The Fertilizer Institute

Nourish, Replenish, Grow

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President

June 29, 2007

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Re: EPA Draft Science Advisory Board Hypoxia Advisory Panel Public Draft (May 24, 2007)

Dear Mr. Brown and Ms. Stallworth:

The Fertilizer Institute (TFI), on behalf of its member companies, submits these comments in response to the U.S. Environmental Protection Agency's (EPA's) *Draft Science Advisory Board Hypoxia Report*. The document was not announced in the *Federal Register* but released for public review on May 24, 2007.

Statement of Interest

TFI represents the nation's fertilizer industry. Producers, manufacturers, retailers, trading firms and equipment manufacturers, which comprise its membership, are served by a full-time Washington, D.C., staff in various legislative, educational and technical areas as well as with information and public relations programs.

As TFI member companies produce and distribute fertilizer nutrients we have a substantive interest in this report on Gulf of Mexico (GOM) hypoxia.

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General Comments

The Fertilizer Institute (TFI) would like to thank the Environmental Protection Agency (EPA) Science Advisory Board (SAB) Hypoxia Advisory Panel for its thoughtful and thorough evaluation of the science regarding hypoxia in the Gulf of Mexico (GOM) and potential nutrient mitigation and control options in the Mississippi-Atchafalaya River Basin. The panel did a commendable job of sorting through the extensive scientific literature that has emerged since the 1999 Integrated Assessment Report and compiling the SAB Draft Report

TFI supports the findings regarding the complex interactions between climate, weather, basin morphology, circulation patterns, water retention times, freshwater inflows, stratification, mixing, and nutrient loadings that determine the nature and extent of hypoxic conditions in the Gulf of Mexico. TFI is encouraged by much of the data presented on nutrient loads, concentrations, speciation, seasonality and biogeochemical recycling processes that are important causal factors in the development and persistence of hypoxia in the Gulf. TFI also supports the concepts of encouraging nutrient management planning through our right rate, right time, right product at the right place paradigm. These best management practices are most effective when paired with appropriate conservation practices which may include no-till or low-till, buffer strips, advanced drainage management and enhanced efficiency fertilizers. In addition, we promote a focus on nutrient use efficiency that allows both an environmental and economic goal to be incorporated while increasing crop yields and ensuring that acres farmed are used most efficiently (land use efficiency). U.S. Corn yields have increased on average 1.8 bushels/acre/year over the last 25 years while the nitrogen input has been steady or slightly declining.

Nutrients, though, come from many sources and systematic changes to the GOM through loss of wetlands, alterations and channelization of transit routes, and extreme weather events all strongly impact the health of the overall ecosystem and must also be addressed to positively change the trend and direction of the hypoxic zone. This includes use of improved public and private land management, better and more consistent monitoring throughout the GOM, and a cooperative, incentive-based approach for addressing hypoxia in the Gulf.

However, TFI remains concerned with certain portions of the SAB Draft Report. While recognizing that the report is in draft form, TFI would encourage the panel to review the document with a primary objective to strengthen the balance and consistency of emphasis on the role that fertilizers play in Gulf hypoxia. In its current form, the report still makes attempts to correlate fertilizer use with hypoxic conditions, de-emphasizes the roles of other point and nonpoint nutrient sources, focuses a disproportionate amount of capital and effort on fertilizer management strategies and gives little credit for U.S. Department of Agriculture (USDA) conservation efforts or to farmers who have made significant efforts to date to control nutrient losses to the Basin's waters. These concerns are captured in more detail in the specific comments below.

Specific Comments

<u>Nutrient Loadings Come From a Variety of Sources</u>

p8. Hypoxic events on the Louisiana continental shelf have been reconstructed over the past 180 years using the relative abundance of low-oxygen-tolerant benthic foraminifera in sediment cores (Osterman et al., 2005). These data show that the intensity of hypoxic events has increased over the past 50 years, due to higher nutrient loadings associated with commercial fertilizer use.

p 14. All studies from dated sediment cores show increases in hypoxia with time, although the precise timing and response varies depending upon the proxy studied and the dating of cores. The accumulated body of evidence shows that the pattern of change is concomitant with increased nutrient loading from the Mississippi River causing increasingly severe hypoxia on the shelf.

p. 35. Given this historical pattern, Mississippi derived OM is unlikely to be the trigger for the level of hypoxia that developed in the NGOM during the past 35 years. This period does coincide well with the time N loads increased, due mainly to the use of synthetic N fertilizer in the Mississippi River Basin.

