Memorandum Regarding Proposed Wild Rice Rule Change

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November 22, 2017

1. My past involvement with the Wild Rice Rule process.

I am a Professor Emeritus of Mathematics, having retired from the University of Minnesota faculty. My most relevant field of expertise is Applications of Mathematics. My *curriculum vitae* is summarized in Section 7 of this report.

In December 2015, I submitted a memorandum about the statistical calculations in MPCA's March 2015 Proposed Approach. A copy of that memorandum is attached (See Attachment 1), because I will refer to some parts of it. I did this submission in cooperation with WaterLegacy and at the urging of Len Anderson, who was a member of the Wild Rice Advisory Committee. On September 30, 2016 I attended a meeting of that Committee at the MPCA office in St. Paul. At the meeting I learned that MPCA staff had devoted significant effort to dealing with some observations made in that memorandum and to overcoming some criticisms.

Some sections of the December 2015 memorandum remain relevant to my analysis of the current Technical Support Document (TSD) and the proposed change in the Wild Rice Rule, particularly:

- §2 Ratios and log-log scale
- §3 Identification of the Main Outlying Cluster

    This is a set of sites where the formula under-predicts the porewater sulfide level. Almost all of these sites exhibit extremely high levels of porewater sulfide. A significant number also have high levels of sediment iron, but the interaction between these two variables is quite complex.

Some progress has been made toward achieving a better fit of the formula to a large subset of the data; however problems presented by the Main Outlying Cluster have not been resolved.

2. New and Old elements in the 2017 TSD.

The March 2015 Proposed Approach was based on an equation, derived from Structural Equation Modeling (SEM), that directly relates (surface water) sulfate and (porewater) sulfide levels, along with sediment iron and sediment carbon. The approach used in the 2017 TSD is based on a formula that calculates the *probability* of the sulfide level being above an assigned protective level, taken as 120 μg/L (micrograms per liter) for purposes of the proposed rule change. This formula is obtained by Multiple Binary Linear Regression (MBLR).

Strict reliance on this current model would make it difficult to do quantitative assessments of goodness of fit, comparable to what I did in my December 2015 memorandum. It is, of course, possible to compare the actual surface water sulfate level with the calculated protective sulfate level (CPSC) for a given site.

Some comparisons also are done in MPCA memos referenced here. The calculation involved in these comparisons uses the assigned protective porewater sulfide level as an input, rather than the actual porewater sulfide level at the site under consideration.

An inverse version of the 2015 SEM equation yields a predicted value of the porewater sulfide level, based on the sulfate, sediment iron, and sediment carbon levels. In my December 2015 memorandum, this predicted value was compared with the measured value from the Wild Rice Field Study. On the other hand, the 2017 MBLR approach does not provide a means for doing a direct comparison of a predicted sulfide value with the measured sulfide value.

Some limited comparisons can be made using the tools provided in the 2017 TSD. I verified the CPSC calculated by the MPCA for each site and sampling event in the field survey and made a comparison of the CPSC with the actual surface water sulfate level at each site. (See Attachment 2.)

- Among these 237 sites (all Minnesota non-paddy data), more than 140 (or about 58%) have CPSC values that exceed the current 10 mg/L Wild Rice Standard for sulfate, some of them by very substantial amounts. The proposed new standard would therefore weaken protection of wild rice, compared to the present standard.

- Reviewing data for all field survey sampling events other than those paddy rice sites, for 170 of the 238 (71 %) sampling events, the CPSC calculated was higher than the existing sulfate level. For 156 of the sites, the CPSC exceeds the actual sulfate level of the site by 20% or more. For about 60 of the sites, the CPSC is less than 80% of the sulfate level of the site. Three sites have a missing measurement, and for the remaining 18 sites, the CPSC is within 20% of the actual sulfate level.

Reviewing data for all field survey sampling events other than those paddy rice sites, for 170 of the 238 (71 %) sampling events, the CPSC calculated was higher than the existing sulfate level.

According to the 2017 TSD, an elevated level of porewater sulfide is the environmental variable which is most directly toxic to wild rice plants. The fact that the output of the MBLR equation cannot be accurately compared to the measured level of porewater sulfate therefore is a serious obstacle to an impartial verification of the MBLR equation.

A more thorough reading of the TSD shows, however, that equations from the SEM approach were extensively used to guide development of the MBLR-based equation. (This is mentioned in the TSD, and in a more detailed way in the MPCA Data Analysis Unit Memos listed in the references.) This means that comments about the previous approach still are highly relevant. Among other things, the Main Outlying Cluster identified in my earlier memorandum still is present in the data, even though it has been de-emphasized by restriction to the Class B data set rather than using all of the data.

3. Advantages and Disadvantages of equation-based approaches to the Wild Rice Standard.

Some of the points mentioned below are briefly discussed in the TSD, although firm conclusions are not always drawn there.

(a) The following statement is found on page 49 of the TSD:

> A major question is whether or not the lower overall error rate of the MBLR equation when compared to a fixed standard (16-19%, compared to 32%) justifies the additional investment in collecting iron and organic carbon data at each wild rice water.

This is indeed a significant question, but no answer is given. In addition to the added cost, it should be pointed out that implementation of the equation-based standard also involves the possibility of sampling error. Here is a diagram from the March 2015 Proposed Approach that indicates that the sampling error problem likely would be widespread:

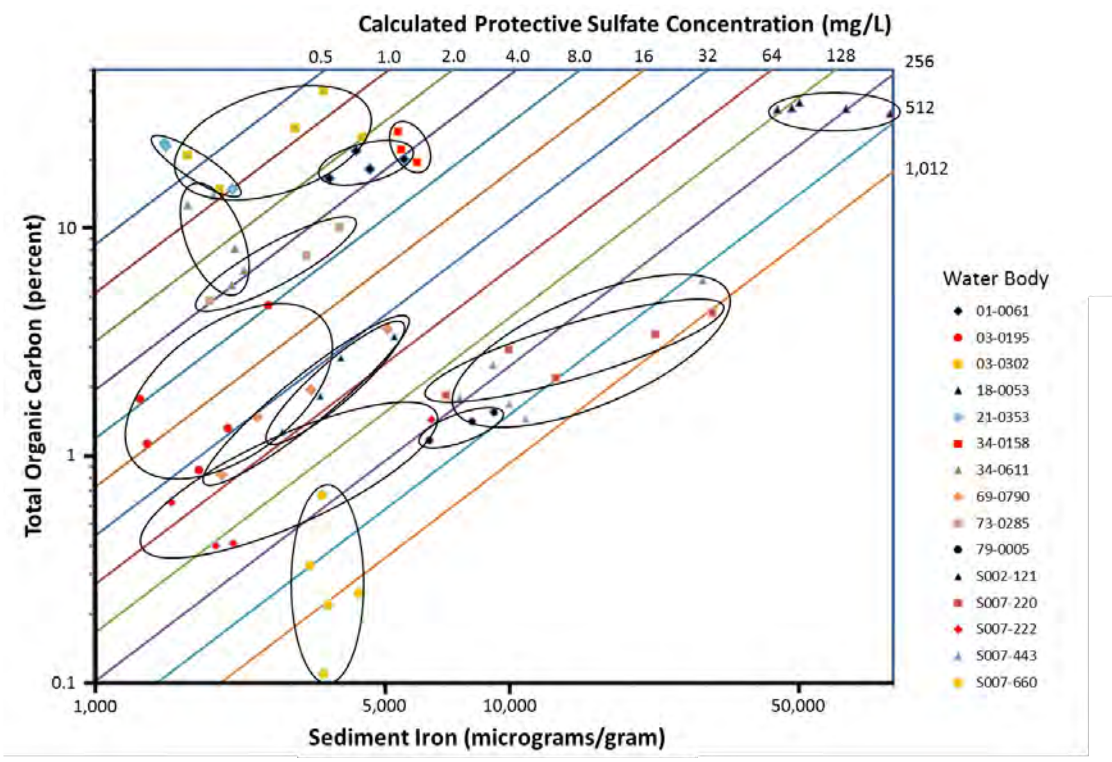


Figure 14. Data from water bodies with wild rice where three or more sediment samples were taken within 1,000 feet of each other. Ellipses encompass the range in calculated protective sulfate concentrations, which are based on sediment iron and total organic carbon data as modeled with Equation 1. The log-log display allows both a greater range of sediment concentrations and better separation of the sites than in Figure 10. Additional water body information is given in Table 6.

Each oval encloses all of the data points for a given water body with wild rice. The sloped lines represent values of the Calculated Protective Sulfate Concentration (CPSC). The number of sloped lines crossed by each oval indicates the size of the uncertainty in the CPSC. For instance, in the water body that corresponds to the small oval at the upper right, the CPSC values range from 128 mg/L to 512 mg/L. Thus, the largest value in this case is 4 times as large as the smallest one, which is a large degree of uncertainty.

(b) For data sets where the formula fits reasonably well, the CPSC levels do not diverge widely from the current 10 mg/L standard. (This statement does not appear explicitly in the TSD, but it is evident in many of the comparisons that are made.)

(c) Although there is no similar illustration in the 2017 TSD of the divergence in CPSC calculated on the basis of sampling the same site at various times, this information can be reviewed using the CPSC for the water bodies identified with the numbers at the right side of the above chart.

Reviewing the 2017 calculated CPSC for sites where multiple samples were taken (Attachment 3), a wide divergence is found at sites where the calculated CPSC is higher than the current 10 mg/L standard. At Second Creek (S007-220), based on sampling dates within the same year, the CPSC ranged from 166.92 mg/L to a CPSC of 657.30, nearly four times higher. At Mississippi Pool 5 (S007-660), again within the same sampling year, the CPSC ranged from a low of 132.16 to a high of 1160.97, a level 8.78 times higher. For Lake Monongalia (34-0158), where various locations within the water body were sampled, calculated CPSC ranged from 3.66 mg/L to 455.39, more than two orders of magnitude of variation.

(d) It is doubtful that the added expense and effort of implementing an equation-based standard is justified. The potential for divergent calculations of CPSC levels calls into question the reliability of the methodology and could create many issues regarding the time and location of sampling. In addition, because an equation-based standard is more complicated, it becomes excessively difficult for many stakeholders and for the general public to have any kind of concrete understanding of what the standard involves.

Despite the fact that the merits of an equation-based standard are debatable, we still should look at the equation that is proposed. We have observed that the SEM equation (whose inputs are sulfate, iron, and organic carbon) provides serious under-prediction of the sulfide level at sites where the measured sulfide level is high. Although not all of these sites have high level of sediment iron, I still believe that the iron exponent provides a significant part of the explanation. Here are the two formulas.

- From the 2015 SEM approach:

  $$\text{Calculated Sulfate Standard} = 0.0000136\left(\text{Sediment Iron}^{1.956} / \text{Organic Carbon}^{1.410}\right)$$

- (Sulfate and sulfide are expressed in mg/L; organic carbon is percent total organic carbon in the sediment; iron is micrograms extractable iron per gram sediment).

- And from the 2017 MBLR approach:

  $$\text{Calculated Sulfate Standard} = 0.0000121\left(\text{Sediment Iron}^{1.923} / \text{Organic Carbon}^{1.197}\right)$$

  (The units are the same as in the previous equation)

In the first case the iron exponent is 1.956, and in the second case the iron exponent is 1.923. Since the exponents nearly are equal to 2, we are close to a situation where the equation (with carbon value held constant) is a quadratic function of the iron value. (This would correspond to the graph being a parabola rather than a straight line.) This means, for instance, that if the iron value is increased by a factor of 10, then the CPSC is increased by a factor of 100. Such an increase in iron values actually is not especially large in the Wild Rice Field Study on which this study is based. Indeed, the values in the data range from 895 µg/g (micrograms of iron per gram of sediment) to 83,421 µg/g. Thus, the ratio of highest to lowest is about 93. The 10^{th} percentile is around 1,800 µg/g while the 90^{th} percentile is around 19,000 µg/g. The ratio between these two values is about 10.6.

If an exponent close to 2 is needed to make the model fit the data in the middle of the range, it would be highly likely to lead to inflated estimates of the CPSC at the upper end of the range. Indeed, this is the natural consequence of moving to the right along a parabola.

In addition, recent research by Prof. John Pastor at the University of Minnesota at Duluth has shown that iron sulfide plaques can form on wild rice roots in sediments where iron and sulfides are present. (Several of his papers are referenced in the TSD, and some other aspects of his research are discussed there. This aspect of his research is not discussed in the TSD, however.) It is relevant to mention this finding here, because it indicates the possibility of a significant interaction between two of the independent variables, specifically iron and carbon. The type of model used in the TSD, however, doesn't make sufficient allowance for complex interactions between the different inputs.

4. COMPARISONS OF THE 2015 FORMULA AND THE 2017 FORMULA.

(a) In the 2015 Proposed Approach, protective sulfate levels were calculated by means of the deterministic SEM equation. The adjective "deterministic" is being used to emphasize the fact that the SEM equation relates an actual value of the porewater sulfide level to the values of the other variables. The protective sulfate concentration was based on an EC20 sulfide level, which was estimated to be 165 µg/L. (The designation EC20 refers to the Effect Concentration of sulfide at which there is a 20% negative effect on the growth of wild rice – see page 31 of the TSD). The probabilistic MBLR formula of the 2017 TSD and the proposed rule change is based on an EC10 sulfide level, which is estimated to be 120 µg/L. The EC10 value, which would correspond to a 10% negative effect on the growth of wild rice, was adopted at the recommendation of a peer review panel as stated in the TSD. The EC10 value seemingly should be more protective of wild rice. Thus, we might have expected that the CPSC values obtained from the new approach to be somewhat lower than the corresponding values obtained from the old approach. What happened, however, was that the values from the 2017 formula are only very slightly changed from the values obtained from the 2015 formula. Indeed, a spreadsheet calculation showed a seemingly random pattern of mostly small changes.

A more robust comparison emerges if we use the deterministic 2015 SEM equations to calculate EC10 values of the protective sulfate concentration (CPSC). Indeed, the March 2015 Proposed Approach provides a straightforward means to modify the CPSC equation: one changes the relevant parameter value from 165 to 120, and then proceeds in a completely similar way to what is done in the March 2015 Proposed Approach. A spreadsheet calculation is included (See Attachment 4). All of the CPSC values from this calculation are between 26% and 94% of the corresponding values obtained from the probabilistic 2017 MBLR equation. Nearly four fifths of the values from the deterministic calculation are below 50% of the corresponding values from the probabilistic calculation. Using the same proposed EC10 threshold of 120 µg/L, the 2015 SEM equation would have resulted in lower sulfate standards in every case, and in sulfate standards less than half those currently proposed by MPCA in almost 80% of the cases.

It is reasonable to ask why the 2017 MBLR equation did not lead to more protective calculated sulfate levels even as the sulfide threshold was changed. One plausible explanation is related to the fact that there is a probabilistic aspect to this equation. Clearly, the 2017 MBLR equation does not immediately appear to be probabilistic. It is, however, derived from an equation which calculates the probability of the porewater sulfide level being greater than 120 µg/L. At a certain stage, this probability is assigned a specific value. The issues associated with this assignment are somewhat technical (see subsection (c) below), but I believe that the choice is rather arbitrary.

(b) The reasons for changing from a deterministic equation to a probabilistic one are not fully explained in the TSD. The main reason given in the TSD is that it is supposed to avoid a phenomenon called *re-transformation bias*, sometimes also called back-transformation bias. This phenomenon occurs when a linear equation is fitted to logarithmically transformed data.

- In the linear formula that is fitted to the log-transformed data, the random errors average to zero. Thus, $\log(Y) = A + B\log(X) + E$ in the transformed data, where E is the error term. After the re-transformation, the error term E is transformed to an error ratio 10^E. Even though the error terms average to 0, the error ratios probably will average to some value larger than 1. Thus, re-transformation bias seems unavoidable.

- The TSD provides no explanation of **how** the MBLR approach overcomes this bias. In fact, the claim that the MBLR approach overcomes the re-transformation bias actually is **subject to serious doubt**, because the derivation of the MBLR equation starts from a regression formula applied to log-transformed data. (That regression formula is presented in subsection (c) below.)

- Methods are available for estimating magnitude of the re-transformation bias. I located one of these in a paper from the journal *Environmental Toxicology and Chemistry* that is referenced in one of the TSD references. For a normally distributed variable, the estimate is based on the root-mean square (RMS) error in the logarithmically transformed data. The RMS error undoubtedly could have been extracted from the calculations that were previously done with the SEM model. Despite the real possibility of implementing such estimates, however, there is no mention in the TSD of any effort to implement any estimate of this type.

Since the use of the MBLR approach makes the whole project much more difficult to understand, and since it is not clear that it actually overcomes the re-transformation bias, more effort should have been devoted to seeing whether it could be avoided by using either a deterministic formula or a fixed standard.

(c) The following equation is presented in the TSD, and it is the starting point for deriving the equation that appears in the proposed rule change:

When all 108 samples are used, the MBLR regression is:

$$\text{logit(sulfide>120 µg/L)} = 9.3176 + 1.8962 \cdot \log_{10}\text{sulfate} - 3.6443 \cdot \log_{10}\text{iron} + 2.2698 \cdot \log_{10}\text{TOC}$$

(equation 1)

If p is the probability that sulfide exceeds 120 µg/L, then the expression logit(sulfide>120 µg/L) refers to the quantity $\log_{10}(p/(1\text{-}p))$. If you know the value of the logit term, then you can find the probability and vice-versa.

A few steps later in the derivation, it is decided to set $p = 0.5$. Values of p range from 0 to 1, so this decision is equivalent to saying that there is a 50% chance of sulfide exceeding 120 µg/L. Mathematically, this is convenient because setting $p = 0.5$ simplifies the equation. Indeed, the quotient $p/(1\text{-}p)$ is then equal to 1. And therefore the logarithm of the quotient is equal to 0, eliminating the expression on the left side of the equation.

Whether or not the decision to set $p = 0.5$ is protective of wild rice is much more debatable, however. Accepting it would mean that we were settling for a 50% chance of wild rice being protected at the EC10 level that was recommended by the peer review panel. This seems inadequate for protecting wild rice. Therefore a lower probability would be needed to be protective of wild rice. The TSD provides no discussion or citation to support the assumption that a 50% chance of protecting wild rice would be sufficiently protective. Absent a compelling rationale to the contrary, simple logic suggests that a lower probability would be needed to be protective of wild rice.

A lower probability alone would not address the concerns raised above regarding sampling error and divergence of CPSC results for the same site, the potential for inflated estimates of CPSC at the higher end of the range, the transformation bias and the potential that the iron exponent misrepresents the role of iron in ecosystems. But, as an illustration, I calculated the outcome applying $p = 0.25$, which would correspond under Equation 1 of the TSD to a 75% probability of wild rice being protected at the EC10 level. With $p = 0.25$, the calculated protected sulfate value (CPSC) for any site would be equal to about 0.56 times the value calculated for that site by the formula in the proposed rule change. This would represent a 44% decrease in the CPSC.

Although a 44% decrease in the CPSC value might initially seem substantial, sites at the higher end of the range, where the equation is most likely to result in prediction errors, would still be substantially above the current standard of 10 mg/L. This modification would lead to more than half of the sites in the all Minnesota non-paddy data set having CPSC values at or below the current standard of 10 mg/L.

5. Conclusions and Recommendations.

The MPCA's proposed one-size-fits-all version of an equation-based standard is inadequate. It is inadequate for explaining the data from the Wild Rice Field Study. It does not resolve all of the concerns raised by analysis of the 2015 SEM equation. And it is inadequate for protecting Minnesota's Wild Rice.

Recommendations:

- If an equation-based approach is specifically sought, more research would need to be done regarding the iron levels in various water bodies and zones of the state, with separate equations adapted to the various zones. The constant iron exponent could also be replaced by a more appropriate mathematical expression. The probability that porewater sulfide exceeds 120 µg/L could be set lower than $p = 0.5$ to make the standard more likely to be protective of wild rice.

- The State of Minnesota could continue to use the existing 10 mg/L sulfate standard, which has been found to be protective of wild rice. This has the additional advantage of being more straightforward to understand and to administer.

6. References

Final Technical Support Document: Refinements to Minnesota's Sulfate Water Quality Standard to Protect Wild Rice, Minnesota Pollution Control Agency, 2017. https://www.pca.state.mn.us/sites/default/files/wq-rule4-15n.pdf

Proposed revision of Minnesota Rule 7050.0224, *in* Proposed Permanent Rules Relating to Wild Rice Sulfate Standard and Wild Rice Waters, MPCA and Revisor of Statutes, July 24, 2017. https://www.pca.state.mn.us/sites/default/files/wq-rule4-15h.pdf

March 2015 proposed approach for Minnesota's sulfate standard to protect wild rice, Minnesota Pollution Control Agency, 2015. https://www.pca.state.mn.us/sites/default/files/wq-s6-43l.pdf

MPCA Data Analysis Unit memos dated 1/22/2016, 1/26/2016, 2/9/2016, 2/16/2016, and 3/10/2016.

Michael C. Newman, Regression Analysis of Log-Transformed Data: Statistical Bias and its Correction, *Environmental Toxicology and Chemistry*, Vol 12 (1993), pp. 1129-1133, Pergamon Press.

7. CURRICULUM VITAE

Joel Roberts was born in Denver, Colorado, and grew up in the Denver area. He majored in mathematics at M.I.T. and received his Ph.D. in mathematics from Harvard University. After teaching at Purdue University for four years, he joined the University of Minnesota mathematics faculty in 1972. He was a full professor starting in 1980. He became professor emeritus of mathematics in 2009.

MathSciNet lists 25 research papers by Joel Roberts. He has had five Ph.D. students and has worked with numerous other graduate students doing thesis research in mathematics, computer science, physical sciences, and engineering. Prof. Roberts has given three different month-long lecture series at the National University of Mexico. He has visited the University of Bergen, Norway, on several occasions for research collaborations, and has been a Visiting Scholar at the University of California, Berkeley.

In recent years he has become interested in the use of computers for calculation with polynomials and also for visualization of algebraic curves and surfaces. This work included participation in the 2005-2006 Special Year on Applications of Algebraic Geometry, held at the Institute for Mathematics and Its Applications.

Mathematical publications are listed in Section 8 (pages 8-9) of my December 16, 2015 Memorandum Regarding Wild Rice Sulfate Standard Calculations provided in Attachment 1 of this Memorandum.

Roberts Memorandum - Wild Rice Rule
November 2017

Attachment 1
(20 pages)

Memorandum Regarding Wild Rice Sulfate Standard Calculations Comparing Expected and Observed Sulfide Levels in Field Study Data and Interpreting Statistical Analysis

Joel Roberts, Ph.D., Professor Emeritus of Mathematics
University of Minnesota
December 16, 2015

1. INTRODUCTION

I am a Professor Emeritus of Mathematics, having retired from the University of Minnesota faculty. My most relevant field of expertise is Applications of Mathematics. My *curriculum vitae* is summarized in Section 8 of this report. On review of the Minnesota Pollution Control Agency's (MPCA) proposal,[1] I was struck by the degree of scatter reflected in the Figure 9 comparison between the modeled levels of porewater sulfide and the levels of sulfide that were actually observed in the field study. I have reproduced the illustrations of this scatter pattern below and provide some discussion of the significance of the fit of the data shown in the *MPCA Proposal.*

In order to further test the predictive power of the proposed MPCA formula to derive sulfide concentrations, I obtained from the MPCA the wild rice, sulfate and sulfide data on which the *MPCA Proposal* is based and replicated the MPCA's calculations of predicted sulfide to compare them with observed sulfide. The spreadsheet containing this analysis is provided in Attachment A and Attachment B, which illustrate different ways of sorting this data. Comparing observed sulfide concentrations in the MPCA field data with predicted sulfide concentrations obtained by applying the MPCA's equation demonstrated to me the poor predictive power of the proposed equation. The lack of consistency in the ratios of predicted and observed sulfide provides no confidence that the MPCA's Proposal will provide a reliable prediction of sulfide levels. Thus, even setting aside questions about the ecology that these predictions represent (a set of issues that are outside my expertise) the MPCA Proposal seems like an unreliable method to protect wild rice from excess sulfide.

