NORTH DAKOTA PETROLEUM COUNCIL

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November 17, 2010

Kayla Eckert Uptmor
United States Army Corps of Engineers
1616 Capitol Avenue
Omaha, NE 68102

Ms. Eckert Uptmor:

As you know, adequate water resources are critical to the development and sustainability of North Dakota's oil and gas industry and essential to development and growth of rural communities in western North Dakota. Without the ability to utilize our state's abundant freshwater resources (Lake Sakakawea) located in the middle of the Bakken formation, the oil and gas industry's production and the region's related population growth may diminish drastically.

North Dakota's stable economy and low unemployment rate in the midst of a national recession are due, in large part, to the success and growth of the oil and gas industry.

Thus far, freshwater has been provided through groundwater sources and surface water, some of which has come from the Missouri River system. However, groundwater sources in North Dakota are insufficient to allow continued, robust development of the Bakken formation in North Dakota without impeding other uses. An alternative water supply is necessary until additional resources can be updated and utilized if continued oil development is sought.

Lake Sakakawea provides one of the few economically viable, alternate water supplies for meeting the needs of the North Dakota oil and gas industry now and in the future.

Enclosed is the North Dakota Water Resources Report completed by The Harms Group on behalf of the North Dakota Petroleum Council. Please review the data and consider the impacts that slowing the process of granting water access to Lake Sakakawea could have on North Dakota's ability to help reduce America's dependence on foreign oil, in addition to the impacts it could have on the revitalization of western North Dakota. Lake Sakakawea could provide a sustainable, reliable water source for these communities.

Sincerely,

Ron Ness

Enclosure

cc Governor Hoeven
Attorney General Stenehjem

Agriculture Commissioner Goehring
Lieutenant Governor Jack Dalrymple
North Dakota Representative Rick Berg
North Dakota State Water Commission
North Dakota Congressional Delegation
North Dakota Petroleum Council Board of Directors
North Dakota Petroleum Council Water Task Force

North Dakota Water Resources Report

Robert Harms
The Harms Group

Issue:

Is there a need to access water from Lake Sakakawea for continued oil development in western North Dakota? (What are the current and projected needs for water in the oil industry and the potential sources to meet those needs?)

Executive Summary:

Development of the Bakken and Three Forks Formations (Bakken) has provided enormous economic benefits for the entire state of North Dakota and for the United States. It provides opportunities for businesses from Williston and Dickinson to Fargo and Grand Forks. North Dakota represents one of the few places in the nation that is expanding oil production to meet America's energy needs. Oil and gas gross receipts taxes (gross production and extraction taxes) will provide an estimated $1.4 billion in the current biennium. Development of the Bakken Formation is dependent upon hydraulic fracturing of the formation through the use of high-pressure water to allow oil to flow from the rock formation to the wellbore, at sufficient quantities to make the development of the Bakken shale formation economic (profitable). Without the use of hydraulic fracturing for this purpose, the wells are not economic (profitable) and continued development of the Bakken (and similar shale formations throughout the country) would stop.

Sufficient quantities of freshwater, combined with sand (proppants) and a precise but limited (<1%) recipe of chemicals, is essential for hydraulic fracturing (1). Hydraulic fracturing is conducted approximately 10,000 feet below ground in the wellbore and is isolated through a series of casing and surface cement that protects any underground sources of drinking water, which can occur up to depths of approximately 2,000 feet in western North Dakota. Thus far, freshwater has been provided through groundwater sources and surface water, most of which has been provided from the Missouri River system. However, groundwater sources in North Dakota are insufficient to allow continued, robust development of the Bakken Formation in North Dakota without impeding other uses. An alternative water supply is necessary if continued oil development is desired.

Lake Sakakawea provides one of the few economically viable, alternate water supplies for meeting the needs of the North Dakota oil and gas industry at present and in the coming years of future development.

Lake Sakakawea represents a substantial portion of the surface water in North Dakota and covers in excess of 500,000 acres of land that was flooded following completion of the Garrison Dam in 1953. It is the largest of the main-stem dams on the entire Missouri River system.

