

Transportation Impacts of the Wisconsin Fracture Sand Industry



**Wisconsin Department of Transportation
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It is safe to say that many fortunes have been made or lost by people trying to predict the future of the energy industry.

The energy industry, by nature, is shaped by a myriad of financial, technological, and socio-political issues that make the industry unpredictable and prone to boom and bust cycles. The Wisconsin Fracture Sand industry, being intrinsically tied to the world energy industry, becomes similarly unpredictable and a challenge to succinctly analyze.

The authors of this report do not claim to be experts in either the energy or fracture sand industries. Our goal has not been to generate our own data, but rather gather data from experts and expert sources and find the corollaries within that data that establishes the data as reliable information.

To that end, we have collected the information contained in this report from scores of conversations with Industry Officials, Logistic Experts, Financial Industry Analysts, other state and federal agencies, local government officials, and other intergovernmental discussions. We studied countless industry journals, local conditional use permits, environmental impact statements, traffic impact analyses, and media reports.

The purpose of our analysis was to identify potential impacts to the Wisconsin transportation system from the rapid expansion of the fracture sand industry, and to develop strategic mitigation plans for those impacts. On several occasions generalized assumptions were used that acknowledge a certain degree of statistical variation. However, upon reading this report one will see that investigating the fracture sand industry boom is an analysis on degree of magnitude as opposed to finite accuracy.

Interested parties that wish to use any of the information for purposes other than that must rely on his or her own inquiries and investigations.

EXECUTIVE SUMMARY

According to the United States Geological Survey data, Wisconsin ranks third in total US industrial silica sand production, after Illinois and Texas, but number one in the production of fracture sand. Wisconsin has attained that number one ranking because it has a plentiful and readily accessible supply of silica sand that meets the most demanding oil and gas industry specifications necessary for deep well fracture proppants. Hydraulic fracturing or, “fracking,” uses hydraulic pressure to fracture oil and gas bearing rock formations surrounding a drilled oil well pipe. Sand or synthetic beads are then pumped into the fracture to serve as a ‘proppant’ to prop open the fractures to maintain a path for gas or oil to flow.

The pace of expansion has been amazing.

- In 2009, Wisconsin had only a handful of mines, five or six processing plants, and demand market primarily dedicated to glass manufacturing, foundry, and abrasives industries. By January 2013, more than 100 mines had been proposed, permitted or opened; more than 20 processing plants had been constructed; and the vast majority of production is now dedicated to fracture sand market.
- In 2009, there were only a handful of legitimate transload facilities in Western Wisconsin for moving freight from truck to railroad modes. By the end of 2012, there were more than two dozen transload locations constructed or in the permit approval process, nearly all of which were directly related to fracture sand industry.

To understand the fracture sand industry it is imperative that one realizes it involves far more than the mining of silica sand in Wisconsin. It involves the transportation of silica sand from the mine to a processing plant. The sand must then be taken to a transload facility where it is loaded onto trains or barges to be shipped to oil or gas drilling fields in places such as North Dakota, Pennsylvania or Texas. Once oil is extracted from shale nearly two miles underground, it is transported either thru pipelines or on trains; much of it crossing Wisconsin to refineries. To understand and quantify the fracture sand industry’s impact on Wisconsin’s Transportation System, one must understand the entire supply chain.

Studying a developing industry presents an array of hurdles to overcome:

- No established nationwide database
- No established statewide database
- Analysis becomes a compilation of numerous sources
 - Industry Officials
 - Logistic Officials (Rail/Barge/Pipeline)
 - Industry Journals
 - Financial Industry Analysts
 - Conditional Use Permits
 - Environmental Impact Statements
 - Media reports
 - Intergovernmental discussions

The purpose of this analysis is to understand the industry well enough to determine if a system-wide concern is occurring and, if so, what program-wide solutions need to be developed.

Total Demand Market for Fracture Sand

Industry analysts in 2012 indicated total US proppant production grew from 6.5 million tons per year (TPA) in 2009 to 28 million TPA 2011.

- ***Analysts' reports as recently as November, 2012 suggest an 8.9% annual increase through 2016 for a CY 2016 market demand of 38 million TPA***

Wisconsin Share of Total Demand Market for Fracture Sand

While Wisconsin does have the largest reserve of the highest quality fracture sand, that type of sand is not constrained solely to Wisconsin. Northern Illinois, Southeastern Minnesota, and Northeastern Iowa all have deposits of what is generally referred to as Northern White of the Wonewoc, St. Peter, Jordan, or Ottawa type sandstone formations, and have been the home to industrial sand mining for many decades. Missouri, Arkansas, and Texas all have growing fracture sand industries using somewhat lower quality sand than Northern White, but since they are in closer proximity to Texas and Oklahoma oil shale plays, they remain attractive alternatives. In addition, several fracture sand mining operations have developed in Canada, providing options for both Canadian and Bakken drilling operations.

- ***WisDOT Northwest Region (NWR) has determined it is reasonable to estimate that Wisconsin is positioned to produce up to 50% of the total fracture sand market, or up to 16-20 million TPA by 2016.***

Fracture Sand Industry Stabilization

A current inventory of active fracture sand processing plant and mine capacity indicates Wisconsin already has the capacity to meet or exceed that projected market share of 16-20 million TPA. A 20 million TPA production rate would require the following active industry assets:

- 20-40 operating processing plants at any given time.
- 30-50 operating mine locations at any given time.

A WisDOT NWR examination of county mining permits and staff field reviews indicates that as of November 2012, Wisconsin already had more than 30 active mines, and approximately 2 dozen active processing plants with capacity to average more than 1 Million TPA per plant. These numbers would strongly suggest that fracture sand industry in Wisconsin should be reaching a market stabilization point.

- ***There is ample evidence to suggest stabilization has been occurring since the summer of 2012. The number of permitted mines going 'active', the number of new processing plants being constructed, and number of new permit applications for mines, processing, or transloads facilities have all slowed to almost a standstill since the summer of 2012.***

Fracture Sand Industry Maturation

The manner in which the recent expansion of the Wisconsin fracture sand industry established itself strongly suggests a specific business model is required to maintain long-term viability as an industry player. That business model defines the who, how, what, and where of a mature fracture sand industry in Wisconsin and has the following critical factors:

1. Established connections with the demand market of drillers and mineral exploration.
2. Secured access to high volume railroads with high capacity (i.e. multiple unit train storage) trans load facilities.
3. Ability to generate large amount of capital (i.e. \$75-\$100 Million) and rapidly (i.e. within 6-18 months) convert those funds to physical production facilities.
4. Minimal “first or last mile” logistical costs for truck transport of processed sand by locating mines and sand processing near or at rail transload facilities

- ***These factors lead to the conclusions that a mature fracture sand industry in Wisconsin will have the following characteristics:***
- ***Large, nationally recognized production players will dominate the market.***
 - ***Geographical location will be dictated by access to Class 1 railroads rather than proximity to sand. Sand is everywhere...access to railroads is limited.***
 - ***Optimized logistics by having close proximity between their transload facility, processing, and mine sites.***
 - ***Processing facilities with capacity in excess of 1 Million TPA***
 - ***Mississippi River barges will provide a link for sand to markets in the southern United States, however, the volume of sand transported by barge will be fractional compared to sand transported by rail.***

Threats and Opportunities for A Stable Wisconsin Fracture Sand Industry

Even though Wisconsin has become the number one producer of fracture sand in the US, that leadership position is not without threats and challenges.

- ***Some of the more prominent threats are:***
- ***Wisconsin sand is not in close proximity to any shale plays and thus has significant imbedded logistical costs.***
 - ***Ongoing technological advances allowing the use of lower quality fracture sand that is much closer to shale plays and can be acquired with lower logistical costs.***
 - ***Synthetic proppants continue to push their cost point down to challenge the low cost edge that natural sand currently has.***
- ***Some of the more prominent opportunities that may enhance Wisconsin’s ability to retain its position as leading producer would include:***
- ***Threat of statewide moratoriums in both Minnesota and Iowa that would further delay and preclude new mines from entering the marketplace in those states.***
 - ***Similar moratoriums in any other fracture sand producing state.***
 - ***Established and active processing plants and permitted mine inventories in Wisconsin that can already meet and exceed more than 50% of total North American market demand.***

Impacts to Wisconsin's State and Local Highway System from Fracture Sand Mining Industry

- ***Most of the roadway impacts related to the fracture sand industry will occur on the local highway system in locations where sand is moved by truck from mine site to processing, or processing to transload.***

Wisconsin Statutes (349.16) allows local units of government to enter into road maintenance agreements with fracture sand companies to mitigate impacts that the increased heavy truck traffic may have on their roadway system. This authority has been used successfully by several counties to the mutual benefit of both the county and sand companies. Some latent concerns remain within the fracture sand industry and members of state legislature regarding inconsistent application of this authority among local units of government.

- ***The overall impact to the state highway system will be relatively minor, constrained to a relatively small percentage of state highways segments or locations, and primarily in the form of improvements at public and private road intersections where fracture sand industry related traffic may be entering or exiting the state highway system. Most of these types of improvements have been covered at fracture sand industry expense through the local permitting process.***
- ***Impact to the pavement life on the state trunk highway by the fracture sand industry will not have a significant impact to overall programming priorities with the WisDOT improvement program.***
- ***Ongoing attention will be required at the interstate bridge crossings at Winona and Wabasha. These bridge locations are natural convergence points and will see increased fracture sand industry traffic moving to and from the transload facilities in those cities.***

Except in instances where direct access to the state system is requested, WisDOT has very limited authority to require improvements be made by a proposed facility. WisDOT routinely works in partnership with local units of government and private sector developers to insure appropriate safe and efficient access onto and off from the state highway system. As fracture sand interests develop plans for building new facilities, it is essential that WisDOT continues to develop and maintain discussions with the local permitting authority to have necessary improvements included as part of an applicants' conditional use permit.

Rail System Impacts

Rail traffic has and will continue to increase because of sand being transported out of Wisconsin and oil being transported back through Wisconsin from the Bakken oil fields in North Dakota. This has and will likely continue to lead to an increase in concerns and complaints regarding train crossing safety, delays to automobile travel and noise.

- ***By late 2012 the number of carloads of oil moving out of the oil fields in North Dakota exceeded the number of carloads of sand coming in. The number of rail cars of oil will continue to rise significantly for a number of years, while the numbers of carloads of sand leaving Wisconsin may already have peaked.***

Continued relationships to maintain current view of energy industry

Continued growth in the fracture sand industry will be directly tied to changes in the energy market. Between 2007 and 2012, natural gas production in the United States grew by 24%. With production at all-time highs, prices dropped precipitously in 2012, resulting in a 38% decrease in the number of drilling rigs in the Marcellus Shale play. This led to a sudden reduction in the market demand for dry gas (fine grain) fracture sand. At the same time, oil production in the Bakken Shale play nearly tripled. This increase in North Dakota drilling led to a sudden increase in the market demand for oil (coarse grain) fracture sand. While Wisconsin's silica deposits contain ample amounts of fine and coarse grain sand, the logistical impacts of the unique demands of the natural gas and oil industries are distinct.

WisDOT should continue to monitor the development of processing and transload facilities in Wisconsin and eastern Minnesota and correlate origin/destination of transport of sand. In addition, WisDOT should continue to establish and maintain partnerships and communications with the Minnesota Department of Transportation and North Dakota Department of Transportation. The three states should monitor both the transport of sand from Wisconsin and Minnesota to North Dakota and the transport of petroleum from North Dakota back through Minnesota and Wisconsin.