The increase in nutrient loadings over the past 50 years have come from a variety of sources, as detailed later in the SAB Draft Report. Associating the increase solely with fertilizer use was argued against in the second National Oceanic and Atmospheric Administration (NOAA) report (*Ecological and Economic Consequences of Hypoxia* - Diaz et al., 1999) and eliminated from the Integrated Assessment. This and similar statements made throughout the report should be eliminated from the final SAB Report. In fact, the United States Geological Survey (USGS) presented data at the 11^{th} Annual Mississippi River Basin meeting demonstrating a decreased loading of at least 20 percent of all nitrogenous compounds over the last five years; which represents significant progress towards the stated goal of 30 percent. The larger question surrounds the poor correlation between either nitrogenous compounds or phosphate loadings and the zone size, indicating a more complex problem than simply nutrient over enrichment.

In regard to the reference to *synthetic* nitrogen fertilizer, is nitrogen from organic sources (manure) better for the GOM? Have these organic sources increased in a similar manner to commercial fertilizers? Nutrients in manure are typically more volatile and prone to runoff than synthetic fertilizer. Synthetic N fertilizers comprise a variety of sources including advanced efficiency products that delay the release of N; or more closely approximate the uptake curve of the crop. The implementation of NMP/BMPs are most easily accomplished with synthetic nitrogen fertilizers, with more predictable release and dissolution curves, and significantly less volatilization into air per unit N. Please delete the reference to synthetic nitrogen fertilizer; and replace with all sources of N.

<u>Hydraulic Control Options</u>

p . 25 "The Panel... finds that 20th century changes in the hydrologic regime of the Mississippi and Atchafalaya Rivers and the timing of freshwater inputs to the Louisiana-Texas continental shelf have likely increased the bottom area where hypoxia is primarily caused by density *stratification rather than respiration...” "A comparative impact study of past, present, and future river flow diversions should be conducted...plans for future Mississippi and Atchafalaya River diversions (U.S. Army corps of Engineers) should be examined with the same coupled physical-biogeochemical models, as these flow diversion plans need to take explicit account of potential positive and negative impacts on shelf hypoxia before being implemented.”*

While TFI agrees with the panel's finding on the importance of changes to the hydraulic regime of the Mississippi and Atchafalaya Rivers to the temporal and spatial extent of Gulf hypoxia, we are concerned that this option is not discussed further in *Section 4: Goals and Management Options*. Given the importance of the amount and timing of freshwater inputs to the shelf relative to vertical mixing intensity, stratification and hypoxia, TFI requests that further discussion of hydraulic control options be included in the final SAB Report beyond the one-paragraph summary included on page 22.

<u>Institute a Monitoring System</u>

p. 27. For example, depending on the season, specific hydrologic events and conditions (storms, floods, droughts), molar ratios of total N to P (N:P) supplied to these waters can vary from over 300 to less than 5 (Turner et al., 1999; Ammerman et al., 2004; Sylvan et al., 2006). Furthermore, additional environmental factors, such as flushing rate (residence time), turbidity and water color (light limitation), internal nutrient recycling, and vertical mixing strongly interact to determine which nutrient(s) may be controlling primary production (Lohrenz et al., 1999). Compounding this complexity is the frequent spatial separation between high nutrient loads, the zones of maximum productivity and hypoxia (e.g. Figure 6; Rowe and Chapman, 2002).

p. 33. "One important aspect of differential nutrient loading is the well-documented increase in N and P relative to Si loading. While N and P loads tend to reflect human activities in and alterations of the watershed, Si loads tend to reflect the mineral (bedrock and soil) composition of the watershed... Agricultural, urban, and industrial development and hydrologic alterations in the Miss. and Atchafalaya basins have led to dramatic increases in N and P relative to Si loading. In addition, the construction of reservoirs on tributaries of these rivers has further exacerbated this situation, by trapping Si relative to N and P... The overall result has been an increase in N:Si and P:Si ratios that can influence both the amounts and composition of phytoplankton; including potential shifts from diatoms to flagellates and dinoflagellates. The dinoflagellates, cyanobacteria and even a few diatom species, while serving important roles in the food web, also contain species that may be toxic and/or inedible [for planktonic and benthic grazers]."