Given its proximity to key areas of Bakken development (Figure 1), access to and utilization of Lake Sakakawea for continued oil and gas development has been sought by the oil and gas industry and is supported by the North Dakota State Water Commission (SWC), the Governor, and the Congressional delegation. While the SWC is responsible for granting water permits from Lake Sakakawea, the U.S. Army Corps of Engineers (USCOE) controls access to the lake. The USCOE has responded to water permit requests by concluding that it cannot provide amendments to existing easements to allow access to Lake Sakakawea, but instead will follow an expedited process (letter report) and National Environmental Policy Act to determine if use of Lake Sakakawea water can be used for these purposes. In doing so, the USCOE asserts that it must first determine if the water quantity being sought is "surplus" beyond the needs of the project purpose. The USCOE has made written and verbal commitments that it will complete this process by January 2011 and will address the three completed applications it has before it and will consider future needs as demonstrated by the industry as well.

Access to Lake Sakakawea for the oil industry will not deplete the water resource and will provide ongoing support and certainty for continued development of the Bakken.

Figure 1. The aerial extent of the Bakken and its location with respect to Lake Sakakawea.

How important is the Bakken?

The North Dakota Industrial Commission's (NDIC) Department of Mineral Resources (DMR) estimated the Bakken to contain 200-300 billion barrels of oil (a 34-year supply for the United States at current rates of consumption), but only 2.1 billion barrels are recoverable based upon the 1.4 percent recovery rate using current technologies. The U.S. Geologic Survey (USGS) declared the Bakken to be the largest continuous resource it had ever assessed in the lower 48 states, estimating 2.6 billion barrels of recoverable oil in North Dakota.

This year, NDIC also completed its evaluation of the Three Forks Formation and concluded that it had 1.9 billion barrels of recoverable oil in the formation. Based upon current estimates, the Bakken and Three Forks formations collectively contain 4.0 billion barrels of recoverable oil and represent one of the largest oil fields in the United States. Together, they will help reduce our dependence upon foreign sources of energy.

Recent oil development:

North Dakota has experienced significant increases in oil production, permits, and drilling rig activity in recent years, which portend future growth and increased demand for water that is essential for continued development.

Year	Permits issued	Wells drilled	Production (BOPD*)	Average drilling rigs
2008	946	720	166,224 (June 2008)	75
2009	623	622	215,073	53
2010	1,272	1,322	315,000 (June 2010)	105

Note: Estimate based upon actual numbers through June 2010.
* Barrels of oil per day

Based upon actual wells drilled through June 2010, North Dakota should see approximately 1,322 wells drilled in 2010. Or, based solely on the average number of drilling rigs (105), we could see approximately 1,260 new wells in 2010. (Each rig is capable of drilling approximately 12 new wells each year.)

Future development:

A number of estimates have been made regarding future oil development of the Bakken in North Dakota, ranging from a low of 1,200 to a high of 2,940 new wells annually.

North Dakota Tax Department projections as of August 2010:
The North Dakota Tax Department's most recent projections are based upon actual numbers for the current biennium, pending a new forecast this fall. New wells drilled annually:

- 1,200 wells (low)
- 1,800 wells (high)

North Dakota State Water Commission estimates based upon industry sources:

- 1,500 wells (low)
- 1,800 wells (high)

North Dakota Department of Mineral Resources projections:
New wells drilled annually:

- 1,450 wells (low)
- 2,940 wells (high)
- 2,140 wells (expected)

Local projected development is expected to follow the following estimates:

Area of North Dakota	No. of wells annually	MM gallons frac water/day
Williston	250	2-5
Ray-Tioga	400	3-6
Parshall	500	1.5-2.5
Alexander	180	2-3
Watford City-Keene	350	3-4
Killdeer	400	3-4
Dickinson/Belfield	60	5-1

The majority of new exploration in northwestern North Dakota is located around Lake Sakakawea with 83 percent of exploration taking place in Williams, McKenzie, Dunn and Mountrail Counties, all of which lie adjacent to the state's largest body of water (Figure 2) (2).

Estimated Future Water Needs:

North Dakota must secure a reliable water supply to meet expected future development in the oil industry and meet the water demands of that anticipated growth. In order to determine how best to meet water demands in the coming years, we have used estimates from public sources to quantify a range of future water needs for the oil industry in North Dakota. We use the following:

- High case: 2,140 new wells (expected)
- Low case: 1,500 new wells

Future water needs based upon the high and low cases are demonstrated below. References are to gallons and acre-feet (1 acre-foot = 325,851 gallons).

