

Testimony of Steve L. Burian, P.E.

Senate Budget Committee Field Hearing

“Devils Lake Flooding Disaster: A Red River Valley Perspective”

West Fargo, North Dakota – August 16th, 2010

Introduction

Good morning, I am Steve Burian, an engineer specializing in water supply and treatment, and a current consultant to the City of Fargo. I would like to thank Senator Conrad and Cass County for hosting this hearing focusing on the Devils Lake Flooding Disaster.

I fully understand the immediate issues surrounding Devils Lake flooding and the need for flood relief, but I am going to shift the focus of my testimony to issues related to the discharge of Devils Lake into the Sheyenne River. Specifically, I would like to address implications related to increased sulfate concentrations in drinking water, increased sulfate concentrations within the Sheyenne River, and how these sulfate concerns will affect downstream users, including the City of Fargo.

Sulfates in Drinking Water

Sulfate is an anion with high solubility that naturally exists in water sources primarily in the forms of sodium sulfate, calcium sulfate, and magnesium sulfate. The United State Environmental Protection Agency (EPA) and North Dakota Department of Health have adopted a secondary standard of 250 mg/L for sulfate in drinking water. Estimates indicate that only three (3) percent of drinking water supplies in the country have provided water in excess of this 250 mg/L recommendation, although sulfate is more common in North Dakota.

Sulfate, especially sodium sulfate, is known to give water a bitter, astringent, and undesirable taste even at low concentrations. One study by Zoeteman (1980) indicated that sodium sulfate, in any concentration, affects the taste of drinking water. Another study by the National Academy of Science (1977) indicated that sulfate concentrations between 250 to 1,000 mg/L caused reported taste impacts and varied depending on the sulfate species, with sodium sulfate being the worst. Based on water quality sampling data from the North Dakota Department of Health, sodium sulfate appears to be the most prevalent form of sulfate in the water discharged from Devils Lake into the Sheyenne River, though all three (3) forms are present.

Regarding health implications, the EPA and World Health Organization have indentified many resources that indicate that sulfates in higher concentrations can cause diarrhea and dehydration, particularly for infants, elderly, and transient populations. The specific concentration for these health effects is variable and inconclusive. The World Health Organization has set a health advisory level for drinking water containing sulfate concentrations above 500 mg/L. In 1994, the EPA proposed a primary standard of 500 mg/L for sulfate, but it was not enacted because the field experiment was inconclusive, primarily

because the researchers could not secure a large enough statistical population of exposed infants and the adult trials produced non-statistically significant results. In the absence of an enforceable health effects standard, the only published standard for sulfate is based on aesthetics at 250 mg/L.

Sulfates in the Sheyenne River

United States Geological Survey (USGS) historic water quality data from 1969 to 2005 (36 years) indicates an average sulfate concentration of approximately 146 mg/L on the Sheyenne River at West Fargo, with higher concentrations occurring since the mid-1990s. **(Attachment 1 shows historic sulfate concentrations in the Sheyenne River at West Fargo from 1969 to July, 2010.)** A closer look at the source water quality data indicates that prior to the Devils Lake Emergency Outlet only three (3) of 65 samples (4.6 percent) from the Sheyenne River at West Fargo exceeded the secondary standard of 250 mg/L, with a maximum recorded concentration of 310 mg/L. With the operation of the Devils Lake Emergency Outlet, however, the sulfate concentration throughout the Sheyenne River is increasing. Water quality sampling performed by the City of Fargo from October 2009 until the present at the City of Fargo's Sheyenne River intake at West Fargo indicates an average sulfate concentration of 270 mg/L and a maximum concentration of 383 mg/L. Sixty three percent of the samples taken by the City of Fargo over this time period are above the 250 mg/L secondary standard. **(Attachment 2 shows sulfate concentrations in the Sheyenne River at West Fargo from October, 2009 to July, 2010.)**

Unfortunately, USGS water quality sampling data from 1975 to 2005 as well as more recent data since operation of the Emergency Outlet began indicate that the Sheyenne River offers almost no dilution of sulfate concentrations between Baldhill Dam and West Fargo. **(Attachment 3 shows the median and maximum sulfate concentration at various gauging stations along the Sheyenne River.)** It is understood recent discussions have suggested extending the temporary emergency sulfate stream standard of 750 mg/L in the upper reaches of the Sheyenne River to the lower reaches of the Sheyenne River. If this variance is approved, historical data suggest the sulfate concentration on the Sheyenne River at West Fargo will be similar to the sulfate concentration released from Baldhill Dam.