TFI agrees with this characterization of the complexity of factors determining hypoxic conditions. However, given this complexity, it is difficult to see how focusing solely on nitrogen and phosphorous use reduction will alleviate hypoxic conditions in the Gulf. A monitoring system that records data on biological conditions such as salinity, turbidity, N, P, C and Si cycling needs to be instituted. It is disappointing that while states such as North Carolina can institute such a monitoring in the Tar Pamlico basin (see Hans Paerl’s work on the FerryMON system) we still do not have such a system in GOM, except on a once-off seasonal basis. Such a system would let us correlate what we now understand to be three distinct zones that may have different nutrient limitations/drivers on a much closer to real-time basis.

Allocation of Relative Source Contributions

p. 31. The panel finds that there is compelling evidence that the inshore Mississippi/Atchafalaya plume regions are P limited and P-N co-limited during the spring periods of highest primary production. Nitrogen limitation of primary production prevails during summer periods. Recent research results indicate that the spring period of maximum primary production is P-limited in at least the plume of the River, largely due to excessive N input. As a result of this man-made imbalance in nutrient loading during this crucial period, P availability plays an important role in contributing to the production of "new" organic carbon in the spring time, and quite likely contributing in a major way to the "fueling" of summer hypoxia in the NGOM.

TFI agrees with this finding, although there are remaining concerns about the Panel's allocation of relative source contributions, as discussed later in this document.

Effects of Coastal Wetlands Loss on Coastal Hypoxia

p. 36. The influence of organic matter losses from coastal wetlands on coastal hypoxia remains unresolved. Whether or not wetlands lose more organic C as they degrade is not well known, but at present this seems unlikely; however, more work is needed in this area. While the timing of wetland loss does not coincide with the onset of hypoxia in the 1970s, as marsh loss has been occurring since the 1940s, stable isotope and lignin analyses of OM over much of the shelf indicates that terrestrially-derived OM is dispersed along and across the shelf (Goni et al., 1998; Gordon et al., 2001). However, marsh particulate organic material is likely to be refractory (i.e., resistant to decay) and may not contribute much to hypoxia creation on time scales of weeks to months. Thus, while the conclusion that the main OM source fueling hypoxia is in-situ production of marine phytoplankton and that this production increased in response to enhanced nutrient loads from the MARB remains sound, a better understanding of the possible role of other sources is appropriate.

p. 45. Wiseman et al. (1995) showed that the area of hypoxia along the Louisiana-Texas shelf was correlated to Mississippi River flow. These relationships were similar to those found for Chesapeake Bay (Harding et al., 1990) demonstrating the important role of river inputs in providing both freshwater inducing stratification and adding nutrients stimulating phytoplankton production. However, this apparent relationship has broken down since 1993. DiMarco et al. (2007, submitted) showed that the Gulf of Mexico hypoxia had worsened following the record breaking 1993 spring floods, e.g., smaller river flows now induce a larger response in hypoxia (see Figure 9). The first large (>15,000 km^2) hypoxic event occurred after the 1993 flood with large hypoxia areas over 15,000 km^2 observed in most following years. A similar pattern has been observed in Danish waters with worsened hypoxia following the appearance of large-scale hypoxic events (Conley et al., 2007).

TFI believes that more work is needed on the effects of coastal wetlands loss on coastal hypoxia. Between 1990 and 2000, wetland loss was approximately 24 square miles per year. The projected loss over the next 50 years, with current restoration efforts taken into account, is estimated to be approximately 500 square miles (Barras et al. 2003). These coastal wetlands also play a critical role in protecting the region from hurricane strength storms. According to land loss estimates, Hurricanes Katrina and Rita transformed 217 square miles of marsh to open water in coastal Louisiana (USGS 2006). Data collected after the 1993 hurricane demonstrated the hypoxic zone was "reset" at a higher level afterwards; perhaps as a result of recycling and upwelling of nutrients. Similar morphological changes in water and nutrient composition have been found post-Katrina in the Tar Pamlico region.

It is counterintuitive that this large-scale loss of organic material, nutrients, water retention time, as well as denitrification and filtering capacity is not a major confounding variable in coastal hypoxia. Also, the transition from marsh to open water would indicate that the shallow shelf upon which hypoxic conditions arise is increasing with time. Finally, given the data that Gulf hypoxia worsened following the 1993 flood, there is reason to believe that the cause-and-effect paradigm would again shift following recent flooding events. TFI encourages the panel to include additional research and discussion on this topic and its potential for causing significant nutrient upwelling and recirculation thus contributing to more severe hypoxic conditions.