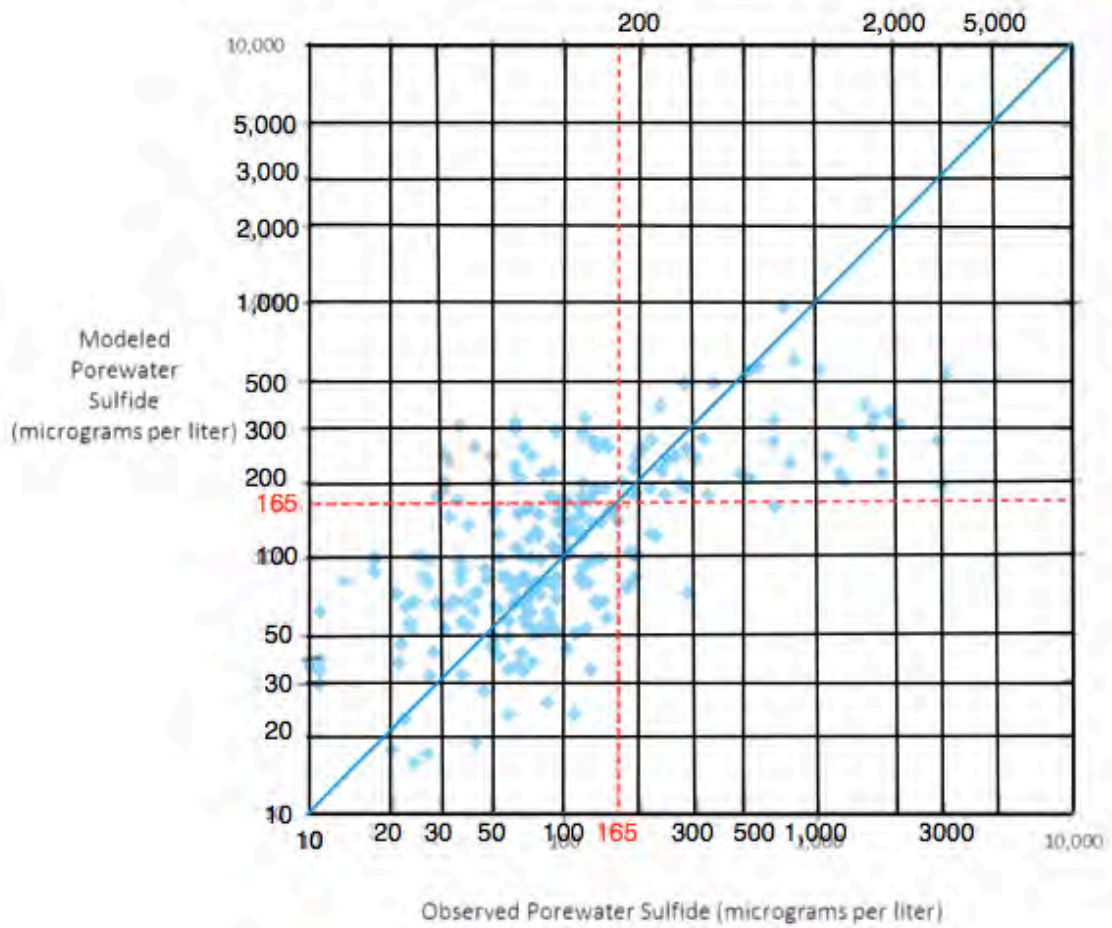
2. GRAPHIC REPRESENTATION AND CHI-SQUARE ANALYSIS OF MPCA DATA

Section 2 of the *MPCA Proposal* is entitled *The relationship between sulfide and sulfate*. The relationship is shown in Figure 9. That figure is reproduced below, with gridlines added to show how the points correspond to actual values. The positions of the gridlines were carefully measured to take account of the logarithmic scale.

The data points tend to cluster around the main diagonal (shown in blue), indicating some degree of relationship. Since this is a log-log plot (logarithmic scale in both variables), however, the relationship is made to appear much closer than what would be seen if the chart had been based on the more commonly used linear scale. Indeed, the measure of closeness actually is the *ratio*

[1] Minnesota Pollution Control Agency, *Proposed Approach for Minnesota's Sulfate Standard to Protect Wild Rice*, March 24, 2015. (hereinafter *MPCA Proposal*)

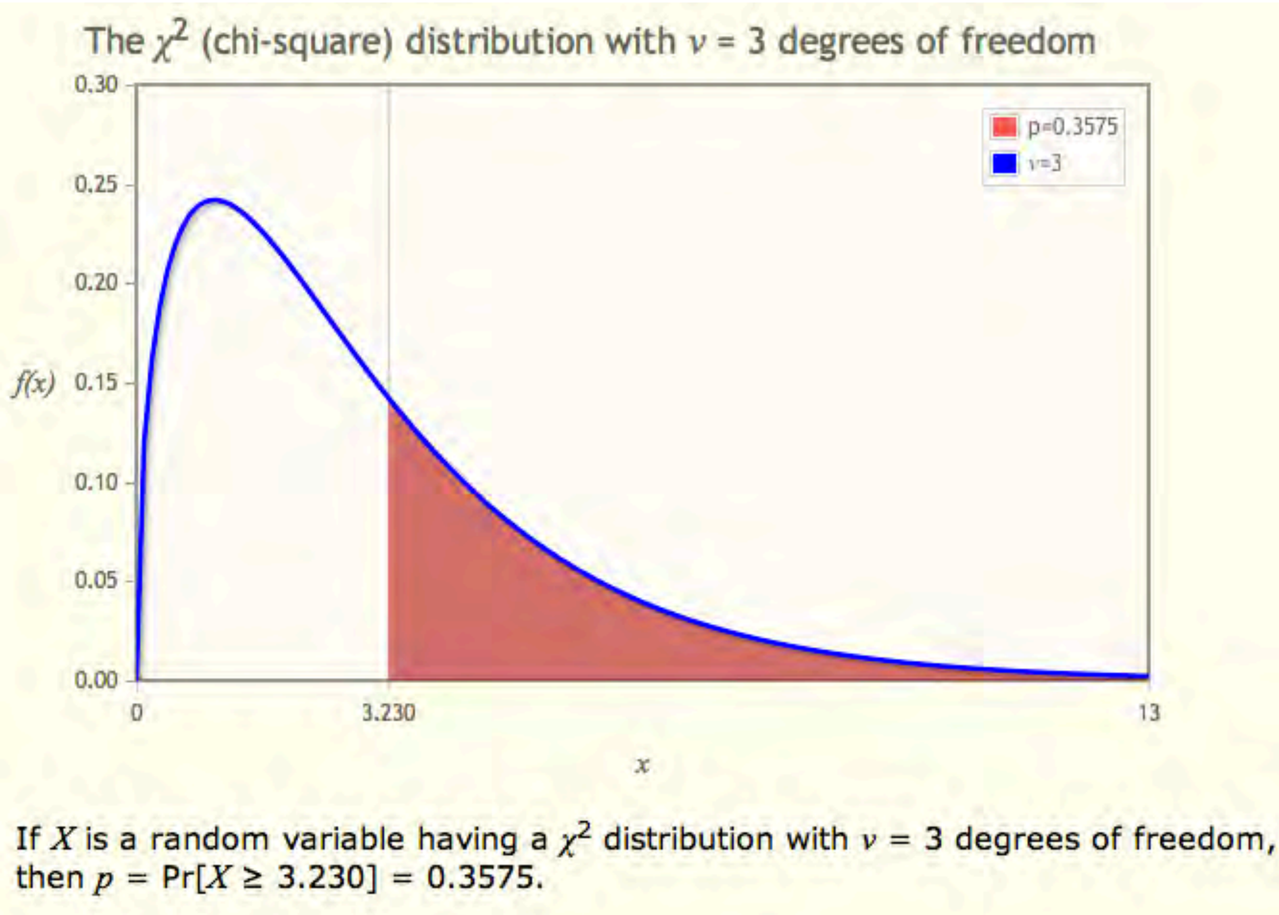
between the expected value and the observed value. This is the ratio that I actually calculated in the spreadsheet reproduced in Attachments A and B.



Some tests of significance are presented in Appendix 1 of the Main Document. The chi-squared statistic is the most basic, since RMSEA (root mean square error of approximation) can be calculated from it. The stated chi squared value is 3.23, with 3 degrees of freedom (essentially the number of independent variables), and N =184. (The number of sites studied in the field study was around 184.) The probability of a chi-squared value with 3 degrees of freedom being greater than 3.23 is given as 0.3572. This means that the value of such a variable being **less** than 3.23 is 0.6428. Now, a better fit to the data corresponds to a **smaller** chi-squared value.

The stated chi-squared value would indicate that the probability of a better fit is 0.6428. In my opinion, the chi-squared calculation presents an inconclusive result. It does not make a compelling case for goodness of fit of the model. In simple terms, using the chi-squared test of the fit of the data, the proposed equation predicts less than half of the variability of the data. Even though it is possible to draw a line through the data points that indicates a potential relationship between the data points, as the MPCA has done, this single line does not provide a powerful predictor of results for specific water bodies/data points.

The figure shown below illustrates the chi-square calculation.



3. Outlying Data and Under-prediction of Porewater Sulfide

I performed some additional analysis to review outlying data points and the potential for under-prediction of porewater sulfide.

In the *MPCA Proposal*, the following formula was presented for calculating pore water sulfide concentration:

. $$Sulfide = 7.873\ Sulfate^{0.345}\ Organic\ Carbon^{0.486}\ Sediment\ Iron^{-0.675}$$ (Equation 2)

(Sulfate and sulfide are expressed in mg/L; organic carbon is percent total organic carbon in the sediment; iron is micrograms extractable iron per gram sediment).

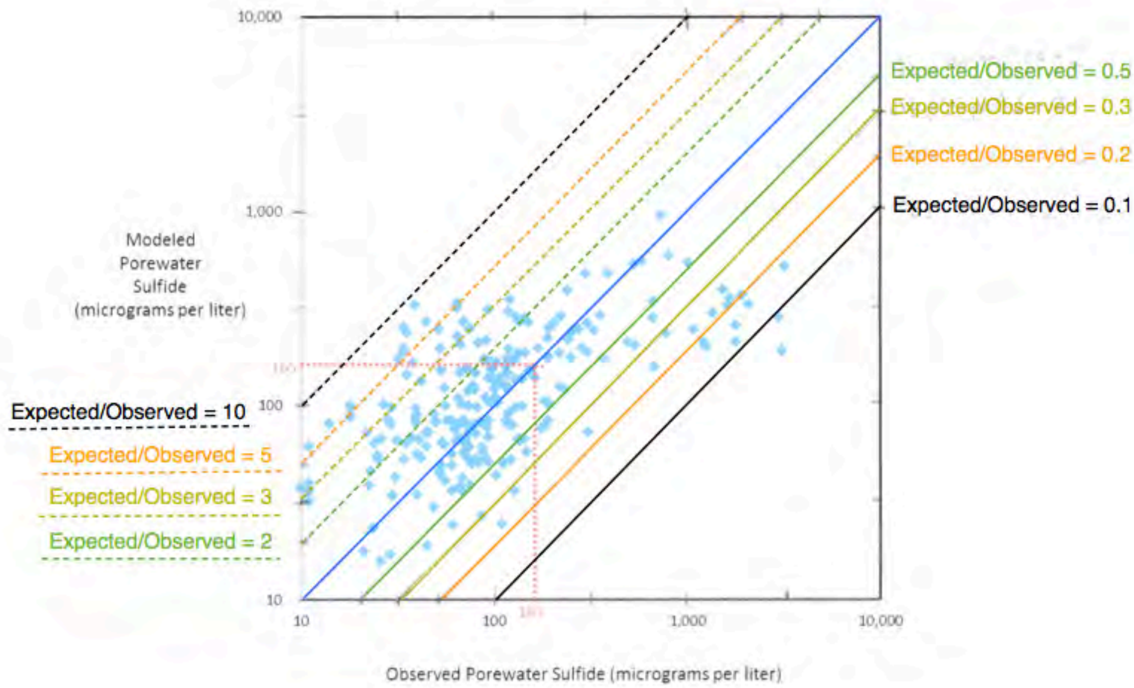
This corresponds to the following logarithmic version:

$$\log(Sulfide) = \log(7.873) + 0.345\log(Sulfate) + 0.486\log(Organic\ Carbon) - 0.675\log(Sediment\ Iron)$$

Thus, the logarithmic version is linear, and the exponents in the original equation are transformed into coefficients in the logarithmic equation. In the linear regression method of fitting an equation to the data, one finds the coefficient values that give the best fit of the equation to the data. In the

MPCA Proposal structural equation modeling was used to derive Equation 2 used to predict expected porewater sulfide, but an equation obtained from linear regression was presented for purposes of comparison.

The following graphic superimposes on Figure 9 of the *MPCA Proposal* diagonal lines corresponding to the ratio of Expected Porewater Sulfide to Observed Porewater Sulfide.

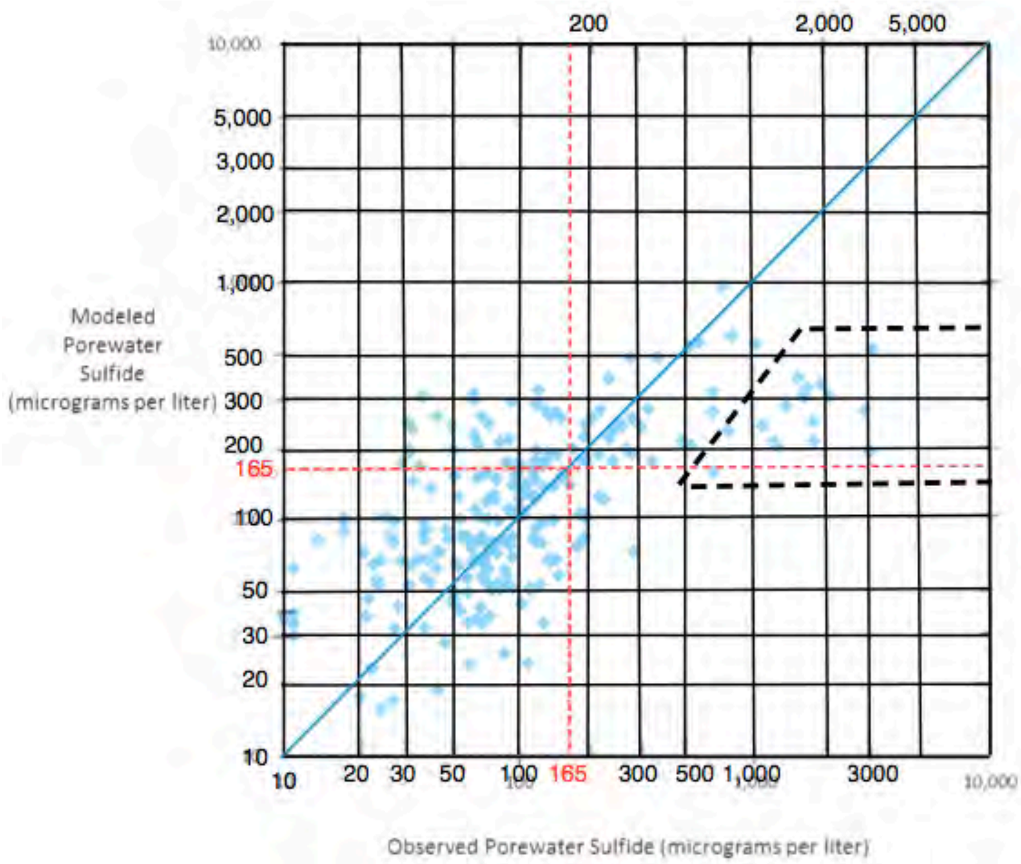


Cases where the Expected/Observed ratio is less than 1 correspond to under-prediction by the model, and cases where the Expected/Observed value is greater than 1 correspond to over-prediction by the model. A solid line and the broken line of the same color, for instance 0.2 and 5, correspond to reciprocal values. The ratio values 3 and 0.3 actually were measured to 3.16 and 0.316 respectively (the square root of 10 and its reciprocal).

A point on the main diagonal (shown in blue) would correspond to a data point where the Observed and Expected (or calculated) values are equal. Points between the solid green line and the dotted green line can be considered to lie in the central region of the diagram. These points correspond to ratio values that are between 0.5 and 2. These values of the ratio correspond to percentage error between 0 and 100% in the case of over-prediction, or between 0 and 50% percent error in the case of under-prediction. These diagonal lines are illustrative and do not consider the range of variation from the ratio of 1 that would be considered acceptable levels of precision in prediction. In addition, it should be noted that for diagonal lines that are farther from the center of the diagram, the logarithmic scale minimizes the distance from the main predictive diagonal (ratio of 1).

Despite this distortion from the use of the logarithmic scale, this graphic representation is useful to identify a cluster where the MPCA equation significantly under-predicts sulfide in waters with high observed sulfide concentrations.

The following diagram graphically shows an outlying cluster where high concentrations of observed porewater sulfide were poorly predicted by the MPCA's equation.



Most of the points with Expected/Observed ratios less than 0.3 have high values of observed porewater sulfide. While it is conceivable that such clustering could happen for purely random reasons, an effort to obtain conclusive results should include investigation of whether or not a peculiarity like this indicates the presence of effects that the model does not account for.

4. Spreadsheet Data Analysis – Methodology and Results

In order to more precisely address the questions raised in Figure 9 of the *MPCA Proposal*, I worked with MPCA staff to obtain the MPCA field study data collected by University of Minnesota researcher Amy Myrbo that provided the basis for Figure 9 and the MPCA Proposal. The specific references used are identified in Section 7 of this report.

I have entered the MPCA field data into my own spreadsheet, and I then programmed Formula 2 of the main document into my spreadsheet, along with a calculation of the ratio of the Expected (or Calculated) Sulfide value to the Observed Sulfide value. My complete spreadsheet is reproduced in Attachment A to my report, which sorts the data according to the Observed Porewater Sulfide level (Column J). A second spreadsheet sorting the data by the Sulfide Ratio Expected to Observed (Column P) for every water body where this calculation could be made is provided in Attachment

B. My methodology in preparing this spreadsheet is described below, then some results of reviewing the spreadsheet data are summarized.

A. METHODS

My complete spreadsheet in Attachment A is explained below.

- Data was provided for every water body on which the MPCA had field data. All quantifiable data was represented.
- The sulfide values (as in the MPCA spreadsheet) are given in milligrams per liter (mg/L) rather than micrograms per liter (μg/L). Hence the EC10 (protective) level of 165 μg/L would appear as 0.165 mg/L.
- Columns A through L give identifying information and observed (measured) values from the Wild Rice Field Survey. Column J, which gives the observed porewater sulfide value is highlighted.
- Column M is the MPCA calculation of the Calculated Protective Sulfate Concentration (CPSC) from its equation. It is the sulfate level that corresponds to the MPCA's proposed EC10 sulfide level of 165 micrograms per liter (ug/L).
- Column N reflects calculation of the CPSC, using the MPCA Equation 1 on page 14 of the MPCA March 2015 proposal (Attachment 2 to this report). This calculation was done to verify accuracy in application of the MPCA formula. As shown by comparing Columns M and N, my results agree closely with those of the MPCA.
- Column O reflects the calculation, using Equation 2 on page 9 of the MPCA March 2015 proposal (Attachment 2) to calculate the porewater sulfide levels that would be predicted from the measured values of sulfate, iron, and total organic carbon. This is the expected sulfide level.
- Column P contains ratios obtained by dividing the calculated porewater sulfide value by the observed value. This is the Expected/Observed sulfide ratio.

In the spreadsheet provided in Attachment B, sorting was done to focus on data points which:

- Sufficient data was given so that the ratio actually could be calculated.
- The value of the Expected/Observed ratio in Column P is 1 or smaller. This allows review of the points where use of the MPCA's equation results in under-prediction of sulfide levels. Column P is also highlighted.
- The data in this spreadsheet is sorted according to the Expected/Observed ratio: wild rice beds with the lowest Expected/Observed ratio value are at the top. Thus, the sites with the highest degree of under-prediction are listed first.

B. RESULTS

Column P ratios of Expected/Observed porewater sulfide levels reflect poor correlation between calculated and observed sulfide levels. Few of the Expected/Observed ratios cluster around the central value of 1, which would be the indicator of a perfect positive correlation. The degree of correlation that would be necessary for this particular application (15% variability, 20% variability or some other percentage variation from perfect correlation) to be deemed protective of wild rice would be a determination that biologists or ecologists would need to make.

However, the spreadsheet results demonstrate a number of situations where the MPCA's Calculated Protective Sulfate Concentration (CPSC) equation would underpredict observed sulfide. In those situations, it is likely that reliance on the formula would insufficiently protect wild rice from elevated sulfide. In Column P, ratios less than 1 correspond to situations where the MPCA formula has under-predicted porewater sulfide.

Nearly every site with Expected/Observed ratios below 0.4 has either no wild rice or very sparse wild rice.[2] For example, applying the MPCA's CPSC equation to Mahnomen Lake (FS-133, line 33 of Attachment A) yields a CPSC of 174.4 mg/L, which suggests that a sulfate limit of 174.4 mg/L of sulfate would be sufficient to protect wild rice in Mahnomen Lake from excess sulfide (levels exceeding 165 ug/L). However, with observed sulfate levels of 16.9 mg/L, porewater sulfide was observed at 308 ug/L. The lake's name suggests this water body once grew wild rice, but MPCA field study data showed no wild rice present.

Sandy Lake in St. Louis County (FS-320, FS-305, FS-348 on Attachment B) was historically a major and abundant ricing site for the Bois Forte Band. Although Sandy Lake has high sediment iron levels, around the 90th percentile among sites that were sampled, Sandy Lake sulfide was significantly underpredicted by the CPSC equation and exceeded the MPCA's proposed protective level of 165 ug/L by more than an order of magnitude: sulfide levels were observed at 3,080 ug/L (FS-320) and at 1,080 ug/L (FS-305). No wild rice was observed at either location.

These two examples of underprediction of sulfide using the MPCA equation do not seem to be anomalies. If one uses a threshold of variability of 20%, for example, the MPCA field data contains at least 77 of the 242 sites for which data was available where the MPCA's CPSC underpredicted sulfide levels or 32% of the sampled sites. Although not specifically analyzed in this report, the MPCA's overprediction of sulfide levels at other sampling sites would also call into questions the use of the proposed CPSC equation.

6. Conclusion

Neither MPCA's graphic representation of field study data in Figure 9 of the *MPCA Proposal*, the chi-square analysis of predictive power nor the analysis of underlying field study data in individual water bodies comparing calculated/expected levels of sulfide with observed levels provides any basis for confidence in the use of MPCA's proposed CPSC equation to predict sulfide levels and protect wild rice from excessive levels of sulfide.

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[2] Monongalia Lake in Kandiyohi County (FS-379, FS-340, in rows 42 and 82, in Attachment A) has divergent ratios, predictions and sulfide observations in sampling, making it difficult to draw conclusions regarding this lake. For Rice Lake (FS-324), despite under-prediction of sulfide, given sulfate levels of 0.5 mg/L and observed sulfide of 0.045, the presence of wild rice is not at all surprising.

7. References

My calculations are based on MPCA data, obtained from the following pages:
http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/sulfate-standard-and-wild-rice/wild-rice-study-and-process-of-revising-standard.html

http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/sulfate-standard-and-wild-rice/draft-proposal-for-protecting-wild-rice-from-excess-sulfate.html
On this page, follow the link Detailed MPCA proposal for protecting wild rice from excess sulfate (wq-s6-43l), which leads to the .pdf version of the main Wild Rice Study document that is discussed above. The scatter chart in question is figure 9 in that document.

In order to find more detailed MPCA field survey data, I also followed a link labeled ftp://files.pca.state.mn.us/pub/wild_rice/ and connected as a guest with a server called files.pca.state.mn.us. One folder on that server is called Wild Rice Field Survey, which contains spreadsheets used in my analysis, notably
MPCA_Field_Survey_Data_with_calculated_protective_sulfate_concentration.xlsx and
Wild_field_survey_updated_Feb_6_2015.xlsx.

8. Curriculum Vitae

Joel Roberts was born in Denver, Colorado, and grew up in the Denver area. He majored in mathematics at M.I.T. and received his Ph.D. in mathematics from Harvard University. After teaching at Purdue University for four years, he joined the University of Minnesota mathematics faculty in 1972. He has been a full professor since 1980.

Joel Roberts has had five Ph.D. students and has worked with numerous other graduate students doing thesis research in mathematics, computer science, physical sciences, and engineering. Prof. Roberts has given three different month-long lecture series at the National University of Mexico. He has visited the University of Bergen, Norway, on several occasions for research collaborations, and has been a Visiting Scholar at the University of California, Berkeley.

In recent years he has become interested in the use of computers for calculation with polynomials and also for visualization of algebraic curves and surfaces. This work included participation in the 2005-2006 Special Year on Applications of Algebraic Geometry, held at the Institute for Mathematics and Its Applications.

Mathematic publications are listed below:

1. Generic projections of algebraic varieties, Amer. J. Math. 93 (1971), 191-214.
2. The variation of singular cycles in an algebraic family of morphisms, Trans. Amer. Math. Soc. 168 (1972), 153-164.
3. Chow's moving lemma: an appendix to lectures of S. Kleiman, *Algebraic Geometry, Oslo 1970* (F.Oort, ed.), Groningen, Wolters-Noordhoff, 1972, p. 89-96.
4. Singularity subschemes and generic projections [research announcement], Bull. Amer. Math. Soc. 78 (1972), 706-708.
5. (with M. Hochster) Actions of reductive groups on regular rings and Cohen-Macaulay rings[research announcement], Bull. Amer. Math. Soc. 80 (1974), 281-284.
6. (with M. Hochster) Rings of invariants of reductive groups acting on regular rings are Cohen-Macaulay, Advances in Math. 13 (1974), 115-175.