Data from 2009 and early 2010 indicate that operation of the Emergency Outlet has a significant impact on sulfate concentrations in the Sheyenne River. **(Attachment 4 shows the Emergency Outlet operations and Sheyenne River sulfate concentrations and the 'Below Baldhill Dam' and the 'West Fargo' gauging stations.)** Sulfate concentrations at the 'Below Baldhill Dam' sampling site rose from just over 114 mg/L in May 2009 to 279 mg/L in October 2009 with near constant operation of the Emergency Outlet at 100 cubic feet per second. Sulfate concentrations at West Fargo continued to rise to 383 mg/L by the end of January 2010 before falling as a result of spring runoff. The pumping capacity of the Emergency Outlet was expanded in June 2010 from 100 to 250 cubic feet per second, but sufficient data is not yet available to evaluate how the expanded capacity will impact the sulfate concentrations in the Sheyenne River.

City of Fargo Water Supply

The City of Fargo relies upon the Red River of the North and the Sheyenne River as its water supplies. Throughout the year, the sources are used independently as well as blended at different ratios.

(Attachment 5 shows City of Fargo’s monthly raw water usage from the Sheyenne River and Red River from 2005 to 2009.) Having redundant water supply sources provides the City with important operational flexibility, in the event of infrastructure failures, contamination of one of the sources, and undesirable discharges from poor quality upstream reservoirs or point sources. The City of Fargo has made significant investments to secure redundant source water supplies, and it would be irresponsible for the City of Fargo to rely exclusively on a single source.

City of Fargo Water Treatment Plant

The City of Fargo successfully provides its consumers with safe and aesthetically pleasing drinking water. The current Fargo Water Treatment Plant, which was constructed in 1997 along with related facility improvement at a cost of approximately \$75 million, includes five (5) main mechanisms for treating its Red River and Sheyenne River sources:

- 1) high rate clarification to remove solids
- 2) two-stage lime / soda ash softening to reduce hardness
- 3) filtration to remove particulate matter
- 4) ozonation for organic taste and odor control and primary disinfection, and
- 5) chloramination for disinfection by-product control and secondary disinfection.

These technologies were selected based on the historic water quality of the Red River and Sheyenne River. Ozone was specifically incorporated for taste and odor treatment to provide an aesthetically pleasing water quality to the Fargo consumers. Because of its solubility, sulfate is very difficult to remove from drinking water using conventional technologies, and none of the treatment technologies incorporated at the Fargo Water Treatment Plant is capable of removing sulfate. Based on the historic water quality of the Red River and Sheyenne River, sulfate removal technologies were not historically necessary for the City of Fargo to provide acceptable drinking water to its consumers.

Sulfate Treatment Strategies

If increased sulfate concentrations on the Sheyenne River persist and further increases stem from the necessity to move additional water from Devils Lake to prevent further flooding impacts and an uncontrolled release, sulfate treatment of the Sheyenne River by the City of Fargo will be warranted. Advanced technologies capable of sulfate removal include:

- Reverse Osmosis (RO)
- Ion Exchange
- Electrodialysis / Reverse Electrodialysis (ED/EDR)

Of these technologies, reverse osmosis is likely the only practical alternative for a large scale drinking water system. City of Fargo staff and consultants have begun preliminary analysis of the scope and estimated costs to incorporate reverse osmosis treatment of the Sheyenne River to maintain a treated water sulfate concentration of 250 mg/L. The preliminary concept developed for the City of Fargo includes a new eight (8) million gallon per day (MGD) reverse osmosis facility to treat water from the Sheyenne River prior to blending and polishing treatment at the existing 30 MGD Fargo Water Treatment Plant. Another option that could be considered is partial reverse osmosis treatment of the Fargo Water Treatment Plant effluent prior to pumping finished water into the City's distribution system. Further facility planning is necessary to identify the most cost effective treatment alternative.

Although reverse osmosis treatment for drinking water has become more common in recent years, the estimated capital costs and operation and maintenance costs to incorporate reverse osmosis for sulfate removal within the Fargo water system are significant. The required size and associated costs for the reverse osmosis system are directly related to the source water quality.