Discussion Regarding Estimated Timelines for Meeting Hypoxia-Related Targets

p. 46. The recovery of hypoxic ecosystems may occur only after long time periods (Diaz, 2001) or with further reductions in nutrient inputs. Experience has shown recovery to be greatly delayed, taking years to decades for ecosystems to recover after nutrient inputs are reduced, and with probably less than complete recovery possible (e.g., Diaz, 2001; Diaz et al., 2003; Mee, 2006; Science News 15 Online, 2004).

Given this data, TFI feels that some discussion is warranted in Section 4 regarding estimated timelines for meeting hypoxia-related targets. For example, is the 2015 target still feasible for the stated goal in the size of the hypoxic zone? Should goals still be based solely on the spatial extent of the hypoxic zone? What about the intensity of the zone – should this also be an important metric conveyed to policymakers and the public?

Discussion Regarding Nutrient Management Progress

p. 47. Over the past 15 years, N loadings from the Mississippi River Basin have decreased, although are still much elevated over historic levels; total phosphorus (P) loadings, however, have not changed greatly during this period (Battaglin, 2006; Turner et al., in press; Section 2.2.1 of this report). This shift in nutrient loadings has led to trend in reduced (albeit still very high by "Redfield" 14 standards) N:P ratios.

p. 60. During the last five years (2001 to 2005 water years), an average of 8,813,000 metric tons of nitrate-N and 429,000 metric tons of total Kjeldahl N (TKN) were 9 transported annually to the Gulf. There is considerable inter-annual variability in these flux values, driven primarily by precipitation patterns and resulting stream flow (Figure 16), which appears to have increased slightly since the 1950s. Since the mid-1990s, annual nitrate-N flux has steadily decreased, which is more clearly shown by the 5-year running average. In addition, TKN has also shown a steady decline since the mid 1980s, so the total N flux, although highly variable from year to year, shows a very striking decline. The annual NH4-N flux also decreased during the *monitoring period (from 0.077 million tons N/yr in 1980 to 1984 to 0.012 for 2001 to 2005), but was not the primary reason for the decline in TKN, as particulate and organic N declined. The decline in NH4 N is likely due to improvements in sewage treatment, as is at least part of the decline in particulate and organic N (Larson, 2001; Metropolitan Council, 2004). In addition, reduced sediment loads because of a reduction in soil erosion may also be a driving factor in reducing particulate N losses (Richards and Baker, 2002).*

p. 63 Nitrogen to P ratios averaged 18 for 2001 to 2005, and have shown little variability since the early 1990s, with perhaps a declining trend.

p. 64. Whereas the annual water flux showed a slightly increasing trend since 1990 (Figure 16), the spring water flux, although highly variable, appears to show a decreasing trend (Figure 19). Spring nitrate-N flux also has declined, with even larger decreases in TKN flux and, therefore, total N flux.

p. 65. Spring P flux (both total and SRP) has changed relatively little, with perhaps a small decrease in total P flux (Figure 20). The spring silicate flux has shown a pronounced decline since 1990s, greater than the decline in water flux. The reason for this decline is not known.

pp.76-77. Although water flux for the MARB has 25 increased slightly during the past 25 years, total N, primarily nitrate-N and 26 particulate/organic N, has decreased. During the spring (April-June), water flux for the MARB appears to have decreased slightly, causing similar decreases in total N (nitrate-N and TKN). Neither total P or SRP fluxes show major annual or seasonal trends.

p. 78. However, when compared to the amount of N removed during crop harvest, which has dramatically increased since 1940, the increase in N inputs from fertilizer and N2 fixation don't appear to have increased proportionately. In fact, this rapid increase in crop production has led to a small decrease in NANI from about 17 kg N/ha/yr in 2000, to net N inputs of 14 kg N ha/yr in 2004 and 2005 (McIsaac, 2006).

There appears to be a trend towards decreasing nutrient inputs to the Gulf. While these do not approach the target reduction levels called for in the draft report, some progress has been made. However, there is no discussion of what management practices have led to these reductions. In fact, as in the Chesapeake Bay region, producers are among the few to meet or even approach their nutrient reduction goals.