Since April 2012, WisDOT NW Region has been meeting monthly with WiDNR Fracture Sand Special Projects Coordinator to exchange information. The relationship has proven to be of great value to both agencies. WisDOT should continue to establish and maintain this partnership with WiDNR to the benefit of both agencies.

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The Wisconsin Fracture Sand Industry: The Big Picture

Industrial Sand mining has been common in Wisconsin for more than 100 years, providing high quality silica sand for glass manufacturing, foundry castings, and sanding abrasives. Within the past decade, there has been a dramatic increase in the demand for this same sand thanks to the increased use of a technique known as “hydraulic fracturing” or ‘fracking’ in oil and gas exploration.

Between 2009 and 2012, Wisconsin’s sand industry went from a handful of mines and processing plants to more than 100 operations that had been proposed, permitted or opened.

When the sand boom hit, immediate attention turned to specific locations where permits were being applied for. Town Boards and County officials were suddenly inundated with permit applications for an industry they were not familiar with, and on a scale beyond available resources. Media attention focused on the legal challenges, the public meetings, and the local debates.

WisDOT Northwest Region (NWR), however, had to focus on the bigger picture. There was a clear danger in just dealing with each permit request as an isolated question. This path would have precluded the department from being able to determine if a system-wide concern was occurring and, if so, what program-wide solutions would need to be developed.

This is where WisDOT NWR began to intensely pursue questions on the totality of the fracture sand industry in terms of total market demand, dynamics of how the industry is organized, and ultimately how that would shape and impact the Wisconsin transportation system.

The following report has two sections:

Section 1 – An Analysis of the Fracture Sand Industry – The fracture sand industry, like all industries follows a somewhat predictable life cycle. The industry will go through various stages: **Introduction, Growth, Stabilization** and **Maturation**. Part 1 is an examination of the life cycle of the industry, its supply and demand limits and market conditions that will shape the industries future.

Section 2 – Impacts to the Wisconsin Transportation System from the Fracture Sand Industry. – Based on the analysis discussed above, Section 2 of this report provides a summary of transportation impacts and issues for the Wisconsin Department of Transportation to consider as it manages the state’s transportation system and recommendations for processes and policies to manage the system in a way that meets the needs of all constituencies.

SECTION 1 – An Analysis of the Fracture Sand Industry

Introduction of the Fracture Sand Industry in Wisconsin

The fracture sand industry, like all industries follows a somewhat predictable life cycle. The industry will go through various stages: **Introduction, Growth, Stabilization** and **Maturation**.

What is Fracture Mining?

“Fracking” uses hydraulic pressure to fracture oil and gas bearing rock formations surrounding a drilled oil well pipe. Sand or synthetic beads are then pumped into the fracture to serve as a ‘proppant’ to prop open the fractures to maintain a path for gas or oil to flow.

Hydraulic fracturing is key in recovering oil and natural gas in shale formations, which until the last decade, were not considered a technological or financially viable source of oil due to the rock’s impermeability. Over the past decade, major shale oil and gas plays have been mapped. Among the largest and most productive plays are the Bakken in North Dakota and Montana, the Marcellus which extends from Ohio through Pennsylvania and New York, and the Eagle Ford in Texas.



“Fracture drilling” has been used in the oil/gas industry for more than 50 years but until recently was only viable in vertical wells at relatively shallow depths. The current gas and oil shale play formations lie 10,000-14,000 feet deep in relatively thin horizontal shale bands. Recent technology allows for drilling at these depths, as well as in long horizontal runs, which can extend up to two miles from the vertical shaft. This combination allows drilling to get at these deep, narrow horizontal bands of oil and gas bearing shale, which, when combined with fracking, can extract that oil or gas. Energy industry analysts believe the shale plays may extend the life of known supplies of domestic crude oil by as much as 50 years.

Proppants used in deep well fracturing must be able to withstand extremely high pressures in excess of 14,000 psi. Most sand proppants used in the low depth, vertical well fracturing were not suitable for these high pressures. Synthetic proppants, such as ceramic, were developed to fill this need for reliable high pressure proppants that most traditional fracture sand could not.

However, it was soon discovered that certain naturally occurring silica sands did have properties suitable for deep well fracture proppants. The most abundant and readily accessible deposits of that sand are

found in Wisconsin. This specific type of silica sand is known as ‘Northern White’, and is referred to as the Gold Standard of fracture sands.

The Wisconsin “Sand Rush”

According to the US Geological Survey data, Wisconsin ranks third in total US industrial silica sand production, after Illinois and Texas, but number one in the production of fracture sand. Wisconsin has attained that number one ranking for several reasons.

- **Sand Specifications**
 - Wisconsin sand meets the stringent oil and gas drilling industry specifications necessary for deep well fracture proppants.
- **Abundant and Accessible Supply**
 - Abundant and widely accessible supply affords lower mining and processing costs, allowing Wisconsin sand to be price competitive with other deep well proppants. Wisconsin ‘Northern White’ can be mined and shipped to drilling locations for \$100-\$400/ton as opposed to \$800- \$1200/ton for synthetics.
- **High Volume Demand Market**
 - High volume demand creates opportunity for a high volume supply industry. A single fracture well may consume 5,000-25,000 tons of fracture sand. High volume supply industry makes it profitable to implement high production processing and transload facilities.
- **Long Term Demand Market Viability**
 - Fracture mining will continue for years to come. North Dakota alone has about 5,000 wells drilled to date, has more than 35,000 additional wells planned, and is drilling 10 new wells every day(*North Dakota Department of Mineral Resources*). Many wells require ‘re-fracturing’ after a few years to maintain oil and gas extraction. This results in a demand market with large, sustainable volumes making fracture sand mining investments sustainable for many years to come.

Because of these desirable market metrics, demand for Wisconsin sand has skyrocketed.

- In 2009, Wisconsin had a handful of mines, five or six processing plants, and demand market primarily dedicated to glass manufacturing, foundry industry, and abrasives. As of January 2013, more than 100 mines have been proposed, permitted or opened; more than 20 processing plants have been constructed; and the vast majority of production is now dedicated to the fracture sand market.
- In 2009, there were only a handful of legitimate transload facilities in Western Wisconsin for moving freight from truck to railroad modes. By the end of 2012, there were more than two dozen transload locations constructed or in the permit approval process, nearly all of which were directly related to fracture sand industry.

Economic Opportunities of Fracture Sand Mining Industry

There has been significant discussion regarding the economic impact that fracture sand mining may have for the state and for communities. It is beyond the scope of this project to analyze the economic studies conducted in any detail. We offer them as information as to why there is an interest in some communities for sand mining.

A recent study funded by the petroleum industry indicates fracture sand mining has resulted in 20,000 jobs in Wisconsin. [*America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy, IHS Global Insights, 2012.*] The largest percentage of these jobs are transportation related, primarily trucking.

A 2012 study by the University of Wisconsin-Extension [*Fracture Sand Mining and Community Economic Development*] reports that wages associated with mining are high relative to other sectors in the local economy. However, the UW-Extension report also notes that due to the volatility of the mining industry and its intrinsic association with commodity prices, one tends to find a lower concentration of activities in mining dependent counties. That is, there are fewer “spin-off” businesses created by the existence of a mine than there are for other private market employers.

Unconventional Oil and Gas *Non-Producing* States: Top 10 Employment Contributions*

(Number of workers)

	2012	2020	2035
New York	44,429	74,007	78,645
Illinois	38,652	66,604	82,817
Michigan	37,848	64,551	78,632
Missouri	37,716	64,228	70,794
Florida	36,532	65,063	79,499
Wisconsin	19,760	33,112	35,976
New Jersey	19,753	34,455	40,537
Minnesota	19,103	34,815	42,691
North Carolina	18,665	32,477	37,439
Georgia	18,505	32,458	38,771
Top 10 Total	290,963	501,771	585,801
Non-Producing Total	474,144	816,563	955,491
US Total	1,748,630	2,985,176	3,498,694

NOTES: *The rank for all years is based on the 2012 ranking.
Source: IHS Global Insight

A 2012 study commissioned by the City of Marshfield in Wood County [*The Economic Impact of Fracture Sand Mining: A Look at Jobs and Earnings in Wood County, Wisconsin, 2012*] found the following economic impacts from fracture sand mining for the Wood County area:

- A new fracture sand plant and transport facility generate investments of over \$161 million within the first seven years, including \$86 million in the first 18 months, and another \$75 million over the subsequent 5½ years.
- In the first year, new facilities construction will result in the creation of approximately 616 new jobs and some \$33.3 million in new earnings in Wood County.
- By Year 3, with plants, mining, and transport facilities in place, fracture sand production will account for approximately 700 new jobs and over \$42.8 million in Wood County earnings.
- By Year 8, with both initial and expansion phase investments in place, fracture sand production will account for nearly 930 permanent jobs and over \$58.7 million in Wood County earnings.

Socio-Political Issues and Their Impacts on Fracture Sand Mining Industry in WI

The fracture sand boom, while providing economic opportunities, also brought significant controversy at the local level. At the risk of oversimplifying the debate, the heart of the controversy lies in differing values; economic benefit vs. potential social and environmental impacts. As local units of government tried to balance those competing values, several phenomena played out.

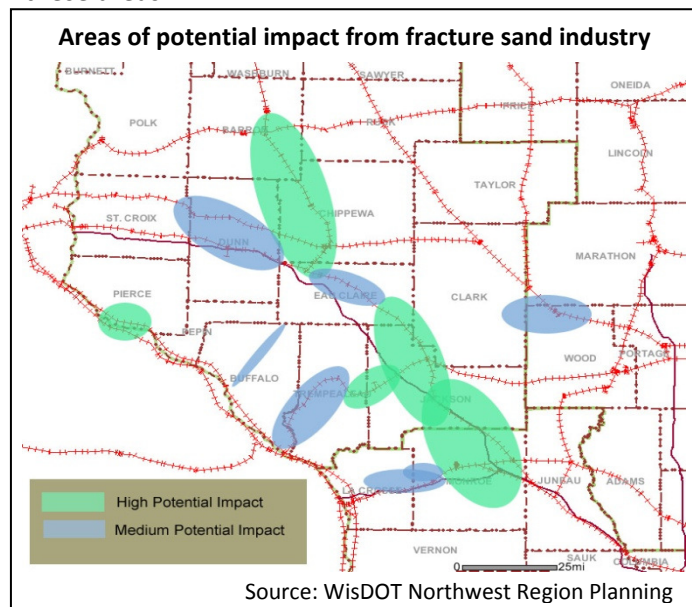
First, early sand industry entrants to the sand rush tended to search for potential industry sites in unzoned, rather than zoned towns. The opinion was that the unzoned towns had far less “red tape” required to garner the necessary permits for mining, processing, and transload facilities.

Secondly, certain localities developed strong public opposition to any aspect of the fracture sand industry and successfully prevented any number and variety of fracture sand facilities from being permitted. This created a socio-political environment that likely precluded other interested companies from even trying to start the permit process in these areas.

Finally, multiple county and town governments implemented moratoriums that prevented sand related businesses from opening new facilities until they could establish land use regulations to deal with the influx of sand related businesses.

The combined result of these phenomena was that the location of the early industry entrants was dictated far more by the ‘path of least socio-political resistance’ as opposed to specific sand locations.

Or stated differently, socio-political factors became an early determinant in defining the geographical location of fracture sand industry expansion within WI. As moratoriums were put in place in Dunn, Eau Claire, Buffalo and Pepin counties, significant sand mine development occurred in Barron, Chippewa, Trempealeau, Jackson and Monroe counties. Consequently, as these moratoriums begin to expire, there is an open question whether there is sufficient market demand remaining to create any significant mining industry in these areas.