Based on the preliminary analysis, the new sulfate treatment facility is estimated to cost approximately \$50 to \$70 million, with additional operation and maintenance costs ranging from \$3.7 million to \$5.5 million per year. These cost ranges are based on maximum sulfate concentrations in the Sheyenne River of 450 mg/L and 750 mg/L, respectively. Higher source water sulfate concentrations would result in higher estimated costs. It is also important to note that reverse osmosis will be capable of removing the cations that are paired with the sulfate in the Sheyenne River, including sodium, calcium, and magnesium.

Conclusion

In conclusion, I would like to re-iterate five key points of my testimony:

1. Research indicates that sulfate starts to impact the taste of drinking water at relatively low concentrations. Research also suggests that sulfates at higher concentrations can potentially impact health. The only published drinking water standard for sulfate is the secondary standard of 250 mg/L based on aesthetics.
2. Sulfate concentrations in the Sheyenne River are increasing due to the operation of the Devils Lake Emergency Outlet and little dilution has been observed between Baldhill Dam and West Fargo. Further sulfate concentration increases on the Sheyenne River may be required to limit further Devils Lake flooding impacts and prevent an uncontrolled discharge.
3. The Sheyenne River is a critical component of the redundant Fargo water supply system.
4. Based on a significant water treatment investment in the mid 1990's, the City of Fargo has been able to routinely provide its consumers with safe and aesthetically pleasing drinking water. The existing Fargo Water Treatment Plant, however, is not capable of removing sulfates.

5. With increasing sulfate concentrations in the Sheyenne River, reverse osmosis treatment by the City of Fargo to maintain a treated water sulfate concentration of 250 mg/L will be warranted with very significant new capital and operation and maintenance costs.

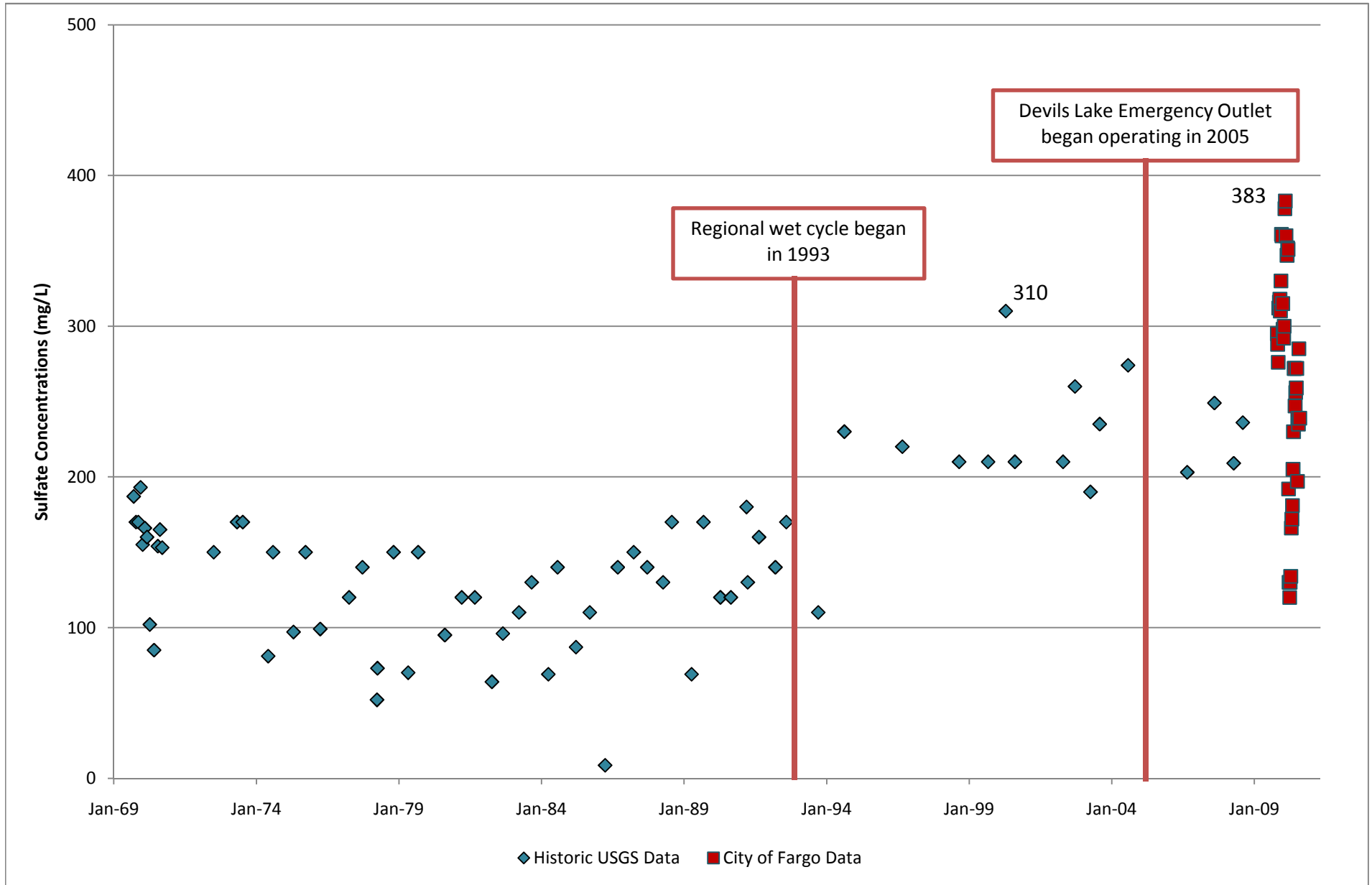
Thank you once again for the opportunity to testify regarding the downstream drinking water impacts of the Devils Lake flooding disaster. I would be happy to join the other panel members in answering any questions you might have.