7. Singularity subschemes and generic projections, Trans. Amer. Math. Soc. 212 (1975), 229-268.
8. (with M. Hochster) The purity of the Frobenius and local cohomology, Advances in Math. 21(1976), 117-172.
9. A stratification of the dual variety, preprint, July 1976.
10. Hypersurfaces with nonsingular normalization and their double loci, J. of Algebra 53 (1978), 253-267.
11. (with A. Holme) Pinch points and multiple locus of generic projections of singular varieties,Advances in Math. 33 (1979), 212-256.
12. Some properties of double point schemes, Compositio Math. 41 (1980), 61-94.
13. (with T. Fujita) Varieties with small secant varieties: the extremal case, Amer. J. Math. 103 (1981),953-976.
14. (with R. Speiser) Schubert's enumerative geometry of triangles from a modern viewpoint, *Algebraic Geometry: Proceedings, University of Illinois at Chicago Circle, 1980* , Springer LectureNotes in Mathematics 862 (1981), 272-281.
15. (with R. Zaare-Nahandi) Transversality of generic projections and seminormality of the image hypersurfaces, Compositio Math 52 (1984), 211-220.
16. (with R. Speiser) Enumerative geometry of triangles, I , Comm. in Algebra 12 (1984), 1213-1255.
17. (with R. Speiser) Enumerative geometry of triangles, II , Comm. in Algebra 14 (1986), 155-191.
18. (with R. Speiser) Enumerative geometry of triangles, III , Comm. in Algebra 15 (1987), 1929-1966.
19. Old and new results about the triangle varieties, *Algebraic Geometry Sundance 1986* , SpringerLecture Notes 1311 (1988), 197-219.
20. (with A. Holme) On the embeddings of projective varieties, *Algebraic Geometry Sundance 1986* ,Springer Lecture Notes 1311 (1988), 118-146.
21. Projective embeddings of algebraic varieties (lecture notes), *Monografías del Instituto deMatemáticas*, no. 19 (1988) Universidad Nacional Autónoma de México.
22. (with J. Weyman) A short proof of a theorem of M. Hashimoto, J. Algebra 134 (1990), 144 - 156.
23. Embeddings of algebraic surfaces in P^4, *Seminari di Geometria 1991-93*, Università di Bologna (1994), pp. 169 - 178.
24. (with A. Holme) Zak's theorem on superadditivity, Arkiv för Matematik 32 (1994), 99 - 120.
25. (with J. Gil de Lamadrid) The Jordan canonical form of a matrix related to a second order systemof ordinary differential equations, preprint, January 1997.
26. (with V. Reiner) Resolutions and the homology of matching and chessboard complexes, J.Algebraic Combinatorics 11 (2000), 135-154.
27. (with H Haghighi and R. Zaare-Nahandi) Some properties of finite morphisms on double points,Compositio Math. 121 (2000), 35 - 53.
28. (with J. Eagon) Minimal resolutions derived from bicomplexes and other Wall complexes, work inprogress.
29. (with A. Holme) The enumerative theory of *k*-secant (*k*-1)-spaces, work in progress

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
2	FS-85	Bean	03-0411-00-201	8/21/12	46.9337	-95.8706	0	0.0	85	16.000	1,967	11.85	1.2	1.15	0.725	0.04531
3	P-55	Lady Slipper	42-0020-00-204	9/22/11	44.5702	-95.6274	0		107.71	14.840	2,814	2.09	26.9	26.85	0.266	0.01791
4	FS-177	South Geneva	24-0015-02-208	7/24/12	43.7709	-93.2851	0	0.0	14.1	3.190	1,618	16.71	0.5	0.49	0.526	0.16487
5	FS-320	Sandy	69-0730-00-204	7/9/13	47.6188	-92.5936	0	0.0	118	3.080	19,749	15.43	72.5	72.45	0.195	0.06316
6	FS-184	Rice	73-0196-00-216	7/30/12	45.3864	-94.6309	0	0.0	2.58	2.970	1,523	15.03	0.5	0.50	0.290	0.09752
7	FS-345	Rice	73-0196-00-216	8/7/13	45.3865	-94.6313	0	0.0	6.85	2.080	2,012	14.83	0.9	0.88	0.334	0.16055
8	FS-339	Christina	21-0375-00-315	7/31/13	46.0734	-95.7567	0.3	0.6	14.6	1.930	1,741	8.96	1.3	1.35	0.374	0.1939
9	FS-188	Stella	47-0068-00-204	8/27/12	45.0683	-94.4334	0.3	0.3	18.1	1.790	1,257	2.34	4.7	4.73	0.261	0.14607
10	FS-186	Westport	61-0029-00-204	8/1/12	45.6897	-95.217	0	0.0	7.11	1.790	4,917	20.15	3.3	3.28	0.215	0.11999
11	FS-78	Lady Slipper	42-0020-00-202	7/27/12	44.5699	-95.6275	0	0.0	335	1.680	2,719	1.66	34.8	34.74	0.360	0.21415
12	FS-79	Lady Slipper	42-0020-00-203	7/27/12	44.5723	-95.6216	0	0.0	330	1.630	3,314	1.85	43.9	43.92	0.330	0.20251
13	FS-176	North Geneva	24-0015-00-209	7/24/12	43.7876	-93.271	0	0.0	15.6	1.540	2,212	13.45	1.2	1.21	0.397	0.25768
14	FS-77	Monongalia	34-0158-02-204	7/26/12	45.3331	-94.927	38.8	121.3	21.7	1.370	4,953	18.66	3.7	3.70	0.303	0.22086
15	FS-357	Lower Panasa	31-0112-00-204	8/15/13	47.3026	-93.2561	0	0.0	28.5	1.260	2,347	2.42	15.3	15.31	0.204	0.16186
16	FS-128	Cromwell	14-0103-00-201	8/22/12	46.9651	-96.3171	0	0.0	41.2	1.220	2,948	2.85	19.0	18.99	0.215	0.17622
17	FS-305	Sandy	69-0730-00-204	6/11/13	47.6187	-92.5937	0	0.0	135	1.080	19,094	22.23	40.6	40.53	0.249	0.23051
18	FS-218	Holman	31-0227-00-202	9/13/12	47.3005	-93.3445	0	0.0	24.2	1.010	3,035	29.74	0.7	0.74	0.548	0.54303
19	FS-308	Rice paddy	WT00028	6/12/13	47.8056	-95.674	36.3	85.9	57.1	0.802	2,779	17.1	1.4	1.35	0.598	0.74579
20	FS-181	Rice	66-0048-00-203	7/27/12	44.3332	-93.4734	0	0.0	5.22	0.777	3,829	21.67	1.8	1.81	0.237	0.30476
21	FS-103	Rice paddy	WT00028	6/26/12	47.8053	-95.6732	23.8	58.9	279	0.732	3,367	19.01	1.7	1.70	0.956	1.30635
22	FS-102	Rice paddy	WT00027	6/26/12	47.9265	-95.6313	39.3	93.6	1.61	0.677	4,932	31.82	1.7	1.73	0.160	0.23683
23	P-34	Anka	21-0353-00-201	9/16/11	46.0769	-95.7292	11.3		2.23	0.671	1,485	23.57	0.3	0.25	0.349	0.51956
24	FS-87	Bee	60-0192-00-202	8/23/12	47.6527	-96.0504	18.8	39.8	11	0.670	3,054	13.62	2.2	2.24	0.285	0.42488
25	FS-353	Holman	31-0227-00-202	8/12/13	47.3009	-93.3444	0	0.0	68	0.583	5,094	30.6	1.9	1.95	0.560	0.96047
26	FS-223	Little Sucker	31-0126-00-202	9/14/12	47.3765	-93.246	0	0.0	13.7	0.534	6,297	16.56	7.0	7.01	0.207	0.38799
27	FS-192	Anka	21-0353-00-202	8/29/12	46.07689	-95.7292	1		8.44	0.530	1,498	22.85	0.3	0.27	0.540	1.01953
28	P-35	Anka	21-0353-00-201	9/16/11	46.0769	-95.7377	1.3		2.23	0.493	2,170	14.84	1.0	1.02	0.216	0.43718
29	FS-326	Rice paddy	WT00028	7/17/13	47.8055	-95.6732	100	251.8	28.8	0.390	2,842	18.37	1.3	1.28	0.482	1.23517
30	FS-190	Pine	15-0149-00-205	8/28/12	47.6841	-95.5414	47.5	114.9	14.7	0.368	4,477	7.08	11.9	11.92	0.177	0.48053
31	FS-194	Gilchrist	86-0064-00-201	8/31/12	45.2309	-93.824	0	0.0	6.98	0.355	3,117	20.81	1.3	1.28	0.295	0.83071
32	FS-61	Swan	31-0067-02-206	8/30/12	47.2888	-93.2127	3	12.4	12.5	0.332	5,827	22.71	3.9	3.86	0.247	0.74282
33	FS-133	Mahnomen	18-0126-02-201	9/17/12	46.4985	-93.9958	0	0.0	16.9	0.308	18,746	7.7	174.4	174.34	0.074	0.23869
34	FS-348	Sandy	69-0730-00-204	8/13/13	47.6186	-92.5934	0	0.0	123	0.305	13,216	8.23	80.2	80.11	0.191	0.62517
35	FS-368	Dark	69-0790-00-202	9/5/13	47.6387	-92.7782	6.3	11.1	175	0.305	3,354	1.94	42.1	42.05	0.269	0.88268
36	FS-101	Rice paddy	WT00026	6/25/12	48.2161	-94.6188	4.3	8.3	11.3	0.298	3,284	44.21	0.5	0.49	0.485	1.627
37	P-57	Unnamed	34-0611-00-201	9/23/11	45.2675	-94.865	32.5		6.42	0.286	2,311	6.48	3.7	3.71	0.199	0.6954
38	FS-191	Ina	21-0355-00-202	8/29/12	46.0715	-95.7281	8.5	30.2	7.08	0.274	2,216	9.09	2.1	2.12	0.249	0.91044
39	FS-214	Bowstring	S007-219	9/11/12	47.7024	-94.0608	27.5	69.7	1.34	0.256	1,974	24.34	0.4	0.42	0.245	0.95751

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
40	FS-328	Eighteen	60-0199-00-203	7/18/13	47.6369	-96.0599	27.5	44.2	3.34	0.250	5,106	24.65	2.7	2.66	0.178	0.71181
41	FS-60	Lower Panasa	31-0112-00-205	8/29/12	47.3018	-93.2521	0	0.0	33.6	0.243	8,048	14.12	14.2	14.18	0.221	0.91117
42	FS-379	Monongalia	34-0158-02-203	9/13/13	45.3332	-94.929	62.5	154.4	34.6	0.242	5,436	26.42	2.7	2.72	0.395	1.63325
43	FS-220	Padua	73-0277-00-202	8/7/12	45.623	-95.0186	0	0.0	0.86	0.230	2,291	9.77	2.0	2.04	0.122	0.53075
44	FS-62	Swan	31-0067-02-206	8/30/12	47.289	-93.2124	0.8	3.8	14	0.221	4,821	22.53	2.7	2.69	0.290	1.31367
45	FS-82	Rabbit	18-0093-02-204	8/8/12	46.5313	-93.9285	0	0.0	15.3	0.220	10,903	11.79	33.1	33.12	0.126	0.5726
46	FS-179	Rice	74-0001-00-201	7/25/12	44.0842	-93.0737	0	0.0	3.84	0.217	4,152	19.07	2.5	2.54	0.190	0.87338
47	FS-346	Westport	61-0029-00-205	8/8/13	45.7042	-95.203	4.5	6.7	6.3	0.205	3,262	19.66	1.5	1.52	0.269	1.3099
48	FS-107	Rice paddy	WT00030	6/28/12	47.8521	-95.4953	80	134.3	9.46	0.194	5,647	28.09	2.7	2.69	0.254	1.3078
49	FS-230	Mill Pond	21-0034-00-202	8/16/12	46.0715	-95.2218	21.5	80.9	7.36	0.192	3,969	3.14	29.7	29.64	0.102	0.53004
50	FS-200	Louisa	86-0282-00-205	8/8/12	45.2998	-94.258	0	0.0	7.04	0.192	7,824	8.76	26.3	26.31	0.104	0.54356
51	P-47	Little Birch	77-0089-00-101	9/21/11	45.7747	-94.7996	11.3		3.2	0.191	2,253	8.37	2.5	2.46	0.180	0.94344
52	P-47	Little Birch	77-0089-00-101	9/21/11	45.7747	-94.7996	11.3		3.2	0.191	3,544	5.11	12.0	11.95	0.104	0.54672
53	P-47	Little Birch	77-0089-00-101	9/21/11	45.7747	-94.7996	11.3		3.2	0.191	2,236	1.75	22.0	22.00	0.085	0.44321
54	FS-228	West battle	56-0239-00-204	8/15/12	46.2906	-95.6049	35	144.8	4.03	0.189	3,108	17.37	1.6	1.65	0.224	1.18475
55	FS-321	Sandy	69-0730-00-203	7/9/13	47.6255	-92.5885	0	0.0	122	0.189	36,502	29.51	96.6	96.55	0.178	0.94257
56	FS-129	Mink	86-0229-00-207	8/23/12	45.2767	-94.0299	0	0.0	1.22	0.182	4,247	13.63	4.3	4.27	0.107	0.58651
57	FS-69	St. Louis	S007-208	9/7/12	47.4671	-91.9279	0	0.0	1.33	0.181	11,429	27.16	11.2	11.20	0.079	0.43544
58	FS-208	Miss.R. Pool 8/Genoa	S007-222	8/14/12	43.5758	-91.2334	43.8	41.4	18	0.176	2,178	0.41	161.8	161.72	0.077	0.43885
59	FS-106	Rice paddy	WT00029	6/28/12	47.8523	-95.4732	25	50.6	7.14	0.169	3,242	9.75	4.0	4.04	0.200	1.18478
60	FS-86	Eighteen	60-0199-00-202	8/22/12	47.6397	-96.0607	23.8	40.1	4.29	0.164	1,860	3.1	6.9	6.85	0.140	0.85384
61	FS-90	Sand	S003-249	9/11/12	47.6351	-92.4234	0.8	2.9	15.9	0.152	7,287	9.68	19.9	19.89	0.152	1.0016
62	FS-183	Unnamed	34-0611-00-201	7/30/12	45.2675	-94.865	16.3	64.9	16.8	0.150	2,157	5.61	4.0	3.97	0.271	1.80479
63	FS-315	St. Louis Estuary	S007-444	6/24/13	46.6516	-92.2373	0	0.0	8.1	0.147	6,056	1.68	163.7	163.61	0.058	0.39699
64	FS-231	Rice	02-0008-00-206	8/17/12	45.1604	-93.121	0	0.0	3.6	0.145	2,159	7.98	2.4	2.42	0.189	1.30152
65	FS-216	Big Sucker	31-0124-00-203	9/12/12	47.3919	-93.2658	1.3	3.8	7.78	0.145	3,559	21.45	1.6	1.59	0.284	1.95924
66	FS-187	McCormic	73-0273-00-203	8/2/12	45.722	-94.9121	1.3	8.9	1.54	0.144	1,512	1.1	19.7	19.70	0.068	0.47467
67	P-24	Second	15-0091-00-201	9/7/11	47.8255	-95.3635	16.3		0.87	0.139	3,813	25.67	1.4	1.42	0.139	0.99974
68	P-19	Wolf	69-0143-00-202	9/2/11	47.2586	-91.9618	56.3		1.54	0.139	8,240	25.1	6.6	6.60	0.100	0.71583
69	FS-352	Dark	69-0790-00-202	8/15/13	47.6388	-92.7782	1.3	2.9	173	0.136	5,120	3.61	40.1	40.07	0.273	2.0041
70	FS-195	Fisher	70-0087-00-201	8/31/12	44.7942	-93.4061	25	20.7	6.85	0.136	11,140	5.76	94.9	94.85	0.066	0.48846
71	FS-382	Sandy	69-0730-00-203	9/17/13	47.6255	-92.5885	0	0.0	67.9	0.135	26,645	32.28	46.0	45.97	0.188	1.39268
72	FS-81	Flowage	01-0061-00-204	8/7/12	46.688	-93.337	0	0.0	0.78	0.134	12,470	32.34	10.4	10.38	0.067	0.50215
73	FS-57	Miss. R./ bel. Clay Boswell	S006-923	8/28/12	47.2551	-93.6342	0	0.0	10.3	0.134	4,225	1.2	130.1	130.02	0.069	0.51229
74	FS-322	Dark	69-0790-00-202	7/10/13	47.6389	-92.7781	1.3	3.2	175	0.131	2,480	1.48	34.1	34.12	0.289	2.20907
75	P-29	Padua	73-0277-00-203	9/13/11	45.6202	-95.0192	1.5		0.76	0.130	4,927	20.15	3.3	3.29	0.099	0.76289

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1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
76	FS-138	Little Round	03-0302-00-203	9/20/12	46.9726	-95.735	46.3	78.0	0.5	0.128	3,069	27.48	0.8	0.84	0.137	1.07328
77	FS-309	Eighteen	60-0199-00-203	6/13/13	47.6369	-96.0599	0	0.0	4.36	0.127	4,478	16.52	3.6	3.61	0.175	1.38175
78	FS-83	Miss.R Crow Wing	S007-205	8/8/12	46.4386	-94.1251	0	0.0	3.13	0.127	13,451	3.88	239.5	239.40	0.037	0.29011
79	FS-59	Upper Panasa	31-0111-00-202	8/29/12	47.306	-93.2652	0	0.0	29.6	0.126	895	0.43	26.6	26.55	0.171	1.35753
80	FS-301	Partridge	S007-443	5/28/13	47.5213	-92.1903	0	0.0	14.8	0.125	9,491	3.94	118.5	118.44	0.080	0.64224
81	FS-251	Sandy	69-0730-00-203	9/21/12	47.6254	-92.5886	1.3	3.8	3.05	0.123	35,905	33.08	79.6	79.59	0.053	0.43361
82	FS-340	Monongalia	34-0158-02-203	7/31/13	45.3331	-94.929	60	87.9	33.6	0.122	5,530	22.1	3.6	3.62	0.355	2.90672
83	FS-105	Second	15-0091-00-202	6/27/12	47.8258	-95.3637	13	48.4	0.74	0.119	2,527	33.3	0.439	0.44	0.197	1.65435
84	FS-350	Ox Hide	31-0106-00-203	8/14/13	47.3351	-93.2132	0	0.0	25.9	0.119	3,889	12.12	4.2	4.24	0.307	2.58002
85	FS-221	Hay Creek Flowage	58-0005-00-202	9/17/12	46.0894	-92.4104	58.8	97.7	1.95	0.119	9,456	22.05	10.4	10.37	0.092	0.77616
86	FS-68	Wolf	69-0143-00-101	9/6/12	47.2564	-91.963	2.3	8.9	2.01	0.119	9,526	17.19	15.0	14.95	0.082	0.69147
87	FS-359	Eighteen	60-0199-00-203	8/20/13	47.6367	-96.06	5.5	21.0	2.83	0.118	5,500	30.88	2.2	2.23	0.178	1.51134
88	FS-139	Welby family farm	86-0231-00-202	9/21/12	45.3592	-94.0782	2	17.2	0.5	0.118	7,267	30.76	3.9	3.88	0.081	0.68731
89	FS-319	Little Round	03-0302-00-203	6/27/13	46.9724	-95.735	5	17.5	0.5	0.117	3,579	39.84	0.7	0.67	0.148	1.26784
90	FS-219	Trout	31-0216-00-212	9/13/12	47.2592	-93.3942	0	0.0	38.6	0.117	12,535	15	31.0	30.99	0.177	1.51591
91	FS-189	Clearwater	S002-121	8/28/12	47.9372	-95.6906	1.8	4.5	23.8	0.117	2,856	1.27	55.8	55.80	0.123	1.04878
92	FS-327	Clearwater	S002-121	7/17/13	47.9371	-95.6906	0.3	0.3	23.7	0.117	3,521	1.82	50.6	50.60	0.127	1.08302
93	FS-93	Turpela	69-0427-00-201	9/12/12	47.4613	-92.2371	0.8	1.0	3.3	0.115	6,979	31.08	3.5	3.53	0.161	1.39674
94	FS-325	Rice paddy	WT00046	7/16/13	47.8481	-95.4865	51.3	79.6	0.46	0.115	4,673	19.28	3.2	3.16	0.085	0.73566
95	FS-67	St. Louis Est. Pok. Bay	S006-928	9/5/12	46.6859	-92.1606	0	0.0	9.97	0.112	14,015	3.66	281.8	281.69	0.052	0.46385
96	FS-331	Partridge	S007-443	7/24/13	47.5212	-92.1904	30	60.5	14.6	0.112	10,082	1.68	443.6	443.39	0.051	0.45262
97	FS-324	Rice	18-0053-00-203	7/15/13	46.3392	-93.8918	27.5	56.7	0.5	0.110	44,704	33.18	121.7	121.67	0.025	0.22442
98	FS-229	Mill Pond	21-0034-00-202	8/16/12	46.0716	-95.2218	30	102.2	7.16	0.109	5,143	7.86	13.5	13.49	0.132	1.21273
99	FS-311	Miss. R Pool 8/Genoa	S007-222	6/20/13	43.5766	-91.2341	10	12.7	29.3	0.107	1,544	0.62	46.1	46.05	0.141	1.31702
100	P-12	Birch	69-0003-00-205	8/30/11	47.7357	-91.9428	30		3.58	0.104	12,431	26.8	13.5	13.45	0.104	1.0011
101	FS-384	Second	S007-220	9/19/13	47.5204	-92.1925	15	27.7		0.104	22,634	3.42		791.54	0.000	0
102	P-20	Gull	04-0120-00-203	9/6/11	47.6559	-94.6944	6.8		0.78	0.103	1,608	5.08	2.6	2.57	0.109	1.05897
103	FS-356	Trout	31-0216-00-212	8/14/13	47.2591	-93.3942	0	0.0	39.1	0.103	11,992	12.59	36.4	36.38	0.169	1.63668
104	FS-75	Mortenson	34-0150-02-201	7/24/12	45.3	-94.9062	0	0.0	0.5	0.103	9,071	12.09	22.3	22.31	0.044	0.43062
105	FS-334	Miss. R Pool 8/Genoa	S007-222	7/29/13	43.5758	-91.2344	28.8	52.8	44.2	0.102	1,969	0.4	137.5	137.46	0.111	1.09193
106	FS-332	Partridge	S007-513	7/24/13	47.5137	-92.1894	53.8	79.6	54.4	0.102	20,512	8.34	185.9	185.77	0.108	1.05537
107	FS-89	Birch	69-0003-00-205	9/10/12	47.7358	-91.943	26.3	33.1	8.61	0.100	16,938	31.2	19.9	19.88	0.123	1.23138
108	FS-303	Second	S007-220	5/30/13	47.5204	-92.1925	0	0.0	303	0.099	13,086	2.2	505.1	504.89	0.138	1.39231
109	FS-316	Partridge	S007-513	6/28/13	47.5137	-92.1899	0	0.0	24.9	0.098	6,291	2.6	95.3	95.22	0.104	1.05717
110	FS-347	Snowball	31-0108-00-202	8/12/13	47.3356	-93.2439	0	0.0	8.2	0.097	1,136	1.19	10.1	10.08	0.153	1.58114
111	P-25	Lower Rice	S006-985	9/8/11	47.3793	-95.4834	50		1.02	0.097	2,337	17.76	0.9	0.91	0.171	1.76084
112	FS-360	Rice paddy	WT00046	8/21/13	47.8479	-95.4866	33.8	66.5		0.094	4,221	14.94		3.71	0.000	0