TFI estimates that since 1980, U.S. farmers are applying 41 percent less nitrogen and 53 percent less phosphate per bushel of corn produced. The science of best management practices has grown, providing farmers with a variety of practices that promote the use of the most appropriate nutrient products, applied at the right rate, time and place. As documented in the draft report, there also has been progress made in conservation practices such as wetland and riparian buffer creation and restoration. However, there is little or no discussion of how or why this progress has occurred. TFI asks that some discussion of progress to date be included in Section 4.

Additional Source Contributions

p. 66. Spring water flux was, on average, 30% of annual flux, whereas nitrate-N was 40%, TKN 34%, and total P 34% of their annual fluxes. Therefore, the river is disproportionately enriched with all nutrients during the spring, but particularly with nitrate. This further substantiates the conclusion drawn earlier that tile-drained fields are a primary source of N, which is released beginning in winter (Ohio into central Illinois) to spring (northern Illinois, Iowa and Minnesota). This was very evident in 2002, when 50% of the nitrate-N flux occurred during the 3 spring months. Royer et al. (2006) pointed out how most of the N and P flux from tile drained watersheds occurred during a few months during winter and spring each year, further supporting the trends at this larger scale.

TFI disagrees with the conclusions reached in this section. The data represents the sum of April, May and June fluxes as a percent of annual (water year basis) for combined Mississippi main stem and Atchafalaya River. These data would not only represent tile drainage, but also increased runoff from urban and suburban lands during the same time period, including flushing of chemicals used for snowmelt. They would also represent some percentage of the EPA-estimated *minimum* 850 billion gallons of untreated wastewater and stormwater as combined sewer overflow discharges directly to surface waters each year in the United States. TFI requests that the panel estimate and include the nutrient load from these CSO discharges in the MARB. While tile drainage would be expected to contribute to these figures, the data do not substantiate the conclusion that tile-drained fields are a primary source of N. TFI requests that this section be rewritten to include other source contributions.

In addition, research into managed or advanced tile drainage indicates that these newer techniques may significantly limit nutrient discharge from tile drained fields. One of the challenges production agriculture faces is farming more acres with less full-time equivalents (FTEs). In many cases, farmers manage several thousand acres with less than ten, and in some cases five FTEs. The challenges are implementing conservation practices or standards that are highly labor intensive. TFI recommends the panel support and outline research needs regarding large scale implementation of such systems.

Net N Inputs and Annual Nitrate-N Fluxes

p. 70. The greater yields from the upper Mississippi and Ohio-Tennessee River basins no doubt reflects the relative sizes of the basins when compared to the Missouri, but also the importance of point sources in the basins, as well as more intensive agricultural inputs.

pp. 72-74. However, the upper Mississippi River subbasin has experienced a decreasing trend in annual flow since the mid 1990s (Figure 25). What appears to be only a slight decrease in nitrate-N yield in the upper Mississippi subbasin in response to what the panel thinks are greatly decreasing net N inputs, demonstrates the difficulty in predicting riverine nutrient yields in tile-drained agricultural lands.

The discussion of the net N inputs and annual nitrate-N fluxes should be re-examined. The comparison seems to indicate that the entire N flux or yield is a function of the net agricultural N inputs to the Basin. Specifically, in the discussion of the upper Mississippi River subbasin, the slight decrease in nitrate-N yield in response to decreased net N inputs is rationalized solely in terms of other agricultural inputs such as "increasing soybean N_2 fixation percentages, net N mineralization of soil organic N (David et al., 2001), long lag times due to a buildup of relatively easily degradable organic N that is now being released (Mulvaney et al., 2001), or perhaps increasing tile drainage and loss of fall applied N."

According to EPA's description of the Upper Mississippi River Basin, the Basin drains large parts of the states of Illinois, Iowa, Minnesota, Missouri and Wisconsin. Small portions of Indiana, Michigan and South Dakota are also within the basin. More than 30 million people live in the basin. Nearly 80 percent of the population lives in urban areas such as Minneapolis-St. Paul, Minn.; St. Louis, Mo.; Chicago, Ill.; Quad Cities, Illinois and Iowa; Des Moines, Iowa; La Crosse, Wis.; and Peoria, Ill.. While mentioning the importance of point sources earlier in the discussion of N yield, there is no discussion of relative contributions from point sources and urban/suburban nonpoint sources to explain the discrepancy between the slight decrease in nitrate-N yield and decreased net N inputs. It is possible that the lack of nitrate-N yield is due to increases from N inputs from these sources. There also is not a discussion of the role atmospheric deposition plays; which is a source that is typically underestimated in most watersheds (lack of measurement for dry deposition). TFI requests that the Panel either provide data to eliminate these sources from discussion or at a minimum qualitatively discuss other source contributions that could be responsible for the observed trend.