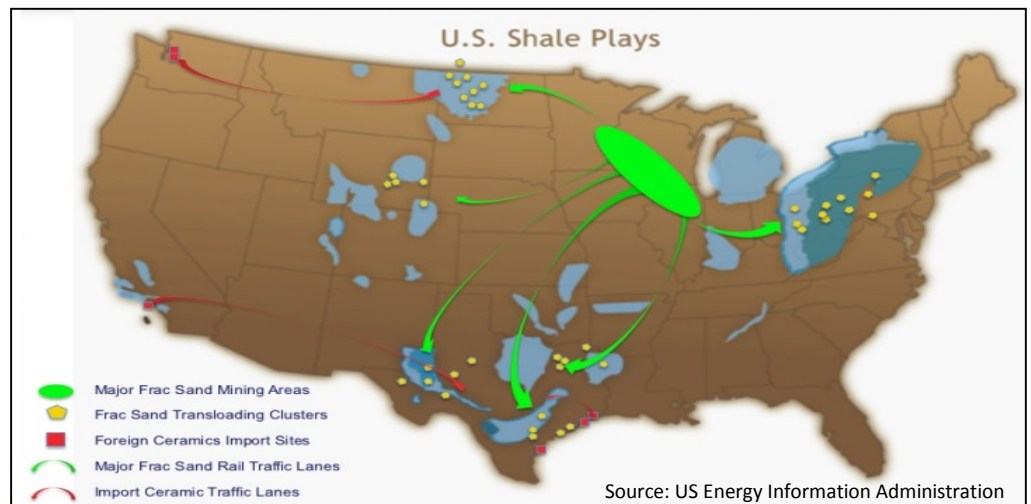
GROWTH OF THE FRACTURE SAND INDUSTRY IN WISCONSIN

When the sand boom hit, immediate attention turned to specific locations where permits were being applied for. Town Boards and County officials were suddenly inundated with permit applications for an industry they were not familiar with, and on a scale beyond available resources. Media attention focused on the legal challenges, the public meetings, and the local debates.

WisDOT NWR, however, had to focus on the bigger picture. There was a clear danger in just dealing with each permit request as an isolated question. This path would have precluded the department from being able to determine if a system-wide concern was occurring, and if so what program-wide solutions would need to be developed.

WisDOT NWR– “The 20,000 foot view”

WisDOT NWR began to intensely pursue questions on the totality of the fracture sand industry in terms of total market demand, dynamics of how the industry is organized, and ultimately how that would shape and impact the WisDOT transportation system.



They key question from which most of these answers follow is simply this:

- What is the total demand for fracture sand and how much of that can be supplied by Wisconsin?

Once this key piece of information is determined, many of the other market metrics can be derived and a probable prediction of how ‘big’ the fracture sand industry in Wisconsin can get can occur.

Early on, some very basic elements of the fracture sand market became evident and quickly led to conclusion that the industry was very quantifiable.

1. Locations for deep well fracture drilling are not unlimited, and thus ultimate market is limited.
2. The fracture sand market is limited to a North American market only. While fracture drilling is beginning to take place in Europe and Asia, transportation costs make Wisconsin fracture sand an uneconomical choice.

Building on these assumptions, investigation focused on data from national and international logistic companies, energy analysts, international banking sources, and myriad of other industry experts. The goal was not to create data or determinations on our own, but rather find that data and analysis done by true experts and then seek to find sufficient correlations between these sources to give that information high probability of accuracy.

What follows is a brief summary of those major market influences that influence the Wisconsin fracture sand industry. It is important to understand these market metrics before discussing probable predictions of future fracture sand demand. If one understands the market metrics, and more importantly, the volatility of those market metrics, one will understand why you only make energy related market predictions with care, caution, and disclaimers.

Demand Market Challenges

Some of the key influences on fracture sand markets are noted below:

1. Commodity speculation creates large recurring fluctuations in oil and gas prices which, in turn, create fluctuations in fracture sand demand.
2. Technology advances allowing lower cost synthetic or pseudo-synthetic proppants being produced in close proximity to shale plays.
3. Introduction of new technologies for oil or gas extraction other than fracture drilling.

Market Volatility and Point-In-Time Market Demand

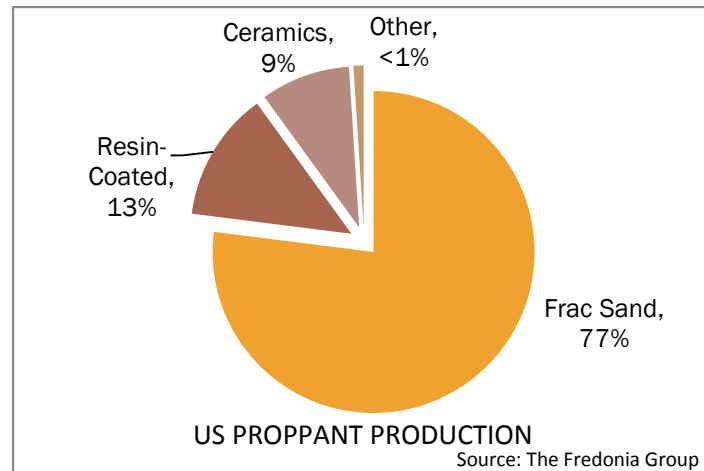
The oil and gas market is known for high volatility which can swing commodity prices by 10-20% in just a matter of days. The rapid escalation of oil prices to record highs of \$90-\$130/barrel in 2008 and 2009 is what made it ultimately economical to use the relatively expensive methods of deep well fracture drilling. Likewise, anecdotal information would suggest an oil price of \$80/barrel may make deep well fracture drilling not economical.

Evidence of these market trends on fracture mining has already become a reality for dry gas fracture mining. Commodity pricing of natural gas fell to historical lows in 2011 and 2012 resulting in fracture drilling for gas becoming an uneconomical enterprise. This resulted in a halting of and mass exodus of deep fracture drilling in the Marcellus Shale area in Pennsylvania which, in turn, resulted in a sudden and mass reduction in the market demand for dry gas fracture sand.

So while there still may be an average trend line toward that upper limit of the total market, there will also be demand surges and retreats because of the inherent commodity market pricing of oil and gas.

Proppant Alternatives Other Than “Northern White” and Other Pure Sand Proppants

Industry analysts indicate the proppant market is split between synthetics (i.e. ceramic), resin-coated sand (i.e. a pseudo-synthetic) and pure fracture sand. Pure sand dominates the market at 77% share. However that market size requires that product remain competitively low-priced.



Domestic and international ceramic proppant producers continue to find ways to push their market costs down from \$1200/ton few years ago to less than \$800/ton or less today. Similarly, with logistics accounting for up to 50% of the point of purchase price for Wisconsin fracture sand, the industry continues to find ways to use lower quality fracture sand that is closer to drilling fields and thus logistically cheaper to acquire.

Improvements in the fracture drilling process

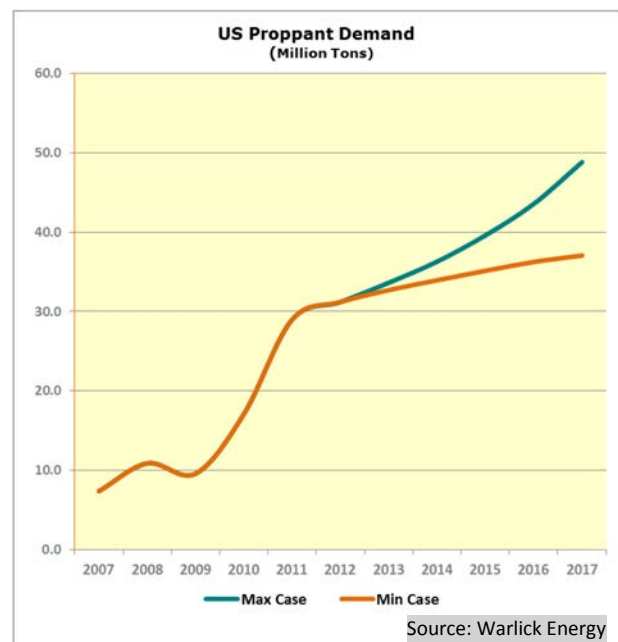
In order to reduce the price of drilling for oil or gas, extensive research is being conducted by the energy industry to lower overall costs of drilling and recovery of natural resources. Researchers are exploring ways to reduce the number of phases the fracking process currently takes, optimizing the proppant mix, reducing the amount of fluid needed to fracture and a multitude of other ideas which could reduce the overall demand for Wisconsin fracture sand.

FUTURE GROWTH – THE PROBABLE TOTAL MARKET DEMAND

North America is clearly the leader in using deep well horizontal fracking to extract oil and natural gas. While other countries are beginning to replicate this success, overseas markets for Wisconsin frac sand appear to be negligible. High transportation costs result in Wisconsin frac sand losing its significant price advantage over synthetic proppants. Additionally, it appears there may be silica deposits in the United Kingdom and elsewhere in Europe and Asia that would contain acceptable grades of frac sand that could be delivered with far lower logistical costs. Consequently, the market for Wisconsin frac sand will likely remain, almost exclusively, constrained to North America.

North American Fracture Sand Market

Industry analysts in 2012 indicated total US proppant production grew from 6.5 million tons per year (TPA) in 2009 to 28 million TPA 2011 [U.S. Geological Survey]. Analysts' reports as recently as November, 2012 suggest an 8.9% annual increase through calendar year 2016, with a CY 2016 market demand of 38million TPA [*"World Industrial Silica Sand" – The Freedonia Group, November 2012*]. This recent analysis remains consistent with WisDOT's 2012 discussions with industry analysts and officials. The consensus expectation was that total domestic demand for proppants for oil/gas exploration will settle at approximately 40 million TPA, with a high-end possibility of 60 million TPA.



A separate analysis was conducted as recently as January 2013 by Warlick Energy confirms the Freedonia estimates and enhances that data by showing the maximum and minimum growth projections for US proppant demand.

Non-Wisconsin Share of the Fracture Sand Market

Based on discussions with multiple industry officials, market analysts and scores of reports and company filings, it is reasonable to estimate that Wisconsin could supply up to 50% of the total fracture sand market.

The immediate question arises as to why only 50% if Wisconsin has the largest and most accessible supply of the highest quality fracture sand available. The most prominent reason is that while Wisconsin does have the largest reserve of the highest quality fracture sand, it does not have a monopoly on that sand.

Northern Illinois, Southeastern Minnesota, and Northeastern Iowa all have deposits of what is generally referred to as Northern White of the Wonewoc, St. Peter, Jordan, or Ottawa type sandstone formations, and have been the home to industrial sand mining for many decades. Missouri, Arkansas, and Texas all have growing fracture sand industries producing somewhat lower quality sand than Northern White, but all closer to Texas and Oklahoma oil shale plays. In addition, several fracture sand mining operations have developed in Canada, providing options for both Canadian and Bakken drilling operations.

When you add up the production capacity already in place in these other locations, the volumes quickly nears the 20 million TPA mark which is approximately 50% of the total demand market noted earlier in this report.

Here are some quick examples of large fracture sand industry growth and capacity outside of WI.

Minnesota

- UNIMIM in Le Seur has mines and processing plants capable of producing in excess of 2 million TPA.
- Preferred Sands in Bloomington is capable of producing nearly 1 million TPA.
- It has been proposed to build facilities in St. Charles that could produce more than 4 million TPA.