Attachments

Attachment 1

Historic Sulfate Concentrations in the Sheyenne River at West Fargo

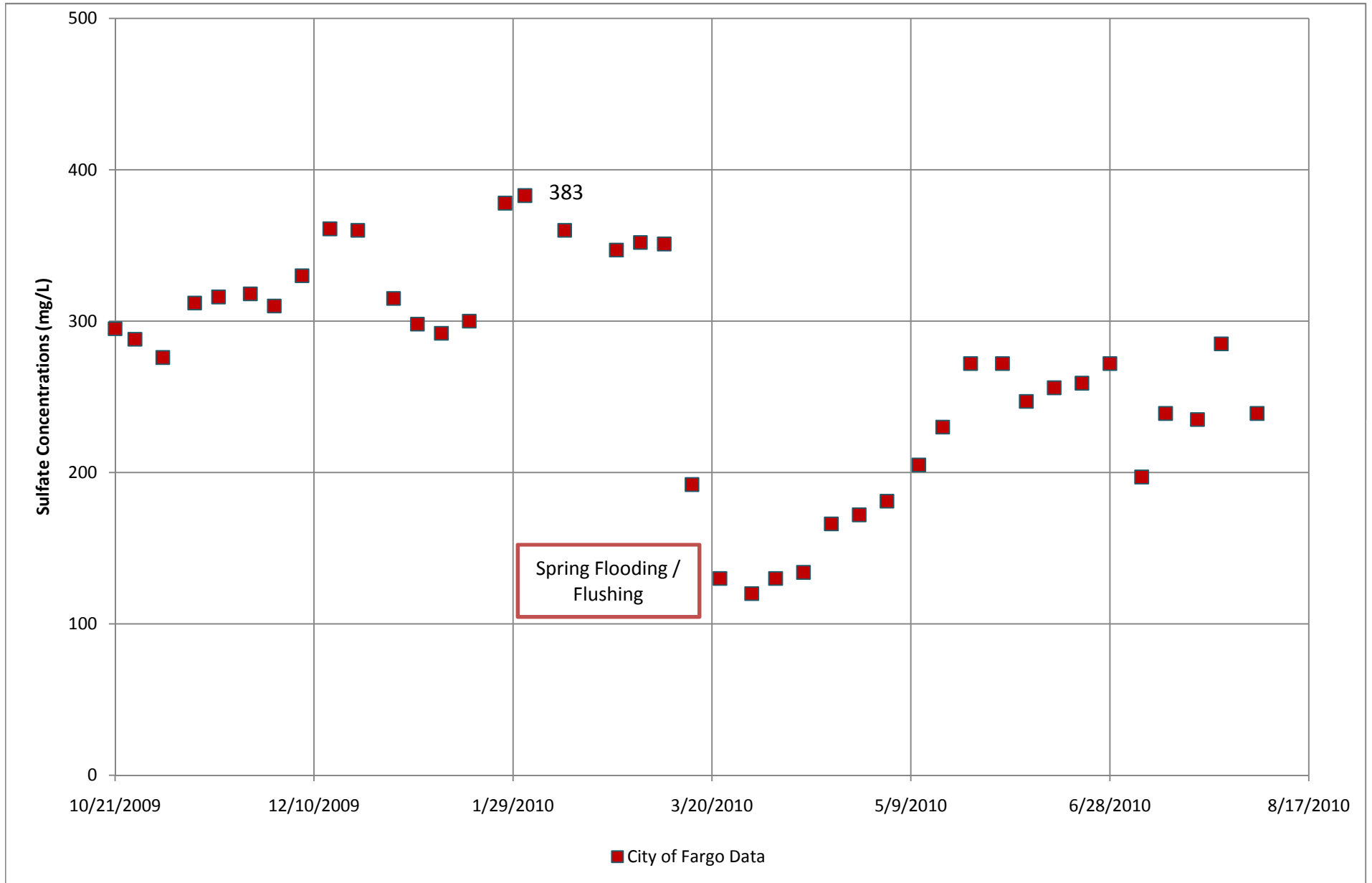