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1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
113	FS-313	Monongalia	34-0158-01-203	6/23/13	45.3334	-94.929	32.5	50.0	34.7	0.094	6,028	19.44	5.1	5.13	0.318	3.37795
114	P-28	Raymond	73-0285-00-203	9/12/11	45.629	-95.0234	30		0.82	0.094	3,922	10.06	5.6	5.61	0.085	0.90141
115	FS-63	Caribou	69-0489-00-206	9/3/12	46.8913	-92.3135	0	0.0	1.21	0.094	13,791	29.44	14.4	14.43	0.070	0.74503
116	FS-137	Elk	15-0010-00-204	9/19/12	47.1952	-95.2249	7.3	42.7	0.5	0.094	6,334	10.07	14.3	14.30	0.052	0.55252
117	FS-197	Snowball	31-0108-00-202	9/4/12	47.3355	-93.244	0	0.0	8.4	0.094	4,213	6	13.4	13.37	0.140	1.49735
118	FS-207	Kelly Lake	66-0015-00-204	8/13/12	44.3542	-93.3743	0	0.0	1.92	0.093	4,387	27.33	1.7	1.71	0.171	1.84732
119	FS-310	Second	S007-220	6/14/13	47.5205	-92.1925	25	57.6	316	0.093	31,190	4.22	1102.4	1,101.9	0.107	1.15317
120	FS-306	Sandy	69-0730-00-203	6/11/13	47.6255	-92.5884	0	0.0	11	0.092	35,357	28.53	95.2	95.14	0.078	0.85042
121	FS-204	Big Swan	77-0023-00-207	8/10/12	45.8795	-94.742	55	133.7	5.49	0.091	1,731	5.94	2.4	2.38	0.220	2.40191
122	FS-343	Raymond	73-0285-00-203	8/6/13	45.629	-95.0233	25	61.4	1.92	0.090	3,270	7.59	5.8	5.85	0.112	1.24071
123	FS-330	St. Louis Estuary	S007-444	7/22/13	46.6518	-92.2372	8.8	11.8	6.71	0.090	5,817	1.55	169.5	169.40	0.054	0.59974
124	FS-341	Stella	47-0068-00-205	8/1/13	45.066	-94.4339	28.8	57.6	24.7	0.088	1,786	1.35	20.4	20.44	0.176	1.98834
125	FS-131	Hinken	S007-207	9/5/12	47.7271	-93.9923	18.8	46.8	0.5	0.088	2,960	4.53	10.0	9.96	0.059	0.66915
126	P-45	Hay	31-0037-00-201	9/21/11	47.2874	-93.1017	0		10.24	0.087	12,403	4.36	173.4	173.30	0.062	0.71258
127	FS-333	Embarrass	69-0496-00-203	7/26/13	47.5333	-92.2976	0	0.0	18.2	0.087	11,179	0.47	3271.6	3,270.1	0.027	0.31719
128	FS-312	Miss. R Pool 5/Spring	S007-660	6/21/13	44.2018	-91.8444	23.8	35.7	28.3	0.084	3,563	0.67	212.0	211.90	0.082	0.97423
129	FS-65	Wild Rice	09-0023-00-202	9/4/12	46.6712	-92.6055	0	0.0	0.5	0.083	13,650	28.82	14.6	14.58	0.051	0.61859
130	FS-358	Turtle River, North Branch	S007-662	8/19/13	47.9952	-97.6276	22.5	121.0	198	0.083	4,262	1.52	94.8	94.77	0.212	2.5574
131	FS-355	Miss. R./bel.Clay Boswell	S006-923	8/13/13	47.2553	-93.634	33.8	78.3	10.2	0.082	10,479	8.98	45.0	45.00	0.099	1.20337
132	FS-344	Padua	73-0277-00-202	8/6/13	45.6231	-95.0187	2.5	9.5	0.5	0.081	4,520	12.61	5.4	5.38	0.072	0.89883
133	FS-58	Miss. R/ ab. Clay Boswell	S007-163	8/28/12	47.2386	-93.7197	0	0.0	1.19	0.081	8,636	9.08	30.4	30.34	0.054	0.66756
134	P-30	Stella	47-0068-00-203	9/14/11	45.0659	-94.4339	13.8		7.59	0.080	2,159	2.88	10.2	10.18	0.149	1.85942
135	FS-202	Long Prairie	S007-204	8/9/12	46.0072	-95.2634	8.8	13.4	7.71	0.079	2,897	2.85	18.4	18.36	0.122	1.53865
136	FS-53	Raymond	73-0285-00-203	8/2/12	45.6286	-95.0225	19	61.1	0.5	0.079	1,905	4.79	3.9	3.89	0.081	1.03044
137	FS-52	Blaamyhre	34-0345-00-203	8/1/12	45.364	-95.186	15	102.2	0.62	0.078	3,517	9.33	5.0	5.04	0.080	1.02357
138	FS-213	Gull	04-0120-00-204	9/10/12	47.6558	-94.6945	4.5	9.5	1.14	0.078	3,527	16.01	2.4	2.37	0.128	1.64297
139	FS-125	Tamarac	56-0192-00-203	8/19/12	46.3637	-95.5714	0	0.0	2.33	0.077	21,908	18.41	69.2	69.19	0.051	0.66439
140	FS-198	Ox Hide	31-0106-00-203	9/7/12	47.335	-93.2134	0.3	0.6	26.4	0.075	8,743	24.51	7.7	7.66	0.252	3.35393
141	P-13	Partridge	S007-443	8/31/11	47.5212	-92.1899	28.8		10.39	0.075	11,026	1.44	656.8	656.47	0.039	0.52498
142	FS-226	Louise	21-0094-00-202	8/14/12	45.9331	-95.4148	17	46.5	4.09	0.075	1,833	0.83	42.7	42.70	0.073	0.98284
143	FS-92	Partridge	S007-443	9/12/12	47.5207	-92.1909	1.5	4.1	36.3	0.074	29,463	5.87	619.3	618.96	0.062	0.83423
144	FS-130	Hay	31-0037-00-202	9/6/12	47.2874	-93.102	53.8	141.0	31.7	0.074	13,154	5.79	130.4	130.33	0.101	1.36851
145	FS-182	Hunt	66-0047-00-208	7/27/12	44.3275	-93.4443	0	0.0	17.1	0.073	2,412	1.21	42.9	42.93	0.120	1.64409
146	FS-126	Bray	56-0472-00-202	8/20/12	46.4518	-95.8783	1.8	7.6	1.65	0.072	3,937	21.95	1.9	1.88	0.157	2.18293
147	FS-211	Miss. R Pool 4/Rob'n Lake	79-0005-02-201	8/16/12	44.3611	-91.9897	51.3	57.6	17.7	0.071	9,265	1.55	421.2	421.04	0.055	0.77246
148	FS-300	St. Louis Estuary	S007-444	5/27/13	46.6515	-92.2376	0	0.0	9.4	0.071	4,499	1.26	137.3	137.25	0.065	0.9156
149	FS-209	Miss.R Pool 8/Reno Bot.	S007-556	8/15/12	43.6025	-91.2686	46.3	72.3	18.1	0.071	9,187	2.29	239.0	238.86	0.068	0.9504

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150	FS-196	Prairie	S007-209	9/3/12	47.2519	-93.4884	16.3	44.6	9.63	0.071	15,071	10.51	73.4	73.37	0.082	1.15106
151	FS-210	Miss. R Pool 4/Rob'n Lake	79-0005-02-202	8/16/12	44.3593	-91.9881	21.3	35.3	15.7	0.070	6,450	1.16	312.1	312.00	0.059	0.8385
152	P-26	Lower Rice	S007-164	9/8/11	47.3817	-95.4926	52.5		0.55	0.070	2,364	6.76	3.7	3.65	0.086	1.22352
153	FS-349	Sandy	69-0730-00-205	8/13/13	47.6191	-92.5898	0	0.0	122	0.070	14,897	20.46	28.1	28.04	0.273	3.91706
154	FS-225	Miltona	21-0083-00-205	8/13/12	46.0496	-95.4217	0	0.0	4.11	0.069	2,624	1.77	29.6	29.61	0.083	1.20025
155	FS-371	Miss. R Pool 5/Spring	S007-660	9/10/13	44.2016	-91.8443	26.3	39.8	34.4	0.069	3,582	0.11	2736.9	2,735.55	0.036	0.52782
156	FS-76	Field	34-0151-00-201	7/25/12	45.2964	-94.9058	0	0.0	0.5	0.069	7,586	8.68	25.1	25.09	0.043	0.62007
157	FS-342	Little Round	03-0302-00-203	8/5/13	46.9721	-95.7358	18.8	58.3	0.5	0.068	4,447	25.16	2.0	1.97	0.102	1.51579
158	FS-323	Second	S007-220	7/11/13	47.5204	-92.1925	45	76.4	405	0.067	10,036	2.91	202.6	202.54	0.209	3.11915
159	FS-134	Bass	31-0576-00-207	9/18/12	47.2844	-93.6276	32.5	64.0	1.01	0.066	3,740	26.12	1.3	1.33	0.149	2.25125
160	FS-314	Clearwater	S002-121	6/24/13	47.9372	-95.6907	0.3	0.6	28	0.066	3,946	2.68	36.7	36.64	0.150	2.25896
161	FS-94	Sturgeon	S004-870	9/13/12	47.656	-92.9315	13.8	37.9	1.62	0.066	2,505	0.65	111.1	111.02	0.038	0.58132
162	FS-318	Height of Land	03-0195-00-210	6/26/13	46.9135	-95.6124	22.5	43.0	1.21	0.066	1,349	1.13	15.2	15.17	0.069	1.04596
163	FS-91	Pike	S006-927	9/11/12	47.7327	-92.3473	23.8	3.5	14.2	0.066	6,565	4.72	44.7	44.65	0.111	1.68919
164	P-57	Unnamed	34-0611-00-201	9/23/11	45.2675	-94.865	32.5		6.42	0.065	1,689	12.6	0.8	0.79	0.340	5.22344
165	P-57	Unnamed	34-0611-00-201	9/23/11	45.2675	-94.865	32.5		6.42	0.065	1,946	13.8	0.9	0.91	0.323	4.96177
166	P-57	Unnamed	34-0611-00-201	9/23/11	45.2675	-94.865	32.5		6.42	0.065	2,193	8.1	2.4	2.44	0.230	3.53304
167	P-7	Itasca	15-0016-00-207	8/25/11	47.2332	-95.1985	8.8		0.26	0.064	1,650	6.01	2.1	2.13	0.080	1.24411
168	FS-136	Itasca	15-0016-00-208	9/19/12	47.2343	-95.2049	7.5	23.6	0.5	0.064	1,496	2.23	7.1	7.12	0.066	1.0352
169	P-10	Pike	S006-927	8/30/11	47.7325	-92.3468	18.8		8.31	0.063	15,572	10.9	74.3	74.30	0.077	1.2258
170	FS-302	Partridge	S007-513	5/30/13	47.5153	-92.1894	0	0.0	43.1	0.062	24,784	6.27	402.3	402.15	0.076	1.21971
171	FS-370	Miss. R Pool 8/Genoa	S007-222	9/9/13	43.5765	-91.2337	11.3	17.8	33.3	0.062	6,558	1.43	240.1	239.95	0.083	1.34327
172	FS-51	Glesne Slough	34-0353-00-201	7/31/12	45.3514	-95.1887	22.5	99.6	0.5	0.061	7,983	3.01	123.5	123.42	0.025	0.40325
173	FS-64	Dead Fish	09-0051-00-202	9/4/12	46.7454	-92.6865	0	0.0	0.71	0.061	14,387	22.4	23.1	23.05	0.049	0.81379
174	FS-175	Maloney	79-0001-00-201	7/23/12	44.2251	-91.9321	0	0.0	3.15	0.061	15,126	4.57	239.2	239.11	0.037	0.60752
175	FS-337	Clearwater	S004-204	7/29/13	47.5175	-95.3906	52.5	69.1	0.95	0.061	14,564	24.58	20.7	20.71	0.057	0.9336
176	FS-336	Miss. R Pool 4/Rob'n Lake	79-0005-02-201	7/30/13	44.3613	-91.9901	30	46.5	55.3	0.060	8,193	1.41	378.5	378.30	0.085	1.40841
177	FS-366	Partridge	S007-443	9/3/13	47.5213	-92.19	17.5	47.7	34.2	0.057	7,671	1.79	237.7	237.57	0.084	1.4795
178	P-44	Dead Fish	09-0051-00-202	9/20/11	46.7451	-92.6863	21.3		0.3	0.056	9,685	16.6	16.2	16.22	0.042	0.74116
179	P-5	Itasca	15-0016-00-208	8/25/11	47.2381	-95.2065	20		0.26	0.056	1,355	7.4	1.1	1.08	0.101	1.79682
180	FS-338	Height of Land	03-0195-00-210	7/30/13	46.913	-95.6116	36.3	94.2	0.5	0.055	2,641	4.58	7.9	7.85	0.064	1.14885
181	FS-199	Rice	S006-208	9/5/12	47.6742	-93.6547	29	75.4	1.57	0.055	3,273	10.88	3.5	3.52	0.124	2.25424
182	FS-372	Mississippi Pool 5 / Spring	S007-660	9/10/13	44.2016	-91.8443	13.8	26.7	34.8	0.054	3,330	0.33	504.1	503.89	0.066	1.22227
183	FS-224	Stone Lake	69-0046-00-201	9/19/12	47.5039	-91.8857	6.3	21.0	3.26	0.053	5,225	18.87	4.1	4.05	0.153	2.86279
184	FS-354	Miss. R/ ab. Clay Boswell	S007-163	8/13/13	47.2376	-93.7187	75	132.7	1.18	0.053	7,052	5.76	38.8	38.78	0.049	0.92679
185	P-1	Height of Land	03-0195-00-209	8/22/11	46.9129	-95.6095	27.5		0.24	0.053	1,298	1.76	7.5	7.53	0.050	0.94601
186	P-14	Miss. R/ ab. Clay Boswell	S007-163	9/1/11	47.2379	-93.7196	71.3		1.09	0.053	7,964	6.43	42.1	42.13	0.047	0.87964
187	FS-205	Big Swan	77-0023-00-207	8/10/12	45.8795	-94.7418	17.5	56.3	5.47	0.053	1,719	4.81	3.2	3.16	0.199	3.77265

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
188	FS-55	Pelkey	49-0030-00-202	8/26/12	45.9962	-94.2273	0	0.0	3.42	0.052	30,642	17.32	145.4	145.35	0.045	0.86373
189	FS-369	Dark	69-0790-00-202	9/5/13	47.6389	-92.7781	12.8	11.8	176	0.052	2,037	0.82	53.4	53.39	0.249	4.77951
190	P-47	Little Birch	77-0089-00-101	9/21/11	45.7747	-94.7996	11.3		3.2	0.050	4,503	4.46	23.1	23.13	0.083	1.66307
191	FS-88	Clearwater	S004-204	8/24/12	47.5174	-95.3904	61.3	148.3	2.04	0.049	9,874	22.17	11.2	11.20	0.091	1.87198
192	FS-80	Mission	S001-646	8/6/12	45.8623	-93.0011	52.3	87.5	0.62	0.049	9,231	4.83	84.2	84.18	0.030	0.6232
193	P-11	Sand	S003-249	8/30/11	47.6348	-92.4235	6.3		7.69	0.046	22,677	17.49	79.6	79.57	0.073	1.59589
194	FS-376	Rice	18-0053-00-203	9/11/13	46.3394	-93.8918	22.5	46.5	0.5	0.045	65,261	33.36	253.2	253.08	0.019	0.42511
195	FS-367	Hay	31-0037-00-202	9/4/13	47.287	-93.1009	83.8	141.0	22.1	0.045	15,436	3.44	371.5	371.33	0.062	1.39045
196	FS-351	Second	S007-220	8/15/13	47.5205	-92.1925	52.5	66.8	838	0.045	7,088	1.84	195.9	195.78	0.272	6.08065
197	FS-66	St. Louis Estuary	S007-206	9/5/12	46.6545	-92.2739	0	0.0	16	0.045	6,169	1.73	162.8	162.76	0.074	1.66149
198	FS-132	Ox Hide	31-0106-00-203	9/7/12	47.335	-93.2134	4	10.5	26.4	0.042	14,936	14.43	46.1	46.11	0.136	3.22953
199	P-42	Monongalia	34-0158-01-201	9/20/11	45.3481	-94.951	2.5		16.51	0.042	46,471	14.76	411.5	411.28	0.054	1.29075
200	P-61	Lily	81-0067-00-202	9/28/11	44.194	-93.6469	22.5		0.66	0.041	6,180	14.06	8.5	8.51	0.068	1.65998
201	P-6	Elk	15-0010-00-203	8/25/11	47.1946	-95.2254	11.3		0.28	0.040	8,480	10.24	24.7	24.71	0.035	0.87637
202	P-17	St. Louis	S007-208	9/1/11	47.4668	-91.9355	30		1.23	0.040	9,654	30.4	6.9	6.87	0.091	2.27037
203	FS-383	Upper Panasa	31-0111-00-204	9/18/13	47.3059	-93.2676	0	0.0	33.6	0.040	19,148	2.86	734.7	734.34	0.057	1.42271
204	FS-365	Partridge	S007-443	9/3/13	47.5212	-92.1901	31.3	76.7	34.1	0.039	9,179	2.5	210.8	210.70	0.088	2.23388
205	FS-374	Little Round	03-0302-00-202	9/10/13	46.9745	-95.738	21.3	37.6	0.12	0.039	2,018	14.8	0.9	0.89	0.082	2.10963
206	FS-203	Long Prairie	S007-203	8/9/12	45.9729	-95.1603	46.3	58.3	6.66	0.039	5,074	4.35	30.3	30.26	0.098	2.49607
207	FS-307	Rice paddy	WT00046	6/12/13	47.8482	-95.4865	4.3	8.3	16.6	0.039	4,292	22.33	2.2	2.17	0.332	8.50213
208	P-23	Gourd	04-0253-00-201	9/7/11	47.812	-94.9654	16.8		0.69	0.038	2,675	27.4	0.6	0.65	0.168	4.42652
209	FS-201	Mink	86-0229-00-206	8/8/12	45.274	-94.0269	0	0.0	1.31	0.037	1,740	1.53	16.3	16.28	0.069	1.85046
210	FS-373	Clearwater	S002-121	9/9/13	47.9372	-95.6909	5	3.2	34.4	0.035	5,315	3.33	48.3	48.30	0.146	4.13469
211	FS-54	Little Birch	77-0089-00-207	8/3/12	45.7779	-94.7978	11.3	70.0	7.4	0.035	1,794	6.02	2.5	2.50	0.239	6.77336
212	P-15	Miss. R./bel.Clay Boswell	S006-923	9/1/11	47.2547	-93.6344	43.8		3.65	0.035	8,667	6.07	53.9	53.92	0.065	1.85623
213	FS-185	Hoffs Slough	76-0103-00-201	8/1/12	45.3255	-95.7059	0	0.0	273	0.034	3,512	0.75	175.8	175.71	0.192	5.58924
214	FS-380	Sandy	69-0730-00-204	9/17/13	47.6187	-92.5939	0.3	0.6	126	0.034	17,868	22.7	34.6	34.56	0.257	7.50964
215	FS-381	Sandy	69-0730-00-204	9/17/13	47.6187	-92.5931	0	0.0	126	0.034	16,172	11.67	72.7	72.66	0.199	5.8133
216	FS-335	Miss. R Pool 5/Spring	S007-660	7/30/13	44.1953	-91.841	42.5	63.0	47.7	0.034	4,362	0.25	1264.4	1,263.8	0.053	1.5553
217	P-3	Little Round	03-0302-00-202	8/24/11	46.9759	-95.7404	25		0.46	0.032	1,689	20.91	0.4	0.38	0.175	5.46618
218	FS-108	Rice paddy	WT00031	6/29/12	46.246	-94.2548	33.8	54.7	0.25	0.031	7,874	37.88	3.4	3.38	0.067	2.13826
219	FS-193	Big Mud	71-0085-00-201	8/30/12	45.4529	-93.7418	4.3	14.3	0.5	0.031	12,943	18.63	24.3	24.30	0.043	1.39776
220	FS-95	Embarrass	69-0496-00-203	9/14/12	47.5334	-92.2979	0	0.0	18.8	0.030	21,847	1.89	1705.2	1,704.4	0.035	1.16622
221	FS-180	Lily	81-0067-00-202	7/26/12	44.1947	-93.647	18.8	38.2	0.5	0.030	5,095	28.07	2.2	2.20	0.099	3.34185
222	FS-250	Little Rice	69-0612-00-201	9/20/12	47.7086	-92.4389	8.8	29.3	1.03	0.029	9,488	26.45	8.1	8.08	0.081	2.75681
223	P-53	Carlos Avery Pool 9	02-0504-00-201	8/19/11	45.3179	-93.0587	18.8		0.35	0.029	37,965	16.51	236.6	236.48	0.017	0.59867
224	FS-377	Mahnomen	18-0126-02-201	9/11/13	46.4986	-93.9956	0	0.0	21.1	0.028	16,540	7.47	142.5	142.43	0.085	3.00714
225	FS-215	Popple	S006-188	9/11/12	47.7254	-94.0817	11.8	36.3	0.5	0.027	2,971	14.42	2.0	1.96	0.103	3.81575

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1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
226	P-46	Hay	31-0037-00-201	9/21/11	47.2869	-93.1018	0		10.24	0.026	16,139	7.69	130.4	130.31	0.068	2.63005
227	FS-56	Rice	18-0053-00-203	8/27/12	46.3389	-93.8915	3.5	19.4	0.5	0.026	83,421	31.88	436.3	436.11	0.016	0.61353
228	FS-378	Duck Lake WMA	18-0178-00-202	9/12/13	46.7521	-93.8851	42.5	113.0	0.5	0.025	12,151	26.57	13.0	13.02	0.053	2.12693
229	P-16	St. Louis	S006-929	9/1/11	47.4015	-92.3773	0		24.5	0.025	1,488	0.1	561.5	561.24	0.056	2.23849
230	P-31	Cloquet	38-0539-00-201	9/14/11	47.4313	-91.4844	32.5		0.81	0.024	4,252	6.58	12.0	11.95	0.065	2.70841
231	FS-304	Rice	18-0053-00-203	6/10/13	46.3387	-93.8906	2.5	5.7	0.5	0.024	48,287	33.61	139.0	138.93	0.024	0.9992
232	P-36	Wild Rice Reservoir	69-0371-00-204	9/16/11	46.9098	-92.1636	7.5		1.13	0.023	5,555	3.75	44.6	44.54	0.046	2.01392
233	FS-212	Miss. R Pool 5/Spring	S007-660	8/17/12	44.1993	-91.8461	17.5	29.6	17.2	0.022	3,674	0.22	1082.3	1,081.8	0.039	1.76237
234	FS-84	Pleasant	11-0383-00-207	8/10/12	46.9228	-94.4874	0	0.0	0.5	0.022	7,065	23.99	5.2	5.21	0.073	3.36026
235	P-69	Rice	18-0053-00-203	9/27/11	46.3394	-93.8913	18.8		0.23	0.021	50,389	35.55	139.6	139.52	0.018	0.85773
236	P-52	Flowage	01-0061-00-205	9/22/11	46.6895	93.338	53.8		0.56	0.018	3,706	16.52	2.5	2.49	0.098	5.45675
237	P-52	Flowage	01-0061-00-206	9/22/11	46.6895	93.338	53.8		0.56	0.018	4,302	21.79	2.3	2.26	0.102	5.64492
238	P-52	Flowage	01-0061-00-206	9/22/11	46.6895	93.338	53.8		0.56	0.018	4,641	18.1	3.4	3.40	0.088	4.90074
239	P-51	Flowage	01-0061-00-205	9/22/11	46.6896	93.338	70		0.56	0.014	5,627	20.1	4.3	4.28	0.082	5.82175
240	FS-109	Carlos Avery Pool 9	02-0504-00-202	7/3/12	45.3192	-93.0611	23.8	52.8	0.5	0.011	14,736	12.51	54.9	54.92	0.033	2.95463
241	FS-127	Height of Land	03-0195-00-210	8/21/12	46.9133	-95.6095	70	111.1	0.5	0.011	2,112	1.32	29.3	29.28	0.040	3.67555
242	FS-375	Height of Land	03-0195-00-210	9/10/13	46.913	-95.6111	63.8	117.5	0.5	0.011	1,795	0.86	39.0	38.98	0.037	3.33093
243	P-4	Little Flat	03-0217-00-201	8/24/11	46.9981	-95.6641	36.3		0.22	0.011	7,479	33.13	3.7	3.69	0.062	5.64764
244	P-63	Maloney	79-0001-00-201	9/29/11	44.2243	-91.9328	65		1.83	0.010	10,269	4.24	124.7	124.60	0.038	3.83534
245	P-22	Ham	02-0053-00-201	9/6/11	45.2572	-93.2264	0		0.95							
246	FS-104	Gourd	04-0253-00-201	6/27/12	47.8121	-94.965	0	0.0	0.27		1,776	36.87	0.2	0.19	0.185	
247	P-43	Wild Rice	09-0023-00-201	9/20/11	46.6735	-92.6023	0		0.37							
248	P-27	Pleasant	11-0383-00-206	9/9/11	46.928	-94.4757	12.5		0.49		5,331	30.37	2.2	2.15	0.099	
249	P-56	Rice	18-0053-00-203	9/23/11	46.3396	-93.8901	0		0.38							
250	P-37	Ina	21-0355-00-201	9/16/11	46.0822	-95.726	0		2.17							
251	FS-178	Bear	24-0028-00-206	7/25/12	43.5465	-93.5028	0	0.0	18.3							
252	P-33	Pelican	26-0002-00-219	9/15/11	46.0616	-95.8296	0		5.79							
253	P-8	Pelican	26-0002-00-219	8/26/11	46.0616	-95.8296	0									
254	FS-50	Swan	34-0223-00-201	7/30/12	45.326	-95.067	0	0.0	11.7							
255	P-18	Lax	38-0406-00-203	9/2/11	47.3508	-91.2921	0		1.43							
256	P-32	Caribou	69-0489-00-205	9/15/11	46.8991	-92.3217	0		0.63							
257	P-9	Embarrass	69-0496-00-202	8/29/11	47.534	-92.3164	0		6.35							
258	P-39	Grand	69-0511-00-203	9/17/11	46.8872	-92.3988	0		0.83							
259	P-64	Maloney	79-0001-00-201	9/29/11	44.2243	-91.9328	0		1.83		10,382	4.05	135.9	135.79	0.037	
260	P-62	Lily	81-0067-00-202	9/28/11	44.194	-93.6469	0		0.64		5,069	13.39	6.2	6.19	0.075	
261	P-2	Mud	S004-735	8/23/11	46.6266	-95.5751	0									
262	P-41	St. Louis Est. Pok. Bay	S006-928	9/19/11	46.6855	-92.1619	0		2.33							
263	FS-70	St. Louis	S006-929	9/7/12	47.4015	-92.3772	0	0.0	73.8							