Unimin Mine/Transload – Kasota, MN

Illinois

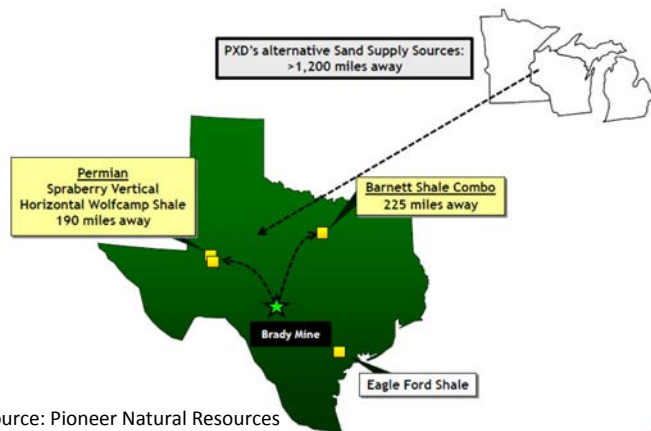
- US Silica expanded its facility at Ottawa and now has the capability of producing up to 2 million tons of fracture sand annually.
- Illinois is already the nation's leader in total industrial sand production. (*USGS, 2010*)

Southwest United States – A study in Vertical Integration

According to the Houston Business Journal [*August 10, 2012*], Texas brown sand is sufficient for drilling to 8,000 feet. Consequently, companies such as EOG, Hunt Global and Cadre Proppants have

purchased thousands of acres of property in Texas to provide lower quality sand at significantly less cost than the Wisconsin Northern White sand can be shipped. With transportation costs accounting for up to 50% of point of purchase costs, one can see why there will continue to be push to use nearby proppant sources. [*DownHoleTrader.com*].

The figure to the left provides an example of this.



Source: Pioneer Natural Resources

In 2012 Pioneer Natural Resources Group purchased Carmeuse Industrial Sand and their Brady Mine shown on the map. This move allowed for the vertical integration of PNR's supply chain and gave the company an alternative to Wisconsin fracture sand that is only about 200 miles from PNR oil shale plays.

According to PNR documents, the company will use Texas brown sand for about three-fourths of its fracture sand needs, with the remaining one-fourth coming from a combination of Wisconsin fracture sand and ceramic proppants for deep well drilling.

EOG reports that its vertical integration strategies saves its company \$500,000 per well.

Canada

While deposits of acceptable fracture sand are limited in Canada, Canadian Silica has opened a site in Alberta capable of producing up to 500,000 tons of fracture sand annually. Superior Sand Systems, which also has mining interests in Buffalo County, has a fracture sand facility in Saskatchewan that services western Canada.

Of additional interest is Victory Nickel. As the name suggests, they are actually a nickel mining company but have entered the fracture sand industry at its Nickel mine in Minago, Manitoba for ulterior reasons. The company reports they have a lower grade nickel deposit that is covered by sandstone layer approximately 10 meters thick and containing at least 11.5 million tons of marketable fracture sand. The derived revenue from sale of the fracture sand now makes it profitable to get at the underlying nickel and their primary revenue source.



Victory Nickel – Frac Sand Processing Plant
Minago, Manitoba, CA

The Victory Nickel story is interesting because similar things are happening within Wisconsin, albeit in regard to other non-metallic products. Over the years, many traditional non-metallic mines that were producing concrete or roadway aggregates were closed when they got to similar thick layers of what was then un-marketable sandstone overburden. Now much of that sandstone is marketable fracture sand and provides a profitable way to remove the sandstone and access the other marketable non-metallic products. These types of efforts can create a downward push on market prices for fracture sand since they can afford to 'break even' on the fracture sand removal and then make their profits on the underlying material.

Conclusions

- **Wisconsin will lead the nation in fracture sand production for the foreseeable future, supplying up to 50% of total North American Demand.**
- **Synthetic proppants, lower quality brown sands, and supply competition of Northern White in other states or Canada, means Wisconsin will be a long way from having a monopoly on either the total proppant or total fracture sand market.**

GROWTH – DEFINING THE SIZE OF WISCONSIN FRACTURE SAND INDUSTRY

The ‘size’ of fracture sand mining in Wisconsin can be defined a number of ways. One is simply the market production rates discussed in the previous section. However, a more accurate way to define the ‘size’ of fracture sand mining is how many unique companies are actually in the industry, how many processing plants are they operating, and finally how many mines are operating.

Probable Number of Process Plants

In a very simplistic, but relatively accurate way one can generate the probable number of processing plants and mine locations based on expected Wisconsin market share for fracture sand.

$\frac{\text{Wisconsin Market Share}}{\text{Average Processing Plant Production Rate}} = \text{Estimated Number of Required Processing Plants}$

Processing plants range in annual capacity from just under 1 million TPA (tons per annum) to 4 million TPA. Based on production capacity of operational processing plants as of late 2012, a conservative average rate would be 1.2 million TPA.

As discussed in the previous section on Market Demand, it is reasonable to assume Wisconsin achieves a 50% market share of the CY 2016 total fracture sand market. Using an expected total demand of 40 million TPA of all proppants, with 36 million TPA of that total being fracture sand and the other 4 million TPA being synthetic proppants, and then applying the 50% factor would give Wisconsin an expected market share of approximately 18 million TPA.

Demand based on 40 Million TPA		WIS SHARE (50%)	Processing Plants (1.2 TPA AVG)
Frac Sand	30.8 TPA	15.4 TPA	13
Resin Coated	5.2 TPA	2.6 TPA	3
Ceramics	3.6 TPA	--	--
Other	<.4 TPA	--	--

This relatively simple analysis, illustrated in the matrix above, arrives at the conclusion you would need about 16 processing facilities operating at 1.2 million TPA to meet the Wisconsin share of the demand market for pure sand. As of March 2013, Wisconsin has more than 20 high volume processing facilities.

From this, one can derive or predict the number of mines needed supply the processing facilities to meet this Wisconsin share of the demand market.

Probable Number of Simultaneously Operating Sand Mines in WI

The chart below is an analysis of the permitted mines in Wisconsin that uses truckloads of sand as the unit of measure for mine production. The chart assumes an average mine production rate of 110 truckloads per day; each carrying the maximum loaded weight of 80,000 lbs , with 10% waste material in the raw sand, and operating 255 work days a year.

The first yellow band indicates it would require 30 such mines to produce Wisconsin's expected demand of 18 million TPA. The second yellow band indicates that 60 such mines could supply the entire North American fracture sand demand. As of March 2013, Wisconsin has more than 40 active sand mines.

	Per Day	Per Day	Per Year	Per Day	By Year	Per Day	Per Year
# of Mines	Truck Loads	Truck Tons	Truck Tons	Raw Sand Tons	Raw Sand Tons	Marketable Sand Ton	Marketable Sand Ton
15	1,650	66,000	16,500,000	41,250	10,312,500	37,125	9,281,250
20	2,200	88,000	22,000,000	55,000	13,750,000	49,500	12,375,000
30	3,300	132,000	33,000,000	82,500	20,625,000	74,250	18,562,500
40	4,400	176,000	44,000,000	110,000	27,500,000	99,000	24,750,000
50	5,500	220,000	55,000,000	137,500	34,375,000	123,750	30,937,500
60	6,600	264,000	66,000,000	165,000	41,250,000	148,500	37,125,000
70	7,700	308,000	77,000,000	192,500	48,125,000	173,250	43,312,500
80	8,800	352,000	88,000,000	220,000	55,000,000	198,000	49,500,000
90	9,900	396,000	99,000,000	247,500	61,875,000	222,750	55,687,500

Based on 110 trucks per day; 10% waste

It is understood these are generalized assumptions and thus contain some statistical variation in final answers. However, this is an analysis on degree of magnitude as opposed to absolute accuracy. The concern isn't whether it is 30 or 35 mines, but whether it is 30 or 300 mines.

Thus it becomes a relatively accurate assessment that Wisconsin market demand based on a total market demand of 36 million TPA by 2016, will create a Wisconsin fracture sand industry that has:

- 20-40 operating processing plants at any given time.
- 30-50 operating mine locations at any given time.

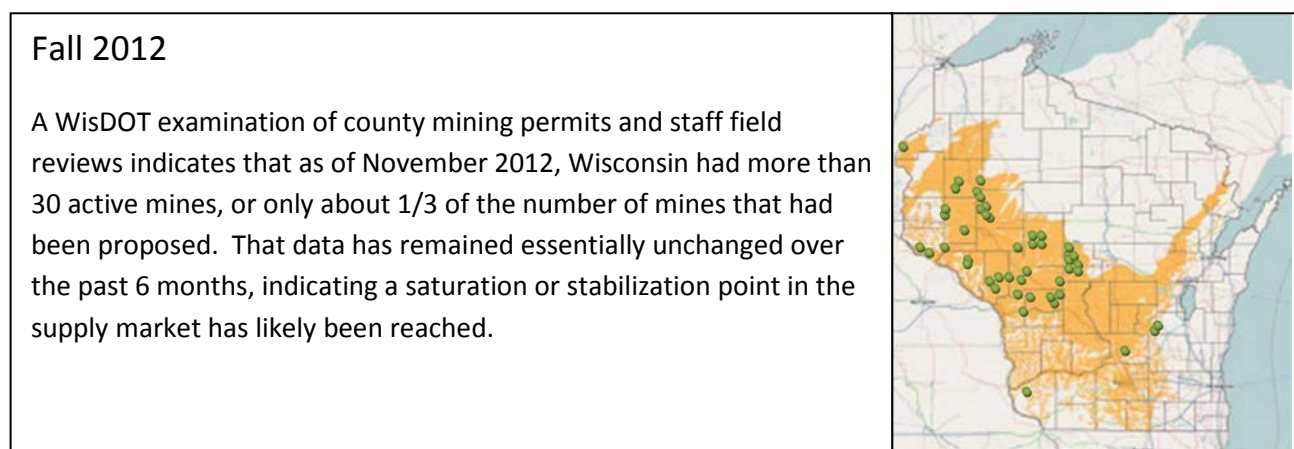
STABILIZATION AND MATURATION OF THE FRACTURE SAND INDUSTRY IN WISCONSIN

For the Wisconsin fracture sand industry, '**Introduction**' began with the advent of deep well horizontal drilling in the early 2000's. '**Growth**' on a rapid scale occurred during the 'sand boom' from 2009 through early 2012. '**Stabilization**' appears to have started in 2012 and is now well on the way to '**Maturation**'.

Stabilization – Supply meets Demand

For our purposes, stabilization indicates supply equals demand and thus overall growth has leveled.

