Digging Deeper on Frac Sand Mining

Industry Presents Water, Tourism Issues in Northeast Iowa

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January 2014

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We gratefully acknowledge the generous support of the Fred and Charlotte Hubbell Foundation, which made the preparation of this report possible. While these funders support the research that went into this report, they may not necessarily agree with policy recommendations that are included. Policy recommendations are solely the perspective of the authors and the Iowa Policy Project.

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POLICY BRIEF

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By Aaron Kline and David Osterberg

Introduction

The frac sand mining industry swept through Wisconsin like a wildfire starting in 2009. An offshoot of the hydraulic fracturing, or "fracking," industry, this mining produces sand that is used to prop open fractures in rock formations permitting the release of oil and gas. Rapid growth of fracking — and thus frac sand mining — has sparked environmental, economic and aesthetic concerns. Some communities now question the long-term benefits of frac sand mining in their regions.

The Wisconsin experience illustrates potential negative effects that now alarm residents of southeastern Minnesota and northeastern Iowa (i.e. Allamakee and Winneshiek counties), who see the industry coming. Citizens of these areas targeted for expansion are not just sitting back and waiting for it. Many have organized to advocate for increased scrutiny of industrial frac sand facility siting. Many residents fear the potential harmful effects on air quality, water quality and quantity, transportation, tourism, and general aesthetics. Their voices will be heard not just locally, but likely in state legislative chambers as well.

To inform this emerging debate, this paper describes the potential water quantity and quality impacts of frac sand mining in northeast Iowa beginning with a brief description of frac sand mining as well as community concern arising from this industry. Next, it describes the unique shallow fractured rock/karst geology of select portions of northeast Iowa and the water resources located within this region. Further, it explores the potential effects of sand mining on Northeast Iowa water resources and trout populations. In addition, the importance of tourism based on the region's natural amenities (i.e. water resources) is highlighted. Following this look at resources is a description of the state and local regulations in Wisconsin and Minnesota, which may inform policy for communities in northeastern Iowa. To conclude, this paper provides several policy suggestions for those Iowa communities to consider when drafting ordinances for industrial frac sand facilities, including the importance of determining the cumulative impacts of closely located mines and processing centers.

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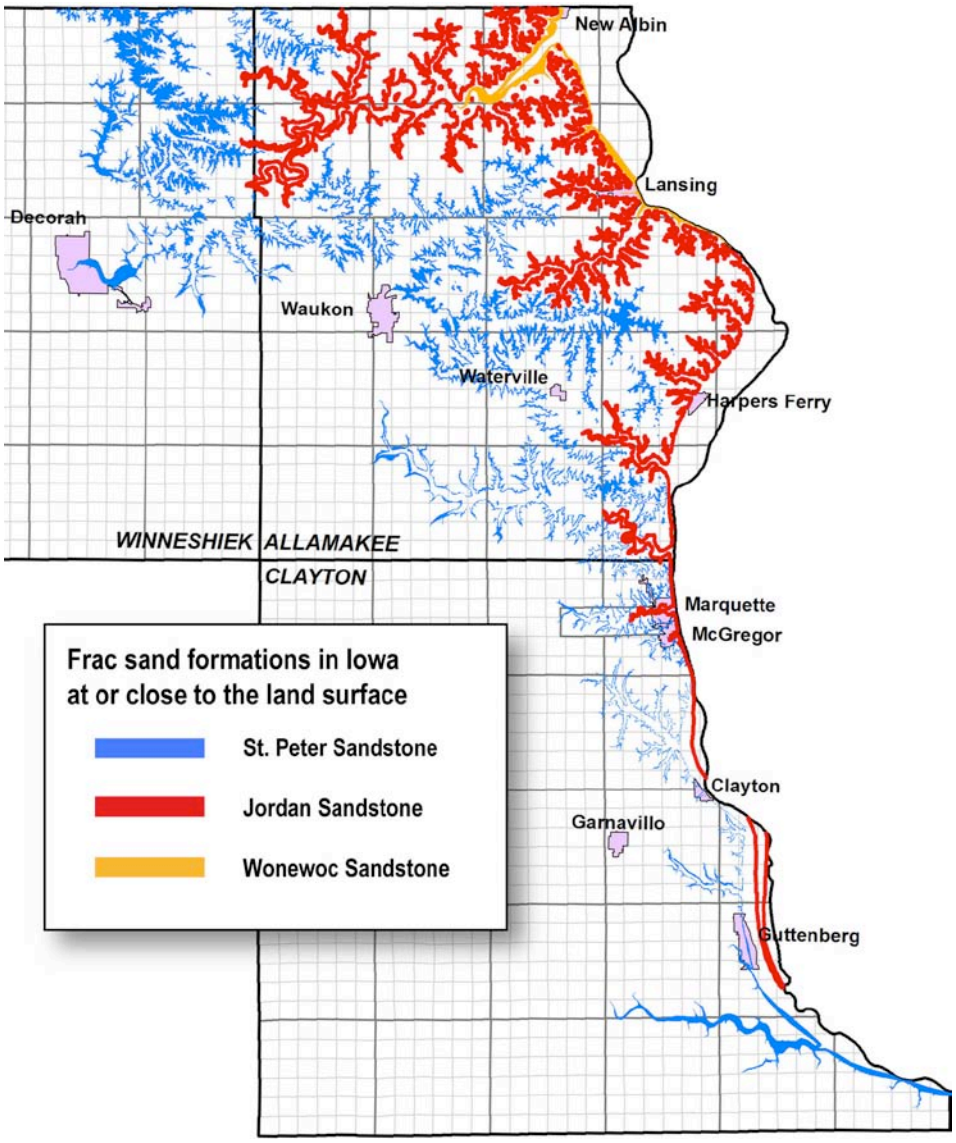
Frac Sand

Frac sand is highly prized by the hydraulic fracturing (i.e. fracking) industry due to properties acquired through natural geologic processes. The sand is well rounded, well sorted, and consists of nearly pure quartz, which has a high crush resistance.[1] Sands containing these characteristics and located near the surface (i.e. easily mined) are found in the northern Midwest's St. Peter Sandstone, Jordan Sandstone, and Wonewoc formations found in Wisconsin, Minnesota and Iowa. Figure 1 at left depicts the locations of frac sand deposits in Iowa.

Figure 1. Easily Mined Frac Sand Deposits Prevalent in Northeast Iowa



Source: Courtesy of Iowa Geological & Water Survey, 2013

The St. Peter formation along the Mississippi River in Northeast Iowa (blue areas on the map in Figure 1) can be seen in the many rock outcroppings and bluffs in the region — the bluffs that sand mining could remove. (See Figure 2).

Mining Operations

Frac sand mining consists of several different phases to achieve a marketable product. A mining operation may be a centralized system where mining occurs at multiple locations with the sand shipped to a central processing location. Trans-shipment and storage locations can also be parts of an operation. In contrast, a mining operation, processing plant, and shipping and storage operations (i.e. industrial frac sand facilities) may be at the same location. The type of setup employed will determine the impacts on the local environment, transportation infrastructure, and water quality and quantity.