USGS and City of Fargo Data



Attachment 2

Historic Sulfate Concentrations in the Sheyenne River at West Fargo

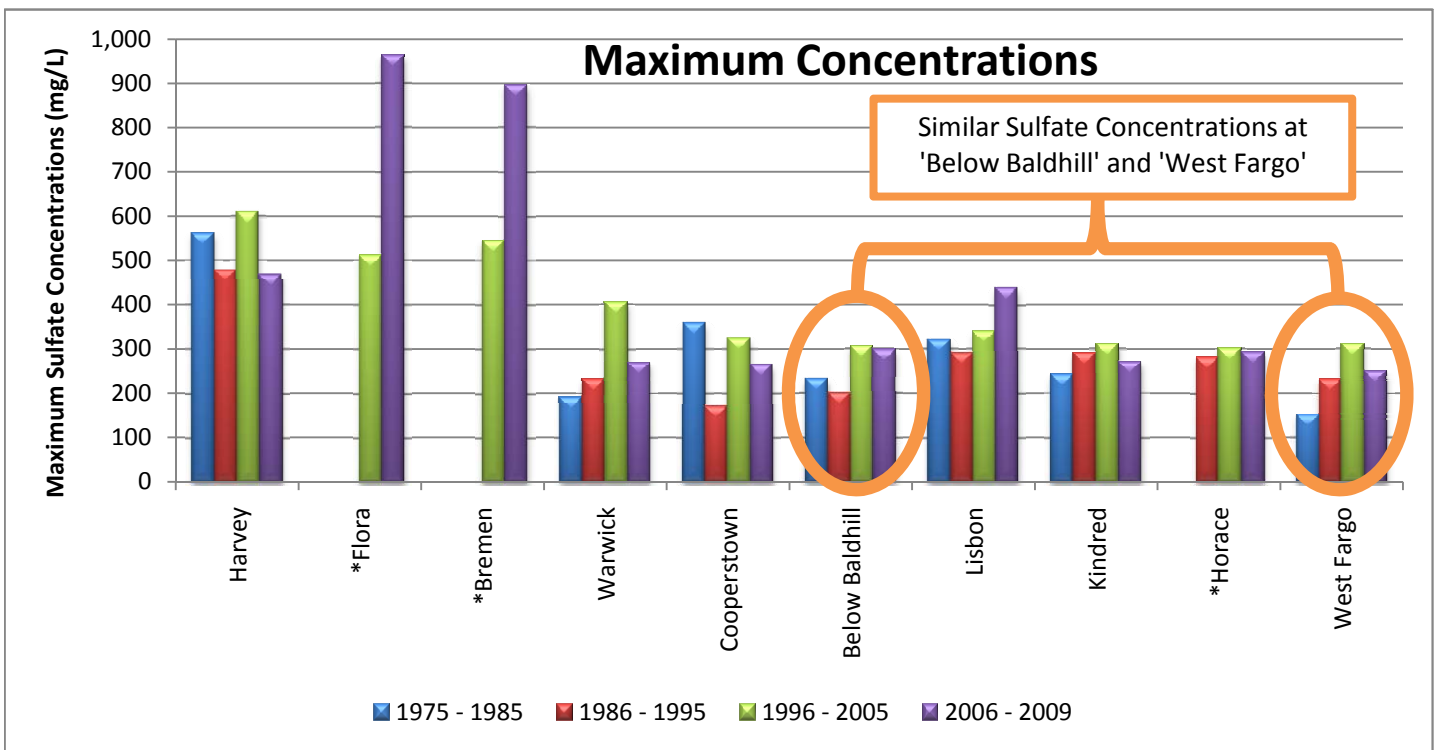
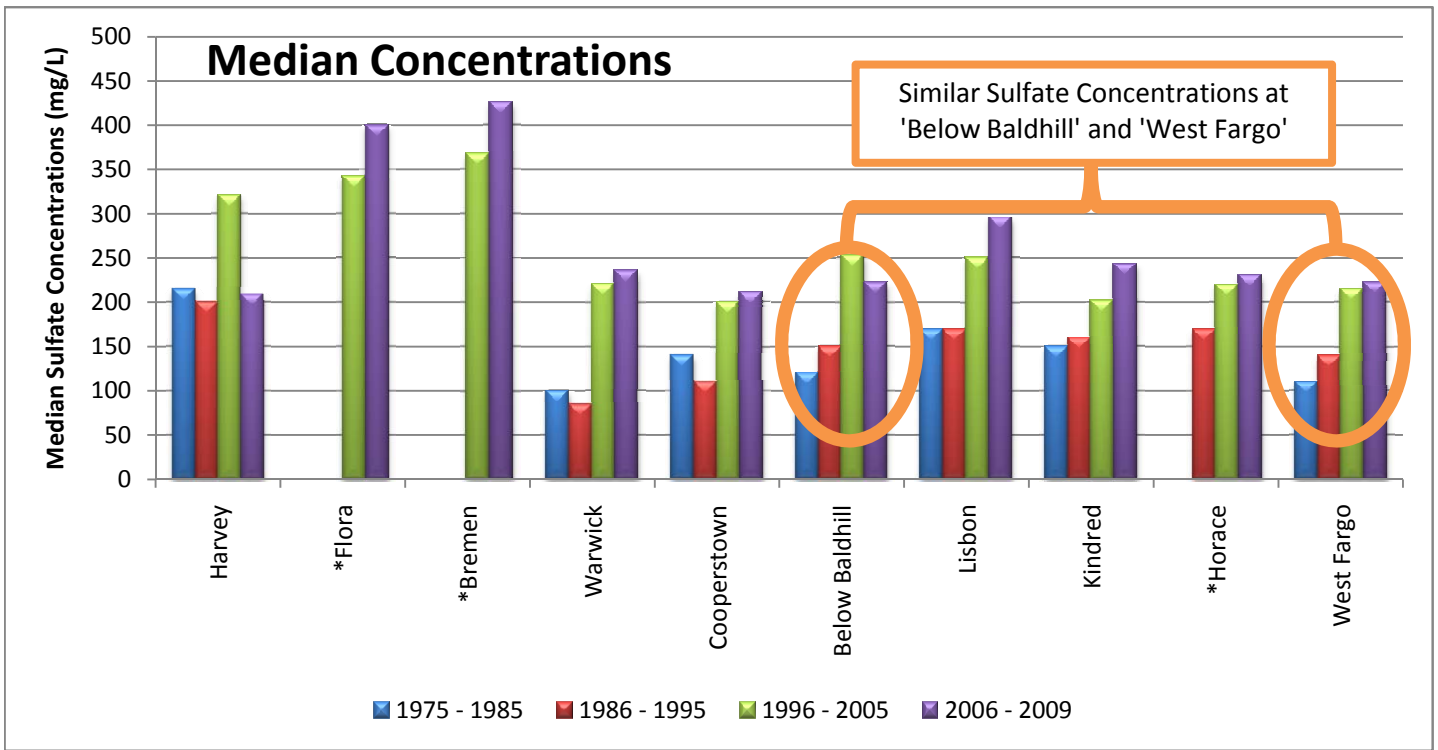
City of Fargo Data