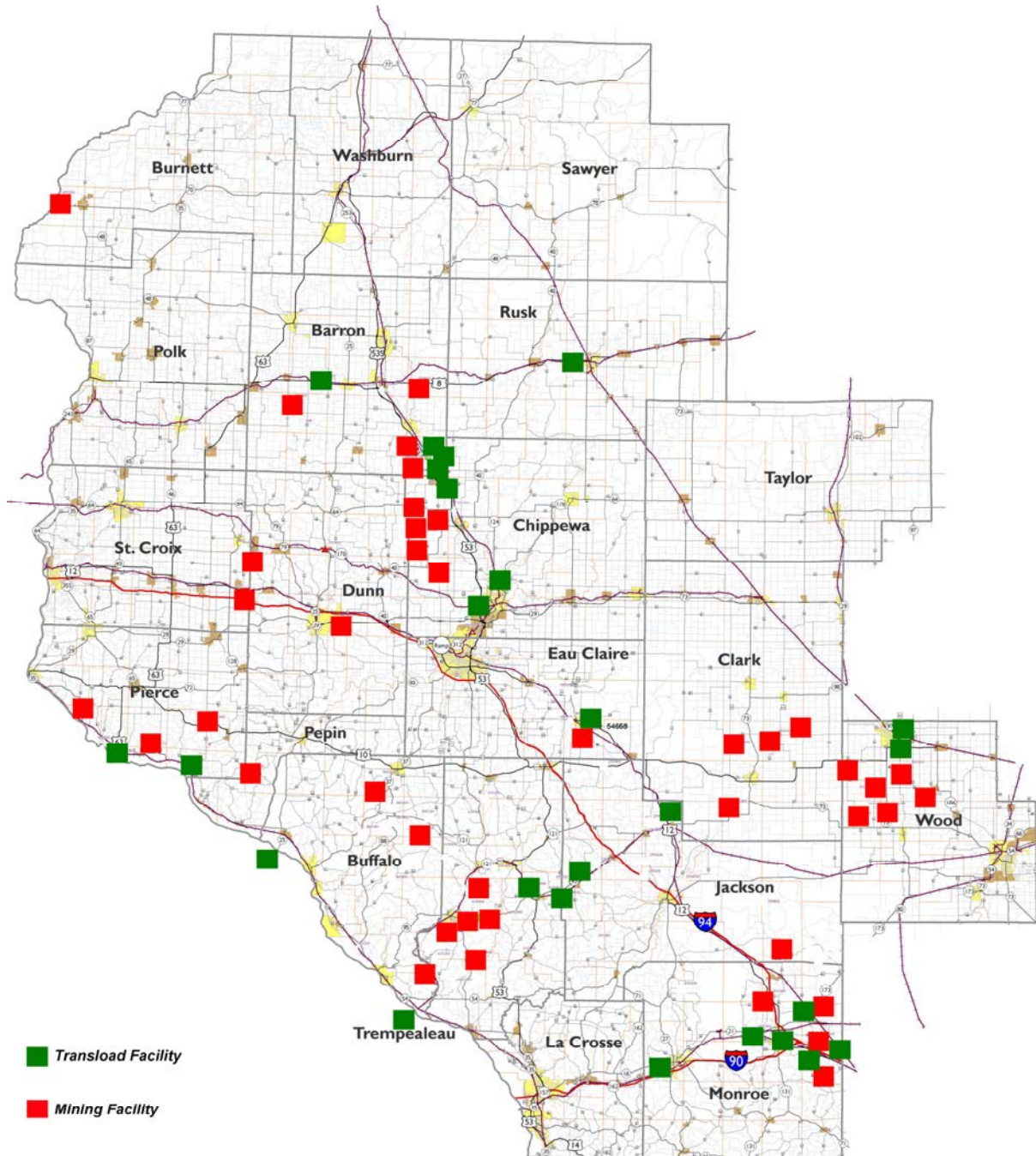
This actual stabilization in the number of new mines or processing plants going active correlates very closely to Wisconsin market size analysis described in the previous section. As stabilization occurs, the next question is whether the current configuration of the Wisconsin fracture sand industry has also 'matured'.



Western Wisconsin Fracture Sand Industry

Active Facilities

March 2013



Maturation – Critical Factors for the Fracture Sand Industry Business Model

Maturation of industry is where the ‘who’, ‘what’, ‘how’, and ‘where’ of the industry is defined in the form it will be for the majority of its foreseeable future. This becomes the final link in being able to make reasonable predictions on how an industry will develop into the future.

WisDOT’s analysis of the Wisconsin fracture sand industry strongly suggests that a clear business model is required to maintain long-term viability. With sand supplies meeting or exceeding demand, maturation of the industry will continue and to a large degree only those companies with a specific business model will survive as long-term players in the market place. That business model contains the following critical factors:

1. Established connections with the demand market of drillers and mineral exploration.
2. Secured access to high volume railroads with high capacity (i.e. multiple unit train storage) transload facility.
3. Ability to generate large amount of capital (i.e. \$75-\$100 Million) and rapidly (i.e. within 6-18 months) convert those funds to physical production facilities.
4. Minimal “first or last mile” logistical costs for truck transport of processed sand by locating mines and sand processing near or at rail transload facilities.

Add this all up and the face of maturation is what you see in 2013 and is defined by:

- Anchored by high volume processing (+/- 1 M to 4M TPA) facility
- Processing facility in close proximity to, or at a high volume (i.e. multiple unit train capacity) transload facility.
- Multiple permitted mine sites within close proximity to processing that have identified reserves for the next 20-50 years.

Established Connections within the Energy Market

Sand production companies with existing connections within the total business model from point of production (the mine) through transportation (railroads) and ultimately the users (fracture drillers), have a significant advantage in competing in the fracture sand industry. These connections allow for long term, “put/call” type contracting ability with Class 1 railroads and oil production companies. These contracts operate in the same manner as put/call options for any commodity, giving both the buyer and seller some price and quantity certainty over a period of time.

- ***Because these are large volume and time dependent contracts, only major players can accomplish this. Without this type of long-term, high-volume, guaranteed contracts, it becomes difficult to sustain long-term viability and profitability in the sand production industry and thus precludes any significant number of small players from entering the market.***
- ***Being one of these players requires cost-effective extraction and processing operations, voluminous production capacity of 1M – 4M TPA, and reliability bulk transportation of product to the demands market in the drilling fields. One key factor allows a company to achieve this:***

Location...Location...Location

Secured Access to bulk shipping (railroads or barges)

There are many, many locations with sand. There are very few which can get it extracted, shipped, and purchased in any economically viable way.

Fracture drilling itself requires large amounts of sands (a single well can use between 15 and 30 train cars of sand) which suggest bulk shipping via rail or barge as opposed to truck shipping. According to the North Dakota Department of Transportation, a drill rig in the Bakken costs, on average, \$88,000/hour. Consequently, optimal economic efficiency for drilling companies is to keep the drills drilling which requires uninterrupted bulk supply of sand, so railroad or barge becomes almost a given. The final aspect is that supply side competition continues to drive down the market price for fracture sand and thus requires supply side efficiencies in all its phases. With logistical costs accounting for up to 50% of supply costs of fracture sand [*DownHoleTrader.com*], bulk shipment by railroad or barge now becomes an absolute economic necessity for the business model.

On the sand production side, while access to rail is obviously required, it also is not necessarily the total solution. Optimal rail access also requires high volume siding capacity to allow sufficient storage of rail cars to keep processing production running 24/7, and to assemble loaded cars into full 'unit trains' (i.e. 75-100 loaded cars that is sufficient to make one complete train haul). Shipping a unit train can result in discounts of 30% or more for the shipper (*Surface Transportation Board, Section of Economics*). This obviously requires significant relationships with rail companies to maintain supply of rail cars and then engines to move full unit trains to market.

It also re-enforces that the demand and supply markets are both driven by high volumes. A sand producer cannot maintain economic or market viability if they are depending on low capacity transload sites with low volume and un-reliable availability of rail cars.

This is also a 'chicken and the egg' part of the business model. You need rail access to be a market player, and you need to be a market player to secure reliable access to cars from Class 1 rail shippers. This is why those companies who have established themselves as true long-term players in the sand industry either already had direct rail access to existing facilities or made acquisition of property on a railroad their first priority in starting a new operation.

It is worthwhile to note that shipping fracture sand by barge remains a minor market player for many reasons:

- Barges are not available for up to 4-5 months per year due to freezing conditions.
- Barges cannot get close to many of the major shale plays.
- Barges are slower than railroads.
- Barging may still require a rail link to get from barge to drill fields in TX, LA, or OK.
- Barges access is limited for supply side loading of sand.
- Barges are susceptible to high water/low water levels (flooding and droughts).
- Far greater logistical location opportunities for railroad.

- ***Consequently, railroad access will remain a predominant factor in the logistics of sand movement, and when combined with the socio-political impacts discussed earlier become the two prime predictors of where any future fracture sand industry expansion will occur.***

Capital

The fracture sand market is one that requires significant initial capital investments. A successful business model must have not only the raw material (sand), but also high volume processing and transload facilities. A processing plant/transload facility is estimated to cost between \$60-100 million. With available supplies exceeding demand, projected profit margins may make it difficult for small operators to enter the market as a full-fledged supplier to the energy market.

Aside from the size of the capital investment, the ability to quickly turn that capital into a producing mine + processing + transload facility is a requirement to be player in the market.

The players comprising the majority market share in Wisconsin and neighboring states either had established locations and business viability in the sand market and could expand directly on those location; or were able to acquire the necessary capital and turn it into operating mines + processing + transload facilities within 12-18 months between 2010 and 2012.



Hi-Crush Mine/Processing/Transload, Augusta

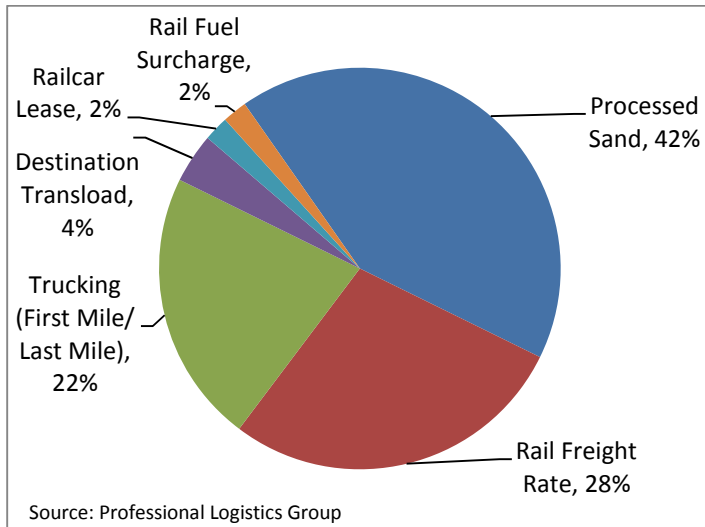
Some firms like Hi-Crush were new firms that raised cash through public offerings of stock. Other were long-standing industrial sand companies like US Silica and UNIMIN who went from private to public companies to quickly raise cash. Yet others were long-standing and diversified sand companies who remained private and had ability to use their own cash reserves or raise their own private equity to expand their existing sites.

Another business strategy is vertical integration which is where an end producer acquires its own supply chain for its end product. In the energy industry, traditional oil companies such as EOG and Pioneer Natural Resources have entered the fracture sand industry and own some of the largest fracture production facilities in the industry.

- ***This ability to raise these large amounts of funds and then convert it to full-production facilities within 12-18 months is probably the biggest factor defining who is or can ever become a player in the fracture sand industry.***

Minimizing “First Mile-Last Mile” costs

The final element in the business model involves having mines and processing plants in close proximity to the rail transload facility in order to eliminate the costs and logistical issues of trucking raw sand from mine to processing plant and processed sand between the processing plant and railroad location.



The graphic to the left indicates the importance of minimizing these “First Mile-Last Mile” impacts.

For Wisconsin Northern White Sand priced at \$180/ton traveling from Wisconsin to Texas, “First Mile-Last Mile” costs make up nearly one-quarter of the total cost of the fracture sand.

The costs are not just the physical overhead of operating trucks and paying drivers, but also include potential highway impact fees

assessed by local units of government for trucking on non-STH routes. In addition, companies may find significant public or local government opposition to placing truck volumes on local routes where little, if any, previously existed.

This is not to say that there won’t be instances where trucks may be making longer trips between mine and processing. There will always be a niche market for small mine operations to provide short-term inventory support to the large market players. A large market player may have a surge in demand that exceeds their own supplies and will turn to small mine operators for short periods to meet that demand.

A large part of that niche market is filled by the traditional ‘quarry’ or ‘sand pit’ operators such as Mathy, Kraemer and Sons, etc. who use those sources for bituminous pavements or concrete production. There are literally hundreds of these locations scattered through ‘fracture sand country’ and which have been open for decades.