Tile Drainage and Fall Fertilization

pp. 74 Finally, another factor may be an increase in tile drainage intensity in the region, combined with increasing fall fertilization and warmer winter temperatures. New and replacement tile drainage is added every year to this region, although no data are available to quantify the increase. Fall fertilizer application in much of the region is has increased greatly since the 1980s. For the four states of the upper Mississippi River basin, all show an increasing winter temperature (for the months following fall application of ammonia). Warmer soils would increase nitrification rates and lead to higher concentrations of soil nitrate that could be lost with late winter and spring precipitation. Therefore, fall applied fertilizer N could be a more important source of spring nitrate-N flux in this subbasin during recent years, and when combined with changing N input and output patterns may be keeping the flux steady despite the reduction in annual net N inputs.

TFI requests citations for the discussion in this section, as we have not seen peer-reviewed data that supports these contentions. Without direct evidence of increased tile drainage and fall fertilization, this section appears highly speculative and should be removed from the final report. TFI also recommends that the report discuss how some of the advanced drainage management tools now available may be encouraged via conservation programs and further research documenting their effectiveness. In addition, the data being utilized to model (AAPFCO) represents disappearance (or sales) and *not* application. Many farmers buy fertilizers in the spring when the price is often less; saving a portion of the product for spring application. We cannot assume that all the fertilizers purchased in the fall were applied in the fall. In addition, fall fertilization is often necessary from a labor management perspective.

N Flux from Basins Due to Intensity of Agriculture and Fertilizer

p. 80. The subbasins that contribute the greatest N flux to the Gulf are the upper Mississippi and Ohio River basins, due largely to the intensity of agriculture with concomitant large inputs of N from fertilizer and fixation combined with the system of tile drains.

Again, given the large population in urban and suburban areas, combined with the large number of point sources in these basins, TFI does not believe that the panel has provided enough data to support the conclusion that the N flux from these basins is "*due largely to the intensity of agriculture with concomitant large inputs of N from fertilizer and fixation combined with the system of tile drains.*" TFI requests that this conclusion be withdrawn from the final Report.

Peer-Review of Estimation Methods

p. 88. The TPCs 12 used in the MART (2006) estimates are lower than those used by other water quality programs, therefore, a new analysis based on effluent concentrations that better reflect 14 measured nutrient concentrations from point sources during 2004 has resulted in revising load estimates upward to 267,000 metric tons N/yr (72% from STPs and 28% from industrial sources) and 53,000 metric tons P/yr (77% from STPs and 23% from industrial 17 sources)... When the contributions from all point sources are compared to the average annual N and P fluxes for the period 2001 – 2005 these new estimates represent about 22% and 34% of the average annual N and P flux, respectively, to the Gulf. When compared to 2004 N and P fluxes (slightly higher than average fluxes) the percentage of the N flux contributed by point sources drops to about 20% and the P flux remains constant at about 34%. Fluxes from point sources are equally distributed throughout the year, but spring flux is critical to the Gulf. Assuming equal monthly loads from point sources, they represent about 14% of spring N flux and 27% of spring P flux for 2001 - 2005.

TFI remains concerned about estimation methods used for calculating point source contribution. Specifically, TFI requests further peer-review of the TPCs used, the assumption that point sources contribute equal monthly loads and some estimate of the contribution of CSO and atmospheric deposition in the MARB, especially during critical spring months. TFI agrees with the panel's recommendation that "*direct measures of N and P from point sources, rather than relying on estimated values based on permits, so that more accurate calculations can be made of their contributions to the nutrient fluxes*" are needed.

p. 96 There are widespread opportunities for wetland restoration in the Mississippi River Basin, and since the CENR reports, approximately 1.4 million acres of wetlands have been restored, created, or enhanced within the basin under the Wetland Reserve Program (WRP), Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), Environmental Quality Incentive Program (EQIP), and Conservation Technical Assistance (CTA) (Table 7). However, the vast majority of wetland restorations have been motivated primarily by concern over habitat loss, and site selection criteria for wetland restorations have not primarily considered water quality functions. This does not lessen the promise of wetlands for water quality improvement, but rather underscores the need for programs focused on restoring wetlands explicitly for the purpose of reducing nonpoint source nutrient loads.