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1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
264	FS-317	Partridge	S007-443	6/26/13	47.5215	-92.1903	0	0.0	7.65							
265	FS-363	St. Louis Estuary	S007-444	8/26/13	46.6518	-92.2372	18.8	31.2			4,761	1.4		132.15		
266	P-40	St. Louis Estuary	S007-444	9/19/11	46.6588	-92.2819	0		4.9							
267	FS-364	Partridge	S007-513	8/30/13	47.5138	-92.1894	57.5	105.7			28,890	8.19		372.42		
268	FS-361	Rice paddy	WT00028	8/21/13	47.8054	-95.6744	68.8	78.6			3,089	12.46		2.60		

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1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
2	P-55	Lady Slipper	42-0020-00-204	9/22/11	44.5702	-95.6274	0		107.71	14.840	2,814	2.09	26.9	26.85	0.266	0.01791
3	FS-85	Bean	03-0411-00-201	8/21/12	46.9337	-95.8706	0	0.0	85	16.000	1,967	11.85	1.2	1.15	0.725	0.04531
4	FS-320	Sandy	69-0730-00-204	7/9/13	47.6188	-92.5936	0	0.0	118	3.080	19,749	15.43	72.5	72.45	0.195	0.06316
5	FS-184	Rice	73-0196-00-216	7/30/12	45.3864	-94.6309	0	0.0	2.58	2.970	1,523	15.03	0.5	0.50	0.290	0.09752
6	FS-186	Westport	61-0029-00-204	8/1/12	45.6897	-95.217	0	0.0	7.11	1.790	4,917	20.15	3.3	3.28	0.215	0.11999
7	FS-188	Stella	47-0068-00-204	8/27/12	45.0683	-94.4334	0.3	0.3	18.1	1.790	1,257	2.34	4.7	4.73	0.261	0.14607
8	FS-345	Rice	73-0196-00-216	8/7/13	45.3865	-94.6313	0	0.0	6.85	2.080	2,012	14.83	0.9	0.88	0.334	0.16055
9	FS-357	Lower Panasa	31-0112-00-204	8/15/13	47.3026	-93.2561	0	0.0	28.5	1.260	2,347	2.42	15.3	15.31	0.204	0.16186
10	FS-177	South Geneva	24-0015-02-208	7/24/12	43.7709	-93.2851	0	0.0	14.1	3.190	1,618	16.71	0.5	0.49	0.526	0.16487
11	FS-128	Cromwell	14-0103-00-201	8/22/12	46.9651	-96.3171	0	0.0	41.2	1.220	2,948	2.85	19.0	18.99	0.215	0.17622
12	FS-339	Christina	21-0375-00-315	7/31/13	46.0734	-95.7567	0.3	0.6	14.6	1.930	1,741	8.96	1.3	1.35	0.374	0.1939
13	FS-79	Lady Slipper	42-0020-00-203	7/27/12	44.5723	-95.6216	0	0.0	330	1.630	3,314	1.85	43.9	43.92	0.330	0.20251
14	FS-78	Lady Slipper	42-0020-00-202	7/27/12	44.5699	-95.6275	0	0.0	335	1.680	2,719	1.66	34.8	34.74	0.360	0.21415
15	FS-77	Monongalia	34-0158-02-204	7/26/12	45.3331	-94.927	38.8	121.3	21.7	1.370	4,953	18.66	3.7	3.70	0.303	0.22086
16	FS-324	Rice	18-0053-00-203	7/15/13	46.3392	-93.8918	27.5	56.7	0.5	0.110	44,704	33.18	121.7	121.67	0.025	0.22442
17	FS-305	Sandy	69-0730-00-204	6/11/13	47.6187	-92.5937	0	0.0	135	1.080	19,094	22.23	40.6	40.53	0.249	0.23051
18	FS-102	Rice paddy	WT00027	6/26/12	47.9265	-95.6313	39.3	93.6	1.61	0.677	4,932	31.82	1.7	1.73	0.160	0.23683
19	FS-133	Mahnomen	18-0126-02-201	9/17/12	46.4985	-93.9958	0	0.0	16.9	0.308	18,746	7.7	174.4	174.34	0.074	0.23869
20	FS-176	North Geneva	24-0015-00-209	7/24/12	43.7876	-93.271	0	0.0	15.6	1.540	2,212	13.45	1.2	1.21	0.397	0.25768
21	FS-83	Mississippi Crow Wing	S007-205	8/8/12	46.4386	-94.1251	0	0.0	3.13	0.127	13,451	3.88	239.5	239.40	0.037	0.29011
22	FS-181	Rice	66-0048-00-203	7/27/12	44.3332	-93.4734	0	0.0	5.22	0.777	3,829	21.67	1.8	1.81	0.237	0.30476
23	FS-333	Embarrass	69-0496-00-203	7/26/13	47.5333	-92.2976	0	0.0	18.2	0.087	11,179	0.47	3271.6	3,270.1	0.027	0.31719
24	FS-223	Little Sucker	31-0126-00-202	9/14/12	47.3765	-93.246	0	0.0	13.7	0.534	6,297	16.56	7.0	7.01	0.207	0.38799
25	FS-315	St. Louis Estuary	S007-444	6/24/13	46.6516	-92.2373	0	0.0	8.1	0.147	6,056	1.68	163.7	163.61	0.058	0.39699
26	FS-51	Glesne Slough	34-0353-00-201	7/31/12	45.3514	-95.1887	22.5	99.6	0.5	0.061	7,983	3.01	123.5	123.42	0.025	0.40325
27	FS-87	Bee	60-0192-00-202	8/23/12	47.6527	-96.0504	18.8	39.8	11	0.670	3,054	13.62	2.2	2.24	0.285	0.42488
28	FS-376	Rice	18-0053-00-203	9/11/13	46.3394	-93.8918	22.5	46.5	0.5	0.045	65,261	33.36	253.2	253.08	0.019	0.42511
29	FS-75	Mortenson	34-0150-02-201	7/24/12	45.3	-94.9062	0	0.0	0.5	0.103	9,071	12.09	22.3	22.31	0.044	0.43062
30	FS-251	Sandy	69-0730-00-203	9/21/12	47.6254	-92.5886	1.3	3.8	3.05	0.123	35,905	33.08	79.6	79.59	0.053	0.43361
31	FS-69	St. Louis	S007-208	9/7/12	47.4671	-91.9279	0	0.0	1.33	0.181	11,429	27.16	11.2	11.20	0.079	0.43544
32	P-35	Anka	21-0353-00-201	9/16/11	46.0769	-95.7377	1.3		2.23	0.493	2,170	14.84	1.0	1.02	0.216	0.43718
33	FS-208	Mississippi Pool 8 at Genoa	S007-222	8/14/12	43.5758	-91.2334	43.8	41.4	18	0.176	2,178	0.41	161.8	161.72	0.077	0.43885
34	P-47	Little Birch	77-0089-00-101	9/21/11	45.7747	-94.7996	11.3		3.2	0.191	2,236	1.75	22.0	22.00	0.085	0.44321
35	FS-331	Partridge	S007-443	7/24/13	47.5212	-92.1904	30	60.5	14.6	0.112	10,082	1.68	443.6	443.39	0.051	0.45262
36	FS-67	St. Louis Estuary Pokegama Bay	S006-928	9/5/12	46.6859	-92.1606	0	0.0	9.97	0.112	14,015	3.66	281.8	281.69	0.052	0.46385
37	FS-187	McCormic	73-0273-00-203	8/2/12	45.722	-94.9121	1.3	8.9	1.54	0.144	1,512	1.1	19.7	19.70	0.068	0.47467
38	FS-190	Pine	15-0149-00-205	8/28/12	47.6841	-95.5414	47.5	114.9	14.7	0.368	4,477	7.08	11.9	11.92	0.177	0.48053

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
39	FS-195	Fisher	70-0087-00-201	8/31/12	44.7942	-93.4061	25	20.7	6.85	0.136	11,140	5.76	94.9	94.85	0.066	0.48846
40	FS-81	Flowage	01-0061-00-204	8/7/12	46.688	-93.337	0	0.0	0.78	0.134	12,470	32.34	10.4	10.38	0.067	0.50215
41	FS-57	Mississippi River below Clay Boswell	S006-923	8/28/12	47.2551	-93.6342	0	0.0	10.3	0.134	4,225	1.2	130.1	130.02	0.069	0.51229
42	P-34	Anka	21-0353-00-201	9/16/11	46.0769	-95.7292	11.3		2.23	0.671	1,485	23.57	0.3	0.25	0.349	0.51956
43	P-13	Partridge	S007-443	8/31/11	47.5212	-92.1899	28.8		10.39	0.075	11,026	1.44	656.8	656.47	0.039	0.52498
44	FS-371	Mississippi Pool 5 / Spring	S007-660	9/10/13	44.2016	-91.8443	26.3	39.8	34.4	0.069	3,582	0.11	2736.9	2,735.55	0.036	0.52782
45	FS-230	Mill Pond	21-0034-00-202	8/16/12	46.0715	-95.2218	21.5	80.9	7.36	0.192	3,969	3.14	29.7	29.64	0.102	0.53004
46	FS-220	Padua	73-0277-00-202	8/7/12	45.623	-95.0186	0	0.0	0.86	0.230	2,291	9.77	2.0	2.04	0.122	0.53075
47	FS-218	Holman	31-0227-00-202	9/13/12	47.3005	-93.3445	0	0.0	24.2	1.010	3,035	29.74	0.7	0.74	0.548	0.54303
48	FS-200	Louisa	86-0282-00-205	8/8/12	45.2998	-94.258	0	0.0	7.04	0.192	7,824	8.76	26.3	26.31	0.104	0.54356
49	P-47	Little Birch	77-0089-00-101	9/21/11	45.7747	-94.7996	11.3		3.2	0.191	3,544	5.11	12.0	11.95	0.104	0.54672
50	FS-137	Elk	15-0010-00-204	9/19/12	47.1952	-95.2249	7.3	42.7	0.5	0.094	6,334	10.07	14.3	14.30	0.052	0.55252
51	FS-82	Rabbit	18-0093-02-204	8/8/12	46.5313	-93.9285	0	0.0	15.3	0.220	10,903	11.79	33.1	33.12	0.126	0.5726
52	FS-94	Sturgeon	S004-870	9/13/12	47.656	-92.9315	13.8	37.9	1.62	0.066	2,505	0.65	111.1	111.02	0.038	0.58132
53	FS-129	Mink	86-0229-00-207	8/23/12	45.2767	-94.0299	0	0.0	1.22	0.182	4,247	13.63	4.3	4.27	0.107	0.58651
54	P-53	Carlos Avery Pool 9	02-0504-00-201	8/19/11	45.3179	-93.0587	18.8		0.35	0.029	37,965	16.51	236.6	236.48	0.017	0.59867
55	FS-330	St. Louis Estuary	S007-444	7/22/13	46.6518	-92.2372	8.8	11.8	6.71	0.090	5,817	1.55	169.5	169.40	0.054	0.59974
56	FS-175	Maloney	79-0001-00-201	7/23/12	44.2251	-91.9321	0	0.0	3.15	0.061	15,126	4.57	239.2	239.11	0.037	0.60752
57	FS-56	Rice	18-0053-00-203	8/27/12	46.3389	-93.8915	3.5	19.4	0.5	0.026	83,421	31.88	436.3	436.11	0.016	0.61353
58	FS-65	Wild Rice	09-0023-00-202	9/4/12	46.6712	-92.6055	0	0.0	0.5	0.083	13,650	28.82	14.6	14.58	0.051	0.61859
59	FS-76	Field	34-0151-00-201	7/25/12	45.2964	-94.9058	0	0.0	0.5	0.069	7,586	8.68	25.1	25.09	0.043	0.62007
60	FS-80	Mission	S001-646	8/6/12	45.8623	-93.0011	52.3	87.5	0.62	0.049	9,231	4.83	84.2	84.18	0.030	0.6232
61	FS-348	Sandy	69-0730-00-204	8/13/13	47.6186	-92.5934	0	0.0	123	0.305	13,216	8.23	80.2	80.11	0.191	0.62517
62	FS-301	Partridge	S007-443	5/28/13	47.5213	-92.1903	0	0.0	14.8	0.125	9,491	3.94	118.5	118.44	0.080	0.64224
63	FS-125	Tamarac	56-0192-00-203	8/19/12	46.3637	-95.5714	0	0.0	2.33	0.077	21,908	18.41	69.2	69.19	0.051	0.66439
64	FS-58	Mississippi River above Clay Boswell	S007-163	8/28/12	47.2386	-93.7197	0	0.0	1.19	0.081	8,636	9.08	30.4	30.34	0.054	0.66756
65	FS-131	Hinken	S007-207	9/5/12	47.7271	-93.9923	18.8	46.8	0.5	0.088	2,960	4.53	10.0	9.96	0.059	0.66915
66	FS-139	Welby family farm	86-0231-00-202	9/21/12	45.3592	-94.0782	2	17.2	0.5	0.118	7,267	30.76	3.9	3.88	0.081	0.68731
67	FS-68	Wolf	69-0143-00-101	9/6/12	47.2564	-91.963	2.3	8.9	2.01	0.119	9,526	17.19	15.0	14.95	0.082	0.69147
68	P-57	Unnamed	34-0611-00-201	9/23/11	45.2675	-94.865	32.5		6.42	0.286	2,311	6.48	3.7	3.71	0.199	0.6954
69	FS-328	Eighteen	60-0199-00-203	7/18/13	47.6369	-96.0599	27.5	44.2	3.34	0.250	5,106	24.65	2.7	2.66	0.178	0.71181
70	P-45	Hay	31-0037-00-201	9/21/11	47.2874	-93.1017	0		10.24	0.087	12,403	4.36	173.4	173.30	0.062	0.71258
71	P-19	Wolf	69-0143-00-202	9/2/11	47.2586	-91.9618	56.3		1.54	0.139	8,240	25.1	6.6	6.60	0.100	0.71583
72	FS-325	Rice paddy	WT00046	7/16/13	47.8481	-95.4865	51.3	79.6	0.46	0.115	4,673	19.28	3.2	3.16	0.085	0.73566
73	P-44	Dead Fish	09-0051-00-202	9/20/11	46.7451	-92.6863	21.3		0.3	0.056	9,685	16.6	16.2	16.22	0.042	0.74116
74	FS-61	Swan	31-0067-02-206	8/30/12	47.2888	-93.2127	3	12.4	12.5	0.332	5,827	22.71	3.9	3.86	0.247	0.74282
75	FS-63	Caribou	69-0489-00-206	9/3/12	46.8913	-92.3135	0	0.0	1.21	0.094	13,791	29.44	14.4	14.43	0.070	0.74503

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	LacCore field ID	Site name	DNR/State ID	Date	Lat	Long	WR ring % cover	Ave. stems /m2	Obs surf water sulfate (mg SO4/L)	Obs pore water Tot Sulfide (TS, mg S/L)	Observed Sediment Fe (µg/g)	Observed Sediment TOC (%)	CPSC (mg/L)	CPSC check	Direct sulfide calc (expect)	Sulfide ratio expect to obs
76	FS-308	Rice paddy	WT00028	6/12/13	47.8056	-95.674	36.3	85.9	57.1	0.802	2,779	17.1	1.4	1.35	0.598	0.74579
77	P-29	Padua	73-0277-00-203	9/13/11	45.6202	-95.0192	1.5		0.76	0.130	4,927	20.15	3.3	3.29	0.099	0.76289
78	FS-211	Mississippi Pool 4/Robinson Lake	79-0005-02-201	8/16/12	44.3611	-91.9897	51.3	57.6	17.7	0.071	9,265	1.55	421.2	421.04	0.055	0.77246
79	FS-221	Hay Creek Flowage	58-0005-00-202	9/17/12	46.0894	-92.4104	58.8	97.7	1.95	0.119	9,456	22.05	10.4	10.37	0.092	0.77616
80	FS-64	Dead Fish	09-0051-00-202	9/4/12	46.7454	-92.6865	0	0.0	0.71	0.061	14,387	22.4	23.1	23.05	0.049	0.81379
81	FS-194	Gilchrist	86-0064-00-201	8/31/12	45.2309	-93.824	0	0.0	6.98	0.355	3,117	20.81	1.3	1.28	0.295	0.83071
82	FS-92	Partridge	S007-443	9/12/12	47.5207	-92.1909	1.5	4.1	36.3	0.074	29,463	5.87	619.3	618.96	0.062	0.83423
83	FS-210	Mississippi Pool 4/Robinson Lake	79-0005-02-202	8/16/12	44.3593	-91.9881	21.3	35.3	15.7	0.070	6,450	1.16	312.1	312.00	0.059	0.8385
84	FS-306	Sandy	69-0730-00-203	6/11/13	47.6255	-92.5884	0	0.0	11	0.092	35,357	28.53	95.2	95.14	0.078	0.85042
85	FS-86	Eighteen	60-0199-00-202	8/22/12	47.6397	-96.0607	23.8	40.1	4.29	0.164	1,860	3.1	6.9	6.85	0.140	0.85384
86	P-69	Rice	18-0053-00-203	9/27/11	46.3394	-93.8913	18.8		0.23	0.021	50,389	35.55	139.6	139.52	0.018	0.85773
87	FS-55	Pelkey	49-0030-00-202	8/26/12	45.9962	-94.2273	0	0.0	3.42	0.052	30,642	17.32	145.4	145.35	0.045	0.86373
88	FS-179	Rice	74-0001-00-201	7/25/12	44.0842	-93.0737	0	0.0	3.84	0.217	4,152	19.07	2.5	2.54	0.190	0.87338
89	P-6	Elk	15-0010-00-203	8/25/11	47.1946	-95.2254	11.3		0.28	0.040	8,480	10.24	24.7	24.71	0.035	0.87637
90	P-14	Mississippi River above Clay Boswell	S007-163	9/1/11	47.2379	-93.7196	71.3		1.09	0.053	7,964	6.43	42.1	42.13	0.047	0.87964
91	FS-368	Dark	69-0790-00-202	9/5/13	47.6387	-92.7782	6.3	11.1	175	0.305	3,354	1.94	42.1	42.05	0.269	0.88268
92	FS-344	Padua	73-0277-00-202	8/6/13	45.6231	-95.0187	2.5	9.5	0.5	0.081	4,520	12.61	5.4	5.38	0.072	0.89883
93	P-28	Raymond	73-0285-00-203	9/12/11	45.629	-95.0234	30		0.82	0.094	3,922	10.06	5.6	5.61	0.085	0.90141
94	FS-191	Ina	21-0355-00-202	8/29/12	46.0715	-95.7281	8.5	30.2	7.08	0.274	2,216	9.09	2.1	2.12	0.249	0.91044
95	FS-60	Lower Panasa	31-0112-00-205	8/29/12	47.3018	-93.2521	0	0.0	33.6	0.243	8,048	14.12	14.2	14.18	0.221	0.91117
96	FS-300	St. Louis Estuary	S007-444	5/27/13	46.6515	-92.2376	0	0.0	9.4	0.071	4,499	1.26	137.3	137.25	0.065	0.9156
97	FS-354	Mississippi River above Clay Boswell	S007-163	8/13/13	47.2376	-93.7187	75	132.7	1.18	0.053	7,052	5.76	38.8	38.78	0.049	0.92679
98	FS-337	Clearwater	S004-204	7/29/13	47.5175	-95.3906	52.5	69.1	0.95	0.061	14,564	24.58	20.7	20.71	0.057	0.9336
99	FS-321	Sandy	69-0730-00-203	7/9/13	47.6255	-92.5885	0	0.0	122	0.189	36,502	29.51	96.6	96.55	0.178	0.94257
100	P-47	Little Birch	77-0089-00-101	9/21/11	45.7747	-94.7996	11.3		3.2	0.191	2,253	8.37	2.5	2.46	0.180	0.94344
101	P-1	Height of Land	03-0195-00-209	8/22/11	46.9129	-95.6095	27.5		0.24	0.053	1,298	1.76	7.5	7.53	0.050	0.94601
102	FS-209	Mississippi Pool 8 at Reno Bottoms	S007-556	8/15/12	43.6025	-91.2686	46.3	72.3	18.1	0.071	9,187	2.29	239.0	238.86	0.068	0.9504
103	FS-214	Bowstring	S007-219	9/11/12	47.7024	-94.0608	27.5	69.7	1.34	0.256	1,974	24.34	0.4	0.42	0.245	0.95751
104	FS-353	Holman	31-0227-00-202	8/12/13	47.3009	-93.3444	0	0.0	68	0.583	5,094	30.6	1.9	1.95	0.560	0.96047
105	FS-312	Mississippi Pool 5 / Spring	S007-660	6/21/13	44.2018	-91.8444	23.8	35.7	28.3	0.084	3,563	0.67	212.0	211.90	0.082	0.97423
106	FS-226	Louise	21-0094-00-202	8/14/12	45.9331	-95.4148	17	46.5	4.09	0.075	1,833	0.83	42.7	42.70	0.073	0.98284
107	FS-304	Rice	18-0053-00-203	6/10/13	46.3387	-93.8906	2.5	5.7	0.5	0.024	48,287	33.61	139.0	138.93	0.024	0.9992
108	P-24	Second	15-0091-00-201	9/7/11	47.8255	-95.3635	16.3		0.87	0.139	3,813	25.67	1.4	1.42	0.139	0.99974

Roberts Memorandum - Wild Rice Rule
November 2017

Attachment 2
(9 pages)

