE
[redacted] — Spring Grove, MN 55974
MAILING ADDRESS — CITY / STATE / ZIPCODE

Scott Iverson — Scott Iverson — 3/28/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Spring Grove MN 55974
CITY / STATE / ZIPCODE

Nora Beckjord — Nora C Beckjord — 4/8/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Spring Grove, MN 55974
CITY / STATE / ZIPCODE

1

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Salle Crutaire — Salle Crutaire — 3/30/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Harmony MN 55939
CITY / STATE / ZIPCODE

Beverly Ruesink — Beverly Ruesink — 3/30/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Preston MN 55965
CITY / STATE / ZIPCODE

Aaron Fox — Aaron Fox — 3/30/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — PRESTON MN 55965
CITY / STATE / ZIPCODE

Christine DeVries — C. DeVries — 3/30/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Preston MN 55965
CITY / STATE / ZIPCODE

Alicia Pearson — [signature] — 30 MAR 26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Lanesboro, MN, 55949
CITY / STATE / ZIPCODE

Bonita A. Underbakke — Bonita A. Underbakke — 4/8/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Lanesboro MN 55949
MAILING ADDRESS — CITY / STATE / ZIPCODE

Julie M Johnson — Julie M Johnson — 4/15/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona MN 55987
CITY / STATE / ZIPCODE

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Luci Schueller | [signature] | 3/28/26
SIGNATURE | DATE
[redacted] | Winona MN 55987
CITY / STATE / ZIPCODE

Mandy Russert | Mandy L Russe | 3/28/26
SIGNATURE | DATE
[redacted] | Winona MN 55987
MAILING ADDRESS | CITY / STATE / ZIPCODE

Greta Hagen | Greta Hagen
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona, MN 55987 | 3/28/26
MAILING ADDRESS | CITY / STATE / ZIPCODE

~~Kristine S Breza~~ | ~~Kristine S Breza~~ | ~~3/28/26~~
FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
~~KATHY BREZA~~ | ~~Kathy Breza~~ | ~~3/28/26~~
MAILING ADDRESS | CITY / STATE / ZIPCODE

~~Kimberly M. Barg~~ | ~~[signature]~~ | ~~3/28/26~~
FULL NAME (PRINTED) | SIGNATURE | DATE
~~[illegible] Haessig Rd~~ | ~~[illegible], WI 546[illegible]~~
MAILING ADDRESS | CITY / STATE / ZIPCODE

Samantha Callahan | [signature] | 3/28/26
SIGNATURE | DATE
[redacted] | W.nona, MN 55987
CITY / STATE / ZIPCODE

4

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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[illegible] Steckl | [illegible] | 3/28/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Goodview, MN 55987
CITY / STATE / ZIPCODE

Judy Casper | Judy Casper | 3-28-26
[redacted]
SIGNATURE | DATE
Winona MN 55987
CITY / STATE / ZIPCODE

Adeline Fife | adeline fife | 3-28-26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona MN 55987
CITY / STATE / ZIPCODE

Kristie Agosto | KristieAR | 3/28/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | winona, MN 55987
CITY / STATE / ZIPCODE

Ariana Gardur | [illegible] | 3/28/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona MN 55987
CITY / STATE / ZIPCODE

~~[illegible]~~ | ~~[illegible]~~ | ~~3/28/26~~
FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

Wesley W. Hamilton | WHamilton | 3/28/26
SIGNATURE | DATE
[redacted]
Winona MN 55987
CITY / STATE / ZIPCODE

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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FULL NAME (PRINTED) ~~Sharyn Kirkpatrick~~ SIGNATURE ~~[signature]~~ DATE

MAILING ADDRESS CITY / STATE / ZIPCODE

~~Sharyn Kirkpatrick~~ ~~Sharyn Kirkpatrick~~ ~~3/28/2026~~

FULL NAME (PRINTED) SIGNATURE DATE

~~W14277 Lehmann Rd Trempealeau, WI 54661~~

MAILING ADDRESS CITY / STATE / ZIPCODE

Catherine Borkowski Catherine Borkowski 3-28-26

[redacted] SIGNATURE DATE

Winona, Mn 55987

CITY / STATE / ZIPCODE

Lorie Walker [signature] 3-28-26

FULL NAME (PRINTED) SIGNATURE DATE

[redacted] Winona, MN 55987

CITY / STATE / ZIPCODE

~~Rachel Wang~~ ~~[signature]~~ ~~3/28/26~~

FULL NAME (PRINTED) SIGNATURE DATE

[redacted] ~~Cashton, WI 54619~~

CITY / STATE / ZIPCODE

~~Janita~~ ~~[signature]~~ ~~Janita Larson~~

FULL NAME (PRINTED) SIGNATURE DATE

[redacted] ~~Galesville WI 54630~~

CITY / STATE / ZIPCODE

Virginia Kranz [signature]

FULL NAME (PRINTED) SIGNATURE DATE

[redacted] Winona MN 3-28-26

MAILING ADDRESS CITY / STATE / ZIPCODE

3

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Ben Bishach — 3/28/26

FULL NAME (PRINTED) — SIGNATURE — DATE

[redacted] — Mabel MN 55954

CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

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Lynn Carlson | 28Mar2026
FULL NA[redacted] SIGNATURE DATE
Winona MN 55987
MAILING ADDRESS CITY / STATE / ZIPCODE

Pat Calton | Pat Calton | 3/28/26
FULL NAME (PRINTED) SIGNATURE DATE
MAILING [redacted] Rushford, MN 55971
CITY / STATE / ZIPCODE

Linda Conway
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Winona Mn 55987 3/28
CITY / STATE / ZIPCODE

Patrick Conway
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Winona MN 55987 3/28
CITY / STATE / ZIPCODE

Laurie Krause | Laurie Krause
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Winona, MN 3/28/26
CITY / STATE / ZIPCODE

Frederick Krause | Krause
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Winona, MN 3-28-26
CITY / STATE / ZIPCODE

Linda Munns | Linda Munns | 3/28/26
SIGNATURE DATE
[redacted] Winona MN 55987
MAILING ADDRESS CITY / STATE / ZIPCODE