Community Concern

Figure 2. Cutting Into Hills Exposes Frac Sand Deposits

The light area in the exposed hillside of the Pattison Mine in Clayton County shows a deposit of the sand sought for hydraulic fracking operations. *David Osterberg photo*

Hydraulic fracking has a long commercial history in the U.S. with its beginning in 1949. However, the advent of horizontal drilling, which allows oil or natural gas wells to expand horizontally in the bedrock reaching previously unobtainable reserves, has led to the expansion of fracking for oil and natural gas over the past several years. This expansion in the fracking industry, allowed by horizontal drilling, has led to an increased demand for frac sand to use in the new horizontal wells. For example, the United States Geological Survey reported that in 2011, "sales of frac sand increased by 32 percent from 2010 to 2011[2]. This sudden increase in demand for frac sand caught many communities off-guard when it came to issuing permits for industrial frac sand facilities. The first operations were treated like the sand and gravel operations communities thought they understood. Community groups quickly formed to advocate for additional regulation of industrial frac sand facilities after experiencing firsthand the effects of facilities in their communities. For example, residents were concerned about the effects of blowing sand originating from stockpiles and the potential risk for silicosis (i.e. a form of lung disease caused by inhaling crystalline silica sand). Further, concerns regarding water quality were raised after discharges of sand into local waterways occurred from poorly planned or constructed sites. Moreover, these concerns led to a new one-year moratorium on allowing additional industrial frac sand facilities in one of the densest sand mining areas in Wisconsin — Trempealeau County. Informed by activities in Wisconsin, citizen groups formed in Minnesota and Iowa as frac sand mining companies began applying for permits to operate. Similar to Wisconsin, citizens in Northeast Iowa are concerned about the potential environmental impacts of industrial frac sand facilities located in their area. Northeast Iowa is known for its environmental attributes-- trout streams, bluffs, and outdoor recreation areas. These

environmental attributes, especially the geology and hydrogeology of the region, require consideration when drafting ordinances allowing industrial frac sand facilities in the region.

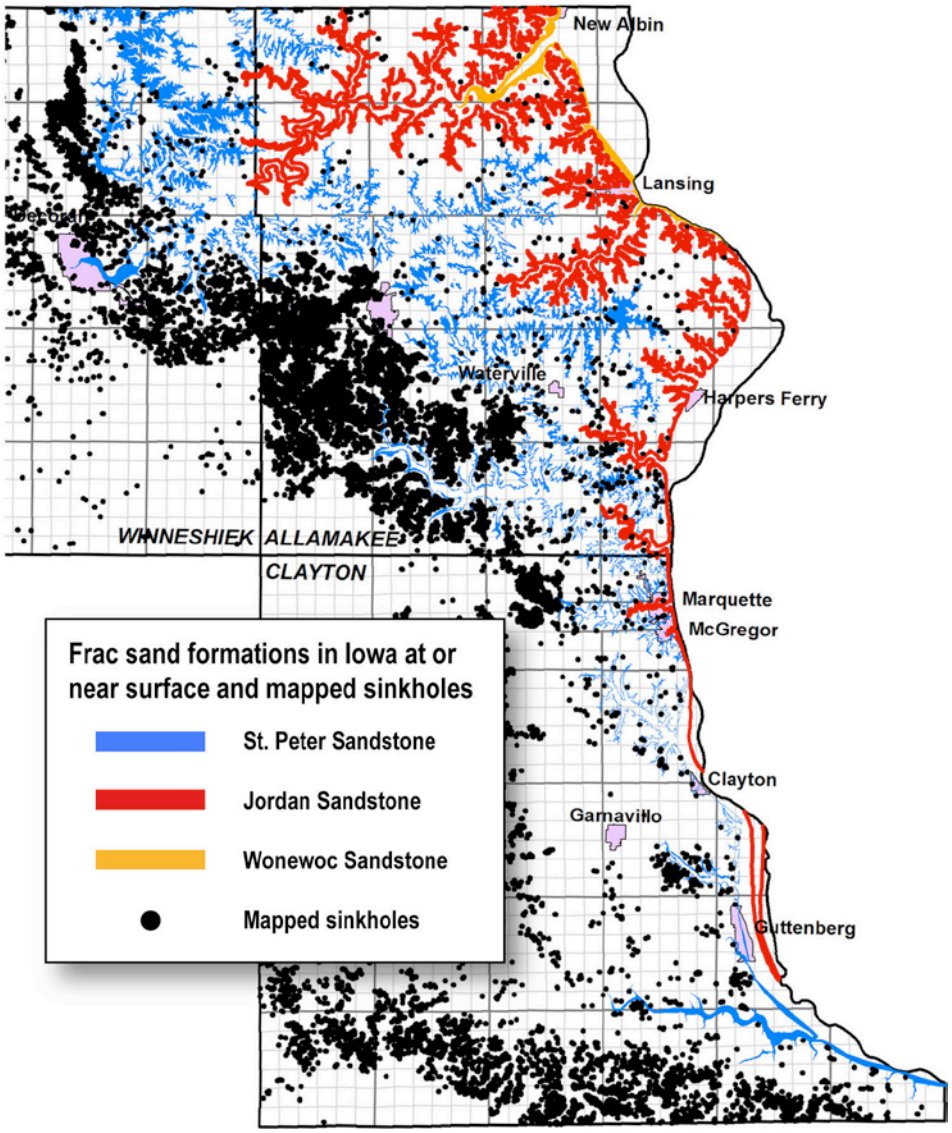
Geology and Hydrogeology of Northeast Iowa

The geology of Northeast Iowa is unique compared to the remainder of the state. It is more similar to the geology of Southeast Minnesota and Southwest Wisconsin than other parts of Iowa. This unique area, known as the Driftless Area, is distinct due to the virtual absence of glacial deposits. This section discusses the groundwater and surface water resources in the region including the Cambrian-Ordovician Aquifer and the two major watersheds, Upper Iowa River and Yellow River. However, a discussion of shallow fractured rock/karst, a unique geological formation of the region, is provided first.

