MEMORANDUM

To: Jamie Konopacky
Environmental Working Group
111 Third Avenue South
Suite 240
Minneapolis, MN 55401

From: George J. Kraft, Ph.D., PH
8640 Old Amish Rd.
Amherst WI 54406

Date: May 1, 2020

Re: Review of Environmental Assessment Worksheet for Nolte Family Irrigation Project

I, George J. Kraft, hold a Ph.D. from the University of Wisconsin – Madison with a major in Soil Science and minor in hydrogeology and a State of Wisconsin Professional Hydrologist license. I am a professor emeritus of water resources at the University of Wisconsin Stevens Point (UWSP) and the University of Wisconsin—Extension and former Director of the Center for Watershed Science and Education at UWSP. For over 30 years, I have researched and published extensively on the specific topic of agricultural groundwater quality and quantity issues in sandy soils and glacial aquifer systems in the Northern Great Lakes States. I have also had opportunities to work with Minnesota agency staff and citizen groups focused on these issues. In November 2019, I visited Park Rapids, Minnesota and made a presentation on how my research applies to water quantity and quality concerns in Minnesota's Pineland Sands Aquifer area.

At the request of the Environmental Working Group, I have reviewed the Environmental Assessment Worksheet for the Nolte Family Irrigation Project (July 2013 version) prepared by the Minnesota Department of Natural Resources (hereinafter "EAW"). My review, as outlined below in this expert report, first briefly focuses on the need for considerably more information on potential groundwater pumping impacts, which are integrally related to the scope and extent of potential water quality issues from the proposed project. Next, I discuss the EAW's incompleteness regarding nitrate and pesticide effects on water quality. It is my expert opinion that the proposed project will almost certainly contribute recharge to groundwater containing nitrate concentrations exceeding the 10 mg/L nitrate-N state and federal drinking water standard. Moreover, this nitrate-laden groundwater will discharge to and contribute nitrate to the nearby Redeye River.

<u>**Conceptual model**</u>

Groundwater in the vicinity of the proposed project area originates from local precipitation that percolates through soils and enters the region's saturated geology (aquifers and aquitards). The saturated geology consists of an uppermost approximately 130-foot thick sand and gravel aquifer underlain by alternating aquitard and aquifer units to a depth of approximately 400 feet. I infer that groundwater in the immediate project area flows west, southwest, and south (depending on the particular subarea of the site in question) through the surficial aquifer and discharges to the Redeye River.[1]

Water Quality and Quantity Resource Concerns

In my opinion, the proposed project presents both water quality (pollution) and water quantity concerns. Water quality will be negatively affected by nitrate and pesticide residues that will leach from the proposed irrigated cropland to groundwater and then discharge to the Redeye River, located only .4 - 1 mile away.[2] Water quantity will be affected by the proposed project when groundwater is pumped from aquifer storage for irrigation and evapotranspired into the atmosphere, causing water level declines in the aquifer and in connected wetlands, as well as flow declines in connected streams. The current information in the EAW is insufficient to assess the type and extent of potential water quantity impacts.

The groundwater quantity effects that will result from the requested 100 million-gallon-per-year water appropriation for irrigating 303 acres of cropland will contribute to cumulative water quantity effects for the broader area. However,_the EAW inaccurately identifies only two water resource related cumulative effects, "Contamination of groundwater, specifically due to nitrate and pesticides," and "Contamination of surface water, specifically due to nitrate and pesticides." (Pg. 38). Completely omitted is the critical category of water quantity cumulative effects. And because the EAW does not identify water quantity cumulative effects as a category for analysis, it fails to provide any meaningful discussion of the likely impacts of pumping on water levels and streamflows.

The omission of water quantity as a cumulative effects category is at odds with information contained in other portions of the EAW. First, the EAW seems to concede pumping effects are a concern, because most of the *Past and Present Conditions* part of the EAW is devoted to cumulative pumping impacts. And second, the EAW states aquifer tests will be required later, presumably to assess pumping drawdowns and streamflow diversions. (Pg. 30).