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~~Shannon Bristol~~ ~~[signature]~~ ~~3/28/26~~
FULL NAME (PRINTED) SIGNATURE DATE
~~2554 N Highway A1A~~ ~~Indialantic / FL / 32903~~
MAILING ADDRESS CITY / STATE / ZIPCODE

Barbi Bell [signature] 3/28/26
SIGNATURE DATE
[redacted]
Winona MN 55987
CITY / STATE / ZIPCODE

Mara Bell [signature] 3/28/26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted]
Winona MN 55987
CITY / STATE / ZIPCODE

Jonathan Hedin [signature] 3/28/26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted]
Winona MN 55987
MAILING ADDRESS CITY / STATE / ZIPCODE

Jennifer Anderson [signature] 03.28.26
SIGNATURE DATE
[redacted]
Winona MN 55987
CITY / STATE / ZIPCODE

David Crawford [signature] 3/28/26
SIGNATURE DATE
[redacted]
Winona, MN 55987
MAILING ADDRESS CITY / STATE / ZIPCODE

Janette Dean [signature] 4/15/26
SIGNATURE DATE
[redacted]
Caledonia, MN 55921
CITY / STATE / ZIPCODE

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Given these considerations, we believe the project warrants careful due diligence, expert evaluation, and thorough examination of the environmental, public health, and economic consequences—both short- and long-term. **Accordingly, we, the undersigned concerned citizens, respectfully request the preparation of an Environmental Assessment Worksheet (EAW).**

Charles Beckjord — 4/8/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Spring Grove, MN 55974
CITY / STATE / ZIPCODE

DUANE ANTHONY TESCHLER — 15/4/26
SIGNATURE — DATE
[redacted] HARMONY, MINNESOTA 55939 0442
MAILING ADDRESS — CITY / STATE / ZIPCODE

Rebecca Mennenga — 4-15-26
[redacted] — SIGNATURE — DATE
Houston Minnesota 55943
CITY / STATE / ZIPCODE

Chelsea McManimon-Moe — 4/15/26
FUL [redacted] — SIGNATURE — DATE
MAI — Spring Grove, MN 55974
CITY / STATE / ZIPCODE

Michael Todd — 4/15/26
[redacted] — SIGNATURE — DATE
Winona / MN / 55987
CITY / STATE / ZIPCODE

Cheryl Whitesitt — 4/15/26
SIGNATURE — DATE
[redacted] — Brownsville MN 55919
CITY / STATE / ZIPCODE

Allie Wolf — 4/15/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Spring Valley MN 55975
CITY / STATE / ZIPCODE

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Susan Carol Greening | Susan C Greening | 4/16/26
SIGNATURE | DATE
[redacted] | LaCrescent MN 55947
CITY / STATE / ZIPCODE

Arlo Darling | Arlo Darling | 4/16/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | La Crescent, MN 55947
MAILING ADDRESS | CITY / STATE / ZIPCODE
Regina [illegible] La Crecent MN

Heather Hulett | Heather Hulett | 4/16/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | La Crescent MN 55947
CITY / STATE / ZIPCODE

Mary S Frye | Mary S Frye | 4/16/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | La Crescent, MN 55947
MAILING ADDRESS | CITY / STATE / ZIPCODE

Anna O. Lucas | Anna O. Lucas | 4-16-25
SIGNATURE | DATE
[redacted] | LaCrescent, MN, 55947
CITY / STATE / ZIPCODE

Darlene Jostad | Darlene Jostad | 4/16/26
SIGNATURE | DATE
[redacted] | LaCrescent, mn. 55947
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Rose M Hinshaw Rose M Hinshaw 3-23-26
[redacted] SIGNATURE DATE
Rushford MN 55971
CITY / STATE / ZIPCODE

Vicki Lynn Heuser Vicki L. Heuser 3-23-26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Spring Grove, MN 55974
CITY / STATE / ZIPCODE

Jo Nalmin J. Nalmin 3-23-26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] RUSHFORD, MN 55971
CITY / STATE / ZIPCODE

Joyce IVERSON Joyce Iverson (2000-2009 worked on Econ Development in Caledonia Houston Co) 3-23-26
[redacted] SIGNATURE DATE
RUSHFORD VILLAGE 55971-5101
MAILING ADDRESS CITY / STATE / ZIPCODE

Joyce Miller Joyce Miller 3-23-26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Rushford, MN 55971
MAILING ADDRESS CITY / STATE / ZIPCODE

May Himlie Rushford, MN 55971 3/23/26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] May Himlie
MAILING ADDRESS CITY / STATE / ZIPCODE

Rushford, mn
FULL NAME (PRINTED) SIGNATURE DATE

6

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JOYCE ROFFLER
SIGNATURE Joyce A. Roffler
DATE 3/18/26
[redacted]
CITY / STATE / ZIPCODE RUSHFORD, MN 55971

Anne Besek
SIGNATURE Anne Besek
DATE 3/21/26
[redacted]
CITY / STATE / ZIPCODE Winona, MN 55987

FULL NAME (PRINTED) Jeff Besell
SIGNATURE Jeff B
DATE 3-21-26
[redacted]
CITY / STATE / ZIPCODE Winona MN 55987 3/21/26

FULL NAME (PRINTED) CARLY JOHNSON
SIGNATURE Carly Johnson
DATE 3/21/26
[redacted]
CITY / STATE / ZIPCODE WINONA, MN 55987

TRISHA SUBLETT
SIGNATURE TSublett
DATE 3/21/26
[redacted]
MAILING ADDRESS
CITY / STATE / ZIPCODE Rushford, MN 55971

Jonas Sublett
SIGNATURE Jonas Sublett
DATE 3/21/26
[redacted]
CITY / STATE / ZIPCODE rushford, mn 55971

Mark Larson
SIGNATURE MLarson
DATE
[redacted]
CITY / STATE / ZIPCODE Rush ford MN 55971 3-22-26

1

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Claire Olstad — SIGNATURE: Claire Olstad — DATE: 3-22-26
[redacted] — CITY / STATE / ZIPCODE: Rushford, Mn 55971

Ione Olstad — SIGNATURE: Ione Olstad — DATE: 3-22-26
[redacted] MAILING ADDRESS — CITY / STATE / ZIPCODE: Rushford Mn 55971