Shallow Fractured Rock/Karst

The Iowa Department of Natural Resources (IDNR) states that karst exists when "easily dissolved bedrock" is found near the surface leading to sinkholes, springs, and losing streams (i.e. streams that lose water to local groundwater sources rather than remaining on the surface).[3] These characteristics of karst topography may enable surface water to bypass the natural filtration provided by soil percolation before it contacts and contaminates groundwater. As shown in Figure 3, karst formations are prevalent in a band across Winneshiek and Allamakee counties in Northeast Iowa. This concentration of sinkholes is found in the Galena Limestone that lies west of the main St. Peter and Jordan Sandstone deposits (i.e. frac sand

Figure 3. Groundwater Threat: Frac Sand Deposits in Iowa Often Near Sinkholes



Source: Courtesy of Iowa Geological & Water Survey, 2013

deposits) found within the counties. However, Figure 3 also shows that there are areas where sand deposits and karst formations overlap and warrant extra precaution when considering industrial frac sand facilities. Furthermore, Iowa State Geologist Bob Libra notes "the entire area where sand might be mined is underlain by permeable rocks with only a few remnants of glacial material atop them, so the groundwater is very vulnerable to contamination"[4] — there is no barrier to downward percolation from the surface. Further, "it should be noted that that the very act of removing the overlying sandstone may increase the probability of karst development, causing an area designated as low or moderate probability to having a moderate or high probability."[5]

Cambrian-Ordovician Aquifer

The main aquifer providing water in Northeast Iowa is the Cambrian-Ordovician Aquifer (aka Jordan Aquifer). In addition, Northeast Iowa is a major recharge area for the aquifer.[6] The aquifer is near the surface and often serves as the source of well water for the area. Any large water withdrawals such as the potential withdrawals from industrial frac sand facilities may have regional effects. It will be important to determine the cumulative regional water withdrawal considering other users such as municipal and private wells including dairy operations supplying water to their herds.

Watersheds

The area consists of two major watersheds, the Yellow River and Upper Iowa River, both of which are sources of recreational and ecological importance within the region. Further, both watersheds are collectors for the Mississippi River.

Upper Iowa River Watershed

The Upper Iowa River and its tributaries span 640,900 acres mostly in Iowa and contain 152 coldwater stream miles and 16 public trout fishing streams.[7] This watershed covers large portions of Winneshiek County and the northern portion of Allamakee County. The watershed provides economic and ecological resources through "waters of exceptional recreational and ecological significance" as designated by the Code of Iowa.[8] IDNR describes these exceptional waters as warranting special protection due to their "above average characteristics" and unaltered nature.[9] Furthermore, these exceptional waters, many cold enough to support trout, are vital to supporting the local tourism industry, with angling and boating being large contributors. Further, the last remaining native trout population in Iowa resides within the watershed.

Yellow River Watershed

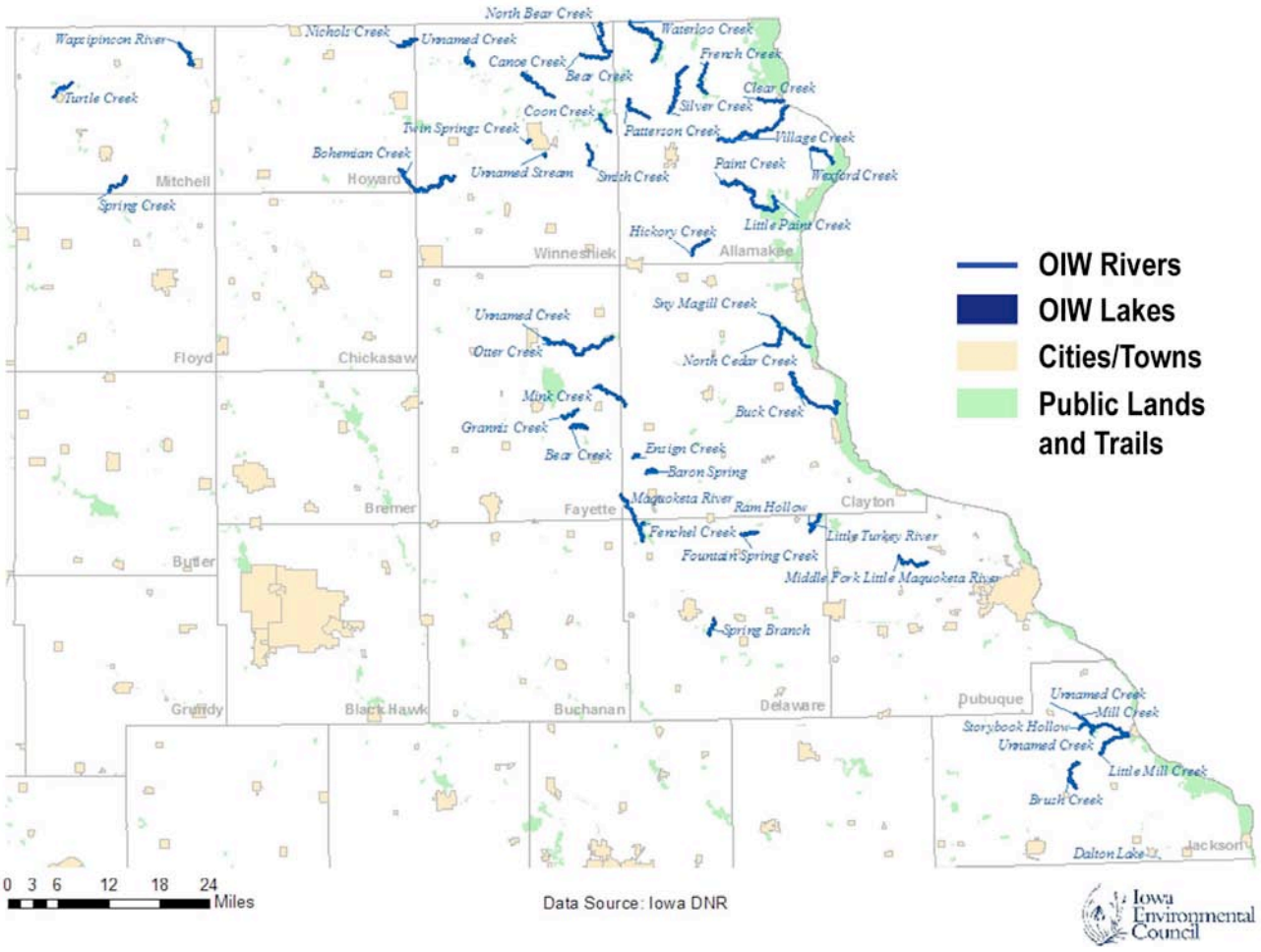
The Yellow River and its tributaries span 154,500 acres collecting water from Allamakee, Clayton and Winneshiek counties.[10] The watershed contains almost 22 miles of trout streams while offering excellent boating opportunities as well.[11] In addition, the IDNR has identified 2,953 sinkholes and 277 springs within the watershed.[12] The vast number of sinkholes and springs indicates a large potential for surface water pollution to enter groundwater resources in this region in particular.

Trout Fisheries

An early IDNR document states, "natural reproduction of trout occurs in a few Iowa waters. Six trout fisheries, however, offer excellent angling opportunities for catching wild, naturally-sustaining brown or brook trout populations."[13] A 2007 report by the same agency reports that

"[T]oday, 32 streams boast naturally reproducing trout populations."[14] Figure 4 from the Iowa Environmental Council shows these trout streams primarily lie in four Northeast Iowa counties including the two of most interest to this paper. State and federal interventions that worked with local landowners enabled this increase in the number of streams capable of supporting trout. These partnerships and local initiatives such as moving cattle away from streams, erosion control near streams, and improved manure management practices led to the cleanup of muddy and polluted waters enabling trout eggs to survive and populations to reproduce.