Importantly, agency staff and the concerned public should not assume that because the irrigation wells are proposed to be completed in a confined aquifer that water level and streamflow impacts will be precluded (pg. 25). All confining units are at least somewhat leaky (and sometimes very leaky). Groundwater in a confined aquifer is not really completely confined nor is it immobile, rather it is in transit toward some discharge point and connected to the surficial aquifer and to surface waters. Accordingly, the proposed project's pumping from the confined aquifer will diminish water levels and streamflows. These impacts may be more spread out in time and space than if the project were pumping from a shallow unconfined aquifer, but they will still occur.

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[1] The EAW seems unclear on this point. It references a 1977 USGS report that "... the general groundwater flow direction for the Pineland Sands area is to the southeast," but then alludes to a re-evaluated map and USGS Hydrologic Atlas that "... clearly shows flow towards rivers and streams..." without ever conclusively stating the direction of groundwater flow at the site of the proposed project.

[2] I assume that water in the surficial aquifer, like most sandy, surficial aquifers is well oxygenated and hence unlikely to rapidly degrade nitrate.

Nitrate Contamination of Groundwater

The EAW lacks any evaluation of the potentially significant nitrate loads to groundwater and surface water from the proposed project. In the following analysis, however, I show that nitrate loads to groundwater and surface water from the proposed project will likely be considerable.

To evaluate the severity of potential nitrate contamination from the proposed project, I compared potential project nitrate loads to groundwater (i.e. the annual loss of nitrate to groundwater in pounds N per acre) to nitrate loads that are consistent with maintaining groundwater quality meeting the Safe Drinking Water Act standard of 10 mg/L nitrate-N. Based on that standard, and using the EAW's groundwater recharge rate of 5 inches per year (Pg. 25), I determined a maximum permissible nitrate-N loading rate (N_{load}) for the proposed project of 11.5 lbs/acre/yr. Using a more generous recharge rate of 10 inches per year (which is common in some sandy areas in the Northern Great Lakes States), the maximum N_{load} would be 23 lbs/acre/yr.

Assessing N_{load} to Groundwater From the Proposed Rotation

I estimated an N_{load} range for parts of the proposed project's crop rotation from the existing scientific literature when it was available, or budget approaches based on University of Minnesota fertilization recommendations and average crop yields.[3] The N_{load} estimate for parts of the proposed project's crop rotation are then available for comparison against the 11.5-23 lbs/acre/yr permissible N_{load} consistent with the drinking water standard.

The EAW states that the rotation will be either four or five years, with the four-year rotation comprising:

Year 1: Corn interseeded with annual rye grass and clover, possible grazed post-harvest.
Year 2: Oats followed by alfalfa and fescue
Year 3: Alfalfa and fescue
Year 4: Potato or edible bean

A five-year rotation would replace year 4 with another year of alfalfa-fescue and add a fifth year of potato or edible bean. (Pg. 17-18).

Below, I present N_{load} estimates for each of the crops in the proposed project's crop rotation, assuming the use of best management practices (BMPs). As can be clearly seen, the BMP N_{load} estimates compare unfavorably with permissible N_{load} for maintaining safe drinking water.

It is important to note that the N_{load} estimates are likely overly optimistic (i.e., underestimates of N_{load}). This is the case because BMP approaches allow producers to add more nitrogen fertilizer when they feel it justified. For example, producers often apply additional nitrogen fertilizer following large rains to make up for perceived leaching losses. This practice substantially increases groundwater N_{load}.

Potato N_{load}

Potato BMP N_{load} of 75 and 106 lbs/acre/yr was estimated in the Wisconsin Central Sands region (Kraft and Stites 2003, Mechenich and Kraft 1997), a region similar to the Pineland Sands, using budget approaches (Meisinger and Randall 1991). In Minnesota, BMP potato N_{load} has been estimated to be 132

[3] University recommendations are usually the standard for BMP approaches.

to 170 lbs/acre after non growing season nitrate losses were accounted for (Bohman et al. 2019, email communication with B. Bohman).