Faye Heiden — FULL NAME (PRINTED) — SIGNATURE: Faye Heiden — DATE: 3-22-26
[redacted] — CITY / STATE / ZIPCODE: Rushford MN. 55971

Kerry Heiden — SIGNATURE: Kerry Heiden — DATE: 3-22-26
[redacted] — CITY / STATE / ZIPCODE: Rushford MN. 55971

Angela Shepard — FULL NAME (PRINTED) — SIGNATURE: Angela Shepard — DATE: 3-22-26
[redacted] MAILING ADDRESS — CITY / STATE / ZIPCODE: Peterson MN 55962

Erik Shepard — FULL NAME (PRINTED) — SIGNATURE: [signature] — DATE: 3-22-26
[redacted] — CITY / STATE / ZIPCODE: Peterson MN 55962

FULL NAME (PRINTED) — SIGNATURE — DATE

8

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Chelsea O'Donnell — 3/21/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Jeffrey O'Donnell — 3/21/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Gail Burt — Gail Burt — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Utica MN 55979
MAILING ADDRESS — CITY / STATE / ZIPCODE

Jared Iverson — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Steffanie Iverson — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Melisa Kinneberg — Melissa Kinneberg — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Heath Ronnenberg — 3/21/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Ellen Jewison — Ellen Jewison — 3/21/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona, MN 55987
CITY / STATE / ZIPCODE

David Jewison — David Jewison — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Winona, MN 55987
CITY / STATE / ZIPCODE

Ashley M. Peterson — Ashley Peterson — 3-21-26
SIGNATURE — DATE
[redacted] — Rushford MN 55971
CITY / STATE / ZIPCODE

Cindy L. Peterson — Cindy Peterson — 3-21-26
SIGNATURE — DATE
[redacted] — Altura, MN 55910
CITY / STATE / ZIPCODE

Larry T. Peterson — Larry T Peterson — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Altura MN 55910
MAILING ADDRESS — CITY / STATE / ZIPCODE

TYLER PETERSON — 3/21/26
SIGNATURE — DATE
[redacted] — Rushford, MN 55971
CITY / STATE / ZIPCODE

Shannon Meier — Shannon Meier — 3/21/26
SIGNATURE — DATE
[redacted] — Rushford MN 55971
CITY / STATE / ZIPCODE

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Sarah Jane Sprague | Sarah J Sprague | 3/21/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Rushford, MN 55971
CITY / STATE / ZIPCODE

Molly Jo Kisln | [signature] | 3/21/26
FULL NAME (PRINTED) | SIGNATURE | DATE
MAIL [redacted] | Rushford MN 55971
CITY / STATE / ZIPCODE

[illegible] | [signature] | 3-21-26
SIGNATURE | DATE
[redacted] | Rushford, MN 55971
CITY / STATE / ZIPCODE

Kim Benson | [signature] | 3-21-26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Rushford MN 55971
CITY / STATE / ZIPCODE

RANDY BENSON | [signature]
FU[redacted] | SIGNATURE | DATE
MA[redacted] | Rushford MN 55971 | 3/21/26
CITY / STATE / ZIPCODE

Lacey Drinkall | Lacey Drinkall | 3-21-21
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Rushford MN 55971
CITY / STATE / ZIPCODE

Chris Drinkall | [signature] | 3-21-26
FULL NAME (PRINTED) | SIGNATURE | DATE
MAI[redacted] | Rushford MN 55971
CITY / STATE / ZIPCODE

7

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KARLA ANN LIND — Karla Lind — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
CITY / STATE / ZIPCODE

ISAAC FRUECHTE — Isaac Fr — 3-21-26
SIGNATURE — DATE
[redacted] — Caledonia MN 55921
CITY / STATE / ZIPCODE

Brenda Blynne Falkowski — Brenda Falk — 3-21-26
SIGNATURE — DATE
[redacted] — Houston MN 55943
CITY / STATE / ZIPCODE

Olive Ann Boyum — Olive Ann Boyum — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, Mn. 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Beverly Meyer — Bev Meyer — 3-21-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Caledonia, MN 55921
CITY / STATE / ZIPCODE

Bob Burmester — Bob B — 3/21/26
SIGNATURE — DATE
[redacted] — Caledonia, MN 55921
CITY / STATE / ZIPCODE

DAVE LIND — Dave Lind
SIGNATURE — DATE
[redacted] — Rushford, MN 55971 — 3/21/26
CITY / STATE / ZIPCODE

7

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Donna Louise Buckfee — SIGNATURE — 3-21-2026 DATE
[redacted] Rushford, MN 55971 CITY / STATE / ZIPCODE

Vicki Olson — D Olson SIGNATURE — 3-22-26 DATE
[redacted] Caledonia Mn 55921 CITY / STATE / ZIPCODE

ANNE G. KRAMÉR YAKLE — SIGNATURE — 3/22/26 DATE
[redacted] CALEDONIA, MN 55921 CITY / STATE / ZIPCODE

MARY DENZER — SIGNATURE — 3/22/26 DATE
[redacted] HOUSTON, MN 55943 CITY / STATE / ZIPCODE

RICHARD JOHN — Richard J Feld SIGNATURE — 3/22/26 DATE
[redacted] HOUSTON, MN 55943 CITY / STATE / ZIPCODE

Elizabeth Reedy — FU[redacted] — Elizabeth K Reedy SIGNATURE — 3/22/26 DATE
MA[redacted] Houston MN 55943 CITY / STATE / ZIPCODE

DUANE A. TESCHLER — FULL NAME (PRINTED) — Duane A. Teschler SIGNATURE — 22/MAR/26 DATE
[redacted] HARMONY, Mn 55939-0442 CITY / STATE / ZIPCODE

1

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Delia Bell | Delia Bell | 3/28/26
[redacted] | SIGNATURE | DATE
[redacted] Lanesboro MN 55949
MAILING ADDRESS | CITY / STATE / ZIPCODE

Kathleen Wold | Kathleen Wold | 3-28-26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Lanesboro, MN 55949
CITY / STATE / ZIPCODE

Mike Simpson | Mike S | 3/28/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Lanesboro, MN
CITY / STATE / ZIPCODE

MATTHEW R. LANGLEY-DENTER | Matt | 3-28-26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Rushford/MN/ 55971
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
Julia Benter | J Benter | 3-28-26
MAILING A[redacted] | Rushford MN 55971
CITY / STATE / ZIPCODE