Attachment 3

Historic Median and Maximum Sulfate Concentrations

At Locations Along the Sheyenne River (Following Flow Direction)



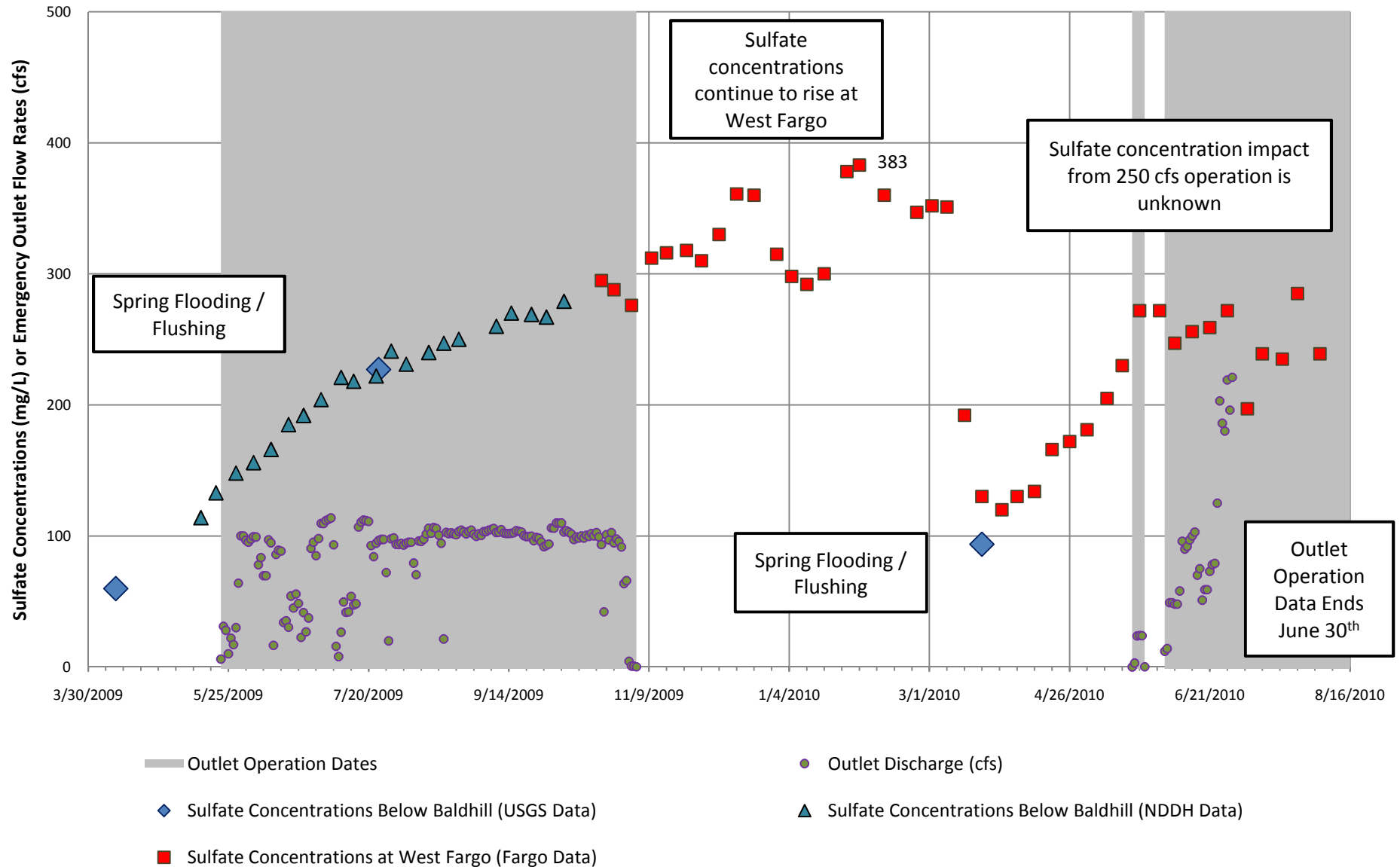
*Flora: Data Ranges are 2005 & '06-'07

*Horace: Data collection began in 1992

*Bremen: Data Ranges are 2005 & '06-'07

Attachment 4

Devils Lake Emergency Outlet Operations and Sheyenne River Sulfate Concentrations



Attachment 5