According to the North Dakota Department of Mineral Resources, it takes 1.5-4 million gallons of water to complete and frac a well drilled in the Bakken (3). Using a conservative average of 2 million gallons per well, water needs for the coming years are projected to be the following:

- **High case:** 2,140 wells × 2 MM gallons = 4.28 billion gallons annually/13,000 acre-feet annually
- **Low case:** 1,500 wells × 2 MM gallons = 3.00 billion gallons annually/9,200 acre-feet annually

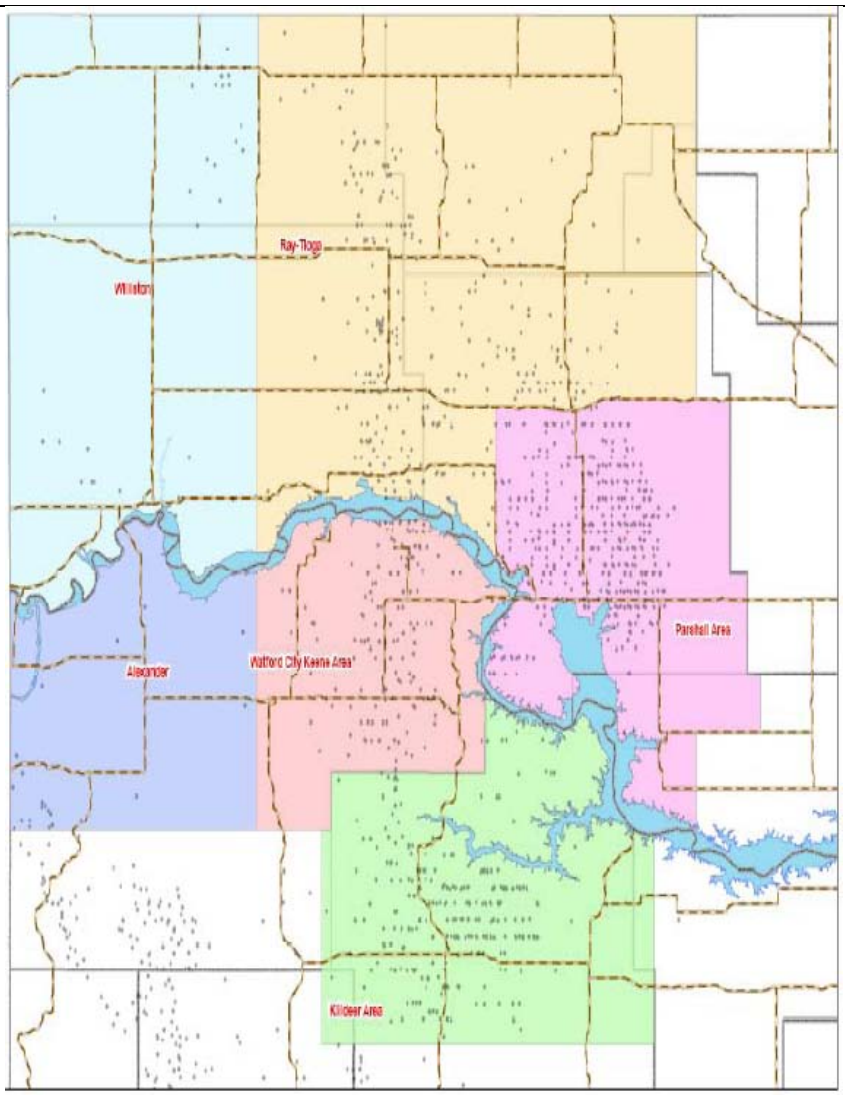

Figure 2. The SWC has done its own analysis of future water needs pursuant to a mandate from the North Dakota Legislature (see House Bill 1322, 61st North Dakota Legislative Assembly). It estimated future water requirements in the oil industry at 13,000-23,000 acre-feet annually. The SWC provided:

Figure [3] *shows a projected 15-year estimate of freshwater use for oil-field production in western North Dakota. All estimates include a baseline of 720 acre-feet for operation (brine dilution) water in 10% of about 4,606 existing operational wells at an annual rate of 526,000 gallons (1.6 acre-feet) per well. For each year, operation water is added at a rate of 10% of new wells, at projected drilling rates of 1,500 wells per year, and 1,800 wells per year. For each additional well, 1 acre-foot of water is assumed for drilling fluid and cement grout for the cased interval. Frac water uses a conservative average of about 2 million gallons (6 acre-feet) per well, based on projected averages of 1.75 million gallons per well from the North Dakota Oil and Gas Division. The results for 2 million gallons of frac water per well indicate initial freshwater needs of 11,000 to 13,000 acre-feet per year, increasing at rates of 242 to 290 acre-feet per year for 1,500 and 1,800 well per year scenarios to about 14,000 to 17,000 acre-feet per year at the end of 15 years, and more beyond that. For 4 million gallons of frac water per well, results indicate initial freshwater needs of 20,000 to 24,000 acre-feet per year, increasing at rates of 242 to 290 acre-feet per year for 1,500 and 1,800 well per year scenarios to about 23,000 to 28,000 acre-feet per year at the end of 15 years, and more beyond that (4).*

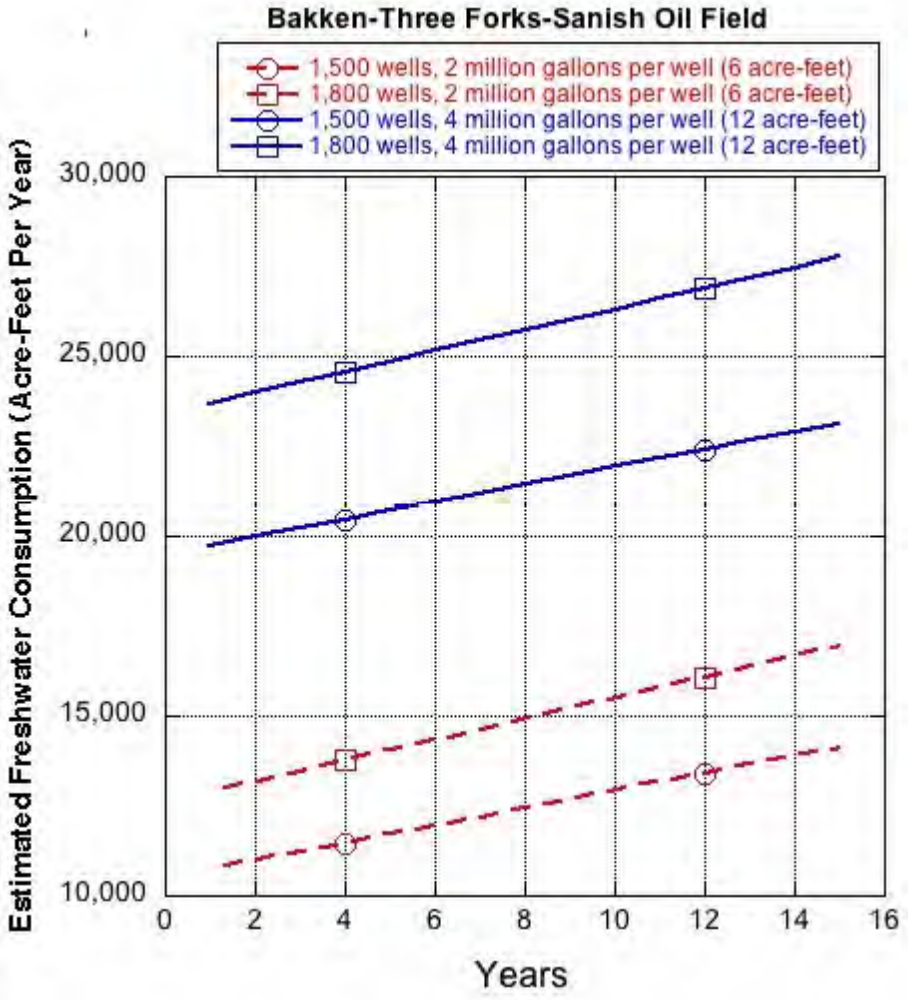

Figure 3. Total estimated annual freshwater requirements for the (Bakken) play are about 13,000-23,000 acre-feet per year initially, depending on the number of wells drilled and the amount of frac water required per well, and as much as 28,000 acre-feet per year at 10-15 years from now (5).