While TFI agrees that there are widespread opportunities for wetland restoration in the Basin and that some focus should be given to restoring wetlands for reducing nonpoint source nutrient loads, we do not agree with the language in this section that appears to discount the 1.4 million acres of wetlands restored, created or enhanced within the Basin. Regardless of the primary motivation, these wetlands serve an important water quality, storm protection, and habitat restoration function in these areas. TFI requests that this section be rewritten.

Enhancing Wetlands Restoration

p. 97. The recent literature supports the importance of forested and other types of coastal wetlands for nutrient uptake and sediment accretion, both of which would lead to reductions in loads to the GOM. Rates appear to be substantial compared to most subtidal estuarine locations (excluding areas like the Mississippi River plume) and moderate to small relative to many freshwater natural and created wetlands. Rates lower than those observed in more northern wetlands of the MARB may be due to the generally lower nutrient loading rates to these coastal wetland systems (< 10 g N/m/yr).

TFI supports the restoration of forested and coastal wetlands. Given the loss of these wetlands, especially in Louisiana, TFI asks that the panel add additional discussion of the importance of, and include recommendations for, restoring and enhancing those areas in which coastal wetlands loss is greatest or of most importance.

Land Requirements and Potential for Flooding

p. 99. - Implement management strategies that include enhancing hydrologic exchange and retention on floodplains and in backwater habitats when discharge, total P and nitrate concentrations are high (e.g., during spring), particularly in rivers of intermediate size, thus enhancing removal of both nutrients."

While TFI agrees with the recommendation in principle, we would ask for greater clarity in terms of how the Panel would apply this recommendation in practice, especially in terms of land requirements and the potential for flooding.

Scientific Justification for Final P Reduction Goal

p. 115. The initial goal for P reduction suggested here – approximately a 40% reduction with half coming from point source reductions and half from non-point sources – would still not restore pristine P loads in the MARB, since human activity has increased P loads by some 3-fold or more. However, 40% is a reasonable target, one that should provide significant improvement in water quality within the freshwaters of the basin, and one that can be revised adaptively as new information becomes available.

The P reduction goal is not supported by data and appears to be an arbitrarily selected target number. While we understand that efforts in the Great Lakes resulted in a 40 percent reduction in P, we question whether this is directly transferable to present conditions in the Gulf. TFI requests that the panel provide greater scientific justification for the final P reduction goal.

Fertilizer Product Selection, Timing and Placement Minimize Nutrient Loss from Fields

p. 119. Given the Batie et al.(1993) research and the results in David et al. (XX), it is reasonable to expect relatively small reductions in N fertilizer rates to result in proportionally higher reductions in N losses if all other factors are held constant.

p. 154. The Upper Mississippi River Sub-basin Hypoxia Nutrient Committee report (UMRSHNC 2006) predicts a 15% reduction in N load by decreasing applications from 150 to 125 kg N/ha/yr, although greater reductions have been observed in other studies (e.g., 27% in Jaynes et al. 2001). Reduction of corn fertilizer to 50 lbs/acre below the normally recommended rate led to only minor yield reductions for spring applied urea ammonium nitrate (UAN) or NH_3 in Iowa (Blackmer and Van De Woestyne 2002). Overall, it appears that substantial reductions in N application to corn, even from the average of 142 kg N/ha/yr are possible with only minor yield reductions.

TFI disagrees with this conclusion. Lower fertilizer use does not equal lower losses to the environment, rather, counter intuitively lower rates may mean increased losses depending on site-specific conditions. Maximized nutrient use depends on several factors, including balanced nutrition and interrelationships among nutrients for efficient plant uptake and use. While crops can mine soil N reserves to counter short-term N application reductions, arbitrary fertilizer reductions will result in longer-term increases in edge-of-field nutrient losses. This is particularly true in high-yield farming practices in use today. TFI requests that the panel include discussion of the available scientific literature concerning appropriate fertilizer product selection, variable rate seeding, timing and placement to minimize nutrient loss from fields.

Voluntary Programs

p 127. Given the historical aversion to imposing mandatory requirements in agriculture, the collective weight of these studies suggest that voluntary agreements are not likely to be adequate on their own to achieve significant reductions in nutrient runoff. In short, voluntary programs can have small effects but cannot be relied upon to induce major environmental improvements.

p 133. The overwhelming body of evidence in scientific studies shows that voluntary agreements -- at least those without any accompanying economic incentives -- are not likely to be adequate to obtain significant reductions in N and P.