MPCA Field Data - All MN non-paddy data
CPSC and Sulfate Ratio

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	LacCore _field_ID	Site_name	Unique site ID	DNR/State ID	Date	Lat	Long	Calculated Wild rice ave stems/m2	surface water SO4 (mg SO4/L)	pore water Total Sulfide (TS, mg S/L)	Sediment Fe (µg/g)	Sediment TOC (%)	potential SO4 standard CPSC120	CPSC120 calculated	surface water SO4 (mg SO4/L)	SO4 ratio: CPSC to actual
2	FS-384	Second	117	S007-220	9/19/13	47.52	-92.1925	27.7		0.104	22634	3.42	657.3	657.30	missing	#VALUE!
3	FS-364	Partridge	121	S007-513	8/30/13	47.514	-92.1894	105.7			28890	8.19	369.5	369.49	missing	#VALUE!
4	FS-363	St. Louis Estuary	120	S007-444	8/26/13	46.652	-92.2372	31.2			4761	1.4	95.5	95.52	missing	#VALUE!
5	FS-56	Rice	19	18-0053-00	8/27/12	46.339	-93.8915	19.4	< 0.5	0.0259	83421	31.88	558.1	558.07	0.50	1116.13
6	P-69	Rice	19	18-0053-00	9/27/11	46.339	-93.8913	43.0	0.23	0.021	50389	35.55	185.8	185.79	0.23	807.78
7	P-53	Carlos Avery Pool 9	4	02-0504-00	8/19/11	45.318	-93.0587	43.0	0.35	0.029	37965	16.51	270.0	269.96	0.35	771.31
8	FS-376	Rice	19	18-0053-00	9/11/13	46.339	-93.8918	46.5	< 0.5	0.0451	65261	33.36	329.7	329.66	0.50	659.31
9	FS-304	Rice	19	18-0053-00	6/10/13	46.339	-93.8906	5.7	< 0.5	0.0236	48287	33.61	183.1	183.07	0.50	366.13
10	FS-324	Rice	19	18-0053-00	7/15/13	46.339	-93.8918	56.7	< 0.5	0.11	44704	33.18	160.3	160.29	0.50	320.58
11	FS-51	Glesne Slough	49	34-0353-00	7/31/12	45.351	-95.1887	99.6	< 0.5	0.061	7983	3.01	103.2	103.23	0.50	206.46
12	FS-80	Mission	95	S001-646	8/6/12	45.862	-93.0011	87.5	0.62	0.0485	9231	4.83	77.5	77.50	0.62	124.99
13	FS-109	Carlos Avery Pool 9	4	02-0504-00	7/3/12	45.319	-93.0611	52.8	< 0.5	< 0.011	14736	12.51	61.0	60.98	0.50	121.95
14	FS-333	Embarrass	73	69-0496-00	7/26/13	47.533	-92.2976	0.0	18.2	0.0866	11179	0.47	1821.2	1821.22	18.20	100.07
15	P-6	Elk	15	15-0010-00	8/25/11	47.195	-95.2254	25.9	0.28	0.04	8480	10.24	26.8	26.78	0.28	95.63
16	FS-175	Maloney	88	79-0001-00	7/23/12	44.225	-91.9321	0.0	3.15	0.0608	15126	4.57	214.0	214.03	3.15	67.95
17	FS-95	Embarrass	73	69-0496-00	9/14/12	47.533	-92.2979	0.0	18.8	0.0298	21847	1.89	1248.9	1248.85	18.80	66.43
18	FS-83	Mississippi Crow Wing	111	S007-205	8/8/12	46.439	-94.1251	0.0	3.13	0.127	13451	3.88	207.8	207.75	3.13	66.37
19	P-64	Maloney	88	79-0001-00	9/29/11	44.224	-91.9328	0.0	1.83		10382	4.05	119.9	119.94	1.83	65.54
20	P-44	Dead Fish	12	09-0051-00	9/20/11	46.745	-92.6863	48.7	0.3	0.056	9685	16.6	19.4	19.39	0.30	64.63
21	P-63	Maloney	88	79-0001-00	9/29/11	44.224	-91.9328	148.7	1.83	0.01	10269	4.24	111.2	111.17	1.83	60.75
22	FS-193	Big Mud	79	71-0085-00	8/30/12	45.453	-93.7418	14.3	< 0.5	0.0308	12943	18.63	29.5	29.50	0.50	58.99
23	FS-76	Field	45	34-0151-00	7/25/12	45.296	-94.9058	0.0	< 0.5	0.0687	7586	8.68	26.3	26.34	0.50	52.68
24	FS-375	Height of Land	5	03-0195-00	9/10/13	46.913	-95.6111	117.5	< 0.5	< 0.011	1795	0.86	26.2	26.23	0.50	52.45
25	FS-75	Mortenson	44	34-0150-02	7/24/12	45.3	-94.9062	0.0	< 0.5	0.103	9071	12.09	25.0	24.99	0.50	49.97
26	FS-55	Pelkey	55	49-0030-00	8/26/12	45.996	-94.2273	0.0	3.42	0.0522	30642	17.32	168.8	168.82	3.42	49.36
27	P-13	Partridge	119	S007-443	8/31/11	47.521	-92.1899	65.9	10.39	0.075	11026	1.44	464.3	464.30	10.39	44.69

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28	FS-94	Sturgeon	100	S004-870	9/13/12	47.656	-92.9315	37.9	1.62	0.0659	2505	0.65	69.6	69.60	1.62	42.97
29	FS-127	Height of Land	5	03-0195-00	8/21/12	46.913	-95.6095	111.1	< 0.5	< 0.011	2112	1.32	21.5	21.47	0.50	42.94
30	FS-64	Dead Fish	12	09-0051-00	9/4/12	46.745	-92.6865	0.0	0.71	0.0608	14387	22.4	29.0	28.99	0.71	40.84
31	FS-65	Wild Rice	11	09-0023-00	9/4/12	46.671	-92.6055	0.0	< 0.5	0.083	13650	28.82	19.4	19.38	0.50	38.76
32	P-14	Mississippi River above Clay Boswell	108	S007-163	9/1/11	47.238	-93.7196	163.2	1.09	0.053	7964	6.43	41.4	41.42	1.09	38.00
33	FS-125	Tamarac	56	56-0192-00	8/19/12	46.364	-95.5714	0.0	2.33	0.0768	21908	18.41	82.3	82.32	2.33	35.33
34	P-36	Wild Rice Reservoir	70	69-0371-00	9/16/11	46.91	-92.1636	17.2	1.13	0.023	5555	3.75	39.5	39.51	1.13	34.96
35	FS-251	Sandy-1	76	69-0730-00	9/21/12	47.625	-92.5886	3.8	3.05	0.123	35905	33.08	105.5	105.54	3.05	34.60
36	FS-378	Duck Lake WMA	22	18-0178-00	9/12/13	46.752	-93.8851	113.0	< 0.5	0.0251	12151	26.57	17.1	17.08	0.50	34.16
37	FS-371	Mississippi Pool 5 / Spring	123	S007-660	9/10/13	44.202	-91.8443	39.8	34.4	0.069	3582	0.11	1161.0	1160.97	34.40	33.75
38	FS-354	Mississippi River above Clay Boswell	108	S007-163	8/13/13	47.238	-93.7187	132.7	1.18	0.0532	7052	5.76	37.4	37.40	1.18	31.69
39	FS-137	Elk	15	15-0010-00	9/19/12	47.195	-95.2249	42.7	< 0.5	0.0936	6334	10.07	15.6	15.59	0.50	31.18
40	FS-212	Mississippi Pool 5 / Spring	123	S007-660	8/17/12	44.199	-91.8461	29.6	17.2	0.0224	3674	0.22	531.7	531.70	17.20	30.91
41	FS-337	Clearwater	98	S004-204	7/29/13	47.518	-95.3906	69.1	0.95	0.0608	14564	24.58	26.6	26.56	0.95	27.96
42	P-42	Monongalia (Middle Fork Crow R)	45.5	34-0158-01	9/20/11	45.348	-94.9509	5.7	16.51	0.042	46471	14.76	455.4	455.39	16.51	27.58
43	FS-58	Mississippi River above Clay Boswell	108	S007-163	8/28/12	47.239	-93.7197	0.0	1.19	0.0806	8636	9.08	32.0	32.02	1.19	26.91
44	P-1	Height of Land	5	03-0195-00	8/22/11	46.913	-95.6095	62.9	0.24	0.053	1298	1.76	6.0	5.97	0.24	24.86
45	FS-67	St. Louis Estuary Pokegama Bay	105	S006-928	9/5/12	46.686	-92.1606	0.0	9.97	0.112	14015	3.66	241.1	241.10	9.97	24.18
46	P-4	Little Flat	6	03-0217-00	8/24/11	46.998	-95.6641	83.1	0.22	0.011	7479	33.13	5.2	5.16	0.22	23.45
47	FS-331	Partridge	119	S007-443	7/24/13	47.521	-92.1904	60.5	14.6	0.112	10082	1.68	325.0	325.02	14.60	22.26
48	FS-131	Hinken	113	S007-207	9/5/12	47.727	-93.9923	46.8	< 0.5	0.0876	2960	4.53	9.4	9.39	0.50	18.78
49	FS-330	St. Louis Estuary	120	S007-444	7/22/13	46.652	-92.2372	11.8	6.71	0.0901	5817	1.55	124.3	124.30	6.71	18.52
50	FS-81	Flowage	1	01-0061-00	8/7/12	46.688	-93.337	0.0	0.78	0.134	12470	32.34	14.2	14.19	0.78	18.19
51	FS-383	Upper Panasa	37	31-0111-00	9/18/13	47.306	-93.2676	0.0	33.6	0.0399	19148	2.86	590.3	590.25	33.60	17.57
52	FS-211	Mississippi Pool 4/Robinson Lake	89	79-0005-02	8/16/12	44.361	-91.9897	57.6	17.7	0.0714	9265	1.55	304.2	304.23	17.70	17.19
53	FS-63	Caribou	72	69-0489-00	9/3/12	46.891	-92.3135	0.0	1.21	0.0938	13791	29.44	19.3	19.27	1.21	15.93
54	FS-92	Partridge	119	S007-443	9/12/12	47.521	-92.1909	4.1	36.3	0.0741	29463	5.87	571.7	571.67	36.30	15.75
55	P-61	Lily	90	81-0067-00	9/28/11	44.194	-93.6469	51.5	0.66	0.041	6180	14.06	10.0	9.97	0.66	15.11
56	P-45	Hay	33	31-0037-00	9/21/11	47.287	-93.1017	0.0	10.24	0.087	12403	4.36	154.6	154.59	10.24	15.10

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57	FS-315	St. Louis Estuary	120	S007-444	6/24/13	46.652	-92.2373	0.0	8.1	0.147	6056	1.68	122.0	121.96	8.10	15.06
58	FS-338	Height of Land	5	03-0195-00	7/30/13	46.913	-95.6116	94.2	< 0.5	0.0554	2641	4.58	7.4	7.44	0.50	14.89
59	P-31	Cloquet	52	38-0539-00	9/14/11	47.431	-91.4844	74.4	0.81	0.024	4252	6.58	12.1	12.05	0.81	14.88
60	P-15	Mississippi River below Clay Boswell	103	S006-923	9/1/11	47.255	-93.6344	100.2	3.65	0.035	8667	6.07	52.2	52.22	3.65	14.31
61	FS-367	Hay	33	31-0037-00	9/4/13	47.287	-93.1009	141.0	22.1	0.0447	15436	3.44	312.7	312.66	22.10	14.15
62	FS-210	Mississippi Pool 4/Robinson Lake	89	79-0005-02	8/16/12	44.359	-91.9881	35.3	15.7	0.07	6450	1.16	214.5	214.49	15.70	13.66
63	FS-84	Pleasant	13	11-0383-00	8/10/12	46.923	-94.4874	0.0	< 0.5	0.0218	7065	23.99	6.8	6.80	0.50	13.61
64	FS-335	Mississippi Pool 5 / Spring	123	S007-660	7/30/13	44.195	-91.841	63.0	47.7	0.0342	4362	0.25	634.7	634.70	47.70	13.31
65	FS-195	Fisher	78	70-0087-00	8/31/12	44.794	-93.4061	20.7	6.85	0.136	11140	5.76	90.1	90.10	6.85	13.15
66	P-46	Hay	33	31-0037-00	9/21/11	47.287	-93.1018	0.0	10.24	0.026	16139	7.69	130.0	130.04	10.24	12.70
67	FS-344	Padua	82	73-0277-00	8/6/13	45.623	-95.0187	9.5	< 0.5	0.0806	4520	12.61	6.2	6.22	0.50	12.45
68	P-11	Sand	97	S003-249	8/30/11	47.635	-92.4235	14.4	7.69	0.046	22677	17.49	93.5	93.53	7.69	12.16
69	FS-136	Itasca	16	15-0016-00	9/19/12	47.234	-95.2049	23.6	< 0.5	0.0636	1496	2.23	5.9	5.91	0.50	11.81
70	P-62	Lily	90	81-0067-00	9/28/11	44.194	-93.6469	0.0	0.64		5069	13.39	7.2	7.22	0.64	11.28
71	FS-306	Sandy-1	76	69-0730-00	6/11/13	47.626	-92.5884	0.0	11	0.0918	35357	28.53	122.3	122.32	11.00	11.12
72	FS-69	St. Louis	114	S007-208	9/7/12	47.467	-91.9279	0.0	1.33	0.181	11429	27.16	14.8	14.79	1.33	11.12
73	FS-139	Welby family farm	93	86-0231-00	9/21/12	45.359	-94.0782	17.2	< 0.5	0.118	7267	30.76	5.3	5.33	0.50	10.67
74	FS-209	Mississippi Pool 8 at Reno Bottoms	122	S007-556	8/15/12	43.603	-91.2686	72.3	18.1	0.0711	9187	2.29	187.6	187.61	18.10	10.36
75	FS-250	Little Rice	75	69-0612-00	9/20/12	47.709	-92.4389	29.3	1.03	0.0293	9488	26.45	10.7	10.67	1.03	10.36
76	FS-300	St. Louis Estuary	120	S007-444	5/27/13	46.652	-92.2376	0.0	9.4	0.0713	4499	1.26	97.2	97.18	9.40	10.34
77	FS-133	Mahnomen	21	18-0126-02	9/17/12	46.499	-93.9958	0.0	16.9	0.308	18746	7.7	173.2	173.16	16.90	10.25
78	P-16	St. Louis	106	S006-929	9/1/11	47.402	-92.3773	0.0	24.5	0.025	1488	0.1	240.3	240.27	24.50	9.81
79	P-51	Flowage	1	01-0061-00	9/22/11	46.69	-93.338	160.2	0.56	0.014	5627	20.1	5.4	5.43	0.56	9.69
80	P-10	Pike	104	S006-927	8/30/11	47.733	-92.3468	43.0	8.31	0.063	15572	10.9	80.0	79.96	8.31	9.62
81	FS-201	Mink	92	86-0229-00	8/8/12	45.274	-94.0269	0.0	1.31	0.0373	1740	1.53	12.4	12.40	1.31	9.46
82	FS-187	McCormic	81	73-0273-00	8/2/12	45.722	-94.9121	8.9	1.54	0.144	1512	1.1	14.0	14.04	1.54	9.12
83	FS-374	Little Round	7	03-0302-00	9/10/13	46.975	-95.738	37.6	0.12	0.0391	2018	14.8	1.1	1.09	0.12	9.08
84	FS-318	Height of Land	5	03-0195-00	6/26/13	46.914	-95.6124	43.0	1.21	0.0658	1349	1.13	10.9	10.92	1.21	9.03
85	FS-68	Wolf	69	69-0143-00	9/6/12	47.256	-91.963	8.9	2.01	0.119	9526	17.19	18.0	18.01	2.01	8.96

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86	FS-52	Blaamyhre	48	34-0345-00	8/1/12	45.364	-95.186	102.2	0.62	0.078	3517	9.33	5.5	5.51	0.62	8.89
87	FS-57	Mississippi River below Clay Boswell	103	S006-923	8/28/12	47.255	-93.6342	0.0	10.3	0.134	4225	1.2	91.3	91.30	10.30	8.86
88	FS-302	Partridge	121	S007-513	5/30/13	47.515	-92.1894	0.0	43.1	0.0624	24784	6.27	378.8	378.83	43.10	8.79
89	P-7	Itasca	16	15-0016-00	8/25/11	47.233	-95.1985	20.1	0.26	0.064	1650	6.01	2.2	2.18	0.26	8.37
90	FS-196	Prairie	115	S007-209	9/3/12	47.252	-93.4884	44.6	9.63	0.0709	15071	10.51	78.4	78.43	9.63	8.14
91	FS-372	Mississippi Pool 5 / Spring	123	S007-660	9/10/13	44.202	-91.8443	26.7	34.8	0.0536	3330	0.33	270.9	270.88	34.80	7.78
92	FS-66	St. Louis Estuary	112	S007-206	9/5/12	46.655	-92.2739	0.0	16	0.0445	6169	1.73	122.0	122.02	16.00	7.63
93	P-17	St. Louis	114	S007-208	9/1/11	47.467	-91.9355	68.6	1.23	0.04	9654	30.4	9.3	9.34	1.23	7.59
94	P-52	Flowage	1	01-0061-00	9/22/11	46.69	-93.338	123.1	0.56	0.018	4641	18.1	4.2	4.25	0.56	7.59
95	P-28	Raymond	83	73-0285-00	9/12/11	45.629	-95.0234	68.6	0.82	0.094	3922	10.06	6.2	6.21	0.82	7.57
96	FS-53	Raymond	83	73-0285-00	8/2/12	45.629	-95.0225	61.1	< 0.5	0.0787	1905	4.79	3.8	3.76	0.50	7.53
97	FS-301	Partridge	119	S007-443	5/28/13	47.521	-92.1903	0.0	14.8	0.125	9491	3.94	104.3	104.32	14.80	7.05
98	FS-88	Clearwater	98	S004-204	8/24/12	47.517	-95.3904	148.3	2.04	0.0488	9874	22.17	14.2	14.23	2.04	6.98
99	FS-226	Louise	25	21-0094-00	8/14/12	45.933	-95.4148	46.5	4.09	0.0746	1833	0.83	28.5	28.49	4.09	6.97
100	P-26	Lower Rice	109	S007-164	9/8/11	47.382	-95.4926	120.1	0.55	0.07	2364	6.76	3.8	3.77	0.55	6.86
101	FS-221	Hay Creek Flowage	59	58-0005-00	9/17/12	46.089	-92.4104	97.7	1.95	0.119	9456	22.05	13.2	13.18	1.95	6.76
102	P-47	Little Birch	87	77-0089-00	9/21/11	45.775	-94.7996	25.9	3.2	0.05	4503	4.46	21.4	21.44	3.20	6.70
103	FS-377	Mahnomen	21	18-0126-02	9/11/13	46.499	-93.9956	0.0	21.1	0.0283	16540	7.47	141.1	141.14	21.10	6.69
104	P-27	Pleasant	13	11-0383-00	9/9/11	46.928	-94.4757	28.6	0.49		5331	30.37	3.0	2.99	0.49	6.09
105	FS-180	Lily	90	81-0067-00	7/26/12	44.195	-93.647	38.2	< 0.5	0.0295	5095	28.07	3.0	3.01	0.50	6.01
106	P-19	Wolf	69	69-0143-00	9/2/11	47.259	-91.9618	128.8	1.54	0.139	8240	25.1	8.7	8.66	1.54	5.63
107	FS-225	Miltona	24	21-0083-00	8/13/12	46.05	-95.4217	0.0	4.11	0.0694	2624	1.77	22.9	22.94	4.11	5.58
108	P-29	Padua	82	73-0277-00	9/13/11	45.62	-95.0192	3.4	0.76	0.13	4927	20.15	4.2	4.19	0.76	5.52
109	P-52	Flowage	1	01-0061-00	9/22/11	46.69	-93.338	123.1	0.56	0.018	3706	16.52	3.1	3.07	0.56	5.49
110	P-47	Little Birch	87	77-0089-00	9/21/11	45.775	-94.7996	25.9	3.2	0.191	2236	1.75	17.1	17.10	3.20	5.34
111	FS-342	Little Round	7	03-0302-00	8/5/13	46.972	-95.7358	58.3	< 0.5	0.0676	4447	25.16	2.6	2.64	0.50	5.28
112	P-52	Flowage	1	01-0061-00	9/22/11	46.69	-93.338	123.1	0.56	0.018	4302	21.79	2.9	2.94	0.56	5.25
113	FS-366	Partridge	119	S007-443	9/3/13	47.521	-92.19	47.7	34.2	0.057	7671	1.79	178.1	178.11	34.20	5.21
114	FS-370	Mississippi Pool 8 at Genoa	118	S007-222	9/9/13	43.577	-91.2337	17.8	33.3	0.062	6558	1.43	172.4	172.39	33.30	5.18

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115	FS-208	Mississippi Pool 8 at Genoa	118	S007-222	8/14/12	43.576	-91.2334	41.4	18	0.176	2178	0.41	92.3	92.34	18.00	5.13
116	FS-365	Partridge	119	S007-443	9/3/13	47.521	-92.1901	76.7	34.1	0.0393	9179	2.5	168.6	168.62	34.10	4.94
117	P-12	Birch	67	69-0003-00	8/30/11	47.736	-91.9428	68.6	3.58	0.104	12431	26.8	17.7	17.66	3.58	4.93
118	FS-336	Mississippi Pool 4/Robinson Lake	89	79-0005-02	7/30/13	44.361	-91.9901	46.5	55.3	0.0602	8193	1.41	269.0	268.98	55.30	4.86
119	FS-215	Popple	101	S006-188	9/11/12	47.725	-94.0817	36.3	< 0.5	0.0269	2971	14.42	2.4	2.37	0.50	4.73
120	FS-312	Mississippi Pool 5 / Spring	123	S007-660	6/21/13	44.202	-91.8444	35.7	28.3	0.0844	3563	0.67	132.2	132.16	28.30	4.67
121	FS-355	Mississippi River below Clay Boswell	103	S006-923	8/13/13	47.255	-93.634	78.3	10.2	0.0819	10479	8.98	47.1	47.07	10.20	4.62
122	P-5	Itasca	16	15-0016-00	8/25/11	47.238	-95.2065	45.8	0.26	0.056	1355	7.4	1.2	1.16	0.26	4.47
123	FS-203	Long Prairie	110	S007-203	8/9/12	45.973	-95.1603	58.3	6.66	0.0391	5074	4.35	27.8	27.79	6.66	4.17
124	FS-129	Mink	92	86-0229-00	8/23/12	45.277	-94.0299	0.0	1.22	0.182	4247	13.63	5.0	5.03	1.22	4.12
125	FS-200	Louisa	94	86-0282-00	8/8/12	45.3	-94.258	0.0	7.04	0.192	7824	8.76	27.6	27.65	7.04	3.93
126	FS-130	Hay	33	31-0037-00	9/6/12	47.287	-93.102	141.0	31.7	0.0738	13154	5.79	123.3	123.26	31.70	3.89
127	P-47	Little Birch	87	77-0089-00	9/21/11	45.775	-94.7996	25.9	3.2	0.191	3544	5.11	11.5	11.49	3.20	3.59
128	FS-230	Mill Pond	23	21-0034-00	8/16/12	46.072	-95.2218	80.9	7.36	0.192	3969	3.14	25.6	25.60	7.36	3.48
129	FS-332	Partridge	121	S007-513	7/24/13	47.514	-92.1894	79.6	54.4	0.102	20512	8.34	187.1	187.13	54.40	3.44
130	P-20	Gull	9	04-0120-00	9/6/11	47.656	-94.6944	15.6	0.78	0.103	1608	5.08	2.5	2.53	0.78	3.25
131	FS-343	Raymond	83	73-0285-00	8/6/13	45.629	-95.0233	61.4	1.92	0.0903	3270	7.59	6.1	6.13	1.92	3.19
132	FS-316	Partridge	121	S007-513	6/28/13	47.514	-92.1899	0.0	24.9	0.098	6291	2.6	77.8	77.80	24.90	3.12
133	FS-89	Birch	67	69-0003-00	9/10/12	47.736	-91.943	33.1	8.61	0.1	16938	31.2	26.7	26.69	8.61	3.10
134	FS-310	Second	117	S007-220	6/14/13	47.521	-92.1925	57.6	316	0.0927	31190	4.22	946.8	946.84	316.00	3.00
135	FS-91	Pike	104	S006-927	9/11/12	47.733	-92.3473	3.5	14.2	0.0656	6565	4.72	41.4	41.36	14.20	2.91
136	FS-220	Padua	82	73-0277-00	8/7/12	45.623	-95.0186	0.0	0.86	0.23	2291	9.77	2.3	2.29	0.86	2.66
137	FS-213	Gull	9	04-0120-00	9/10/12	47.656	-94.6945	9.5	1.14	0.0778	3527	16.01	2.9	2.90	1.14	2.55
138	FS-199	Rice	102	S006-208	9/5/12	47.674	-93.6547	75.4	1.57	0.0552	3273	10.88	4.0	3.99	1.57	2.54
139	FS-82	Rabbit	20	18-0093-02	8/8/12	46.531	-93.9285	0.0	15.3	0.22	10903	11.79	36.7	36.68	15.30	2.40
140	FS-138	Little Round	7	03-0302-00	9/20/12	46.973	-95.735	78.0	< 0.5	0.128	3069	27.48	1.2	1.16	0.50	2.33
141	P-24	Second	17	15-0091-00	9/7/11	47.826	-95.3635	37.3	0.87	0.139	3813	25.67	1.9	1.92	0.87	2.20
142	FS-202	Long Prairie	110	S007-204	8/9/12	46.007	-95.2634	13.4	7.71	0.0793	2897	2.85	15.7	15.69	7.71	2.04
143	FS-319	Little Round	7	03-0302-00	6/27/13	46.972	-95.735	17.5	<0.5	0.117	3579	39.84	1.0	1.00	0.50	2.01