As stated above, these BMP potato N_{load} estimates are likely optimistically low. N_{load} of over 200 lbs/acre for BMP potato was measured in the Wisconsin Central Sands after growers added additional nitrogen fertilizer in response to large rainfalls (Kraft and Stites 2003).

Corn and Oat N_{load}

BMP corn and oat N_{load} was estimated at 57 and 20 lbs/acre for Wisconsin Central Sands using budget approaches (Mechenich and Kraft 1997).

Though the MN Department of Agriculture did not evaluate N_{load} in its Byron #1 study (MN DoA 2020) (referred to as the "Winnemucca Study" in the EWG comment), it reported groundwater nitrate-N concentrations more than 2.5 times the drinking water standard in downgradient monitoring wells during the year and a half following corn. The same study found nitrate-N concentrations following oat reached 1.5 to 2 times the drinking water standard. These monitoring data are consistent with my projections that BMP N_{load} from the proposed project will likely exceed that which is consistent with keeping nitrate-N in groundwater below the Safe Drinking Water Act limit of 10 mg/L.

Edible Beans N_{load}

I was unable to find a reference for edible bean N_{load} for this setting, but calculated an overly optimistic (i.e, low) N_{load} of 24 lb/acre using a budget approach that considered only BMP fertilizer rate as an N input, neglecting long-term native humus mineralization and precipitation N.

Alfalfa-fescue N_{load}

I expect that the standing-crop alfalfa-fescue N_{load} during years 3 and 4 would be small, perhaps less than the permissible N_{load} required to produce safe drinking water. However, and critically, the alfalfa-fescue N_{load} depends on if, and how much, manure-nitrogen might be applied in these years. The EAW fails to include sufficient information on manure application rates and timing to fully assess this point. In addition, post-plowdown N_{load} is potentially large[4] because substantial amounts of mineralized alfalfa-fescue residue N may be uncaptured by subsequent crops.

Manure Management

The EAW's failure to specify how manure will be managed confounds estimates of N_{load} to groundwater. The 720 tons of solid cattle manure that will be produced is not insignificant, amounting to approximately 14400 pounds of nitrogen, assuming a nominal 20 pounds of N per ton of manure (UMNE 2020).

Manure that is applied to fields potentially contributes more nitrate to groundwater than commercial fertilizer when applied in amounts equal as plant available N. This is because manure may be mineralized at times of the year when plant uptake is small, leaving more nitrate that can seep beneath plant roots and into groundwater.

[4] Estimating N_{load} from alfalfa is difficult as most agronomic literature only reports how much N can be credited to subsequent crops, not how much leaches to groundwater or is accounted for.

In addition to spread manure, the EAW does not provide any analysis as to the contribution of manure deposited directly on fields during grazing.

Mitigating Factors in the EAW Cannot be Assumed to Reduce Nitrate Losses

The EAW throughout discusses supposed pollution reduction measures in the abstract. It mentions BMPs, soil health principles, alfalfa's deep roots, the project proposer's MAWQCP certification, and cover crops. However, it is empirically faulty to assume that these measures will prevent unsafe levels of nitrate leaching to groundwater beneath the proposed project's irrigated cropland. Reducing N_{load} to groundwater requires decreasing nitrogen inputs (commercial fertilizer, manure, fixed N) or increasing nitrogen removed during crop harvest. The EAW fails to supply information showing the supposed pollution reduction measures will result in decreased inputs or increase crop harvest in any meaningful way. Hence they should be disregarded.

N_{load} Summary

The EAW fails to estimate N_{load} for crops in the rotation and does not specify management details that would allow estimates of N_{load} for manure and post-plowdown alfalfa-fescue residue. This information is critical to understanding the likely significant risk of nitrate pollution to groundwater and surface water from the proposed project.

As presented above, in the best-case scenario, potato and corn crops in the proposed project will likely contribute a N_{load} to groundwater that is many times higher than that consistent with maintaining nitrate-N concentrations below the Safe Drinking Water Act limit of 10 mg/L. Although not as large as corn and potatoes, projected edible bean and oat N_{load} from the proposed project is also still greater than the N_{load} consistent with achieving the above-stated water quality goal.