- ***The ultimate form of efficiency within this aspect of the business model is where mining + processing + transload occurs without any highway trips. A model which many of the largest players such as Badger, Fairmont, UNIMIN, US Silica all employ.***
- ***Discussions with industry experts indicate that any existing or future entrant into fracture sand industry that has any significant distances of trucking between mine and processing, or processing and transload, has a very questionable probability of being able to sustain any long term viability.***
- ***Vertical integration will allow some oil/gas companies to get into the fracture sand industry without worrying about profit margin on the sand itself. Profits will come from oil/gas exploration.***

The Face of Wisconsin's Fracture Sand Industry

2013 and Beyond

Badger Mining (right) is Wisconsin's largest industrial sand producer. Badger's plant in Taylor, WI offers all the critical business model factors:

- Badger has extensive contacts within the sand industry
- Mining, processing and rail transload on the CN rail line are all located on site
- The company is stable, having been in business for more than 40 years, allowing capitalization of improvements
- In addition, Badger has additional processing facilities along the UP railroad in nearby Merrilan



The Chieftain (left) and Great Northern (right) processing/transload facilities near New Auburn are typical of facilities that have met many of the critical business model factors:

- They provides access to a high capacity rail line
- Have a high capacity siding for storing unit trains
- The facilities are in close proximity to the feeder mines
- They were built at a combined cost of more than \$100 million in less than one year

EOG's fracture sand facilities in Chippewa County (right) provide an example of vertical integration strategy.

- EOG is a major oil company in Texas and North Dakota
- **Controlling its fracture** sand supply saves EOG an estimated \$500,000 per well.
- Processing and rail transload allow access to the UP railroad via Progressive Rail
- The facility is in close proximity to the feeder mines



Major Players in the Wisconsin Fracture Sand Industry

Established National Fracture Sand Producers Doing Business in Wisconsin

Badger Mining
Unimin
US Silica
Fairmont Minerals
Carbo Ceramics
Chieftan Sands
Smart Sand

New/Recent Fracture Sand Producers Doing Business in Wisconsin

Atlas
Superior Silica Sands
Preferred Sands
Superior Sand Systems
Hi-Crush
Great Northern Sands

Petroleum Companies who have entered the Fracture Sand Production Industry in Wisconsin

EOG
Pioneer Natural Resources

SECTION 1 SUMMARY

The Wisconsin Fracture Sand Industry ***Introduction, Growth, Stabilization, and Maturation***

- The demand for Wisconsin Fracture Sand is a percentage of the total North America proppant demand, which is estimated to increase to a total of 36-40 million tons per year by 2016.
- It is reasonable to estimate that Wisconsin could supply up to 50% of the total North America demand.
- There are several challenges to Wisconsin reaching or maintaining its maximum share of the proppant market.
 - Sand sources closer to shale plays
 - Advances in synthetic proppant technology,
 - Vertical integration strategies by oil/gas companies, and
 - The volatility surrounding energy commodities
- There are a sufficient number of existing mines, processing plants and transload facilities to meet Wisconsin's market share. Consequently, we see that the Fracture Sand Industry has stabilized in Wisconsin
- The fracture sand industry has an intrinsic association with commodity prices for oil and gas. That said, with supply in excess of demand, we would expect the industry to remain relatively stable in Wisconsin, with 30-50 active mines and 20-40 processing facilities.
- Additional mines may open, but any market share would likely come at the expense of other Wisconsin mines. Thus, while impacts may shift from one locale to another, the total number of mines or processing plants operating at any given point in time in Wisconsin will remain relatively constant and within the ranges noted.
- We believe the Wisconsin Fracture Sand Industry has matured to the point that it is difficult for new players to enter the industry. To compete, new companies wishing to successfully enter the Wisconsin Fracture Sand Industry must have:
 1. Established connections with the demand market of drillers and mineral exploration.
 2. Secured access to high volume railroads with high capacity (i.e. multiple unit train storage) trans load facility.
 3. Ability to generate large amount of capital (i.e. \$75-\$100 Million) and rapidly (i.e. within 6-18 months) convert those funds to physical production facilities.
 4. Minimal "first or last mile" logistical costs for truck transport of processed sand by locating mines and sand processing near or at rail transload facilities

The maturation of the industry allows us to make the following observations about future growth of the industry.

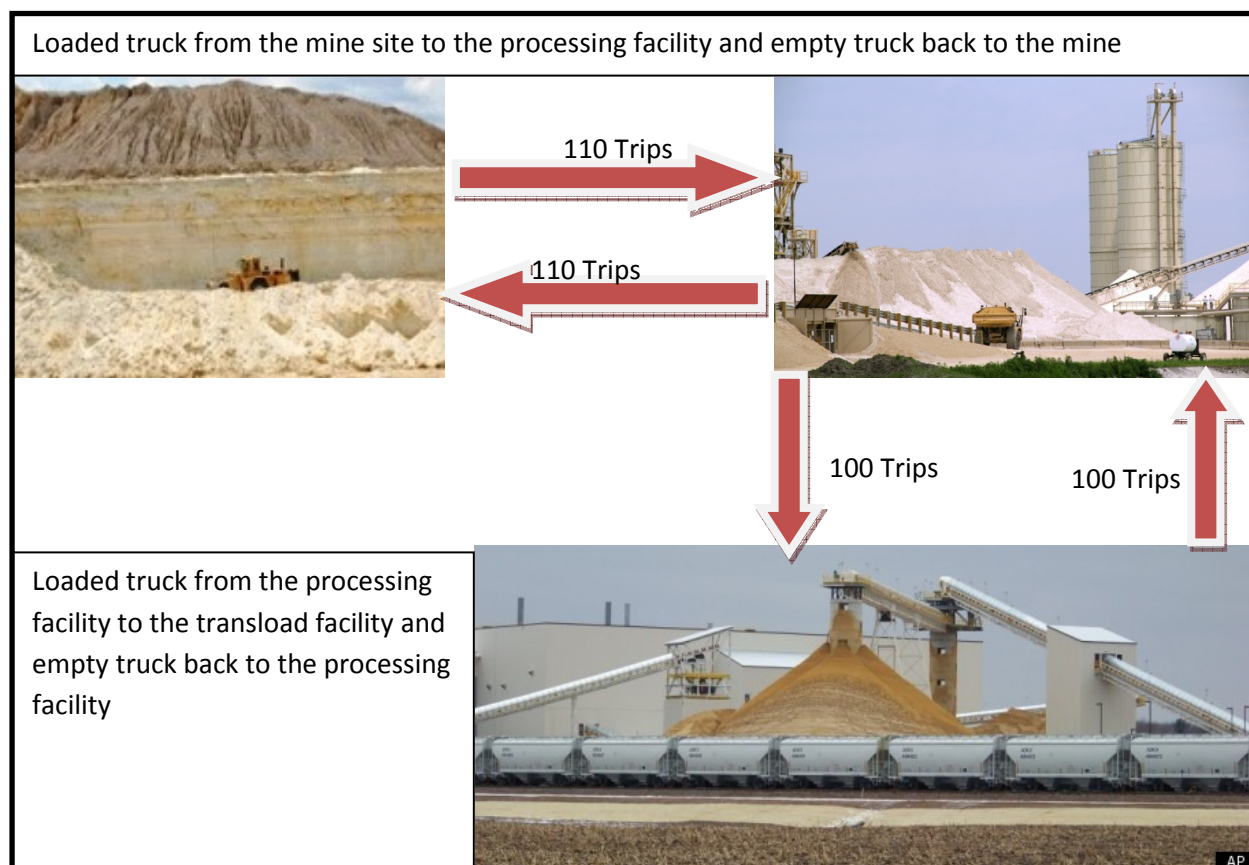
- Big production players will anchor the industry along, or with access to, the existing Class 1 railroads.
- We would expect mines to be located in close proximity to the processing/transload facilities, thereby reducing highway trips to short distances and primarily on local roads.
- This proximity combined with the expected continued deep well drilling for oil and natural gas should make these facilities viable for 40-50 years.
- Geographical dispersion of the industry will be dictated by accessibility and proximity to railroad transload facilities. The dispersal of the transload facilities and close proximity mines geographically disperses any highway impacts.
- Localized political opposition and fracture sand industry moratoriums will also limit areas where fracture sand mining is likely to occur and increase probability of where it will occur.

SECTION 2 - TRANSPORTATION IMPACTS FROM THE WISCONSIN FRACTURE SAND INDUSTRY

Fracture sand is classified as a common non-metallic mineral. Transportation is normally handled as a dry, bulk commodity and is hauled by all modes... truck, conveyor, rail, and barge.

Highways

On the most basic level, fracture sand mining involves a mine, a processing facility and a transload facility. Sand can be trucked from mine to processing plant, as well as from processing plant to transload facility; each of these trips would have return trips to the originating facility. This “Triad of Operation” can result in a multiplier effect for the total number of highway trips that occur within the fracture sand industry. As demonstrated below, a mine permitted for a production rate of 110 trucks/day (with 10% waste material) could result in more than 400 total truck trips. In the majority of cases, sand is trucked from the mine to a joint processing plant + transload facility.



The most common truck units are either a 5-axle semi-tractor-trailer (80,000 GVW) or a quad-axle dump truck (GVW 73,000). Experience thus far indicates that sand haulers have a low incidence of weight violations. Many of the large players employ professional, third party fleet management companies to

oversee all trucking operations. A 'zero tolerance' policy for any driver or vehicle violation is typical. Since these companies pay a very competitive wage for truck driving and allows drivers to be home every night, the driver workforce tends to be the best drivers available.

Most of the impact to the highway system will be to local roadways. Wisconsin Statutes (349.16) allows local units of government to enter into road maintenance agreements with fracture sand companies to mitigate impacts increased heavy truck traffic may have to their roadway system. In Northwest Wisconsin, our experience is that these agreements have worked to the mutual benefit of the company and the local unit of government. However, inconsistencies have occurred in the application of this authority among local units of government, which has raised concern by the sand industry and some state legislators. The Wisconsin Towns Association, Wisconsin Counties Association and Wisconsin County Highway Association all offer information and training regarding these statutory authorities to their members.

As the business model suggests, most of the truck trips are short distances on local routes. Consequently, impacts to the state system are greatly reduced. Impact to the state system will also be minimized by the fact that several of the high volume industry players have operations that have no impact to highways. Badger Mining in Taylor, Preferred Sands in Blair, Fairmont Minerals in Pierce County, Hi-Crush in Augusta, and Unimin in Tunnel City are all major producers who have mining, processing and transload facilities all in one location.

In regard to the State Trunk System, transportation of fracture sand will have localized impacts in the following areas:

Access: Trucks transporting sand from mines to processing plants and/or transload facilities will gain access to the State Trunk System either by direct access onto the state trunk highway or via a local road connection. In either case, given the volume and nature of trucks involved, turning lanes will likely be required at access points. If direct access is granted via a commercial driveway, WisDOT has authority to attach conditions for that access, which would include the necessary turn lanes. If access to the state system is not direct and via a local road, WisDOT does not have statutory authority to require such improvements. Instead, WisDOT must work in cooperation with local units of government to have necessary safety and operational improvements made as a condition of the company's Use Permit.

Pavements: Pavement deterioration over time is caused by a combination of factors; however, traffic loads play a key role in the life of pavement. Given the complexities and variables that exist, it is not prudent to generalize impacts to pavement. In light of the nature of approved and active mining activity, WisDOT Northwest Region has identified highways that have an increased probability of truck traffic from the fracture sand industry that may warrant adjusting traditional pavement strategies.