Range of estimated water needs in North Dakota	
Low case	9,200 acre-feet annually (1,500 wells at 2 MM gallons)
High case (expected)	13,000 acre-feet annually (2,140 wells at 2 MM gallons)
4-MM gallon case	20,000-24,000 acre-feet annually (1,500 wells at 4 MM gallons)

At 2 MM gallons of water per day, 1,500 wells will require 3 billion gallons of water annually. The North Dakota Department of Mineral Resources estimates that 1 inch from Lake Sakakawea will provide enough water for 5,000 wells (assuming 2 million gallons of water are used per frac), which is sufficient for 3-4 years at the current rate of development (6).

Regarding the capacity of the "big lake," the ND State Engineer points out that, "The average flow in the Missouri River past Bismarck, North Dakota, is about 40,000 acre-feet per day. The maximum estimated oil field water demand is about 20,000 acre-feet per year (about 55 acre-feet per day), or about one-tenth of one percent of the daily flow past Bismarck" (7).

Alternatives to meeting water demands:

Some alternatives to meeting the water demands have been explored recently and/or are being developed within the industry. The North Dakota Oil and Gas Research Council helped fund a study by the Energy & Environmental Research Center (EERC) to evaluate the feasibility of recycling water used for hydraulic fracture stimulation. The EERC concluded that this practice is likely not a cost-effective means of providing water because of several factors. The quantity and quality of frac flowback water represented significant challenges of utilizing even the most robust technologies for treating and recycling the water, so widespread use of treatment and recycling technology is unlikely at present (8).

The EERC continues to look for other alternatives in meeting the growing demand for freshwater in North Dakota and has been exploring a project of utilizing a marginal water supply in the Dakota Formation. In describing the importance of the issue and the project, the EERC has stated, "The regional and national importance of providing sufficient volumes of water for such an extremely high-value use cannot be overstated. These water supplies will need to come from a variety of resources. One opportunity is to upgrade marginal quality groundwater resources to satisfy a portion of the demand. An evaluation of a membrane technology for the treatment of nonpotable groundwater to supply water for hydraulic fracturing in the same geographic area is being conducted as a Phase 2 Bakken Water Opportunities Assessment project" (9).

Finally, other efficiencies and techniques are under review within the industry. Recently, the NDIC has approved "eco-pad" permits, where an operator is given permission to drill several wellbores (e.g., four) on one well site, reducing environmental impacts, reducing the well site footprint, and lowering the impact upon local roads. Additionally, the industry is currently testing the efficiency of utilizing the same water for hydraulic fracturing of the same wellbores on one location, which would reduce demand for freshwater as well. This technique appears promising but is still in the experimental stage.

While these techniques are means to reduce demand for freshwater and make more efficient use of water resources, they are unlikely to fully meet the demand for freshwater in the near term. Other sources are required.

Current water supply:

The actual source and quantity of water being used in the oil field is a moving target, in part because of the changing nature of development, competition for limited water resources (causing demand to migrate to sources other than the nearest supply), and a host of other factors. We've attempted to identify the quantity and source of current water supply and demand below with the assistance of the SWC staff.

Previous demand (based on 2 MM gallons or 6 acre-feet per well)		
2008	720 wells	4,320 acre-feet
2009	622 wells	3,732 acre-feet
2010	1,322 wells*	7,932 acre-feet

* Assumes 1,322 wells drilled based upon actual wells drilled to date.

However, the reported median and mean of water used in 2009 was 2 acre-feet per well, representing 1,440 and 1,244 acre-feet for 2008 and 2009, respectively (10).

Current groundwater supply:
As of December of 2009, there were 28 water depots (private) with an allocation of 2,340 acre-feet per year serving the oil industry. At present, the State has issued 34 permits to divert groundwater with an allocation of 2,654 acre-feet of groundwater. Forty-nine more water permits for groundwater depots for an additional 11,803 acre-feet per year are pending. Because of the limited nature of the groundwater supply in North Dakota, it is not likely that much of this quantity will be authorized (see Figure 3).

Current surface water supply: The State Engineer has issued six surface water permits to divert water for industrial use (oil field water depots) in western North Dakota. The total surface water allocation is 22,429 acre-feet per year. Two permits representing 20,000 acre-feet from Lake Sakakawea are under review by USCOE (see Figure 4).