Katie Humble | Katie Humble | 3/28/26
[redacted] | SIGNATURE | DATE
Rushford MN 55971
CITY / STATE / ZIPCODE

James Reynold | James N. Reynold
[redacted] | SIGNATURE | DATE
Rushford, MN 55971 | 3/28/2026
CITY / STATE / ZIPCODE

1

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NANCY SEFTON — SIGNATURE: Nancy Sefton — DATE: 3/28/26
[redacted] — CITY / STATE / ZIPCODE: Canton MN 55922

David SEFTON — SIGNATURE: David Sefton — DATE: 3/28/26
[redacted] — CITY / STATE / ZIPCODE: CANTON MN 55922

Cliff Grevstad — SIGNATURE: Cliff Grevstad — DATE: 3/28/26
[redacted] — CITY / STATE / ZIPCODE: Lanesboro MN 55949

Charles Toulouse — SIGNATURE: Charles Toulouse — DATE: 3-28-26
[redacted] Winona, MN 55987 — CITY / STATE / ZIPCODE

Kathleen Brenner — SIGNATURE: Kathleen Brenner — DATE: 3-28-26
[redacted] shane — CITY / STATE / ZIPCODE: Rushford MN 55971

Jodi Hilderbrand — SIGNATURE: Jodi Hilderbrand — DATE: 3/28/2026
[redacted] — CITY / STATE / ZIPCODE: Lanesboro, MN 55949

Jim Reinhardt — SIGNATURE: Jim Reinhardt — DATE:
[redacted] — CITY / STATE / ZIPCODE: Rushford MN 55971

1

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JOHN F JORDAN — John F Jordan — 3-28-26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] HOUSTON MN 55943
CITY / STATE / ZIPCODE

DEE EDMISTON — Dee Edmiston — 3-28-26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] HOUSTON MN 55943
MAILING ADDRESS CITY / STATE / ZIPCODE

Kris Litscher Lee — Kristine Litscher Lee
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Houston, MN 55943 3/28/2026
CITY / STATE / ZIPCODE

Joan Redig — Joan L Redig — 3/28/2026
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Houston, MN 55943
CITY / STATE / ZIPCODE

Joy Hoiland — Joy Hoiland — 3/28/26
[redacted] SIGNATURE DATE
Rushford MN 55971
MAILING ADDRESS CITY / STATE / ZIPCODE

Kay Dahl — Kay Dahl — 3/28/2026
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Rushford, MN 55971
MAILING ADDRESS CITY / STATE / ZIPCODE

Thomas L Diana — Th L Di — 3/28/26
[redacted] SIGNATURE DATE
Houston MN 55943
CITY / STATE / ZIPCODE

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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David Brockway — 3/28/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Lanesboro MN 55949
MAILING ADDRESS — CITY / STATE / ZIPCODE

Tom Sautter — 3-28-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Lanesboro, MN 55949
MAILING ADDRESS — CITY / STATE / ZIPCODE

GAYle Simpson — Gayle Simpson — 3-28-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Lanesboro Mn 55949
MAILING ADDRESS — CITY / STATE / ZIPCODE

STAN PEAL — 3/28/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — LANESBORO MN 55949
MAILING ADDRESS — CITY / STATE / ZIPCODE

Adrienne Sweeney — 3/28/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Lanesboro MN 55949
MAILING ADDRESS — CITY / STATE / ZIPCODE

Laura Depta Peal — 3/28/25
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Lanesboro 55949
MAILING ADDRESS — CITY / STATE / ZIPCODE

Jane Grevstad — 3/28/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Lanesboro MN
MAILING ADDRESS — CITY / STATE / ZIPCODE

7

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Sharie Brunk — SIGNATURE: Sharie Brunk — DATE: 3-28-26
[redacted]
CITY / STATE / ZIPCODE: LaCrescent, Mn.

Jill Drye — SIGNATURE: Jill Drye — DATE: 3/28/26
[redacted]
CITY / STATE / ZIPCODE: La Crescent, MN 55947

Susan Oddsen — SIGNATURE: Susan Oddsen — DATE: 3/28/26
[redacted]
CITY / STATE / ZIPCODE: La Crescent, MN 55947

Darlene Jostad
FULL NAME (PRINTED) — SIGNATURE: Darlene Jostad — DATE: 3/28/26
[redacted]
CITY / STATE / ZIPCODE: LaCrescent, Mn. 55947

Joan Mitchell — SIGNATURE: Joan E Mitchell — DATE: 3/28/26
[redacted]
MAILING ADDRESS — CITY / STATE / ZIPCODE: La Crescent MN 55947

Sally Eglinton — SIGNATURE: Sally Eglinton — DATE
[redacted]
CITY / STATE / ZIPCODE: Hokah, MN 55941

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Ben Jass-Mahoney | SIGNATURE: B J-Mahoney | DATE: 3/25/26
[redacted]
MAILING ADDRESS | CITY / STATE / ZIPCODE: Winona, MN, 55987

Rob Thoresen | SIGNATURE | DATE: 3/25/26
[redacted]
MAILING ADDRESS | CITY / STATE / ZIPCODE: Goodview MN 55987

Jourdain Hellkamp
FULL NAME (PRINTED) | SIGNATURE | DATE: 3/25/26
[redacted]
CITY / STATE / ZIPCODE: Winona MN 55987

Ashley Brommerich
FULL NAME (PRINTED) | SIGNATURE | DATE: 3/25/2026
[redacted]
CITY / STATE / ZIPCODE: Winona, MN 55987

~~[illegible]~~
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted]
MAILING ADDRESS | CITY / STATE / ZIPCODE

Cal Pasuzzel
FULL NAME (PRINTED) | SIGNATURE | DATE: 3/25/26
[redacted]
MAILING ADDRESS | CITY / STATE / ZIPCODE: La Crescent MN

Adam Pasucco
FULL NAME (PRINTED) | SIGNATURE: Adam Pasucco | DATE: 3/25/26
[redacted]
CITY / STATE / ZIPCODE: La Crescent, MN

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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LINDA GRIGGS | Linda Griggs | 3-24-2026
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | HOUSTON, MN 55943
CITY / STATE / ZIPCODE