Figure 4. Outstanding Iowa Waters (OIW) in Northeast Iowa



Source: Courtesy of Iowa Environmental Council; data source: Iowa Department of Natural Resources

Bear Creek Watershed, covering portions of Allamakee and Winneshiek counties and some of southeastern Minnesota, illustrates the successful cooperation between federal, state, and county governments in conjunction with local landowners and volunteer groups. Table 1, from a report by the Winneshiek County Supervisors, demonstrates the significant amount of effort as well as dollars invested in the restoration and protection of water resources in northeastern Iowa.[15] Moreover, it also demonstrates that all levels of government and the cooperation of local individuals are essential in recreating a stream environment that can support self-sustaining trout populations. For example, in 2004, IDNR completed habitat improvements to 27 sites on Bear Creek, while in 2013, IDNR expended over $45,000 on stocking trout in Bear Creek.[16] In terms of private expenditures, the Iowa Driftless Chapter of Trout Unlimited reports that since 2001, the

Chapter has contributed over $13,000 in labor to improving Bear Creek.[17] These efforts have led to Bear Creek acquiring the ability to support naturally reproducing trout since 2010 leading to its "outstanding Iowa Water" designation and contributing $2,778,886 to the regional economy. [18]

Table 1. Federal, State, County and Private Funding for Bear Creek Watershed Improvement since 1998

	Funding	Examples
Federal	$1, 860,600	Environmental Quality Incentives Program/Water Quality Improvement Program
State	$655,603	Watershed Protection Fund
County	$60,000	General Fund
Landowners	$233,599	Cost share practices
Total	**$2,809,802**	

Source: Winneshiek County Board of Supervisors, 2013

Iowa promotes its trout-fishing opportunities and the importance of recreation with images like these on the Iowa Department of Natural Resources website.

Frac Sand Mining's Impact on Water Resources

Water Quantity

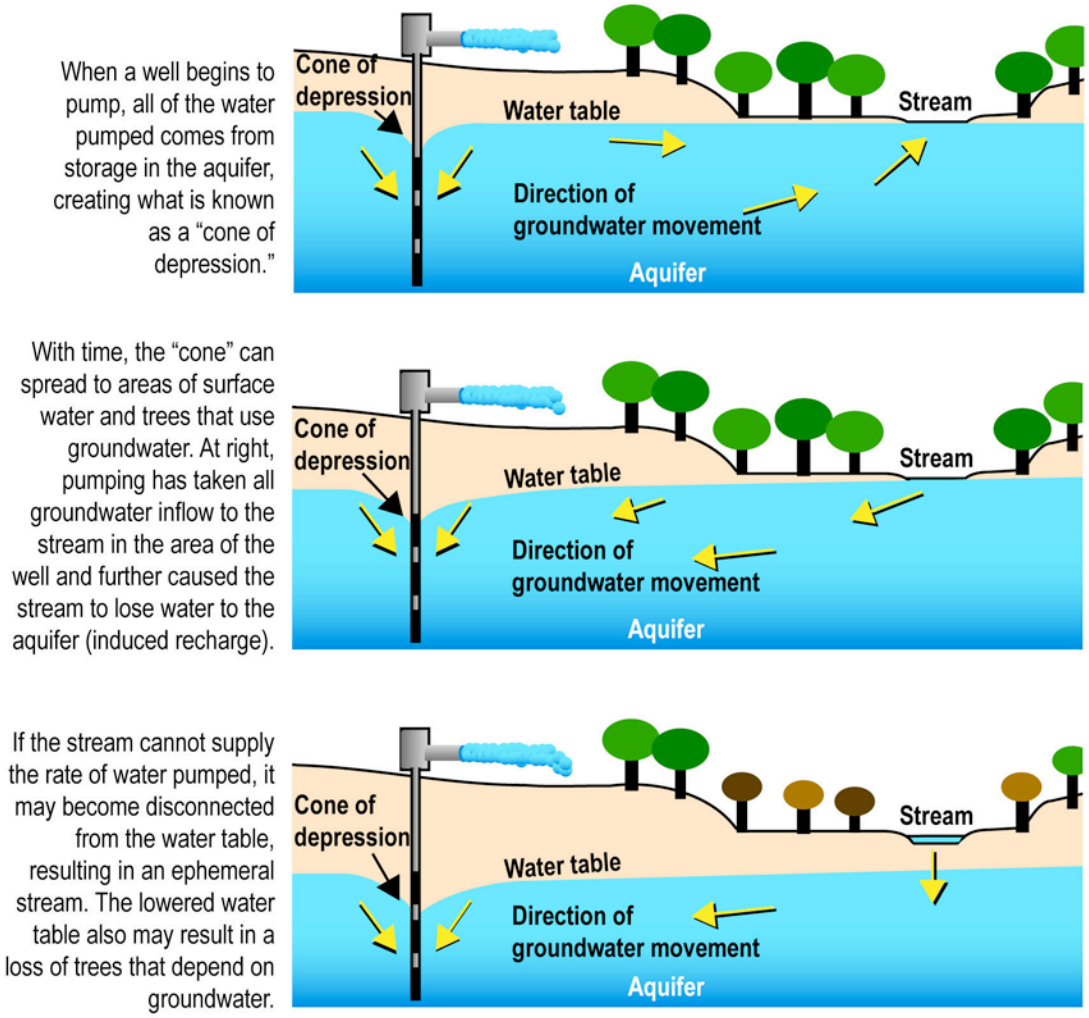
Industrial frac sand facilities have the potential to affect local water quantity due to the Cambrian-Ordovician Aquifer's role in providing water throughout the region (e.g. anthropogenic uses and environmental uses such as sustaining trout streams or wetlands). Water quantity concerns arise from onsite water usage for washing and processing sand or through mining beneath the water table. The water quantity effects of frac sand mining depend on the nature of each facility's location. However, several potential problems are common in any large-scale operation.

Groundwater Flows

High-capacity wells and dewatering of mines lead to water quantity concerns due to changing the nature of groundwater flows. These changes in groundwater flows can have large local impacts affecting residents, natural environments, and wildlife. A large concern associated with water withdrawals is the resulting cone of depression. A cone of depression forms when water is withdrawn from groundwater creating a depression in water levels in areas surrounding the

withdrawal source. This depression decreases in level as the distance from the withdrawal source increases as shown in Figure 5.

Figure 5. Wells Can Cause Water Quantity Concerns



Source: Modified from Leake and Haney, 2010[19]

Nearby Wells: Wells located near an industrial frac sand facility may experience declines in their capacity depending on the facility's water withdrawal rate and the resulting cone of depression. It is important to note that even if a cone of depression does not intercept a stream or waterway, it may capture water that would have supplied the stream naturally. In addition, clustering of industrial frac sand facilities may have a further cumulative effect on local water levels.

Induced Recharge: If a cone of depression reaches a nearby water body (e.g. stream or lake), the water body will begin to lose water to the groundwater source.[20] This is known as induced recharge as depicted in Figure 5. If located near a wetland, inadvertent draining of the wetland may occur through this hydrologic process.[21] Furthermore, if located near a stream, the stream may dry up as the water flows to the cone of depression rather than the stream. Induced recharge caused by industrial frac sand facilities could have negative consequences for trout streams in the region.