Public water supply: Some of the larger public water supplies available to meet current needs and potential expansion are:

Source	Currently available (acre-feet)	Potential/Margin (acre-feet)
Southwest Pipeline (Dodge)	140	1,000-2,000
Northwest Area Water Supply (in litigation)	0	0
Parshall	370	1,000
*Williston	6,600 (uncertain)	4,000
*McKenzie Rural Water/W.C.	(minimal/uncertain)	**
R & T Rural Water	0	0
Burke/Divide/Williams	($127 million integrated system, includes McKenzie)	15,000
Dickinson (Patterson/BOR)	170 (est).	12,400
Estimated Total	1,000-2,000	
Total Apparent Water Supply Available	**6,000-7000**	

* Includes municipal/domestic and other industrial uses also.
** Represents 4,000 acre-feet from Williston.

A number of proposals to expand these public systems are in various stages of planning or development and have three common elements: 1) each relies on Missouri River or Lake Sakakawea water, 2) each is dependent upon a level of public funding, and 3) each may provide a part of the future water needs of the oil industry, but timeliness of implementing the projects remains a concern.

Note: Additional work is necessary to provide precise estimates and location of the current water supply, which may be difficult given the changing dynamics of the development. Based upon comments from the North Dakota Water Commission and submissions to USCOE, groundwater

sources and surface water, other than Lake Sakakawea and the Missouri River, are essentially exhausted (as described within this document).

Additional water permits pending for Lake Sakakawea:

Requested permit(s)	Permits	Requested allocation (acre-feet)
International Western Company	3	28,900
Steve Mortenson of Williston	2	5,370
Hexom of Williston	1	2,000
Pease	1	1,000
Pennington of New Town	1	800
Total		**38,070**

All applications are in various steps of processing, with the exception of one water permit for 18,000 acre-feet that has been granted to International Western Company.

Future water supply (Lake Sakakawea and the Missouri River):

Lake Sakakawea and the Missouri River are the most rational and viable means of meeting the water demands of North Dakota's growing oil industry. According to the State Engineer, other surface and groundwater sources in western North Dakota cannot meet water demands of this magnitude (11). Lake Sakakawea should be the primary source for meeting future needs for the following reasons:

- It is centrally located and bisects the region where the bulk of oil development occurs, promoting the efficient distribution of water near oil development;
- Access to Lake Sakakawea can be timely in response to the demand in comparison to lengthy and costly studies necessary for accessing groundwater supplies;
- Sufficient quantities of water exist in Lake Sakakawea to meet the demand, without impeding other uses or the purposes of the Garrison project, and without degrading water quality;
- Lake Sakakawea has consistent water characteristics to meet the quantitative and qualitative requirements of hydraulic fracturing;
- Utilization of Lake Sakakawea will enhance efficient distribution of water resources in concert with the development and will reduce impacts upon other systems, infrastructures, and people in northwestern North Dakota; and
- There is little to no risk of overappropriating water from Lake Sakakawea, in contrast to the potential of doing so with groundwater and threatening the water resource itself.

Future water supply for the growing industry will include other resources. However, for the reasons described above, none can meet the needs in such a well-suited manner as Lake Sakakawea.