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144	FS-132	Ox Hide	35	31-0106-00	9/7/12	47.335	-93.2134	10.5	26.4	0.042	14936	14.43	52.7	52.75	26.40	2.00
145	FS-229	Mill Pond	23	21-0034-00	8/16/12	46.072	-95.2218	102.2	7.16	0.109	5143	7.86	14.0	14.05	7.16	1.96
146	FS-182	Hunt	65	66-0047-00	7/27/12	44.328	-93.4443	0.0	17.1	0.0729	2412	1.21	30.8	30.76	17.10	1.80
147	FS-134	Bass	43	31-0576-00	9/18/12	47.284	-93.6276	64.0	1.01	0.0664	3740	26.12	1.8	1.81	1.01	1.79
148	FS-334	Mississippi Pool 8 at Genoa	118	S007-222	7/29/13	43.576	-91.2344	52.8	44.2	0.102	1969	0.4	78.3	78.33	44.20	1.77
149	FS-189	Clearwater	96	S002-121	8/28/12	47.937	-95.6906	4.5	23.8	0.117	2856	1.27	40.2	40.17	23.80	1.69
150	FS-327	Clearwater	96	S002-121	7/17/13	47.937	-95.6906	0.3	23.7	0.117	3521	1.82	39.1	39.06	23.70	1.65
151	FS-197	Snowball	36	31-0108-00	9/4/12	47.336	-93.244	0.0	8.4	0.0936	4213	6	13.2	13.23	8.40	1.57
152	FS-224	Stone Lake	68	69-0046-00	9/19/12	47.504	-91.8857	21.0	3.26	0.0533	5225	18.87	5.1	5.08	3.26	1.56
153	FS-126	Bray	58	56-0472-00	8/20/12	46.452	-95.8783	7.6	1.65	0.072	3937	21.95	2.5	2.46	1.65	1.49
154	FS-93	Turpela	71	69-0427-00	9/12/12	47.461	-92.2371	1.0	3.3	0.115	6979	31.08	4.9	4.87	3.30	1.48
155	FS-86	Eighteen	61	60-0199-00	8/22/12	47.64	-96.0607	40.1	4.29	0.164	1860	3.1	6.1	6.05	4.29	1.41
156	FS-90	Sand	97	S003-249	9/11/12	47.635	-92.4234	2.9	15.9	0.152	7287	9.68	21.4	21.40	15.90	1.35
157	P-23	Gourd	10	04-0253-00	9/7/11	47.812	-94.9654	38.4	0.69	0.038	2675	27.4	0.9	0.90	0.69	1.30
158	FS-303	Second	117	S007-220	5/30/13	47.52	-92.1925	0.0	303	0.0991	13086	2.2	388.6	388.62	303.00	1.28
159	FS-373	Clearwater	96	S002-121	9/9/13	47.937	-95.6909	3.2	34.4	0.0354	5315	3.33	41.8	41.84	34.40	1.22
160	FS-207	Kelly Lake	64	66-0015-00	8/13/12	44.354	-93.3743	0.0	1.92	0.0927	4387	27.33	2.3	2.33	1.92	1.21
161	P-30	Stella	54	47-0068-00	9/14/11	45.066	-94.4339	31.6	7.59	0.08	2159	2.88	8.8	8.80	7.59	1.16
162	P-25	Lower Rice	107	S006-985	9/8/11	47.379	-95.4834	114.4	1.02	0.097	2337	17.76	1.2	1.16	1.02	1.14
163	P-3	Little Round	7	03-0302-00	8/24/11	46.976	-95.7404	57.2	0.46	0.032	1689	20.91	0.5	0.51	0.46	1.11
164	FS-359	Eighteen	62	60-0199-00	8/20/13	47.637	-96.06	21.0	2.83	0.118	5500	30.88	3.1	3.11	2.83	1.10
165	FS-314	Clearwater	96	S002-121	6/24/13	47.937	-95.6907	0.6	28	0.0664	3946	2.68	30.6	30.60	28.00	1.09
166	FS-104	Gourd	10	04-0253-00	6/27/12	47.812	-94.965	0.0	0.27		1776	36.87	0.3	0.29	0.27	1.06
167	FS-328	Eighteen	62	60-0199-00	7/18/13	47.637	-96.0599	44.2	3.34	0.25	5106	24.65	3.5	3.53	3.34	1.06
168	FS-356	Trout	41	31-0216-00	8/14/13	47.259	-93.3942	0.0	39.1	0.103	11992	12.59	40.7	40.72	39.10	1.04
169	FS-321	Sandy-1	76	69-0730-00	7/9/13	47.626	-92.5885	0.0	122	0.189	36502	29.51	124.9	124.90	122.00	1.02
170	FS-309	Eighteen	62	60-0199-00	6/13/13	47.637	-96.0599	0.0	4.36	0.127	4478	16.52	4.4	4.42	4.36	1.01
171	FS-311	Mississippi Pool 8 at Genoa	118	S007-222	6/20/13	43.577	-91.2341	12.7	29.3	0.107	1544	0.62	29.0	29.04	29.30	0.99
172	FS-219	Trout	41	31-0216-00	9/13/12	47.259	-93.3942	0.0	38.6	0.117	12535	15	35.9	35.95	38.60	0.93

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
173	FS-382	Sandy-1	76	69-0730-00	9/17/13	47.626	-92.5885	0.0	67.9	0.135	26645	32.28	61.2	61.24	67.90	0.90
174	FS-347	Snowball	36	31-0108-00	8/12/13	47.336	-93.2439	0.0	8.2	0.097	1136	1.19	7.4	7.38	8.20	0.90
175	FS-105	Second	17	15-0091-00	6/27/12	47.826	-95.3637	48.4	0.74	0.119	2527	33.3	0.6	0.64	0.74	0.86
176	FS-179	Rice	84	74-0001-00	7/25/12	44.084	-93.0737	0.0	3.84	0.217	4152	19.07	3.2	3.22	3.84	0.84
177	P-47	Little Birch	87	77-0089-00	9/21/11	45.775	-94.7996	25.9	3.2	0.191	2253	8.37	2.7	2.66	3.20	0.83
178	FS-190	Pine	18	15-0149-00	8/28/12	47.684	-95.5414	114.9	14.7	0.368	4477	7.08	12.2	12.19	14.70	0.83
179	FS-231	Rice	2	02-0008-00	8/17/12	45.16	-93.121	0.0	3.6	0.145	2159	7.98	2.6	2.60	3.60	0.72
180	FS-320	Sandy-2	76	69-0730-00	7/9/13	47.619	-92.5936	0.0	118	3.08	19749	15.43	83.3	83.30	118.00	0.71
181	FS-348	Sandy-2	76	69-0730-00	8/13/13	47.619	-92.5934	0.0	123	0.305	13216	8.23	81.6	81.64	123.00	0.66
182	FS-381	Sandy-2	76	69-0730-00	9/17/13	47.619	-92.5931	0.0	126	0.0342	16172	11.67	79.2	79.24	126.00	0.63
183	FS-223	Little Sucker	40	31-0126-00	9/14/12	47.377	-93.246	0.0	13.7	0.534	6297	16.56	8.5	8.50	13.70	0.62
184	FS-341	Stella	54	47-0068-00	8/1/13	45.066	-94.4339	57.6	24.7	0.0884	1786	1.35	15.1	15.14	24.70	0.61
185	P-57	Unnamed	50	34-0611-00	9/23/11	45.268	-94.865	74.4	6.42	0.286	2311	6.48	3.8	3.80	6.42	0.59
186	FS-186	Westport	63	61-0029-00	8/1/12	45.69	-95.217	0.0	7.11	1.79	4917	20.15	4.2	4.18	7.11	0.59
187	FS-205	Big Swan	86	77-0023-00	8/10/12	45.88	-94.7418	56.3	5.47	0.0527	1719	4.81	3.1	3.07	5.47	0.56
188	P-35	Anka	26	21-0353-00	9/16/11	46.077	-95.7377	3.0	2.23	0.493	2170	14.84	1.2	1.25	2.23	0.56
189	FS-59	Upper Panasa	37	31-0111-00	8/29/12	47.306	-93.2652	0.0	29.6	0.126	895	0.43	15.8	15.77	29.60	0.53
190	FS-228	West battle	57	56-0239-00	8/15/12	46.291	-95.6049	144.8	4.03	0.189	3108	17.37	2.1	2.06	4.03	0.51
191	FS-60	Lower Panasa	38	31-0112-00	8/29/12	47.302	-93.2521	0.0	33.6	0.243	8048	14.12	16.5	16.48	33.60	0.49
192	FS-181	Rice	66	66-0048-00	7/27/12	44.333	-93.4734	0.0	5.22	0.777	3829	21.67	2.4	2.37	5.22	0.45
193	FS-357	Lower Panasa	38	31-0112-00	8/15/13	47.303	-93.2561	0.0	28.5	1.26	2347	2.42	12.7	12.73	28.50	0.45
194	FS-204	Big Swan	86	77-0023-00	8/10/12	45.88	-94.742	133.7	5.49	0.0914	1731	5.94	2.4	2.42	5.49	0.44
195	FS-214	Bowstring	116	S007-219	9/11/12	47.702	-94.0608	69.7	1.34	0.256	1974	24.34	0.6	0.58	1.34	0.43
196	FS-323	Second	117	S007-220	7/11/13	47.52	-92.1925	76.4	405	0.067	10036	2.91	166.9	166.92	405.00	0.41
197	FS-185	Hoffs Slough	85	76-0103-00	8/1/12	45.326	-95.7059	0.0	273	0.0343	3512	0.75	112.3	112.32	273.00	0.41
198	P-57	Unnamed	50	34-0611-00	9/23/11	45.268	-94.865	74.4	6.42	0.065	2193	8.1	2.6	2.63	6.42	0.41
199	FS-61	Swan	34	31-0067-02	8/30/12	47.289	-93.2127	12.4	12.5	0.332	5827	22.71	5.0	5.02	12.50	0.40
200	FS-128	Cromwell	14	14-0103-00	8/22/12	46.965	-96.3171	0.0	41.2	1.22	2948	2.85	16.2	16.23	41.20	0.39
201	FS-198	Ox Hide	35	31-0106-00	9/7/12	47.335	-93.2134	0.6	26.4	0.0751	8743	24.51	10.0	9.99	26.40	0.38

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
202	FS-305	Sandy-2	76	69-0730-00	6/11/13	47.619	-92.5937	0.0	135	1.08	19094	22.23	50.4	50.43	135.00	0.37
203	FS-54	Little Birch	87	77-0089-00	8/3/12	45.778	-94.7978	70.0	7.4	0.0353	1794	6.02	2.6	2.55	7.40	0.34
204	FS-380	Sandy-2	76	69-0730-00	9/17/13	47.619	-92.5939	0.6	126	0.0342	17868	22.7	43.3	43.29	126.00	0.34
205	FS-191	Ina	27	21-0355-00	8/29/12	46.072	-95.7281	30.2	7.08	0.274	2216	9.09	2.3	2.34	7.08	0.33
206	FS-346	Westport	63	61-0029-00	8/8/13	45.704	-95.203	6.7	6.3	0.205	3262	19.66	2.0	1.95	6.30	0.31
207	FS-349	Sandy-3	76	69-0730-00	8/13/13	47.619	-92.5898	0.0	122	0.0697	14897	20.46	34.6	34.55	122.00	0.28
208	FS-216	Big Sucker	39	31-0124-00	9/12/12	47.392	-93.2658	3.8	7.78	0.145	3559	21.45	2.1	2.08	7.78	0.27
209	FS-62	Swan	34	31-0067-02	8/30/12	47.289	-93.2124	3.8	14	0.221	4821	22.53	3.5	3.52	14.00	0.25
210	FS-87	Bee	60	60-0192-00	8/23/12	47.653	-96.0504	39.8	11	0.67	3054	13.62	2.7	2.67	11.00	0.24
211	FS-184	Rice	80	73-0196-00	7/30/12	45.386	-94.6309	0.0	2.58	2.97	1523	15.03	0.6	0.62	2.58	0.24
212	FS-194	Gilchrist	91	86-0064-00	8/31/12	45.231	-93.824	0.0	6.98	0.355	3117	20.81	1.7	1.67	6.98	0.24
213	FS-183	Unnamed	50	34-0611-00	7/30/12	45.268	-94.865	64.9	16.8	0.15	2157	5.61	4.0	3.96	16.80	0.24
214	FS-188	Stella	54	47-0068-00	8/27/12	45.068	-94.4334	0.3	18.1	1.79	1257	2.34	4.0	3.99	18.10	0.22
215	FS-77	Monongalia (near hwy embankment)	46	34-0158-02	7/26/12	45.333	-94.9268	121.3	21.7	1.37	4953	18.66	4.6	4.64	21.70	0.21
216	FS-352	Dark	77	69-0790-00	8/15/13	47.639	-92.7782	2.9	173	0.136	5120	3.61	35.3	35.35	173.00	0.20
217	FS-369	Dark	77	69-0790-00	9/5/13	47.639	-92.7781	11.8	176	0.052	2037	0.82	35.4	35.41	176.00	0.20
218	P-55	Lady Slipper	53	42-0020-00	9/22/11	44.57	-95.6274	0.0	107.71	14.84	2814	2.09	21.5	21.51	107.71	0.20
219	FS-350	Ox Hide	35	31-0106-00	8/14/13	47.335	-93.2132	0.0	25.9	0.119	3889	12.12	4.9	4.89	25.90	0.19
220	FS-368	Dark	77	69-0790-00	9/5/13	47.639	-92.7782	11.1	175	0.305	3354	1.94	33.0	32.96	175.00	0.19
221	FS-313	Monongalia	46	34-0158-01	6/23/13	45.333	-94.9293	50.0	34.7	0.0941	6028	19.44	6.4	6.45	34.70	0.19
222	FS-351	Second	117	S007-220	8/15/13	47.521	-92.1925	66.8	838	0.0447	7088	1.84	148.0	148.03	838.00	0.18
223	P-57	Unnamed	50	34-0611-00	9/23/11	45.268	-94.865	74.4	6.42	0.065	1946	13.8	1.1	1.11	6.42	0.17
224	FS-345	Rice	80	73-0196-00	8/7/13	45.387	-94.6313	0.0	6.85	2.08	2012	14.83	1.1	1.08	6.85	0.16
225	P-34	Anka	26	21-0353-00	9/16/11	46.077	-95.7292	25.9	2.23	0.671	1485	23.57	0.3	0.35	2.23	0.16
226	P-57	Unnamed	50	34-0611-00	9/23/11	45.268	-94.865	74.4	6.42	0.065	1689	12.6	0.9	0.94	6.42	0.15
227	FS-322	Dark	77	69-0790-00	7/10/13	47.639	-92.7781	3.2	175	0.131	2480	1.48	25.5	25.50	175.00	0.15
228	FS-340	Monongalia	46	34-0158-02	7/31/13	45.333	-94.9292	87.9	33.6	0.122	5530	22.1	4.7	4.69	33.60	0.14
229	FS-379	Monongalia	46	34-0158-02	9/13/13	45.333	-94.9292	154.4	34.6	0.242	5436	26.42	3.7	3.66	34.60	0.11
230	FS-79	Lady Slipper	53	42-0020-00	7/27/12	44.572	-95.6216	0.0	330	1.63	3314	1.85	34.1	34.09	330.00	0.10

MPCA Field Data - All MN non-paddy data
CPSC and Sulfate Ratio

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
231	FS-339	Christina	28	21-0375-00	7/31/13	46.073	-95.7567	0.6	14.6	1.93	1741	8.96	1.5	1.50	14.60	0.10
232	FS-176	North Geneva	29	24-0015-00	7/24/12	43.788	-93.271	0.0	15.6	1.54	2212	13.45	1.5	1.46	15.60	0.09
233	FS-78	Lady Slipper	53	42-0020-00	7/27/12	44.57	-95.6275	0.0	335	1.68	2719	1.66	26.5	26.53	335.00	0.08
234	FS-177	South Geneva	30	24-0015-02	7/24/12	43.771	-93.2851	0.0	14.1	3.19	1618	16.71	0.6	0.62	14.10	0.04
235	FS-192	Anka	26	21-0353-00	8/29/12	46.077	-95.7292	2.3	8.44	0.53	1498	22.85	0.4	0.37	8.44	0.04
236	FS-218	Holman	42	31-0227-00	9/13/12	47.301	-93.3445	0.0	24.2	1.01	3035	29.74	1.0	1.04	24.20	0.04
237	FS-353	Holman	42	31-0227-00	8/12/13	47.301	-93.3444	0.0	68	0.583	5094	30.6	2.7	2.71	68.00	0.04
238	FS-85	Bean	8	03-0411-00	8/21/12	46.934	-95.8706	0.0	85	16	1967	11.85	1.4	1.35	85.00	0.02

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Attachment 3

(3 pages)

MPCA Field Data - CPSC Variability within Sites
Sites from MPCA March 2015 Draft, Figure 14

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	LacCore _field_ID	Site_name	Unique site ID	DNR/State ID	Date	Lat	Long	Calculated Wild rice ave stems/m2	surface water SO4 (mg SO4/L)	pore water Total Sulfide (TS, mg S/L)	Sediment Fe (µg/g)	Sediment TOC (%)	potential SO4 standard CPSC120	CPSC120 calculated
2	FS-81	Flowage	1	01-0061-00-204	8/7/12	46.688	-93.337	0.0	0.78	0.134	12470	32.34	14.2	14.19
3	P-51	Flowage	1	01-0061-00-205	9/22/11	46.69	-93.338	160.2	0.56	0.014	5627	20.1	5.4	5.43
4	P-52	Flowage	1	01-0061-00-205	9/22/11	46.69	-93.338	123.1	0.56	0.018	3706	16.52	3.1	3.07
5	P-52	Flowage	1	01-0061-00-206	9/22/11	46.69	-93.338	123.1	0.56	0.018	4641	18.1	4.2	4.25
6	P-52	Flowage	1	01-0061-00-206	9/22/11	46.69	-93.338	123.1	0.56	0.018	4302	21.79	2.9	2.94
7														
8	P-1	Height of Land	5	03-0195-00-209	8/22/11	46.913	-95.6095	62.9	0.24	0.053	1298	1.76	6.0	5.97
9	FS-375	Height of Land	5	03-0195-00-210	9/10/13	46.913	-95.6111	117.5	< 0.5	< 0.011	1795	0.86	26.2	26.23
10	FS-127	Height of Land	5	03-0195-00-210	8/21/12	46.913	-95.6095	111.1	< 0.5	< 0.011	2112	1.32	21.5	21.47
11	FS-338	Height of Land	5	03-0195-00-210	7/30/13	46.913	-95.6116	94.2	< 0.5	0.0554	2641	4.58	7.4	7.44
12	FS-318	Height of Land	5	03-0195-00-210	6/26/13	46.914	-95.6124	43.0	1.21	0.0658	1349	1.13	10.9	10.92
13														
14	FS-374	Little Round	7	03-0302-00-202	9/10/13	46.975	-95.738	37.6	0.12	0.0391	2018	14.8	1.1	1.09
15	P-3	Little Round	7	03-0302-00-202	8/24/11	46.976	-95.7404	57.2	0.46	0.032	1689	20.91	0.5	0.51
16	FS-342	Little Round	7	03-0302-00-203	8/5/13	46.972	-95.7358	58.3	< 0.5	0.0676	4447	25.16	2.6	2.64
17	FS-138	Little Round	7	03-0302-00-203	9/20/12	46.973	-95.735	78.0	< 0.5	0.128	3069	27.48	1.2	1.16
18	FS-319	Little Round	7	03-0302-00-203	6/27/13	46.972	-95.735	17.5	<0.5	0.117	3579	39.84	1.0	1.00
19														
20	FS-56	Rice	19	18-0053-00-203	8/27/12	46.339	-93.8915	19.4	< 0.5	0.0259	83421	31.88	558.1	558.07
21	P-69	Rice	19	18-0053-00-203	9/27/11	46.339	-93.8913	43.0	0.23	0.021	50389	35.55	185.8	185.79
22	FS-376	Rice	19	18-0053-00-203	9/11/13	46.339	-93.8918	46.5	< 0.5	0.0451	65261	33.36	329.7	329.66
23	FS-304	Rice	19	18-0053-00-203	6/10/13	46.339	-93.8906	5.7	< 0.5	0.0236	48287	33.61	183.1	183.07
24	FS-324	Rice	19	18-0053-00-203	7/15/13	46.339	-93.8918	56.7	< 0.5	0.11	44704	33.18	160.3	160.29
25														
26	P-35	Anka	26	21-0353-00-201	9/16/11	46.077	-95.7377	3.0	2.23	0.493	2170	14.84	1.2	1.25

MPCA Field Data - CPSC Variability within Sites
Sites from MPCA March 2015 Draft, Figure 14

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
27	P-34	Anka	26	21-0353-00-201	9/16/11	46.077	-95.7292	25.9	2.23	0.671	1485	23.57	0.3	0.35
28	FS-192	Anka	26	21-0353-00-202	8/29/12	46.077	-95.7292	2.3	8.44	0.53	1498	22.85	0.4	0.37
29														
30	P-42	Monongalia (Middle Fork Crow R)	45.5	34-0158-01-201	9/20/11	45.348	-94.9509	5.7	16.51	0.042	46471	14.76	455.4	455.39
31	FS-313	Monongalia	46	34-0158-01-203	6/23/13	45.333	-94.9293	50.0	34.7	0.0941	6028	19.44	6.4	6.45
32	FS-340	Monongalia	46	34-0158-02-203	7/31/13	45.333	-94.9292	87.9	33.6	0.122	5530	22.1	4.7	4.69
33	FS-379	Monongalia	46	34-0158-02-203	9/13/13	45.333	-94.9292	154.4	34.6	0.242	5436	26.42	3.7	3.66
34	FS-77	Monongalia (near hwy embankment)	46	34-0158-02-204	7/26/12	45.333	-94.9268	121.3	21.7	1.37	4953	18.66	4.6	4.64
35														
36	P-57	Unnamed	50	34-0611-00-201	9/23/11	45.268	-94.865	74.4	6.42	0.286	2311	6.48	3.8	3.80
37	P-57	Unnamed	50	34-0611-00-201	9/23/11	45.268	-94.865	74.4	6.42	0.065	2193	8.1	2.6	2.63
38	FS-183	Unnamed	50	34-0611-00-201	7/30/12	45.268	-94.865	64.9	16.8	0.15	2157	5.61	4.0	3.96
39	P-57	Unnamed	50	34-0611-00-201	9/23/11	45.268	-94.865	74.4	6.42	0.065	1946	13.8	1.1	1.11
40	P-57	Unnamed	50	34-0611-00-201	9/23/11	45.268	-94.865	74.4	6.42	0.065	1689	12.6	0.9	0.94
41														
42	FS-352	Dark	77	69-0790-00-202	8/15/13	47.639	-92.7782	2.9	173	0.136	5120	3.61	35.3	35.35
43	FS-369	Dark	77	69-0790-00-202	9/5/13	47.639	-92.7781	11.8	176	0.052	2037	0.82	35.4	35.41
44	FS-368	Dark	77	69-0790-00-202	9/5/13	47.639	-92.7782	11.1	175	0.305	3354	1.94	33.0	32.96
45	FS-322	Dark	77	69-0790-00-202	7/10/13	47.639	-92.7781	3.2	175	0.131	2480	1.48	25.5	25.50
46														
47	P-28	Raymond	83	73-0285-00-203	9/12/11	45.629	-95.0234	68.6	0.82	0.094	3922	10.06	6.2	6.21
48	FS-53	Raymond	83	73-0285-00-203	8/2/12	45.629	-95.0225	61.1	< 0.5	0.0787	1905	4.79	3.8	3.76
49	FS-343	Raymond	83	73-0285-00-203	8/6/13	45.629	-95.0233	61.4	1.92	0.0903	3270	7.59	6.1	6.13
50														
51	FS-211	Mississippi Pool 4/Robinson Lake	89	79-0005-02-201	8/16/12	44.361	-91.9897	57.6	17.7	0.0714	9265	1.55	304.2	304.23
52	FS-336	Mississippi Pool 4/Robinson Lake	89	79-0005-02-201	7/30/13	44.361	-91.9901	46.5	55.3	0.0602	8193	1.41	269.0	268.98
53	FS-210	Mississippi Pool 4/Robinson Lake	89	79-0005-02-202	8/16/12	44.359	-91.9881	35.3	15.7	0.07	6450	1.16	214.5	214.49
54														

MPCA Field Data - CPSC Variability within Sites
Sites from MPCA March 2015 Draft, Figure 14