JOHN GRIGGS | [signature] | 3-24-2026
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | HOUSTON, MN 55943
CITY / STATE / ZIPCODE

Patrick Fryer | Patrick Fryer | 3-24-2026
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona MN 55987
CITY / STATE / ZIPCODE

Dustan Hoffman | [signature] | 3/24/26
SIGNATURE | DATE
[redacted] | Winona, MN 55987
CITY / STATE / ZIPCODE

John CURRAN | [signature] | 3/24/26
[redacted]
SIGNATURE | DATE
Winona MN 55987
CITY / STATE / ZIPCODE

Charles Shepard | Charles Shepard | 3/25/26
SIGNATURE | DATE
[redacted] | Winona MN
CITY / STATE / ZIPCODE

Bill Kuhl | Bill Kuhl | 3/24/2026
[redacted] | Winona MN 55987
SIGNATURE | DATE
CITY / STATE / ZIPCODE

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Thomas Walter | Thomas J Walter | 4/18/26
SIGNATURE | DATE
[redacted] | LA Crescent, MN 55947
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

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JEFF CADWELL — FULL NAME (PRINTED) | JM Cadwell — SIGNATURE | 3/25/26 — DATE
[redacted] | WINONA, MN 55987 — CITY / STATE / ZIPCODE

Adler Blumentritt | Adler Blumentritt — SIGNATURE | 3/25/26 — DATE
[redacted] | Winona, MN 55987 — CITY / STATE / ZIPCODE

William BREZA | William Breza — SIGNATURE | 3-25-26 — DATE
[redacted] MAILING ADDRESS | WINONA, MN 55987 — CITY / STATE / ZIPCODE

Stacy Quecke | S Quecke — SIGNATURE | 3/25/26 — DATE
[redacted] | Winona, MN 55987 — CITY / STATE / ZIPCODE

CHARLES LOBOCC — FULL NAME (PRINTED) | Charles Lobocc — SIGNATURE | 3/25/26 — DATE
[redacted] MAILING ADDRESS | WINONA MN 55987 — CITY / STATE / ZIPCODE

David White — FULL NAME (PRINTED) | David J White — SIGNATURE | 3/25/26 — DATE
[redacted] | Winona Mn. 55987 — CITY / STATE / ZIPCODE

Marge White | Marge White — SIGNATURE | 3/25/26 — DATE
[redacted] | Winona MN 55987 — CITY / STATE / ZIPCODE

7

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| FULL NAME (PRINTED) | SIGNATURE | DATE |
|---|---|---|
| Burton Svendsen | Burton Svendsen | 03/28/26 |
| **MAILING ADDRESS** | **CITY / STATE / ZIPCODE** | |
| [redacted] | Rushford, MN 55971 | |
| Nancy Svendsen | Nancy Svendsen | 3/28/26 |
| [redacted] | Rushford, MN 55971 | |
| Leah Mensink-Jacobson | Leah Mensink Jacobson | 3/28/26 |
| [redacted] | Peterson, MN 55962 | |
| Nancy Snyder | Nancy Snyder | 3/28/26 |
| [redacted] | Rushford MN 55971 | |
| MIKE JERESEK | Mike Jeresek | 3/28/26 |
| [redacted] | RUSHFORD, MN 55971 | |
| Sharon Manley | Sharon Manley | 3/28/2026 |
| [redacted] | Rushford MN 55971 | |
| ~~MARY PANZER~~ | ~~[illegible]~~ | ~~3/26~~ |
| [redacted] | ~~Houston, MN 55943~~ | |

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Heather Hulett | SIGNATURE: Heather Hulett | DATE: 3/28/26
[redacted] | CITY / STATE / ZIPCODE: La Crescent MN 55947

Deb Hoskins | SIGNATURE | DATE: 3/28/26
FULL NAME (PRINTED)
[redacted] | CITY / STATE / ZIPCODE: Houston, MN 55943

Lisa M. Radtke | SIGNATURE: Lisa M Radtke | DATE: 3/28/2026
FULL NAME (PRINTED)
[redacted] | CITY / STATE / ZIPCODE: Dakota, MN 55925

Mary Ann Ekern | SIGNATURE: Mary Ann Ekern | DATE: 3/28/2026
FULL NAME (PRINTED)
[redacted] | CITY / STATE / ZIPCODE: LaCrescent, MN 55947

ART EKERN | SIGNATURE: Art Ekern | DATE: 3-28-26
[redacted]
MAILING ADDRESS: LACRESCEN, MN | CITY / STATE / ZIPCODE

Patricia Bruger | SIGNATURE: Patty Bruger | DATE: 3 28 26
FULL NAME (PRINTED)
[redacted] | CITY / STATE / ZIPCODE: LaCrescent MN 555947

Becky Glomstad | SIGNATURE: Becky Glomstad | DATE: 3.28.26
FULL NAME (PRINTED)
[redacted] | CITY / STATE / ZIPCODE: LaCrescent MN 55947
MAILING ADDRESS

1

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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| FULL NAME (PRINTED) | SIGNATURE | DATE | MAILING ADDRESS | CITY / STATE / ZIPCODE |
|---|---|---|---|---|
| CAROLINE VAN SCHAIK | [signature] 28 mar 2026 | 3-28-26 | [redacted] | La Crescent MN 55947 |
| Patricia Wright | Patricia C Wright | 3-28-26 | [redacted] | Brownsville, MN 55919 |
| Marjorie Loch-Wouters | [signature] | 3-28-26 | [redacted] | La Crescent MN 55947 |
| JOHN D. HAUGAN | John D Haugan | 3-28-26 | [redacted] | La Crescent MN 55947 |
| Christopher John Iremonger | [signature] | 3/28/26 | [redacted] | La Crescent MN 55947 |
| Sandra K. Grunwald | [signature] | 3/28/26 | [redacted] | LaCrescent MN 55947 |
| Kurt Grunwald | [signature] | 3/28/26 | [redacted] | La Crescent MN 55947 |