That said, the geographical dispersion and limits to the number of loads per day and the self contained sites of several major producers may make most pavement impacts from the fracture sand industry statistically insignificant.

Capacity: Because the Fracture Sand Business Model stems from the transload facilities located along the Class 1 rail lines, it is conceivable that localized capacity issues could materialize. This convergence issue occurs because multiple mines may be shipping product to the same transload facility. There are three areas that this convergence issue could create localized capacity issues.

STH 54/Winona Crossing - The first is along STH 54 and its connection to Winona, MN. The two-lane crossing has current traffic of approximately 10,000 AADT (annual average daily traffic) The Port of Winona is the primary destination for fracture sand destined to be shipped by barge to southern states. However, current restrictions on the amount of sand the Port may ship results in only about 400 additional trucks crossing the Mississippi River Bridge daily at this location. Consequently, given current restrictions there is no reason to believe sand transport will rise to the level that the crossings level of service will be significantly impacted.

STH 25/Wabasha Crossing - The second area of concern is the STH 25 crossing from Wisconsin into Wabasha, MN. The two-lane crossing has current traffic of approximately 5,200 AADT. Superior Sand Systems is opening a transload facility along the Canadian Pacific Railroad in Wabasha. At this point, their primary source of sand is a mine located just south of Mondovi along STH 37 in Buffalo County. Sand will be transported by truck, traveling south on STH 37, then north on STH 35 before turning onto STH 25 at an intersection in Nelson, WI. This intersection is currently being studied for operational issues that are independent of fracture sand transport. Based on the Superior Sand System permit in Minnesota, up to 800 additional trucks could use the STH 25/35 intersection creating additional stress on the connection into Minnesota.

USH 8/City of Barron - The third area of concern for capacity is along USH 8 in the City of Barron. Traffic volumes range between 8,000 – 14,000 AADT through Barron. This segment of USH 8 is currently under study for capacity expansion, as approved by the Wisconsin Transportation Projects Commission in 2001. At the current time, fracture sand mining in this area is largely confined to an area west of the city of Barron and south of USH 8, with sand being transferred to the Superior Silica Sand facility along the Canadian National rail line near Poskin. However, to meet their market demand, Superior Silica Sand is currently transporting sand from its mine west of New Auburn, along STH 64 to USH 53 to USH 8 through the city of Barron.

Geometric Improvements: Haul routes from sand mines to transload facilities may occur on low volume state trunk highways which may feature substandard geometrics. Typically, these are roadways with very low traffic volumes.

Over the years, highway standards have changed to maintain safety and operational efficiency in the face of higher speeds, growing traffic volumes, and a more diverse mix of vehicles. Today, many highways contain geometric features that are considered sub-standard by current highway engineering standards. However, it is important to point out that a sub-standard feature does not necessarily create a deficiency.

When a sub-standard feature of a highway starts to contribute to certain numbers or types of crashes, safety standards would identify this highway as becoming deficient. Likewise, if sub-standard features create certain levels of congestion, consistently lowered speeds of travel, and recurring difficulties in getting onto the highway, operational standards may identify this highway as becoming deficient.

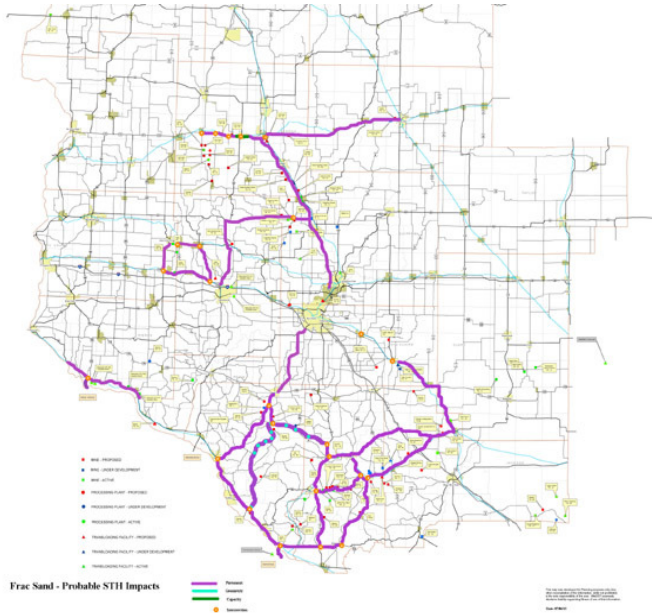
Without safety or operational deficiencies, it becomes much harder to justify reconstructing a highway even when it contains sub-standard features. However, improvements can be considered in cases where the specific nature of the sub-standard feature creates such a high probability of operational or safety problems that it becomes prudent to address the geometric concerns before safety or operations become deficient. Usually these occur as isolated locations within a larger segment of roadway, most typically at intersections. Reconstruction typically occurs only in conjunction with a larger project in the area.

The region either has or is currently studying a number of segments for potential corrections to some substandard features should some proposed fracture sand efforts actually become reality. Among those highways that have been or are currently being studied include STH 88 in Buffalo County, USH 8 in Barron County, and STH 25/STH35 in Buffalo County

The most frequent improvement will be at intersection locations on industry truck hauling routes. While most of these locations will simply require the addition of turn lanes, some may involve a full reconstruction to install traffic signals or a modern roundabout. It should be noted that in those situations where level of service may be an issue, it is likely the intersection is already operating with high volumes prior to adding the additional fracture sand traffic. As a rule, fracture sand traffic is not voluminous enough or concentrated enough to singularly drive capacity or level of service concerns.

- **In terms of system impacts, most of the transportation impacts to the highway system will be on the local system. The permitting authority for operation of a mine, processing and transload facility lies with a local unit of government. WisDOT's strategy should be to continue to establish and maintain partnerships with local units of government. Improvements to provide safe access to the state trunk system should be handled on a case-by-case basis with the WisDOT Regional Access Coordinator working in concert with Regional Planning and Traffic staff to develop requirements for direct access to the State Trunk System.**
- **WisDOT Regional Planning Staff will work cooperatively with local units of government to provide recommendations for improvements to local road connections that may be accomplished through the local governments' permitting authority, as well as include any impact mitigation for the STH system from fracture sand mining into the local permit requirements**
- **WisDOT will include fracture sand industry in its list of state highway project scoping criteria to identify and potentially address substandard geometric features that either are or have a high probability of becoming deficient due to the increase traffic from fracture sand industry.**

Areas of Concern for Potential Highway Impact Spring 2012

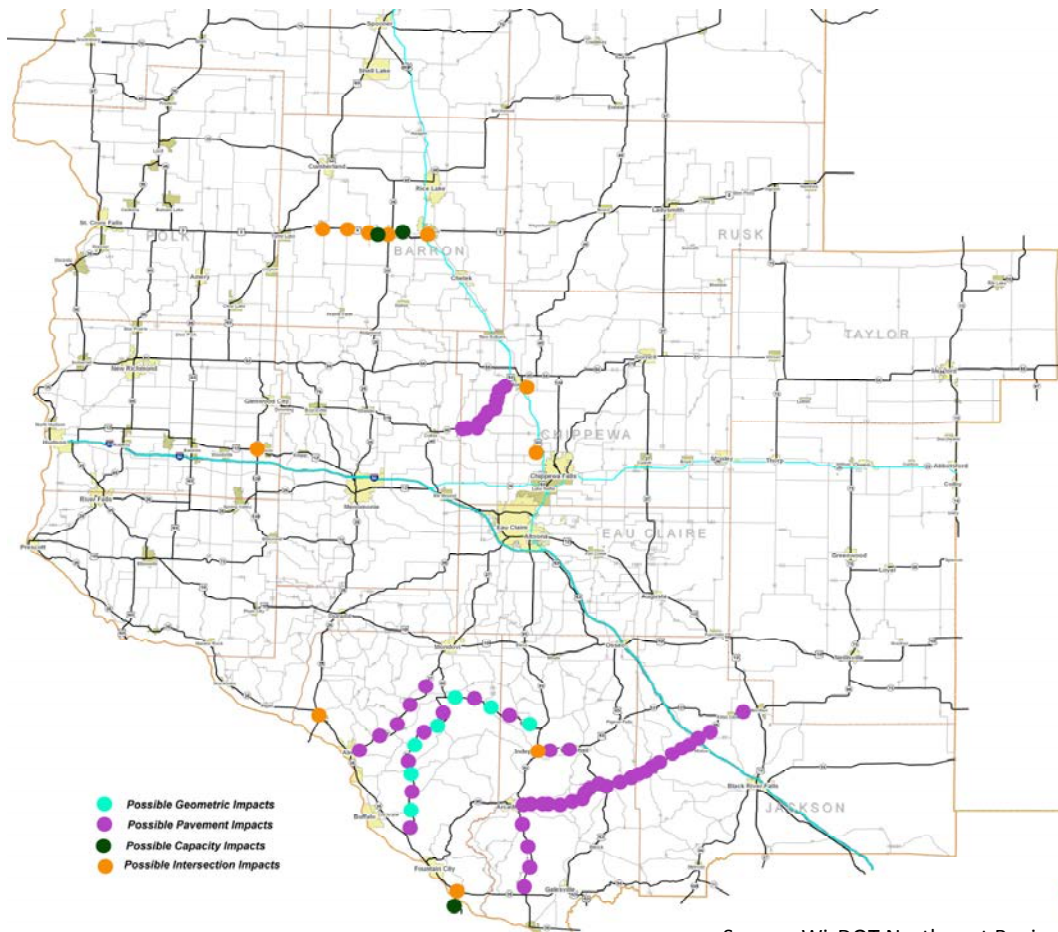


Source: WisDOT Northwest Region Planning

Highway Impacts

In early 2012, the Wisconsin Fracture Sand Boom was at its peak. At that time, WisDOT NWR did a preliminary scan of highways that had potential to be impacted by the industry. A significant number of miles of state trunk highway were identified as having potential for impacts to the pavement (purple), numerous intersections (orange), some potential geometric issues (teal) and potential capacity issues (green) at the crossings into Minnesota and in the city of Barron. With the Stabilization and Maturation of the Industry, WisDOT's concern for potential areas of impact have decreased significantly in the spring of 2013.

Areas of Concern for Potential Highway Impact Spring 2013



Source: WisDOT Northwest Region Planning

Rail

Fracture sand is normally hauled in unit trains of 100-125 cars, with a payload of 10,000-12,500 tons per train. Wisconsin's freight railroad network is comprised of nearly 4,200 miles of track and is served by four major (Class I) railroads, three regional railroads, two local railroads and one switching and terminal railroad.

The key lines hauling sand out of Wisconsin include the BNSF, Union-Pacific (UP) and Canadian National (CN) lines.