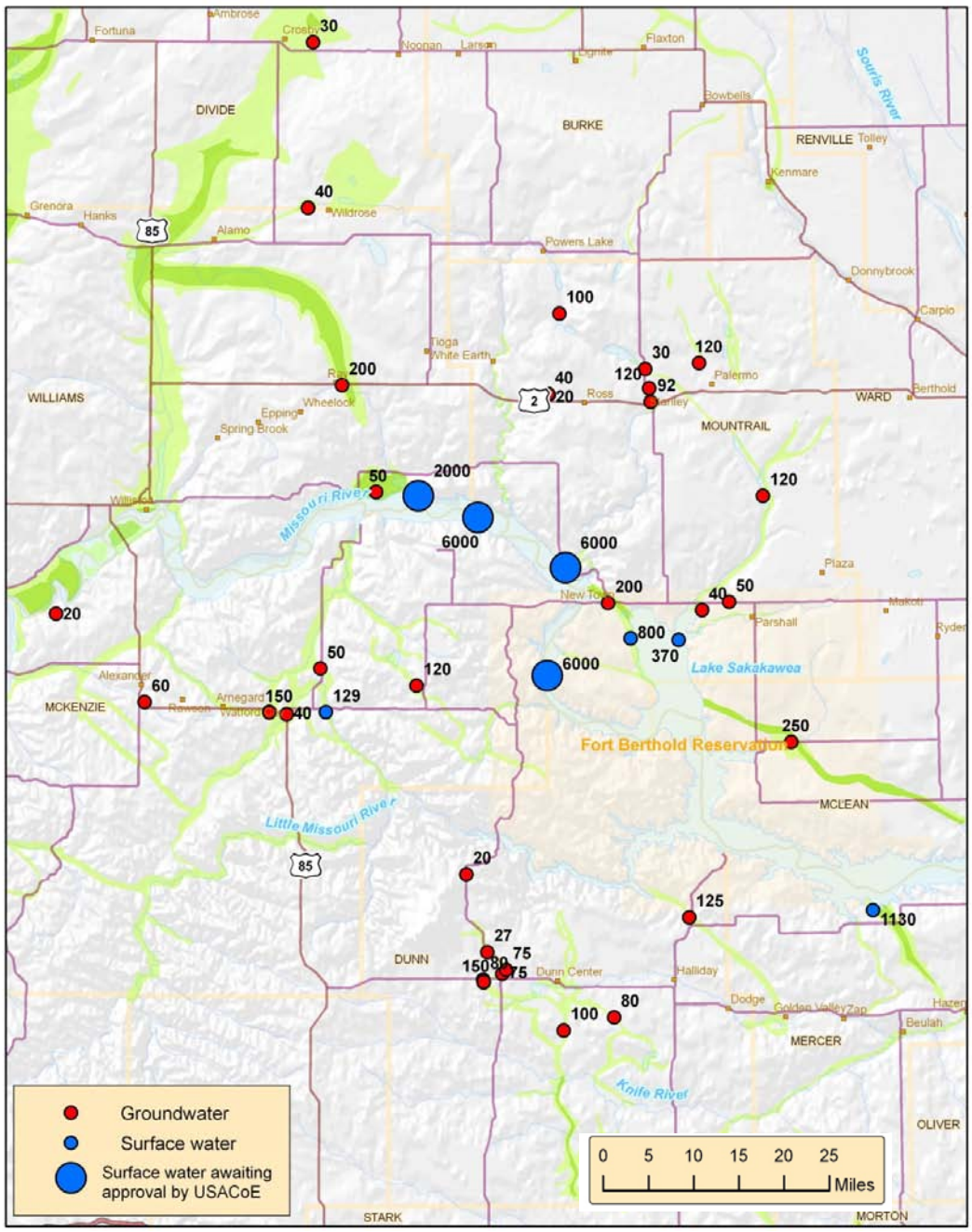

Figure 4. Permitted water sale depots for industrial use (in acre-feet/year). Glacial aquifers shown in yellowish-green shading.

Surface water and groundwater sources, excluding Lake Sakakawea/Missouri River, are limited in western North Dakota. Rivers and streams are characterized by large spring flows and low summer, fall and winter flows. Groundwater resources in western North Dakota are also limited. The only freshwater bedrock aquifer capable of providing sufficiently large individual well yields is the Fox Hills Aquifer. Fox Hill water level monitoring over the past 30 years indicates a consistent pressure head decline of 1-2 feet per year. Given the head pressure trends and prior appropriations from Fox Hills, the State Engineer will not approve large-scale diversions from this aquifer (12).

The State Engineer indicates that groundwater will not meet future demands for oil development for the following reasons:

- Large appropriations to other and higher legal uses/priorities,
- Uncertainty regarding the quantity and quality of water from these sources,
- Timeliness and cost of doing studies, modeling, and analysis necessary to reduce uncertainty (13).

The only plentiful and dependable supply of water for the oil industry in western North Dakota at projected rates of extraction is the Missouri River system, including Lake Sakakawea (10).

Redirection of the water supply is currently designated as irrigation, but redirection to the oil industry may also be a source. There are presently 55 permits for withdrawing water from Lake Sakakawea for irrigation, some of which wish to withdraw water for industrial use. The State Engineer favors such a request on a temporary basis, which is under review by the USCOE).