Water Temperature: Changes in groundwater flow can affect the temperature of water. In shallow fractured rock/karst regions, it is possible for streams to flow above and below the surface. Water that flows underground receives a cooling effect. However, when the flow of water changes, the amount of time that the water spends underground may be decreased thus creating a higher water temperature. When the water reemerges, it may increase the temperatures of the receiving water body possibly affecting aquatic biota.[22] Green and others[23] found this effect in one of the studied quarries noting that water flowing from the quarry was 17 degrees warmer than the water flowing into the quarry. Water temperature is of specific concern for Northeast Iowa due to the cold-water trout streams found in the region. An increase in water temperature will directly affect the trout's ability to survive and reproduce in local waterways.

Dewatering Mines

If mining is to occur under the water table, dewatering of the pit will generally be required. It is important to note that due to the height above the water table and permeable rocks of Northeast Iowa, dewatering should not be necessary; however, mines closer to the water table and near streams may require it. Dewatering of the mine consists of pumping water from a pit, which may lead to alterations in the local groundwater flow and availability. Green and others[24] examined quarries and gravel pits for impacts on water resources finding in one case, "Ground-water flow paths, water table elevations, ground-water gradients and both surface- and ground-water basins have been altered by mining below the water table." The Minnesota Environmental Quality Board[25] supports this finding, stating that the pits essentially become large wells altering local groundwater flow. This alteration in local water flows can contribute to the groundwater flow concerns outlined previously.

High-Capacity Wells

In addition to dewatering of mines influencing local hydrology, high-capacity wells providing water to industrial frac sand facilities that wash and process sand may negatively affect local water resources. The Wisconsin Department of Natural Resources[26] states that a typical closed-loop facility (i.e. where recycling of water occurs) will require well capacity ranging from 700 to 1,380 gallons per minutes (gpm), while an open-loop system will require well capacity of 2,000 to 3,700 gpm. For comparison, an average U.S. resident may consume 100 gallons of water per day[27] whereas a close-looped industrial frac sand facility operating at 1,000 gpm for 24 hours would use 1,440,000 gallons per day. For example, Allamakee County had a population of 14,300 in 2010,[28] which would mean an average daily water use for the county's population of 1,430,000 gallons equating to a little less than one "average"-sized closed-loop system operating 24 hours a day within the county.

Cumulative Impacts

The direct impact on a specific region depends on an area's unique geography and geology. Further, the cumulative effect of multiple facilities in a small geographic area can exacerbate mining's impact on water resources at the local level. Recognizing this, the Wisconsin Geological and Natural History Survey (WGNHS) and other partners initiated a five-year study to evaluate frac sand mining's groundwater impacts in Chippewa County.[29] While such a study will be a boon to those deciding on future regulations for the industry, it is occurring after the fact. Undertaking this study, the WGNHS acknowledges the necessity in evaluating mining's effect on the local hydrogeology from an individual mine perspective and a cumulative perspective.

Water Quality

Industrial frac sand facilities have the potential to affect the quality of water resources in the region if adequate protection of the natural environment is not incorporated into site development and maintenance, and adequately enforced. Potential water quality concerns include pond overflow, site runoff, the use of chemicals in water recycling efforts, and inadequate groundwater filtration due to the facility's activity.

Overflow and Runoff

Industrial frac sand facilities use water to wash sand of low quality to remove unacceptable sand and debris. As mentioned earlier, this processing can take place either on the mine site or at a centralized processing facility. The water may be stored onsite in storage ponds that hold water for reuse in washing. Overflow and runoff from sand piles and storage ponds entering local waterways introduces water quality concerns through increased sedimentation. Increased sedimentation contributing to turbidity in the local waterways is one concern particularly for wetlands where it can stifle native flora.[30] Further, the increased sedimentation may directly affect trout populations. High levels of turbidity during spawning may lead to suffocation of eggs effectively reducing number of fish spawned during that season.[31] Mine runoff that increases waterway sedimentation also contributes to concerns at trout hatcheries in the region. Fish health in hatcheries is reliant on reliable and clean sources of water for rearing of fish.[32] Potential reductions in water quality from runoff in the region will have a negative impact on fish health. Further, turbidity of the water may decrease the aesthetic pleasure received from boating activities on the waterways.

Examples from Wisconsin illustrate the concern regarding proper planning for runoff from industrial frac sand facilities, but also for enforcement of these requirements. From November 2011 to August 2013, there were 20 citations issued for water-related violations in Wisconsin frac sand mines.[33] Further, a discharge from Pattison Sand located in Clayton County, the only operational frac sand mining company in Iowa, resulted in the destruction of threatened and endangered mussel habitat along the Mississippi River in 2011.[34]

In addition to storage pond concerns, lack of adequate stormwater diversion may lead to runoff from frac sand mines affecting local waterways. Large piles of sand are generally stored onsite for processing, transportation or reclamation. These sand piles may contain wet sand from washing or from mining under the water table, in addition to saturation from rain events. When the sand piles become oversaturated, the pile itself may become structurally compromised leading to a deluge of sand/water slurry that could potentially reach local waterways.

Flocculants

The chemical of concern in frac sand mining is generally polyacrylamide, which naturally breaks down forming small amounts of acrylamide,[35] listed by the U.S. Environmental Protection Agency[36] as “likely to be carcinogenic.” When mines recycle water in the sand washing process, polyacrylamide may be added to the water storage ponds to settle out the solid debris from previous washing. The clarified water may then be reused in the washing process while the separated solids are stored in sand piles to be used in mine reclamation. This sand may contain small amounts of acrylamide when it is buried during reclamation, introducing a potential water quality concern. If acrylamide remains in the sand when it is buried, water flowing through the buried sand may transport the chemical into groundwater resources, especially in shallow fractured rock/karst geology where water may not be naturally filtered before entering

groundwater. In addition, if storage ponds experience overflow events, the water containing polyacrylamide and some amount of acrylamide may then be released into the environment, where it may enter groundwater reserves. Furthermore, events where sand piles become saturated and overflow may introduce the chemical into local streams and waterways.

Natural Groundwater Filtration and Stormwater Flow

Mining disrupts the natural environment including its normal capacity to filter water before entering groundwater sources through disrupting and removing the sediment that naturally filters the water. This may occur through a change in water flow on the mine site diverting water from its natural flow path, which may lead to reduced filtration of the water. In addition, the scenic bluffs that characterize this part of Iowa are also where frac sand deposits are found. Mining of the sand may lead to the blasting and removal of the bluffs, which potentially changes the flow of water in the area near the mined bluff. The changes in surface water and groundwater flow may increase stresses on regional trout populations through unfiltered water entering their habits, increases in water temperature, and decrease the allure of the area for recreational boating through increased turbidity. Further, mining enables pathways for pollutants to reach groundwater, particularly as mining near the water table can create access points for interaction of surface and groundwater.[37]

Mine reclamation plans attempt to restore the natural filtering capacity of the land; however, this can introduce its own set of concerns. Soil removed during the mining process is often stored onsite for use in reclamation. In addition, washed sand not suitable for sale is stored onsite for use in reclamation. This potentially flocculant-contaminated sand presents a groundwater contamination risk especially in shallow fractured rock/karst geology.[38]

Tourism

The water resources in Northeast Iowa play a vital role in the local economy drawing tourists for recreational activities such as angling and boating. The water quality and quantity concerns previously outlined could have a direct effect on the tourist economy of the region. The U.S. Travel Association[39] conducted an economic impact of travel in Iowa. Its findings in Table 2 show that Allamakee and Winneshiek counties generated approximately $68 million in domestic travel expenditures leading to over 500 travel-related jobs in 2012.