7

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| FULL NAME (PRINTED) | SIGNATURE | DATE |
|---|---|---|
| PATSY GAVIN | Patsy Gavin | 3/25/26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: WINONA, MN 55987 | |
| ~~Lee George~~ | ~~L George~~ | ~~3/25/26~~ |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: ~~Fountain City WI 54629~~ | |
| ~~JAMES BROWN~~ | ~~James Brown~~ | ~~3/25/26~~ |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: ~~Fountain City WI 54629~~ | |
| PAUL GIRTLER | Paul R. Girtler | 3/25/26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: WINONA MN 55987 | |
| ROGER BERG | RM Berg | 3-25-2026 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: WINONA MN 55987 | |
| FULL NAME (PRINTED) | SIGNATURE | DATE |
| MAILING ADDRESS | CITY / STATE / ZIPCODE | |
| FULL NAME (PRINTED) | SIGNATURE | DATE |
| MAILING ADDRESS | CITY / STATE / ZIPCODE | |

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| FULL NAME (PRINTED) | SIGNATURE | DATE |
|---|---|---|
| Ann O'Malley | Ann O'Malley | 3-28-2026 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: La Crescent, MN 55947 | |
| JOHN MAASS | John W. Maass | 3.28.26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: LaCRESCENT MN 55947 | |
| Judy Flaten | Judy Flaten | 2/27/26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: La Crescent MN 55947 | |
| Sidney Miller | Sidney Miller | 3-27-26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Hokah / MN / 55941 | |
| Vicki Olson | V. Olson | 3-28-26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Caledonia Mn 55921 | |
| | | |
| MAILING ADDRESS | CITY / STATE / ZIPCODE | |
| | | |
| MAILING ADDRESS | CITY / STATE / ZIPCODE | |

5

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Gabriela Walsh | Gabriela Walsh | 4-8-26
FULL NAME (PRINTED) [redacted] SIGNATURE | DATE
Houston Mn 55943
CITY / STATE / ZIPCODE

Tom Walsh | 4-8-26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted]
HOUSTON, MN 55943
CITY / STATE / ZIPCODE

Sara Griggs | 4/11/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted]
Dakota MN 55925
CITY / STATE / ZIPCODE

Jacob Griggs | 4/11/2026
[redacted] SIGNATURE | DATE
Dakota, MN 55925
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

4

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Jackie Baker — SIGNATURE: Jackie Baker — DATE: 4-10-26
[redacted]
MAILING ADDRESS — CITY / STATE / ZIPCODE: Rushford MN 55971

Cory Baker — SIGNATURE: Cory Baker — DATE: 4-10-26
[redacted]
MAILING ADDRESS — CITY / STATE / ZIPCODE: Rushford MN 55971

Brooklyn Baker
FULL NAME (PRINTED) — SIGNATURE: Brooklyn Baker — DATE: 4/10/26
[redacted]
CITY / STATE / ZIPCODE: Rushford MN 55971

Zach Baker
FULL NAME (PRINTED) — SIGNATURE: Zach Baker — DATE: 4/10/26
[redacted]
MAILING ADDRESS — CITY / STATE / ZIPCODE: Rushford MN 55971

Laura Logue
FULL NAME (PRINTED) — SIGNATURE: Laura Logue — DATE: 4/10/26
[redacted]
CITY / STATE / ZIPCODE: Chatfield, MN 55923 Fillmore County

FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

5

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

Bruening Rock Products Inc., of Decorah, Iowa, is proposing a new silica sand mine in Houston County near Rushford, Minnesota. The proposed site is situated along Minnesota's Historic Scenic Byway 16, within the Richard J. Dorer Memorial Hardwood State Forest. It is in close proximity to Ferndale Creek trout stream and state-registered Ferndale Fish Hatchery. It is adjacent to several residential and recreational properties, and includes a significant stretch of Root River shoreline.

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Given these considerations, we believe the project warrants careful due diligence, expert evaluation, and thorough examination of the environmental, public health, and economic consequences—both short- and long-term. **Accordingly, we, the undersigned concerned citizens, respectfully request the preparation of an Environmental Assessment Worksheet (EAW).**

Tracy Heim — [signature] — 4-16-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Brownsville MN 55919
CITY / STATE / ZIPCODE

RICHARD SCHILD — Richard Schild — 4/19/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — HOUSTON, MN 55943
CITY / STATE / ZIPCODE

Deborah Miller — Deborah Miller — 4/19/26
SIGNATURE — DATE
[redacted] — Houston Mn. 55943
CITY / STATE / ZIPCODE

LEE EDMISTON — Lee Edmiston — 4/19/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted]
MAILING ADDRESS — HOUSTON MN 55943
CITY / STATE / ZIPCODE

ELIZABETH K. REEDY — Elizabeth K. Reedy — 4/19/26
SIGNATURE — DATE
[redacted] — HOUSTON MN 55943
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

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David W. Anderson — David W. Anderson — 4-20-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Marilyn E. Anderson — Marilyn E. Anderson — 4-20-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford Mn 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Tony Christensen — Tony [signature] — 4/20/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Rebecca Christensen — Rebecca Christensen — 4/20/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Rushford, MN 55971
MAILING ADDRESS — CITY / STATE / ZIPCODE

Teri Bernhardt
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] Spring Grove — [signature] — 4-20-26
MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

5

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Frances Rinaldi — Frances Rinaldi

SIGNATURE — DATE

[redacted]

Rushford, Mn 55971

CITY / STATE / ZIPCODE

Ann Dolalie — Ann Dolalie

FULL NAME (PRINTED) — SIGNATURE — DATE

[redacted]

Rushford mN 55971

CITY / STATE / ZIPCODE

Helen Peterson → Rushford Mn 55971

FULL NAME (PRINTED) — SIGNATURE — DATE

[redacted]

Helen Peterson

CITY / STATE / ZIPCODE

Mike Lamb — Mike Lamb — 3/23/2026

SIGNATURE — DATE

[redacted]

Rushford MN 55971

CITY / STATE / ZIPCODE

William Peterson — W Peterson — 3/23/2026

FULL NAME (PRINTED) — SIGNATURE — DATE

[redacted]