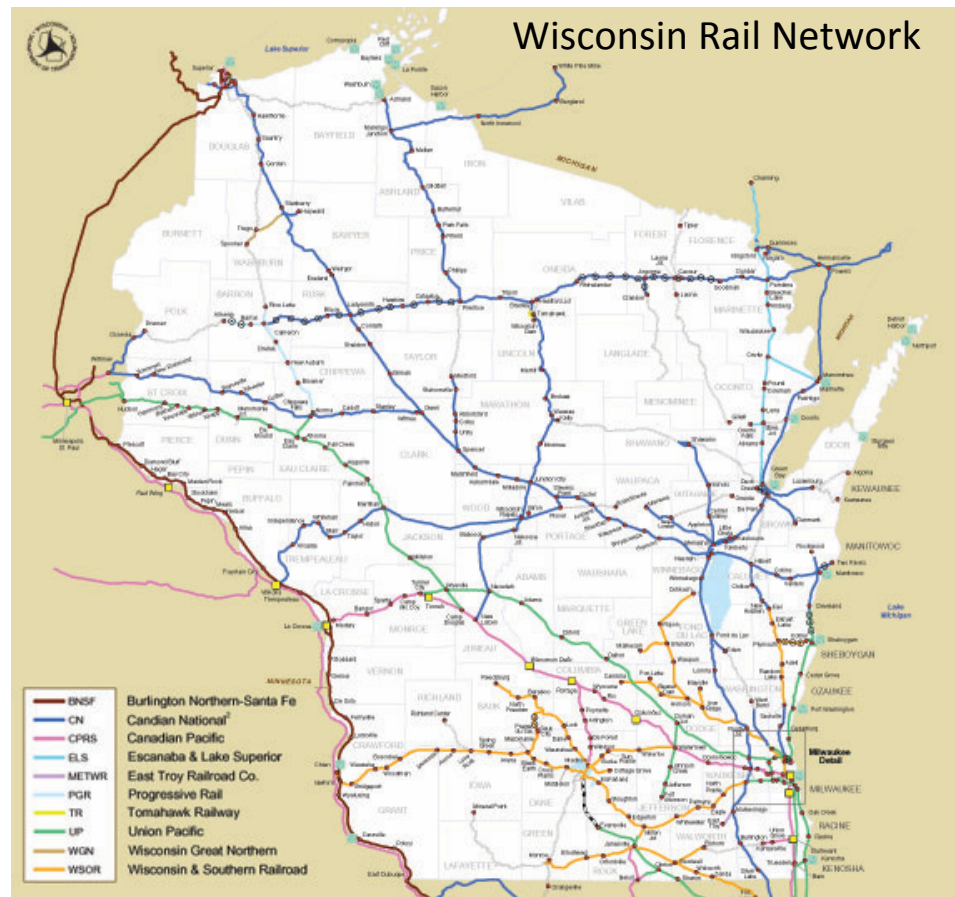
One regional line, Progressive Rail, provides a critical link between Chippewa Falls and Chetek which is home to five fracture sand processing/transload facilities. Wet raw sand may be loaded in open hoppers or gondolas; dry processed sand is transported in covered hoppers to prevent loss or contamination of cargo.

Additionally, the Canadian Pacific Railroad runs along the Mississippi River on the Minnesota side and can haul Wisconsin fracture sand out of Winona and

Wabasha. However, socio-political issues have made opening Wisconsin mines within a cost-effective distance of these transload facilities unlikely.

According to *Forward Wisconsin*, The major categories of freight traffic products *originating* in Wisconsin include:

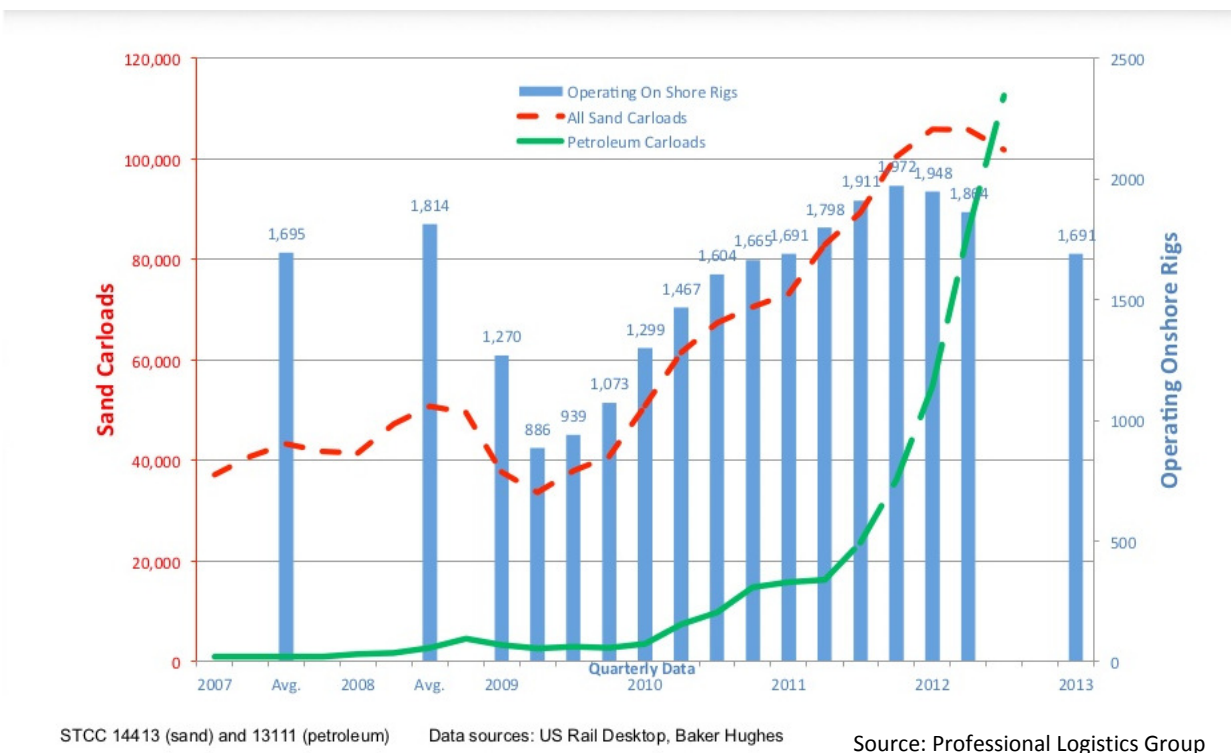
- Nonmetallic Minerals - 22%
- Pulp and Paper Products - 14%
- Farm Products - 13%
- Food Products - 11%
- Glass and Stone Products - 11%



Rail transport of fracture sand has grown significantly over the past five years. However, as indicated by the chart below, the volume of fracture sand being transported nationally by rail began to level out in mid-2012. Given the market conditions of the fracture sand industry that flattened level of transport is expected to continue in the near term.

In terms of freight traffic, it is worth noting that as rail transport of sand has leveled off, rail transport of crude oil continues to grow. Oil companies are expediting plans to build or expand terminals in North Dakota that can load or transload 95- to 118-car unit trains, or 60,000 to 68,000 barrels per trip out of North Dakota.

With North Dakota oil production currently at 700,000 barrels per day and possibly increasing to 1 million barrels by 2015, some analysts believe BNSF Railway and Canadian Pacific could combine to carry up to 25 percent of outbound oil flow.



As the previous chart indicates, the number of train cars hauling oil has passed the number of cars hauling sand. Since 2008 this combination has grown to now take a significant portion of rail capacity.

On a national basis, other freight dynamics are occurring that could impact Wisconsin in some significant ways. Because of its continued low costs, natural gas has replaced coal as the energy source of choice

for producing electricity. In turn, this has dramatically reduced the number of trains carrying coal to the extent that the increase in oil and sand freight barely equals the amount of decrease in coal transport.

However, of interest to Wisconsin is that the rail lines carrying sand and oil had minimal coal traffic and are major rail lines within Wisconsin. Thus Wisconsin rail lines are seeing the increase in oil and case freight, but not the major decreases due to drop in coal.

The increased train traffic is leading to an increasing number of complaints regarding delays to roadway traffic caused by train crossings, concerns regarding railroad crossing safety and complaints regarding increased noise from the increased volumes of trains.

Barge

Silica sand is hauled by barge in applications similar to rail. The normal payload of a river barge is 1,500 tons per barge. A river tow of barges may carry 22,500 tons or more.

The Port of Winona, Minnesota is the primary port for Wisconsin fracture sand. Fracture sand accounts for approximately 15% of the Port's business. In January 2013, the Winona City Council approved a proposal that may double the amount of sand the port may ship. However, even with a doubling, the Port has a sand capacity of approximately 400 truckloads a day – an amount that does not make a significant impact to the transportation system.



The Twin Ports of Superior/Duluth appear to be too far from fracture sand mines to be a legitimate option for shipping fracture sand out of Wisconsin. However, the Twin Ports are being studied by firms wishing to barge oil which has been transported via pipeline from North Dakota to Superior/Duluth.

Pipelines

Enbridge is in process of doubling the volume of oil in its pipelines from North Dakota to Superior/Duluth. However, that doubling hits a logistic pinch point in Duluth/Superior. It is reported that Enbridge could ultimately have capacity to send an additional 500,000 barrels of oil per day than they can currently send out of Superior/Duluth.

It is anticipated that once the Enbridge pipeline capacity doubles, the refinery in Superior will nearly double its production. This doubling could have an impact on any of the modes of bulk transport.

Officials at Calumet LLC, who own the oil refinery in Superior, are currently considering building a \$25 million crude oil transfer dock in Superior, where oil would be loaded onto tankers and barges and moved across the Great Lakes to refineries in Ontario, Michigan, Ohio and the East Coast. (*Superior Telegram, February 24, 2013*). It is also possible, if not likely, that additional petroleum will be shipped via highways or rail.

SECTION 2 SUMMARY

The Wisconsin Fracture Sand Industry Impacts and Recommendations to the Wisconsin Transportation System

- In terms of system impacts, most of the transportation impacts to the highway system will be on the local system. The permitting authority for operation of a mine, processing and transload facility lies with a local unit of government. WisDOT's strategy should be to continue to establish and maintain partnerships with local units of government.
- Improvements to provide safe access to the state trunk system should be handled on a case-by-case basis with the WisDOT Regional Access Coordinator working in concert with Regional Planning and Traffic staff to develop requirements for direct access to the State Trunk System.
- WisDOT Regional Planning Staff will work cooperatively with local units of government to provide recommendations for improvements to local road connections that may be accomplished through the local governments' permitting authority, as well as include any impact mitigation for the STH system from fracture sand mining into the local permit requirements
- WisDOT will include fracture sand industry in its list of state highway project scoping criteria to identify and potentially address substandard geometric features that either are or have a high probability of becoming deficient due to the increase traffic from fracture sand industry.
- Continued growth in the fracture sand industry will be directly tied to changes in the energy market. WisDOT should continue to monitor these market trends and any impacts they may have on development of processing and transload facilities in Wisconsin and eastern Minnesota.
- Since April 2012, WisDOT NW Region has been meeting monthly with WiDNR Fracture Sand Special Projects Coordinator to exchange information. The relationship has proven to be of great value to both agencies. WisDOT should continue to establish and maintain this partnership with WiDNR to the benefit of both agencies.
- Since oil coming back into Wisconsin is more voluminous than sand going out, WisDOT needs to monitor the complete logistical cycle of the energy industry, WisDOT should continue to establish and maintain partnerships and communications with the Minnesota Department of Transportation and North Dakota Department of Transportation. The three states should monitor both the transport of sand from Wisconsin and Minnesota to North Dakota and the transport of petroleum from North Dakota back through Minnesota and Wisconsin.

Bibliography, Links and Sources

North Dakota Department of Mineral Resources

IHS Global Insights, “America’s New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy, 2012

City of Marshfield, “The Economic Impact of Fracture Sand Mining: A Look at Jobs and Earnings in Wood County, Wisconsin, 2012

University of Wisconsin-Extension, “Fracture Sand Mining and Community Economic Development, 2012”

U.S. Geological Survey

The Freedonia Group, “World Industrial Silica Sand, November 2012”

Warlick Energy, “US Proppant Demand, January 2013”

DownHoleTrader.com

Houston Business Journal, August 10, 2012

Surface Transportation Board, Section of Economics

Professional Logistics Group

Industrial Minerals

Bakken Oil Business Journal

Seeking Alpha.com

United States Energy Information Administration

Wisconsin Department of Natural Resources

Minnesota Department of Transportation

North Dakota Department of Transportation

Pennsylvania Department of Transportation