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
55	FS-189	Clearwater	96	S002-121	8/28/12	47.937	-95.6906	4.5	23.8	0.117	2856	1.27	40.2	40.17
56	FS-327	Clearwater	96	S002-121	7/17/13	47.937	-95.6906	0.3	23.7	0.117	3521	1.82	39.1	39.06
57	FS-373	Clearwater	96	S002-121	9/9/13	47.937	-95.6909	3.2	34.4	0.0354	5315	3.33	41.8	41.84
58	FS-314	Clearwater	96	S002-121	6/24/13	47.937	-95.6907	0.6	28	0.0664	3946	2.68	30.6	30.60
59														
60	FS-384	Second	117	S007-220	9/19/13	47.52	-92.1925	27.7		0.104	22634	3.42	657.3	657.30
61	FS-310	Second	117	S007-220	6/14/13	47.521	-92.1925	57.6	316	0.0927	31190	4.22	946.8	946.84
62	FS-303	Second	117	S007-220	5/30/13	47.52	-92.1925	0.0	303	0.0991	13086	2.2	388.6	388.62
63	FS-323	Second	117	S007-220	7/11/13	47.52	-92.1925	76.4	405	0.067	10036	2.91	166.9	166.92
64	FS-351	Second	117	S007-220	8/15/13	47.521	-92.1925	66.8	838	0.0447	7088	1.84	148.0	148.03
65														
66	FS-370	Mississippi Pool 8 at Genoa	118	S007-222	9/9/13	43.577	-91.2337	17.8	33.3	0.062	6558	1.43	172.4	172.39
67	FS-208	Mississippi Pool 8 at Genoa	118	S007-222	8/14/12	43.576	-91.2334	41.4	18	0.176	2178	0.41	92.3	92.34
68	FS-334	Mississippi Pool 8 at Genoa	118	S007-222	7/29/13	43.576	-91.2344	52.8	44.2	0.102	1969	0.4	78.3	78.33
69	FS-311	Mississippi Pool 8 at Genoa	118	S007-222	6/20/13	43.577	-91.2341	12.7	29.3	0.107	1544	0.62	29.0	29.04
70														
71	P-13	Partridge	119	S007-443	8/31/11	47.521	-92.1899	65.9	10.39	0.075	11026	1.44	464.3	464.30
72	FS-331	Partridge	119	S007-443	7/24/13	47.521	-92.1904	60.5	14.6	0.112	10082	1.68	325.0	325.02
73	FS-92	Partridge	119	S007-443	9/12/12	47.521	-92.1909	4.1	36.3	0.0741	29463	5.87	571.7	571.67
74	FS-301	Partridge	119	S007-443	5/28/13	47.521	-92.1903	0.0	14.8	0.125	9491	3.94	104.3	104.32
75	FS-366	Partridge	119	S007-443	9/3/13	47.521	-92.19	47.7	34.2	0.057	7671	1.79	178.1	178.11
76	FS-365	Partridge	119	S007-443	9/3/13	47.521	-92.1901	76.7	34.1	0.0393	9179	2.5	168.6	168.62
77														
78	FS-371	Mississippi Pool 5 / Spring	123	S007-660	9/10/13	44.202	-91.8443	39.8	34.4	0.069	3582	0.11	1161.0	1160.97
79	FS-212	Mississippi Pool 5 / Spring	123	S007-660	8/17/12	44.199	-91.8461	29.6	17.2	0.0224	3674	0.22	531.7	531.70
80	FS-335	Mississippi Pool 5 / Spring	123	S007-660	7/30/13	44.195	-91.841	63.0	47.7	0.0342	4362	0.25	634.7	634.70
81	FS-372	Mississippi Pool 5 / Spring	123	S007-660	9/10/13	44.202	-91.8443	26.7	34.8	0.0536	3330	0.33	270.9	270.88
82	FS-312	Mississippi Pool 5 / Spring	123	S007-660	6/21/13	44.202	-91.8444	35.7	28.3	0.0844	3563	0.67	132.2	132.16

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Attachment 4
(4 pages)

MPCA Field Data - CPSC and SEM Ratio
120 ug/L Sulfide

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	LacCore_ field_ID	Site_name	UniqID	DNRStateID	Date	Lat	Long	WR ave stems /M2	WRpre sent	SO4 mg/L	TSmg/L	SedFeµgg	SedTOCpct	CPSC120	CPSC120: probablilis tic formula	CPSC120: determini stic formula	ratio
2	FS-104	Gourd	10	04-0253-00-201	6/27/12	47.8121	-94.965	0.0	NO	0.27		1776	36.87	0.3	0.29	0.08	0.265
3	FS-105	Second	17	15-0091-00-202	6/27/12	47.8258	-95.3637	48.4	YES	0.74	0.119	2527	33.3	0.6	0.64	0.17	0.274
4	FS-218	Holman	42	31-0227-00-202	9/13/12	47.3005	-93.3445	0.0	NO	24.2	1.01	3035	29.74	1.0	1.04	0.29	0.283
5	P-4	Little Flat	6	03-0217-00-201	8/24/11	46.9981	-95.6641	83.1	YES	0.22	0.011	7479	33.13	5.2	5.16	1.47	0.284
6	P-27	Pleasant	13	11-0383-00-206	9/9/11	46.928	-94.4757	28.6	YES	0.49		5331	30.37	3.0	2.99	0.86	0.287
7	FS-93	Turpela	71	69-0427-00-201	9/12/12	47.4613	-92.2371	1.0	YES	3.3	0.115	6979	31.08	4.9	4.87	1.40	0.288
8	FS-139	Welby family farm	93	86-0231-00-202	9/21/12	45.3592	-94.0782	17.2	YES	<0.5	0.118	7267	30.76	5.3	5.33	1.54	0.289
9	P-34	Anka	26	21-0353-00-201	9/16/11	46.0769	-95.7292	25.9	YES	2.23	0.671	1485	23.57	0.3	0.35	0.10	0.290
10	FS-214	Bowstring	116	S007-219	9/11/12	47.7024	-94.0608	69.7	YES	1.34	0.256	1974	24.34	0.6	0.58	0.17	0.291
11	FS-180	Lily	90	81-0067-00-202	7/26/12	44.1947	-93.647	38.2	YES	<0.5	0.0295	5095	28.07	3.0	3.01	0.87	0.291
12	FS-207	Kelly Lake	64	66-0015-00-204	8/13/12	44.3542	-93.3743	0.0	NO	1.92	0.0927	4387	27.33	2.3	2.33	0.68	0.291
13	P-17	St. Louis	114	S007-208	9/1/11	47.4668	-91.9355	68.6	YES	1.23	0.04	9654	30.4	9.3	9.34	2.73	0.292
14	FS-134	Bass	43	31-0576-00-207	9/18/12	47.2844	-93.6276	64.0	YES	1.01	0.0664	3740	26.12	1.8	1.81	0.53	0.292
15	FS-379	Monongalia	46	34-0158-02-203	9/13/13	45.3332	-94.9292	154.4	YES	34.6	0.242	5436	26.42	3.7	3.66	1.08	0.295
16	FS-63	Caribou	72	69-0489-00-206	9/3/12	46.8913	-92.3135	0.0	NO	1.21	0.0938	13791	29.44	19.3	19.27	5.74	0.298
17	P-3	Little Round	7	03-0302-00-202	8/24/11	46.9759	-95.7404	57.2	YES	0.46	0.032	1689	20.91	0.5	0.51	0.15	0.299
18	FS-65	Wild Rice	11	09-0023-00-202	9/4/12	46.6712	-92.6055	0.0	NO	0.5	0.083	13650	28.82	19.4	19.38	5.79	0.299
19	FS-250	Little Rice	75	69-0612-00-201	9/20/12	47.7086	-92.4389	29.3	YES	1.03	0.0293	9488	26.45	10.7	10.67	3.21	0.301
20	FS-324	Rice	19	18-0053-00-203	7/15/13	46.3392	-93.8918	56.7	YES	<0.5	0.11	44704	33.18	160.3	160.29	48.35	0.302
21	P-12	Birch	67	69-0003-00-205	8/30/11	47.7357	-91.9428	68.6	YES	3.58	0.104	12431	26.8	17.7	17.66	5.35	0.303
22	P-19	Wolf	69	69-0143-00-202	9/2/11	47.2586	-91.9618	128.8	YES	1.54	0.139	8240	25.1	8.7	8.66	2.62	0.303
23	FS-378	Duck Lake WMA	22	18-0178-00-202	9/12/13	46.7521	-93.8851	113.0	YES	<0.5	0.0251	12151	26.57	17.1	17.08	5.17	0.303
24	FS-126	Bray	58	56-0472-00-202	8/20/12	46.4518	-95.8783	7.6	YES	1.65	0.072	3937	21.95	2.5	2.46	0.75	0.304
25	FS-62	Swan	34	31-0067-02-206	8/30/12	47.289	-93.2124	3.8	YES	14	0.221	4821	22.53	3.5	3.52	1.07	0.304
26	FS-216	Big Sucker	39	31-0124-00-203	9/12/12	47.3919	-93.2658	3.8	YES	7.78	0.145	3559	21.45	2.1	2.08	0.63	0.305
27	FS-181	Rice	66	66-0048-00-203	7/27/12	44.3332	-93.4734	0.0	NO	5.22	0.777	3829	21.67	2.4	2.37	0.72	0.305
28	FS-194	Gilchrist	91	86-0064-00-201	8/31/12	45.2309	-93.824	0.0	NO	6.98	0.355	3117	20.81	1.7	1.67	0.51	0.305

MPCA Field Data - CPSC and SEM Ratio
120 ug/L Sulfide

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
29	P-52	Flowage	1	01-0061-00-206	9/22/11	46.6895	-93.338	123.1	YES	0.56	0.018	4302	21.79	2.9	2.94	0.90	0.305
30	FS-346	Westport	63	61-0029-00-205	8/8/13	45.7042	-95.203	6.7	YES	6.3	0.205	3262	19.66	2.0	1.95	0.60	0.309
31	P-25	Lower Rice	107	S006-985	9/8/11	47.3793	-95.4834	114.4	YES	1.02	0.097	2337	17.76	1.2	1.16	0.36	0.313
32	FS-221	Hay Creek Flowage	59	58-0005-00-202	9/17/12	46.0894	-92.4104	97.7	YES	1.95	0.119	9456	22.05	13.2	13.18	4.12	0.313
33	FS-88	Clearwater	98	S004-204	8/24/12	47.5174	-95.3904	148.3	YES	2.04	0.0488	9874	22.17	14.2	14.23	4.45	0.313
34	FS-177	South Geneva	30	24-0015-02-208	7/24/12	43.7709	-93.2851	0.0	NO	14.1	3.19	1618	16.71	0.6	0.62	0.19	0.313
35	FS-179	Rice	84	74-0001-00-201	7/25/12	44.0842	-93.0737	0.0	NO	3.84	0.217	4152	19.07	3.2	3.22	1.01	0.314
36	FS-224	Stone Lake	68	69-0046-00-201	9/19/12	47.5039	-91.8857	21.0	YES	3.26	0.0533	5225	18.87	5.1	5.08	1.61	0.317
37	FS-228	West battle	57	56-0239-00-204	8/15/12	46.2906	-95.6049	144.8	YES	4.03	0.189	3108	17.37	2.1	2.06	0.65	0.317
38	FS-184	Rice	80	73-0196-00-216	7/30/12	45.3864	-94.6309	0.0	NO	2.58	2.97	1523	15.03	0.6	0.62	0.20	0.319
39	FS-349	Sandy-3	76	69-0730-00-205	8/13/13	47.6191	-92.5898	0.0	NO	122	0.0697	14897	20.46	34.6	34.55	11.14	0.322
40	FS-193	Big Mud	79	71-0085-00-201	8/30/12	45.4529	-93.7418	14.3	YES	<0.5	0.0308	12943	18.63	29.5	29.50	9.66	0.327
41	FS-223	Little Sucker	40	31-0126-00-202	9/14/12	47.3765	-93.246	0.0	NO	13.7	0.534	6297	16.56	8.5	8.50	2.79	0.328
42	FS-215	Popple	101	S006-188	9/11/12	47.7254	-94.0817	36.3	YES	<0.5	0.0269	2971	14.42	2.4	2.37	0.78	0.329
43	FS-176	North Geneva	29	24-0015-00-209	7/24/12	43.7876	-93.271	0.0	NO	15.6	1.54	2212	13.45	1.5	1.46	0.48	0.331
44	P-44	Dead Fish	12	09-0051-00-202	9/20/11	46.7451	-92.6863	48.7	YES	0.3	0.056	9685	16.6	19.4	19.39	6.45	0.332
45	P-57	Unnamed	50	34-0611-00-201	9/23/11	45.2675	-94.865	74.4	YES	6.42	0.065	1689	12.6	0.9	0.94	0.31	0.333
46	FS-87	Bee	60	60-0192-00-202	8/23/12	47.6527	-96.0504	39.8	YES	11	0.67	3054	13.62	2.7	2.67	0.89	0.334
47	FS-125	Tamarac	56	56-0192-00-203	8/19/12	46.3637	-95.5714	0.0	NO	2.33	0.0768	21908	18.41	82.3	82.32	27.50	0.334
48	FS-129	Mink	92	86-0229-00-207	8/23/12	45.2767	-94.0299	0.0	NO	1.22	0.182	4247	13.63	5.0	5.03	1.70	0.337
49	FS-85	Bean	8	03-0411-00-201	8/21/12	46.9337	-95.8706	0.0	NO	85	16	1967	11.85	1.4	1.35	0.46	0.339
50	FS-55	Pelkey	55	49-0030-00-202	8/26/12	45.9962	-94.2273	0.0	NO	3.42	0.0522	30642	17.32	168.8	168.82	57.77	0.342
51	FS-219	Trout	41	31-0216-00-212	9/13/12	47.2592	-93.3942	0.0	NO	38.6	0.117	12535	15	35.9	35.95	12.32	0.343
52	FS-350	Ox Hide	35	31-0106-00-203	8/14/13	47.3351	-93.2132	0.0	NO	25.9	0.119	3889	12.12	4.9	4.89	1.69	0.345
53	FS-199	Rice	102	S006-208	9/5/12	47.6742	-93.6547	75.4	YES	1.57	0.0552	3273	10.88	4.0	3.99	1.40	0.351
54	FS-220	Padua	82	73-0277-00-202	8/7/12	45.623	-95.0186	0.0	NO	0.86	0.23	2291	9.77	2.3	2.29	0.81	0.355
55	FS-75	Mortenson	44	34-0150-02-201	7/24/12	45.3	-94.9062	0.0	NO	<0.5	0.103	9071	12.09	25.0	24.99	8.87	0.355
56	FS-109	Carlos Avery Pool 9	4	02-0504-00-202	7/3/12	45.3192	-93.0611	52.8	YES	<0.5	< 0.011	14736	12.51	61.0	60.98	21.83	0.358
57	FS-339	Christina	28	21-0375-00-315	7/31/13	46.0734	-95.7567	0.6	YES	14.6	1.93	1741	8.96	1.5	1.50	0.54	0.358
58	P-42	Monongalia (Middle Fork Crow R	45.5	34-0158-01-201	9/20/11	45.3481	-94.9509	5.7	YES	16.51	0.042	46471	14.76	455.4	455.39	163.45	0.359

MPCA Field Data - CPSC and SEM Ratio
120 ug/L Sulfide

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
59	FS-82	Rabbit	20	18-0093-02-204	8/8/12	46.5313	-93.9285	0.0	NO	15.3	0.22	10903	11.79	36.7	36.68	13.16	0.359
60	FS-191	Ina	27	21-0355-00-202	8/29/12	46.0715	-95.7281	30.2	YES	7.08	0.274	2216	9.09	2.3	2.34	0.84	0.360
61	FS-52	Blaamyhre	48	34-0345-00-203	8/1/12	45.364	-95.186	102.2	YES	0.62	0.078	3517	9.33	5.5	5.51	2.00	0.363
62	FS-137	Elk	15	15-0010-00-204	9/19/12	47.1952	-95.2249	42.7	YES	<0.5	0.0936	6334	10.07	15.6	15.59	5.68	0.365
63	FS-231	Rice	2	02-0008-00-206	8/17/12	45.1604	-93.121	0.0	NO	3.6	0.145	2159	7.98	2.6	2.60	0.96	0.370
64	P-5	Itasca	16	15-0016-00-208	8/25/11	47.2381	-95.2065	45.8	YES	0.26	0.056	1355	7.4	1.2	1.16	0.43	0.370
65	FS-196	Prairie	115	S007-209	9/3/12	47.2519	-93.4884	44.6	YES	9.63	0.0709	15071	10.51	78.4	78.43	29.16	0.372
66	FS-58	Mississippi River above Clay Bosw	108	S007-163	8/28/12	47.2386	-93.7197	0.0	NO	1.19	0.0806	8636	9.08	32.0	32.02	12.06	0.377
67	FS-200	Louisa	94	86-0282-00-205	8/8/12	45.2998	-94.258	0.0	NO	7.04	0.192	7824	8.76	27.6	27.65	10.46	0.378
68	FS-76	Field	45	34-0151-00-201	7/25/12	45.2964	-94.9058	0.0	NO	<0.5	0.0687	7586	8.68	26.3	26.34	9.97	0.379
69	FS-355	Mississippi River below Clay Bosw	103	S006-923	8/13/13	47.2553	-93.634	78.3	YES	10.2	0.0819	10479	8.98	47.1	47.07	17.88	0.380
70	FS-229	Mill Pond	23	21-0034-00-202	8/16/12	46.0716	-95.2218	102.2	YES	7.16	0.109	5143	7.86	14.0	14.05	5.36	0.382
71	P-26	Lower Rice	109	S007-164	9/8/11	47.3817	-95.4926	120.1	YES	0.55	0.07	2364	6.76	3.8	3.77	1.45	0.384
72	FS-190	Pine	18	15-0149-00-205	8/28/12	47.6841	-95.5414	114.9	YES	14.7	0.368	4477	7.08	12.2	12.19	4.74	0.389
73	FS-54	Little Birch	87	77-0089-00-207	8/3/12	45.7779	-94.7978	70.0	YES	7.4	0.0353	1794	6.02	2.6	2.55	1.00	0.390
74	FS-204	Big Swan	86	77-0023-00-207	8/10/12	45.8795	-94.742	133.7	YES	5.49	0.0914	1731	5.94	2.4	2.42	0.95	0.391
75	P-31	Cloquet	52	38-0539-00-201	9/14/11	47.4313	-91.4844	74.4	YES	0.81	0.024	4252	6.58	12.1	12.05	4.75	0.394
76	FS-377	Mahnomen	21	18-0126-02-201	9/11/13	46.4986	-93.9956	0.0	NO	21.1	0.0283	16540	7.47	141.1	141.14	56.61	0.401
77	P-20	Gull	9	04-0120-00-203	9/6/11	47.6559	-94.6944	15.6	YES	0.78	0.103	1608	5.08	2.5	2.53	1.02	0.403
78	FS-53	Raymond	83	73-0285-00-203	8/2/12	45.6286	-95.0225	61.1	YES	<0.5	0.0787	1905	4.79	3.8	3.76	1.55	0.411
79	FS-195	Fisher	78	70-0087-00-201	8/31/12	44.7942	-93.4061	20.7	YES	6.85	0.136	11140	5.76	90.1	90.10	37.70	0.418
80	FS-130	Hay	33	31-0037-00-202	9/6/12	47.2874	-93.102	141.0	YES	31.7	0.0738	13154	5.79	123.3	123.26	51.80	0.420
81	FS-131	Hinken	113	S007-207	9/5/12	47.7271	-93.9923	46.8	YES	<0.5	0.0876	2960	4.53	9.4	9.39	3.96	0.422
82	FS-91	Pike	104	S006-927	9/11/12	47.7327	-92.3473	3.5	YES	14.2	0.0656	6565	4.72	41.4	41.36	17.74	0.429
83	FS-80	Mission	95	S001-646	8/6/12	45.8623	-93.0011	87.5	YES	0.62	0.0485	9231	4.83	77.5	77.50	33.45	0.432
84	P-63	Maloney	88	79-0001-00-201	9/29/11	44.2243	-91.9328	148.7	YES	1.83	0.01	10269	4.24	111.2	111.17	49.52	0.445
85	P-36	Wild Rice Reservoir	70	69-0371-00-204	9/16/11	46.9098	-92.1636	17.2	YES	1.13	0.023	5555	3.75	39.5	39.51	17.70	0.448
86	FS-86	Eighteen	61	60-0199-00-202	8/22/12	47.6397	-96.0607	40.1	YES	4.29	0.164	1860	3.1	6.1	6.05	2.72	0.450
87	FS-301	Partridge	119	S007-443	5/28/13	47.5213	-92.1903	0.0	NO	14.8	0.125	9491	3.94	104.3	104.32	47.07	0.451
88	FS-83	Mississippi Crow Wing	111	S007-205	8/8/12	46.4386	-94.1251	0.0	NO	3.13	0.127	13451	3.88	207.8	207.75	95.15	0.458

MPCA Field Data - CPSC and SEM Ratio
120 ug/L Sulfide

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
89	FS-67	St. Louis Estuary Pokegama Bay	105	S006-928	9/5/12	46.6859	-92.1606	0.0	NO	9.97	0.112	14015	3.66	241.1	241.10	111.95	0.464
90	FS-202	Long Prairie	110	S007-204	8/9/12	46.0072	-95.2634	13.4	YES	7.71	0.0793	2897	2.85	15.7	15.69	7.30	0.465
91	FS-128	Cromwell	14	14-0103-00-201	8/22/12	46.9651	-96.3171	0.0	NO	41.2	1.22	2948	2.85	16.2	16.23	7.55	0.465
92	FS-188	Stella	54	47-0068-00-204	8/27/12	45.0683	-94.4334	0.3	YES	18.1	1.79	1257	2.34	4.0	3.99	1.88	0.472
93	FS-51	Glesne Slough	49	34-0353-00-201	7/31/12	45.3514	-95.1887	99.6	YES	<0.5	0.061	7983	3.01	103.2	103.23	49.05	0.475
94	FS-314	Clearwater	96	S002-121	6/24/13	47.9372	-95.6907	0.6	YES	28	0.0664	3946	2.68	30.6	30.60	14.56	0.476
95	FS-357	Lower Panasa	38	31-0112-00-204	8/15/13	47.3026	-93.2561	0.0	NO	28.5	1.26	2347	2.42	12.7	12.73	6.09	0.478
96	FS-316	Partridge	121	S007-513	6/28/13	47.5137	-92.1899	0.0	NO	24.9	0.098	6291	2.6	77.8	77.80	37.84	0.486
97	P-55	Lady Slipper	53	42-0020-00-204	9/22/11	44.5702	-95.6274	0.0	NO	107.7	14.84	2814	2.09	21.5	21.51	10.67	0.496
98	P-1	Height of Land	5	03-0195-00-209	8/22/11	46.9129	-95.6095	62.9	YES	0.24	0.053	1298	1.76	6.0	5.97	2.99	0.502
99	FS-209	Mississippi Pool 8 at Reno Botton	122	S007-556	8/15/12	43.6025	-91.2686	72.3	YES	18.1	0.0711	9187	2.29	187.6	187.61	94.93	0.506
100	FS-225	Miltona	24	21-0083-00-205	8/13/12	46.0496	-95.4217	0.0	NO	4.11	0.0694	2624	1.77	22.9	22.94	11.77	0.513
101	FS-351	Second	117	S007-220	8/15/13	47.5205	-92.1925	66.8	YES	838	0.0447	7088	1.84	148.0	148.03	77.81	0.526
102	FS-66	St. Louis Estuary	112	S007-206	9/5/12	46.6545	-92.2739	0.0	NO	16	0.0445	6169	1.73	122.0	122.02	64.69	0.530
103	FS-322	Dark	77	69-0790-00-202	7/10/13	47.6389	-92.7781	3.2	YES	175	0.131	2480	1.48	25.5	25.50	13.56	0.532
104	FS-95	Embarrass	73	69-0496-00-203	9/14/12	47.5334	-92.2979	0.0	NO	18.8	0.0298	21847	1.89	1248.9	1248.85	677.38	0.542
105	FS-347	Snowball	36	31-0108-00-202	8/12/13	47.3356	-93.2439	0.0	NO	8.2	0.097	1136	1.19	7.4	7.38	4.00	0.543
106	FS-363	St. Louis Estuary	120	S007-444	8/26/13	46.6518	-92.2372	31.2	YES			4761	1.4	95.5	95.52	52.52	0.550
107	FS-182	Hunt	65	66-0047-00-208	7/27/12	44.3275	-93.4443	0.0	NO	17.1	0.0729	2412	1.21	30.8	30.76	17.06	0.555
108	FS-187	McCormic	81	73-0273-00-203	8/2/12	45.722	-94.9121	8.9	YES	1.54	0.144	1512	1.1	14.0	14.04	7.83	0.557
109	FS-210	Mississippi Pool 4/Robinson Lake	89	79-0005-02-202	8/16/12	44.3593	-91.9881	35.3	YES	15.7	0.07	6450	1.16	214.5	214.49	124.00	0.578
110	FS-226	Louise	25	21-0094-00-202	8/14/12	45.9331	-95.4148	46.5	YES	4.09	0.0746	1833	0.83	28.5	28.49	16.97	0.596
111	FS-185	Hoffs Slough	85	76-0103-00-201	8/1/12	45.3255	-95.7059	0.0	NO	273	0.0343	3512	0.75	112.3	112.32	69.83	0.622
112	FS-311	Mississippi Pool 8 at Genoa	118	S007-222	6/20/13	43.5766	-91.2341	12.7	YES	29.3	0.107	1544	0.62	29.0	29.04	18.30	0.630
113	FS-94	Sturgeon	100	S004-870	9/13/12	47.656	-92.9315	37.9	YES	1.62	0.0659	2505	0.65	69.6	69.60	44.12	0.634
114	FS-312	Mississippi Pool 5 / Spring	123	S007-660	6/21/13	44.2018	-91.8444	35.7	YES	28.3	0.0844	3563	0.67	132.2	132.16	84.21	0.637
115	FS-59	Upper Panasa	37	31-0111-00-202	8/29/12	47.306	-93.2652	0.0	NO	29.6	0.126	895	0.43	15.8	15.77	10.55	0.669
116	P-16	St. Louis	106	S006-929	9/1/11	47.4015	-92.3773	0.0	NO	24.5	0.025	1488	0.1	240.3	240.27	223.05	0.928