With the strictest adherence to minimum University of Minnesota fertilization recommendations, and ignoring manure and plowdown losses of alfalfa-fescue N and supplemental nitrate applications after heavy rainfall, the proposed rotation will likely still have a N_{load} double to quadruple the N_{load} consistent with keeping nitrate-N levels in groundwater below the Safe Drinking Water Act limit of 10 mg/L.

Pesticide Residues

Attachment D in the EAW enumerates a lengthy list of pesticide compounds. And, the EAW states that the residues of 45 pesticides have been identified in nearby groundwater. (Pg. 27). In the hydrologically similar Wisconsin Central Sands, neonicotinoid pesticides have recently been found in groundwater and surface water at concentrations that have potential negative consequences for aquatic and terrestrial invertebrates. (Bradford et al. 2018; W.DeVita pers. comm.). Accordingly, it is my recommendation that environmental review of this project incorporate more analysis of the potentially significant effect of neonicotinoids in groundwater and surface water.

Conclusion

In conclusion, the EAW neglects consideration of potentially significant water quantity effects, including water level drawdowns and streamflow depletion, associated with the proposed project. The EAW also lacks an analysis of likely significant nitrate and pesticide leaching and associated groundwater and surface water contamination. Based on my expert analysis, the proposed project will likely contribute nitrate loads to groundwater that are inconsistent with achieving a water quality goal of keeping nitrate concentrations in groundwater below the Safe Drinking Water Act limit of 10 mg/L nitrate.

Literature cited

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UMNE 2020. Manure characteristics. https://extension.umn.edu/manure-land-application/manure-characteristics.

GEORGE J. KRAFT

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CAREER EXPERIENCE

Professor Emeritus/Research Specialist/Outreach Educator/Consulting Hydrologist. 2018 -

College of Natural Resources, University of Wisconsin -Stevens Point & Freelance

- Conduct groundwater research in the public interest
- Provide public water resource education
- Consulting services on groundwater and surface water matters

Director - Center for Watershed Science and Education 1990 to 2018

& Professor of Water Resources

College of Natural Resources, University of Wisconsin -Stevens Point

- Appointment (2017): 50% administration, 25% program, research, and service leadership, 10% classroom teaching, 15% Cooperative Extension education.
- Responsibilities (2017): Manage personnel and budget; conduct outreach programming; assist state government, local governments, citizens and groups in water resources matters; support county Extension offices; collaborate with state, local and federal government agencies; conduct applied research; and teach courses at the College of Natural Resources.
- Supervise of staff of 14 professionals plus 12 student workers.
- Oversee a program with a continuously increasing staff, budget, and mission.
- Serve on College's management team ("Dean's Council")

Hydrogeologist 1989 to 1990

Wisconsin Department of Natural Resources, Madison WI

- Managed Superfund and state Environmental Repair projects
- Designed and reviewed hydrogeologic investigations

Groundwater Research Associate 1986 to 1990

Wisconsin Geological and Natural History Survey, Madison WI

- Conducted groundwater investigations on pesticide fate in groundwater
- Procured grants, managed budget

Hydrogeologist and Hazardous Waste Specialist 1980 to 1985

Wisconsin Department of Natural Resources, Green Bay WI

- Managed spill and contaminated site investigation and cleanups
- Enforced RCRA and CERCLA laws

EDUCATION

Ph.D., 1990

University of Wisconsin – Madison

Major: **Soil Science (Soil Chemistry)**

Minor: **Geology (Hydrogeology)**

M.S., 1982

University of Wisconsin - Stevens Point

Major: **Natural Resources Land Use Planning**

B.S., 1978

University of Wisconsin - Stevens Point

Major: **Soil Science**

PROFESSIONAL LICENSES

- Professional Hydrologist 111-17

PROFESSIONAL MEMBERSHIPS

- Association of Ground Water Scientists and Engineers
- Soil Science Society of America
- Sigma Xi Honorary Research Society

SELECT COUNCILS, COMMITTEES, WORK GROUPS

University of Wisconsin System Groundwater Research Advisory Council Member of a scientific council that defines Wisconsin groundwater research priorities, requests research proposals, and recommends proposals for funding. 2002 to present.