RuShford MN 55971

CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

5

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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| FULL NAME (PRINTED) | SIGNATURE | DATE |
|---|---|---|
| Yvonne Krogstad | Yvonne Krogstad | 3/28/26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Spring Grove MN 55974 | |
| Carol Thompson | Carol Thompson | 3/28/24 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Mabel, MN 55954 | |
| Sheila Blackwell | [signature] | 3/28/26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Spring Grove MN 55974 | |
| Cheryl Demet | Cheryl Demet | 3/28/26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Hokah, MN 55941 | |
| Lara Wild-Mendez | Lara | 3/28/24 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Spring Grove, MN 55974 | |
| Alison E Rautman | Alison E Rautman | 3/28/26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Caledonia MN 55921 | |
| Mavis E Peterson | Mavis C Peterson | 3-28-26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Caledonia, MN 55921 | |

1

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Jeff Hoiland — SIGNATURE — DATE: 3-28-26
MAILING ADDRESS: [redacted] — CITY / STATE / ZIPCODE: Rushford MN 55971

FULL NAME (PRINTED): Jon Dahl — SIGNATURE — DATE: 3/28/26
MAILING ADDRESS: [redacted] — CITY / STATE / ZIPCODE: Spring Valley 55975

FULL NAME (PRINTED): Deb Dahl — SIGNATURE — DATE: 3/28-26
MAILING ADDRESS: [redacted] — CITY / STATE / ZIPCODE: Spring Valley MN- 55975

FULL NAME (PRINTED): Cj Robinson — SIGNATURE — DATE: 3 28 26
MAILING ADDRESS: [redacted] — CITY / STATE / ZIPCODE: Rushford, MN 55971

FULL NAME (PRINTED): Pam Flattum — SIGNATURE: Pam Flattum — DATE: 3-28-2024
MAILING ADDRESS: [redacted] — CITY / STATE / ZIPCODE: Lanesboro MN 55949

FULL NAME (PRINTED): Linda Sifford — SIGNATURE: L J Sifford — DATE: 3/28/26
MAILING ADDRESS: [redacted] — CITY / STATE / ZIPCODE: Lanesboro Mn 55949

FULL NAME (PRINTED): Carrie Brockway — SIGNATURE — DATE: 3/28/26
MAILING ADDRESS: [redacted] — CITY / STATE / ZIPCODE: LANESBORO 55949

1

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Liza M. Eng — Liza Eng — 03/22/26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] Winona, MN. 55987
CITY / STATE / ZIPCODE

BRUCE ENG — Bruce Eng — 3/22/26
FULL NAME (PRINTED) SIGNATURE DATE
MAILIN[redacted] WINONA, MN 55987
CITY / STATE / ZIPCODE

STEPHEN NEVDAUX — 3/22/26
[redacted] SIGNATURE DATE
RUSHFORD MN 55971
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) SIGNATURE DATE
MAILING ADDRESS CITY / STATE / ZIPCODE

FULL NAME (PRINTED) SIGNATURE DATE
MAILING ADDRESS CITY / STATE / ZIPCODE

FULL NAME (PRINTED) SIGNATURE DATE
MAILING ADDRESS CITY / STATE / ZIPCODE

FULL NAME (PRINTED) SIGNATURE DATE
MAILING ADDRESS CITY / STATE / ZIPCODE

2

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Cynthia Cresswell Hatleli | Cynthia Cresswell Hatleli | 3/21/2026

SIGNATURE | DATE

[redacted]

Rushford MN 55971

MAILING ADDRESS | CITY / STATE / ZIPCODE

Scott Hatleli | Scott Hatleli | 3-21-2026

FULL NAME (PRINTED) | SIGNATURE | DATE

[redacted] | Rushford MN 55971

MAILING ADDRESS | CITY / STATE / ZIPCODE

Dean Mierau | 4-5-2026

FULL NAME (PRINTED) | SIGNATURE | DATE

[redacted] | Houston MN 55943

CITY / STATE / ZIPCODE

Kim Mierau | 4-5-2026

FULL NAME (PRINTED) | SIGNATURE | DATE

[redacted] | Houston MN 55943

CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE

MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE

MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE

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Pam Caldwell | Pamela J Caldwell | 4/8/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona, MN 55987
CITY / STATE / ZIPCODE

Bob Caldwell | Robert Caldwell | 4/8/26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona, MN 55987
CITY / STATE / ZIPCODE

Virginia Thilmany | Virginia Thilmany | 4/18/24
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Winona, MN 55987
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE
MAILING ADDRESS | CITY / STATE / ZIPCODE

3

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)



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SONJA M. DULEK — Sonja M. Dulek — 5-04-26
FULL NAME (PRINTED) — SIGNATURE — DATE

[redacted] — Rushford, MN. 55971
CITY / STATE / ZIPCODE

Christy Hanson — Christy Hanson — 5/4/26
FULL NAME (PRINTED) — SIGNATURE — DATE

[redacted] — Rushford MN 55971
CITY / STATE / ZIPCODE

Kenny Peerboom — [signature] — 5/4/26
FULL NAME (PRINTED) — SIGNATURE — DATE

[redacted] — 55971 Rushford MN
CITY / STATE / ZIPCODE

Ayra Brown — [signature] — 5/4/26
FULL NAME (PRINTED) — SIGNATURE — DATE

[redacted] — Rushford, MN 55971
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

4

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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DIANE PALM | Diane Palm | 4/21/2026
FULL NAME (PRINTED) | SIGNATURE | DATE

[redacted] | LACRESCENT, MN 55947
MAILING ADDRESS | CITY / STATE / ZIPCODE

Marjorie Loch-Wouters | Marjorie Loch-Wouters | 4/21/2026
FULL NAME (PRINTED) | SIGNATURE | DATE

[redacted] | LaCrescent MN 55947
MAILING ADDRESS | CITY / STATE / ZIPCODE

Patricia Martell | Patricia Martell | 4/21/26
FULL NAME (PRINTED) | SIGNATURE | DATE

[redacted] | Lacrescent MN 55947
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE

MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE

MAILING ADDRESS | CITY / STATE / ZIPCODE

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MAILING ADDRESS | CITY / STATE / ZIPCODE

FULL NAME (PRINTED) | SIGNATURE | DATE

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Deborah Joan Johannes — Deborah Joan Johannes — 4·8·26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] LaCrescent MN 55947
CITY / STATE / ZIPCODE

Debbie Tetzlaff — Debbie Tetzlaff — 4-8-26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] La Crescent Mn 55947
CITY / STATE / ZIPCODE