This economic activity depends on local waterways. Specifically, in 2010, the Upper Iowa River generated approximately $10.3 million and 128 jobs while the Yellow River generated $2.2 million and 27 jobs to the local economy.[40] In addition, the Bear Creek fishery mentioned above as an example of national, state, and local cooperation that covers both counties, alone generates nearly $3 million dollars a year from expenditures made by anglers who come to the region to enjoy the clean water conditions. A degradation of either water quality or quantity from industrial frac sand facilities would reverse the gains made over the past several decades and might adversely influence the livelihood of local residents who depend on tourism associated with local waterways and natural amenities.

Table 2. Domestic Travel Brings Tourism Spending, Jobs to Allamakee, Winneshiek Counties (2012)

	Expenditures ($ Millions)	Payroll ($ Millions)	Employment	State Tax Receipts ($ Millions)	Local Tax Receipts ($ Millions)
Allamakee County	$ 39.00	$ 3.63	190	$ 1.82	$ 0.91
Winneshiek County	$ 29.07	$ 4.95	330	$ 1.62	$ 0.28

Source: U.S. Travel Association, 2013

As noted earlier, tourism and outdoor recreation are important components of the local economy with $68 million in expenditures leading to over 500 persons employed in 2012. The region is marketed as "Iowa's Bluff Country."[41] Yet, the scenic bluffs that the region promotes are the same bluffs that frac sand mining companies propose to remove during the sand extraction process.

Industrial frac sand facilities are an intensive land use that has the potential to negatively change the local environment with implications for land use decisions near mines. Undoubtedly, the mining industry would create a local economic impact. However, the specifics of how the mining industry would affect the local tourist industry are in question. As noted earlier, frac sand mining can harm the water resources of the region. Power and Power,[42] in a report on the economic benefits and costs of frac sand mining in Wisconsin, found that mining promises wealth generation for the community but rarely leads to continued prosperity. The Power and Power report[43] continues that this is due to boom and bust cycles associated with mining and the limited connections between mining and local economies; much equipment is purchased from outside the region. Moreover, the report states that the mining "can discourage or displace other economic activities" leading to potential economic losses in the region.[44] Two economists from the University of Wisconsin-Madison reported on the economic effects of the frac sand industry on communities in Pepin County Wisconsin, known for its unique natural amenities. They concluded—"For these particular communities, the cost of local frac sand activity may exceed the benefits in both the short and long run."[45] Thus, when analyzing the economic impacts of proposed frac sand mines, it is important to consider the opportunity cost of other land uses (i.e. tourism and general quality of life from natural amenities and recreational activities).

Natural amenities have shaped and characterized this region of Northeast Iowa with links to the vitality of the local economy. McGranahan[46] states that population change in rural counties and growth of rural recreation are tied to the presence of natural amenities such that counties with high amenities scores saw, "three times as many new jobs in 1996 as in 1969" compared to counties with low amenity scores. Frac sand mining has the potential to alter or remove the local amenity resources, which may ultimately affect the vitality of the region. Table 3 depicts the number of city, county, state, and national parks found in Allamakee and Winneshiek counties, indicating the importance of open spaces and natural amenities to these communities.

Table 3. Parks Important to Allamakee, Winneshiek Counties (Parks by County)

	City Parks	County Parks	State Parks	National Monuments
Allamakee County	5	16	2	1
Winneshiek County	15	6	2	0

Source: Northeast Iowa Tourism Association, n.d.

Regulations in Wisconsin and Minnesota

Regulation of sand mining generally falls under two distinct categories: land use regulations and environmental regulations.[47] Land use regulations generally reside with the local municipality, township or county in the form of zoning ordinances or police powers used to protect the health, safety and welfare of residents. Environmental regulations are generally administered by the state, but local governments may implement environmental regulations also. Regulations at the local and state level play a critical role in the expansion and location of industrial frac sand facilities. The differences between local and state regulations, in both Wisconsin and Minnesota, illustrate this point.

Wisconsin

Wisconsin has seen the greatest growth in frac sand mining due to its abundant and accessible supply of sand, as well as the presence of transportation infrastructure capable of moving large quantities of sand. Bergquist[48] reports that there were only five sand mines and five processing centers in 2010; however, by June 2013, the state reported approximately 115 licensed industrial frac sand facilities. Redden[49] argues that the growth in Wisconsin is due to the weak regulation and strong government support for the industry.

The state government of Wisconsin has been favorable to the frac sand industry since its explosion in 2009 illustrated by Governor Scott Walker's quote that Wisconsin is "open for business." For example, in 2013 there was significant investment in freight rail and roadway infrastructure improvements, which would allow greater transportation and export of frac sand.[50] The state agency in charge of monitoring frac sand mining is the Wisconsin Department of Natural Resources, which administers air and water quality permits for the state. Local governments have also implemented ordinances that can regulate some aspects of industrial frac sand operations. The Wisconsin League of Conservation Voters[51] finds two fundamental problems with current Wisconsin state regulation: 1) inadequate laws do not account for cumulative effects of mine clustering, and 2) the current laws are not enforced, a point highlighted by Wisconsin Department of Natural Resources (WDNR) sending noncompliance letters to 80 percent to 90 percent of mines visited.

Local Regulation

Local governments in each state have been leading the charge for increased scrutiny of the industry. Wisconsin local governments granted industrial frac sand licenses before knowing the full range of externalities associated with industrial frac sand operations. Local governments can address industrial frac sand facilities through zoning ordinances. However, many townships in Wisconsin do not have zoning ordinances, and if they do, they must work with the county to receive approval for any changes.[52] This lack of local zoning ordinances led to one municipality using its police powers (i.e. government authority to regulate by protecting the "health, safety, and welfare" of its citizens) to prevent siting of a frac sand mine. The State Supreme Court ultimately ruled the municipality's action legal in 2012; this court decision was to some extent the impetus for a 2013 Wisconsin legislative bill seeking to limit local powers.[53] In this case, the State Supreme Court found that, "while zoning ordinances and pure police power regulations are closely related, they are not the same" and that "a town may exercise its police power authority to regulate activities involving land use, such as non-metallic mining (i.e. frac sand mining)."[54] Local governments in Wisconsin have responded to the sand surge by enacting moratoria or preventing the siting of industrial frac sand facilities, using their police powers to regulate health, safety and

welfare. However, local authority is being undermined by competition between cities, leading to annexation of frac sand land from local townships. In this "annexation battle", once an industrial frac sand facility is annexed to a different jurisdiction, new and generally more lax rules may apply, leading to further concern. This is what happened in Blair, Wisconsin, when the city annexed land with an active industrial frac sand facility and drafted rules that allowed the facility to operate 24 hours a day.[55]

Minnesota

In contrast to the state of Wisconsin, the Minnesota state government has taken a more conservative approach toward permitting the frac sand industry. Minnesota's Environmental Quality Board[56] noted that as of December 2012, the state had six operational frac sand mines, which indicated much slower growth in Minnesota compared to Wisconsin.