Wisconsin Initiative on Climate Change Impacts Member of a collaboration between the University of Wisconsin System, Wisconsin Department of Natural Resources, and other institutions that assesses and anticipates climate change impacts on Wisconsin natural resource; evaluates potential effects on industry, agriculture, tourism and other human activities; and develops and recommends adaptation strategies. 2009 to present.

Wisconsin Groundwater Coordinating Council – Governor's representative, both Republican and Democratic, to this statutory council on groundwater. 2002 to 2015.

Wisconsin Groundwater Advisory Council Technical Committee A scientific group advising a Council implementing 2003 Wisconsin Act 410 on groundwater pumping. 2004-5.

Wisconsin Joint Assembly -Senate Groundwater Working Group Appointed by the state legislature to advise policy on creating groundwater quantity management statutes. 2003.

COURSES TAUGHT

Introduction to Soil and Water Resources	Groundwater Management
Contaminant Hydrogeology	Hydrology
Water Chemistry	Applications of Groundwater Models
Hydrogeology	Techniques in Hydrogeology

OUTREACH PROGRAMMING

Watershed-scale water resources management, watershed partnerships, climate change, agricultural impacts on water quality, groundwater quantity issues, groundwater resource sustainability.

RESEARCH AREAS

Effects of land uses on water quality, agricultural and environmental sustainability, contaminant hydrogeology, climate change and water resource connections, groundwater pumping impacts on lakes and streams.

SELECT AWARDS (*Since 2000*)

University Scholar Award. University of Wisconsin – Stevens Point.

Water Conservationist of the Year. Wisconsin Wildlife Federation.

Distinguished Service Award. Wisconsin Chapter of the American Water Resources Association, for a career's work of water issues.

Outreach Award. Awarded by the University of Wisconsin - Stevens Point College of Natural Resources for outstanding outreach service to Wisconsin citizens, professionals, and students.

Wisconsin Idea Fellow. University of Wisconsin System. In recognition of extraordinary public service on behalf of the University of Wisconsin to local communities, business, and improving the quality of life and economy in Wisconsin.

Outstanding Environmental Contribution Award. Wisconsin Stewardship Network.

River Champion Award. Wisconsin Rivers Alliance. Awarded for ongoing service, technical assistance, and public education work.

Outstanding Service Award. Wisconsin Society of Professional Soil Scientists. For distinguished service in instituting a Soil Science professional license.

PUBLICATIONS *Peer-reviewed journal papers since 2000*

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and watershed conditions in and adjacent to Pictured Rocks National Lakeshore (Michigan)

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Kraft, G.J., B.A. Browne, W.M. DeVita, and D.J. Mechenich. 2004. Nitrate and pesticide penetration into a Wisconsin central sand plain aquifer. Report to the Wisconsin Department of Natural Resources. Center for Watershed Science and Education, University of Wisconsin - Stevens Point. 48 p.

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Kraft, G.J. 2000. Nitrate loading and impacts on central Wisconsin groundwater basins. In Proceedings of the 2000 Wisconsin fertilizer, aglime, & pest management conference. University of Wisconsin - Extension. Madison WI.

GRANT HISTORY *Select grants since 2000*

WDNR. *Monitoring Support for Groundwater Management in the Wisconsin Central Sands.* $240,000. 2016-2020.

WDNR. *Monitoring and Modeling Support for Groundwater Management and Policy Activities in the Wisconsin Central Sands*. $97,000. 2014-2016.

WDNR "Information Support for Groundwater Management in the Wisconsin Central Sands." $84,000. 2012-2014.

Consortium "Impacts of crop management and climate change on groundwater recharge across the Central Sands" (with Chris Kucharik, UW-Madison). $40,000. 2012-2014.