Riverine development outside the flood pool of the Garrison Reservoir may also provide other water resources to help meet the growing demand. Development of a riverine water source is likely to occur in extreme western North Dakota but will be on the far end of the Bakken development, making distribution of the water throughout the Bakken region economically and environmentally inefficient. Trucking water from a riverine source for long distances in the Bakken region is undesirable because of the cost (trucking is often twice as expensive as pipelines), the inefficiency (more efficient to use water located near the well, if available), and the impact to the environment and infrastructure.

The current fleet of groundwater depots has been exhausted or will be nearly exhausted, leaving the industry to look to the few remaining surface water depots or public supplies for a stable supply of freshwater. The industry will look to Williston, New Town, Parshall, Halliday, and Dickinson, transporting water by truck to the area where it is needed. The remaining water supplies are not ideally suited to provide efficient distribution of water for orderly development, and some currently report long waiting periods for trucks seeking to acquire water (e.g. Dickinson reports a waiting period of 4-8 hours at its municipal water depot).

These depots are not located to provide efficient distribution of water supply for continued development in the western North Dakota region. Rather, reliable water depots will draw trucks from 20-100 miles in order to secure the freshwater necessary for fracing. Inefficient distribution of the water supply increases transportation distances and places a greater burden on an already strained highway system that shows clear signs of being stressed under current loads. Concern for the highway infrastructure in western North Dakota is a key issue for public officials, the general public who live and work in the area, and the industry. A study by the North Dakota Department of Transportation (ND DOT) has shown that truck traffic in western counties impacted by oil development has grown by approximately 200 percent in one year (2008-09). Annual freshwater truck loads have grown from approximately 118,900 in 2008 to approximately 224,900 truckloads in 2009 (14). The ND DOT study is being updated and is likely to show similar load growth in 2010.

Recent expenditures by ND DOT alone also signal an ongoing challenge of maintaining a viable highway system in the four key oil producing counties of Williams, Mountrail, McKenzie, and Dunn. In those four counties (without consideration of expanding Highway 2 to four lanes), ND DOT has spent in excess of $100 million strictly on the roads since 2006. Adding the expansion of Highway 2 to a four-lane roadway brings the total to $165 million spent in state funds since 2006.

Demands of the public indicate a strong interest in further improvements and better maintenance of the road systems in the area. Providing more strategically located water supply depots to accommodate the development that is underway will help immensely in reducing truck traffic, premature deterioration of roads, and hazards of truck traffic in the west. Accessing Lake Sakakawea in strategic locations will place water closer to where the development occurs, make for greater efficiencies, save fuel, and reduce impacts to roads and people.

Promoting a rational, well-designed water delivery system that will provide an economic, efficiently distributed water supply is in the best interests of the public both statewide and nationally. Accessing Lake Sakakawea water to encourage continued development of the Bakken in North Dakota appears to be the most rational alternative of the options available in western North Dakota.

Respectfully submitted,

Robert W. Harms

Robert W. Harms
The Harms Group
Bismarck, North Dakota

Endnotes:

(1) Hydraulic fracturing of the formation is conducted through three separate series of enclosed pipe (surface casing, production casing, and production tubing), as it is injected approximately 10,000 feet below the surface in a closed and carefully monitored system. No potable water supply exists at these depths.
(2) ND Department of Mineral Resources, August 2010, Lynn Helms, Director.
(3) ND Department of Mineral Resources, June 2010, Bruce Hicks, Assistant Director.
(4) ND State Water Commission, Water Resource Investigation # 49, August 2010, W.M. Schuh.
(5) Ibid.
(6) ND Department of Mineral Resources, June 2010, Bruce Hicks, Assistant Director.
(7) ND State Engineer, NEPA response to Corps of Engineers, September 2010.
(8) Energy & Environmental Research Center, Final Report to ND Oil and Gas Research Council, April 8, 2010; http://www.nd.gov/ndic/ogrp/info/g-018-036-fi.pdf.
(9) Ibid.
(10) Schuh, supra.
(11) ND State Engineer, August 2010, supra.
(12) ND State Engineer letter to Phillip Brown, Project Manager, USCOE, February 23, 2010.
(13) ND State Engineer, August 2010, supra.
(14) ND DOT Report, Mon-Dak Ag Open, August 3, 2010, Jack Olson, Assistant Director, Planning Division.