Minnesota has two state agencies in charge of permitting industrial frac sand facilities: the Minnesota Department of Natural Resources (MDNR) and the Minnesota Pollution Control Agency (MPCA). The MPCA is in charge of issuing permits for compliance with air and water quality while the MDNR is responsible for interactions with the natural environment such as stream setbacks and reclamation efforts.[57] In 2013, the state Legislature passed a frac sand mine setback requirement of one mile from trout streams without a permit, in addition to asking the state's Environmental Quality Board (EQB) to develop draft standards to assist local governments in regulating sand mining.[58] The EQB is an entity consisting of the "Governor's Office, five citizens and the heads of nine state agencies" that determine environmental policy for the state and reviews projects that have large impacts on Minnesota's environment.[59]

The EQB released the draft standards in September 2013. Environmentalists criticized the guidelines as less restrictive than what local governments were currently enacting.[60] Following this, the EQB disseminated a draft report containing tools for local governments to use while regulating the frac sand industry.[61] Assisting the anti-sand movement in Minnesota, Hemphill[62] reports that, "Gov. Mark Dayton has suggested the fragile, interconnected groundwater systems in southeastern Minnesota should be off-limits to frac sand mines." Governor Dayton recognizes the concern associated with frac sand mining in karst geology due to the interaction of surface water and groundwater in these regions. This is in stark contrast to Wisconsin's executive branch fully supporting frac sand facility growth within the state.

Local Regulation

Local governments in Minnesota have learned from the experience in Wisconsin and have taken proactive measures to mitigate the risks from frac sand mining. This mitigation has taken the form of moratoria or increased scrutiny of industrial frac sand facility siting. For example, Goodhue County, while under a mining moratorium, passed two ordinances in June 2013 that limit the size of mines to 40 acres at any given time, limited the hours of operation, required air monitoring, and required a 1,000-foot setback from dwellings or residential subdivisions.[63] In addition, Winona County approved its first mine in June 2013, requiring 40 conditions be met covering concerns that included dust mitigation, noise, erosion and water quality.[64] Local governments in Minnesota have been studying the frac sand issue in Wisconsin and adopting practices to mitigate the worst of the concerns.

Comparison of Wisconsin and Minnesota State Environmental Regulations

Minnesota Public Radio examined several differences in terms of frac sand mining's environmental regulation for both Wisconsin and Minnesota, prior to 2013 legislative changes in Minnesota.[65] Table 4 highlights the key points from the article. As the table indicates, Wisconsin environmental regulations are less stringent than Minnesota's, with no environmental reviews and greater water pumping rates without permits.

Table 4. More Stringent Frac Sand Regulations in Minnesota than Wisconsin

	Minnesota	Wisconsin
Environmental Review	Mandatory environmental review for mines of a certain size (> 40 acres)	Environmental review only necessary if involving government land
Water Appropriation	Permit for pumping more than 10,000 gallons/day	Permit for pumping more than 100,800 gallons/day
Reclamation	No state requirement for reclamation plan	Requires reclamation plan ahead of time and financial assurances
State Resources	Two different agencies must approve permit	One state frac sand contact person for permits
Inspections	No designated frac sand inspector	No designated frac sand inspector

Source: Dunbar, 2013

Another comparison of the strength of protection of communities in the two states comes from a 2012 exchange of letters from officials in Wisconsin and a new report by environmental officials in Minnesota. The Wisconsin Association of Local Health Departments and Boards asked WDNR and the Wisconsin Department of Health Services (WDHS) to "Establish a task force made up of public health and industry experts to determine the health hazards associated with the frac sand industry in Wisconsin and, if necessary, identify a set of measures that can be incorporated into administrative code to mitigate those health hazards."[66]

The two agencies answered this letter in just a month to say, "WDNR has considered your request for development of new standards. WDNR believes that existing regulatory tools provide for successful management of the issue." Following this, the letter explained the existing regulatory framework and offered to discuss the issues raised in more detail.[67]

The response to local concerns in Minnesota was quite different. In December 2013, the EQB disseminated a draft report containing tools for local governments to use while regulating the frac sand industry.[68] Among the recommendation in the 165-page report was an offer to assist local governments by creating a silica sand technical assistance team. The team — to be made up of staff members of the MDNR, the MPCA, Board of Water and Soil Resources, Department of Health, Department of Transportation and universities in the state as well as federal agencies — would bring their expertise to the service of local governments. There was a strong recommendation to pay for these services by assessing the project proposer for reasonable costs associated with the technical assistance.

Policy Considerations for Iowa

This paper has examined the potential water quality and quantity impacts of frac sand mining in Northeast Iowa. Frac sand mining has many other potential negative impacts such as air quality, transportation, and reclamation concerns that are outside the focus of this paper. The following policy considerations are focused solely on water quality and quantity concerns.

State Preemption of Local Regulation

Allamakee and Winneshiek counties in Iowa have established moratoria on new frac sand mine operations in order to study the issue and decide on a set of ordinances to properly regulate these operations. It is possible that these actions are in vain however. It is possible the state could take local decision-making away. Iowa has a history of preempting local government from regulating in some areas. While it is common for higher levels of government to try to keep laws consistent, the lower level government is often allowed to adopt regulations that are more stringent. This is not true in several high profile areas.

Proponents of preemption laws generally couch their support as a way of maintaining consistency in laws across a state. For instance, the National Rifle Association (NRA) joined a lawsuit to protect an Ohio law to prevent an "unreasonable and confusing patchwork of municipal gun laws" in the state.[69]

> *The NRA works with gun owners and lawmakers to enact preemption laws in the few states that still permit local ordinances more restrictive than state law. To ensure uniform firearm laws throughout your state and to guarantee equal rights for all, support statewide firearms preemption.*[70]

Not generally mentioned by the NRA or any other group is the reality that it is easier to pass one law at the state level than to go to 99 Iowa counties or a plethora of cities to pass the legislation that a group favors. An example is the following Iowa state statute:

> *"A political subdivision of the state shall not enact an ordinance regulating the ownership, possession, legal transfer, lawful transportation, registration, or licensing of firearms when the ownership, possession, transfer, or transportation is otherwise lawful under the laws of this state."*[71]

Other areas of Iowa law where local governments are prevented from enacting more stringent limits than those of the state include pesticides, tobacco and genetically modified seeds.