WDNR "Impacts of potato and maize management and climate change on groundwater recharge across the Central Sands" (with Chris Kucharik, UW-Madison) $120,000. 2012-2014.

Assessment of natural resources conditions for four national parks. National Park Service. $275,000. 2011-2014.

Lost Creek Wetland Mitigation Site evaluation. Stantec. $10,000. 2011-12.

Information support for groundwater management in the Wisconsin Central Sands. Wisconsin Department of Natural Resources, $43,290. 2010-2012.

Mass spectrometry facility for research, education, and outreach on drinking and ground water quality. (With P. McGinley, W. DeVita, R. Stephens.) National Science Foundation major Research Instrumentation Grant Program, $248,000.

Lost Creek Wetland Mitigation Site evaluation. Stantec. $34,000. 2009-10.

Assessment of natural resources conditions for Isle Royale National Park. National Park Service. $97,000. 2008-10.

Understanding the effects of groundwater pumping on lake levels and streamflows in central Wisconsin. Wisconsin Department of Natural Resources. $69,166. 2007-9.

Assessment of water resources and watershed conditions in and adjacent to Sleeping Bear Dunes National Lakeshore. $80,000. National Park Service. 2007-9.

Lost Creek wetland remediation groundwater modeling study. $15,000. Wisconsin Department of Transportation. 2007-8.

Knowledge Development for groundwater withdrawal management around the Little Plover River . $98,000. Wisconsin Department of Natural Resources. 2006-2008.

Assessment of water resources and watershed conditions in and adjacent to Pictured Rocks and Apostle Islands National Lakeshore. $80,000. National Park Service. 2005-6.

A survey of baseflow for groundwater protection areas of the western Fox-Wolf watershed. $65,500. Wisconsin Department of Natural Resources. 2005-2007.

Nitrate and pesticide penetration into a northern Mississippi Valley Loess Hills Aquifer. $60,000. University of Wisconsin - System. 2005-2007.

Lost Creek wetland remediation groundwater modeling study. $28,000. Wisconsin Department of Transportation. 2005.

Groundwater Pollutant Transfer and Export from Northern Mississippi Valley Loess Hills Watersheds.

$62,000. Wisconsin Department of Natural Resources. 2003-2005.

Nitrate loading history, fate, and origin for two Wisconsin groundwater basins. Wisconsin Groundwater Groundwater Coordinating Council, $64,476. 2000-2002.

Choroacetanilide and atrazine residue penetration in two Wisconsin groundwater basins. $63,416. Wisconsin Groundwater Coordinating Council. 2000.

Developing groundwater flow and particle track models for source water protection and groundwater management. Wisconsin Department of Natural Resources / Environmental Protection Agency. $145,000. 1999-2001.

Nitrate and triazine concentrations in the groundwater of the northern Wisconsin River basin. State of Wisconsin - Department of Natural Resources. $5585. 2000.

A basin-scale denitrification budget for a nitrate contaminated Wisconsin aquifer. (With Bryant A. Browne.) Wisconsin Groundwater Research Council. $59,273 2000-2002.

Effectiveness of anionic surfactant in reducing nitrate leaching to groundwater under potato production. (With Birl Lowery and Frederick Madison) Wisconsin Potato and Vegetable Growers Association. $20,000. 2000.

Assessing the impacts of irrigated agriculture on water quality and economics in the central sands. (With W. Bland and M. Anderson.) University of Wisconsin - Consortium. $22,820. 2000.

COMMUNITY INVOLVEMENT

- Tomorrow River Scholarship Foundation Current president, past secretary. This foundation with a $1 million endowment serves residents of the Tomorrow River School District, providing some 80 scholarships annually (by way of reference, graduating classes are about 70) to deserving young people to pursue higher education.

- Iola Winter Sports Club Nordic High School / Middle School Racing Team Coach. Along with co-coaches, solicit athlete participation, run trainings, arrange race participation, fund-raise, report to the Club board of directors.

- Friends of the Tomorrow Waupaca River Member. Write news releases, organize river clean-ups, solicit membership, generally contribute to the smooth running of a healthy river organization.