Lloyd Lorenz — Lloyd Lorenz — 4/9/26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] LaCrescent MN 55947
CITY / STATE / ZIPCODE

Maxine Blair — Maxine Blair — 4-9-26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] La Crescent MN 55947
CITY / STATE / ZIPCODE

James Mav — James Mav — 4/9/26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] La Crescent, MN 55947
MAILING ADDRESS CITY / STATE / ZIPCODE

JOANNE BURGE — Joanne Burge — 4/10/26
FULL NAME (PRINTED) SIGNATURE DATE
[redacted] CALEDONIA MN 55921
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) SIGNATURE DATE

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Tara K. Schmitz | Tara Schmitz | 4-21-26
SIGNATURE | DATE
[redacted] | Caledonia MN 55921
CITY / STATE / ZIPCODE

Tim Heintz | T. C. Heintz | 4-21-26
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | Brownsville MN 55919
CITY / STATE / ZIPCODE

Gerald Walhovd | Jim Walhovd | 4-21-26
SIGNATURE | DATE
[redacted] | Brownsville, MN 55919
CITY / STATE / ZIPCODE

Joe Flannery | Joe Flannery | 4/21/26
SIGNATURE | DATE
[redacted] | LaCrescent MN 55947
MAILING ADDRESS | CITY / STATE / ZIPCODE

Laurie Flannery | Laurie Flannery | 4-21-26
SIGNATURE | DATE
[redacted] | LaCrescent, MN. 55947
CITY / STATE / ZIPCODE

Roberta J. Bringe | Roberta J Bringe | 4-21-26
SIGNATURE | DATE
[redacted] | LaCrescent, MN, 55947
MAILING ADDRESS | CITY / STATE / ZIPCODE

Marvin W Bringe | Marvin Bringe | 04.21.2026
FULL NAME (PRINTED) | SIGNATURE | DATE
[redacted] | LaCrescent MN 55947

7

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

369

Bruening Rock Products Inc., of Decorah, Iowa, is proposing a new silica sand mine in Houston County near Rushford, Minnesota. The proposed site is situated along Minnesota's Historic Scenic Byway 16, within the Richard J. Dorer Memorial Hardwood State Forest. It is in close proximity to Ferndale Creek trout stream and state-registered Ferndale Fish Hatchery. It is adjacent to several residential and recreational properties, and includes a significant stretch of Root River shoreline.

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| FULL NAME (PRINTED) | SIGNATURE | DATE |
|---|---|---|
| Eric Kiesau | [signature] | 4-19-26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: LaCrescent, MN 55947 | |
| Joseph R. Gohres | [signature] | 4-19-26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: LaCrescent, MN, 55947 | |
| Marilyn Huckenpoehler | [signature] | 4-19-26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: La Crescent MN 55947 | |
| Lynn Wolter | [signature] | 4/19/26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: La Crescent MN 55947 | |
| Mark Becker | [signature] | 4-20-26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: La Crescent MN 55947 | |
| Laurie Haake | Laurie Haake | 4-21-26 |
| MAILING ADDRESS: [redacted] | CITY / STATE / ZIPCODE: Lacrescent, MN 55947 | |
| | | |

6

# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)



Bruening Rock Products Inc., of Decorah, Iowa, is proposing a new silica sand mine in Houston County near Rushford, Minnesota. The proposed site is situated along Minnesota's Historic Scenic Byway 16, within the Richard J. Dorer Memorial Hardwood State Forest. It is in close proximity to Ferndale Creek trout stream and state-registered Ferndale Fish Hatchery. It is adjacent to several residential and recreational properties, and includes a significant stretch of Root River shoreline.

The proposed mining operation threatens one of Minnesota's most distinctive regions. Beyond the routine disturbances commonly associated with active mining—including clear-cutting, removal of overburden, blasting, commercial hauling traffic, erosion, water use, noise, dust and light pollution—this proposal raises critical issues due to its location in the Root River Valley. The area's karst topography presents ecological, geological, and hydraulic complexity. Combined with the presence of rare and threatened species and sensitive plant communities on this free standing bluff, this proposal will cause irreparable environmental damage.

Given these considerations, we believe the project warrants careful due diligence, expert evaluation, and thorough examination of the environmental, public health, and economic consequences—both short- and long-term. **Accordingly, we, the undersigned concerned citizens, respectfully request the preparation of an Environmental Assessment Worksheet (EAW).**

Joyce L. Packard — Joyce L. Packard — 4/16/26
[redacted] — LaCresent MN 55947
FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

Brian Blair — Brian Blair — 4/17/26
[redacted] — LaCrescent, MN 55947
FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

Joe Myhre — [signature] — 4.19.26
[redacted] — La Crescent MN 55947
FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

Melanie Myhre — Melanie Myhre — 4.19.26
[redacted] — LaCrescent MN 55947
FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

Jay D McHenry — J McHenry — 4.19.26
[redacted] — LaCrescent MN 55947
FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

Kelly A. McHenry — [signature] — 4/19/26
MAILING [redacted] — LaCrescent, MN 55947
FULL NAME (PRINTED) — SIGNATURE — DATE
MAILING ADDRESS — CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

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# Citizen Petition for Preparation of an Environmental Assessment Worksheet (EAW)

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Kristin Buege — Kristin Buege — 4-10-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Caledonia MN 55921
MAILING ADDRESS — CITY / STATE / ZIPCODE

Gretchen Buege — Gretchen Buege — 4-10-26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Caledonia, MN 55921
CITY / STATE / ZIPCODE

ARIANE LYDON — [signature] — 4/13/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — LA CRESCENT MN 55947
CITY / STATE / ZIPCODE

Leonard Olson — Leonard Olson
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — Houston Minn 55943 — 4-15-26
CITY / STATE / ZIPCODE

LAURA EGLINTON — Laura Eglinton — 4/15/26
FULL NAME (PRINTED) — SIGNATURE — DATE
[redacted] — CALEDONIA, MN 55921
CITY / STATE / ZIPCODE

Cynthia Konecznу — Cynthia R Koneczny — 4/15/26
SIGNATURE — DATE
[redacted] — Houston, MN 55943
CITY / STATE / ZIPCODE

FULL NAME (PRINTED) — SIGNATURE — DATE

6