The Centers for Disease Control and Prevention (CDC) recognizes that preemption by states can lead to weaker laws than if local governments were able to act. The CDC monitors state laws on

preemption of local regulation of tobacco. As stated on the CDC website, "A *Healthy People 2010* objective (27-19) is to eliminate state laws that preempt stronger local tobacco control laws."[72]

In Iowa, perhaps the closest issue to local control over industrial frac sand facilities is preemption of local government powers to regulate the location and emissions to air and water from concentrated animal feeding operations (CAFOs).

A series of Iowa Supreme Court cases have established that the Iowa Legislature can limit any local government action governing locations of CAFOs or placing limits on their discharges to water or air. The Iowa Supreme Court held that all agriculture, including an animal feeding operation, is exempt from any county zoning. (*Kuehl v. Cass County 1996*) Humboldt County later attempted to put controls on CAFOs as a proper application of "home rule" authority but lost in the Iowa Supreme Court. (*Goodell v. Humboldt County, 1998)* In the face of this state preemption, a Worth County ordinance sought to regulate CAFO operators based not on home rule, but on the county's ability to protect public health. This ordinance was also struck down as being void and unenforceable because it was contrary to state law. The opinion of the court was that "We conclude the Worth County ordinance is the type of ordinance expressly preempted by the state statute. Our legislature intended livestock production in Iowa to be governed by statewide regulation, not local regulation. It has left no room for county regulation."[73] (*Worth County Friends of Agriculture v. Worth County, 2004*)

In exchange for eliminating local governmental action, Iowa legislators provided an opening for local advice and limited consent when the Master Matrix went into effect in 2003. This is a scoring system that forces an operation to adopt measures such as greater separation distances and more stringent manure practices. However, if the operation attains a minimum score on the Master Matrix, its permits will be approved by the DNR even if there is public opposition to the operation and the county recommends against it.[74] The Winneshiek County Board of Supervisors voted 5-0 and two supervisors appeared before the Iowa Environmental Protection Commission to appeal a DNR approval of a permit for a CAFO in the county in a karst region in October of 2013. They were turned down.[75] This is not an exception. An earlier Iowa Policy Project report documented that the Master Matrix is extremely weak since it does not distinguish between types of rivers that could receive pollution from a CAFO location. In 2008, very few restrictions were put on two facilities that could drain into the pollution-impaired Raccoon River above where the City of Des Moines Water Works receives water that must be treated to potable levels for more than half a million Iowans.[76]

Iowa county governments should be concerned that frac sand operations might be treated the same as CAFOs and local regulation eviscerated. Preemption of local regulation of frac sand operations is already under discussion in Wisconsin. Several Wisconsin state legislators introduced legislation in October 2013 that would limit local governments' ability to enact restrictions on the sand mining industry. While the bill has been delayed until the spring 2014 session of the Legislature, it is a very real threat to local control. The proposed bill, SB349, would restrict municipalities to regulating industrial frac sand facilities only through zoning ordinances and not be able to use any additional authority such as police powers, "essentially preempting much of local governments' authority in regulating the industry."[77] At a hearing on the bill October 24, 2013, the director of the Wisconsin Towns Association, Richard Stadelman, concluded his lengthy testimony with the following statement:

> *Our Association believes that the current authority of towns and counties to regulate*

non-metallic mining operations should be retained. Preempting town licensing ordinances for non-metallic mines would leave many towns and town residents without protections that have already been granted and agreed to by the over 100 industrial sand operations existing in Wisconsin.[78]

Silica Sand Technical Assistance Team

Based on the concepts of home rule and protecting the health and safety of citizens, the authors believe that zoning and site planning for frac sand mines should mainly rest with the local jurisdiction. However, the state can play an important role in facilitating an informed decision-making process for local governments when considering an industrial frac sand facility permit. For example, Minnesota's EQB has empaneled a technical assistance team to assist with "ordinance development, zoning, environmental review and permitting, monitoring, or other issues arising from silica sand mining and processing operations."[79] As explained above, a team can consist of members from state agencies and others that have technical competencies related to industrial frac sand operations and their impacts. The State of Iowa should develop a comparable team of experts to assist local governments in determining the proper placement and environmental impacts associated with an industrial frac sand facility prior to permit approval. Furthermore, by placing the cost burden on the project proposer, financially constrained local governments will be able to provide proper evaluation and monitoring services financed by the industrial frac sand facility itself rather than from their limited budgets.

Ordinance Recommendations

The EQB draft toolkit[80] for local governments should be the starting point for ordinances now being considered in Allamakee and Winneshiek counties in Iowa. The toolkit provides detailed ordinance recommendations for a range of topics including water resource issues. Northeast Iowa local governments should consider all the suggestions, in addition to the following general water-related items when drafting ordinances.

Hydrologic Mapping

A comprehensive hydrologic analysis of the industrial frac sand facility site and the surrounding area should be completed to show groundwater flow patterns and the facility's impact on the area.

Local Well Monitoring

Monitoring of local wells should begin prior to a facility's activation to determine a baseline level for well quality and quantity; monitoring should continue at least quarterly after a facility has become operational.

Sinkhole Setbacks

Where applicable, a setback from sinkholes and other karst features should be required. For example, Minnesota requires a mine site to identify all karst features within 500 feet of the site and then requires a hydrologic analysis to determine a facility's impact.

Trout Stream Setbacks

Trout streams represent a valuable component of the local economy and natural environment and need to be protected. As demonstrated earlier, frac sand mining may impose significant impacts on these streams. Minnesota has responded to this concern by requiring a one-mile setback from

trout streams without a permit from the DNR. Iowa local governments should consider a similar one-mile setback from trout streams.

Cumulative Impact

One of the largest issues facing local governments is the cumulative impact of multiple industrial frac sand facilities in a close proximity. The placement of multiple facilities in a close geographic area may exacerbate water quality and quantity concerns. For example, if several industrial frac sand facilities were located in a close area, the withdrawal of water could be significant leading to a cone of depression over a wide geographic area.

Conclusion

As with any form of resource extraction, environmental concerns are associated with industrial frac sand facilities. The frac sand industry's potential foray into Iowa has raised concerns from local residents regarding the potential environmental impacts as illustrated by Wisconsin's experience. These environmental impacts (e.g. water quality and quantity concerns) could potentially alter the nature of the Northeast Iowa economy and residents' quality of life. When drafting ordinances for frac sand mining, local governments need to be aware of the potential costs the industry will impose (e.g. loss of tourism and general aesthetics) along with the benefits. The cumulative effects of multiple industrial frac sand facilities operating in a small geographic need to be understood prior to permitting any single mine.

Finally, state leaders in Iowa should recognize the responsibility, expertise and concerns of local officials in determining what is best for their area. Any discussion of state preemption of local government action similar to what is being discussed in Wisconsin should not be part of the discussion of how the water resources of this beautiful area of the state of Iowa should be protected. The example of the Bear Creek fishery demonstrates that local people can work together to find what is in the interest of nearly all citizens in the region. State environmental personnel can help in this effort but success requires local officials to lead and control the effort.

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