TFI does not believe that a cursory review of four studies, many of which do not include agriculture-related programs, provides the "collective weight of evidence" necessary to suggest that voluntary agreements will not achieve significant reductions in nutrient runoff. TFI requests the Panel to include some review of agriculture-related voluntary agreements and their results and to remove this conclusion from the final Report.

Water Quality Trading Programs

p. 129. In a recent survey of the programs to support water quality trading in the U.S., Breetz et al. (2004) identified 40 water trading initiatives and an additional six state policies with specific programs related to water quality trading. EPA has supported these programs (EPA, 2004) and has produced explicit policies related to their implementation. Many states and regions also *have explicit policy guidance. However, the effectiveness of these programs appears to have been quite limited as very few trades are actually occurring. Further, little evidence of environmental improvement associated with these programs exists (Breetz et al.)... A key problem with these programs is the lack of a required water quality improvement that is necessary to generate adequate demand for credits generated by adoption of conservation practices (King, 2005).*

TFI disagrees with the characterization of water quality trading programs by the Panel. The majority of these programs are in their initial stages and trades are expected to increase as load and loading allocations are defined under state TMDL development. Further, much like the case with hypoxia, a significant time lag is expected between the date of the trade and resulting environmental improvement. TFI supports water quality trading programs and feels that they have the potential to be a significant tool in addressing local water quality issues in the Basin as well as Gulf hypoxia.

Fertilizer Tax is Not Appropriate

p 132. The use of a nitrogen fertilizer tax was considered in Doering et al. (2000) and found to be as cost-effective as any of the policies they considered (they note that the initial incidence falls on farmers). In addition, Wu and Tanaka (2005) also found the fertilizer tax to be the most cost-effective of the policies considered.

TFI disagrees that a nitrogen fertilizer tax is an appropriate policy to address Gulf hypoxia. Most economic studies of fertilizer nutrient demand indicate that fertilizer demand is quite inelastic (Denbaly and Vroomen, 1993; Larson and Vroomen, 1991; Burrell, 1989); that is, an increase in nutrient price brings about a less than (typically significantly less than) proportional decrease in demand. For example, in their study of nutrient demand in U.S. corn production, USDA economists Denbaly and Vroomen (1993) concluded that "Elasticities estimated here indicate that a tax on fertilizer would have only limited effectiveness in reducing fertilizer nutrient use in corn production. Similarly, USDA economists Larson and Vroomen (1991) conclude, "Thus, while a uniform tax policy on fertilizer may be relatively easy to implement, more location-specific technology-based policies, such as "best management" practices, may be necessary to achieve desired environmental benefits."

The concept of fertilizer as a "cheap" input that is over applied beyond realistic yield expectations or as insurance is dated and counterproductive. According to USDA data, the cost of nitrogen fertilizers increased 121% from 1999 to 2006, while potash and phosphate prices increased 37% over the same period. U.S. fertilizer prices paid by farmers have continued to rise since 2006 and hit an all time high in May 2007 as nitrogen prices stood 161 percent above the 1999 level while potash and phosphate prices were up 74 percent compared to 1999. Furthermore, USDA data indicate that the prices paid by farmers have risen significantly more than the prices received, particularly for inputs like fertilizer. USDA's Index of Prices Paid for Commodities and Services, Interest, Taxes, and Farm Wage Rates (PPITW) for May 2007 stood 58 percent above the 1990-92 average, while the index of fertilizers prices paid by farmers was up 117 percent from 1990-92. Meanwhile, USDA's All Farm Products Index of Prices Received by Farmers in May 2007 was up only 38 percent from its 1990-92 base. With fertilizer prices at these levels, assuming farmers over apply fertilizer nutrients does not make economic sense.

Economic Incentives to Reduce N and P

pp.133-134. To achieve N and P reductions at minimum cost, economic incentives are needed to change behavior. These incentives can take the form of taxes on activities that increase nutrient inputs to the MARB, and/or subsidies on actions that reduce nutrient inputs. This goal might be achieved by restructuring and/or eliminating existing subsidy programs... To minimize the adverse effects of existing agricultural subsidy programs, conservation compliance requirements and enforcement of existing requirements, are needed as a condition of receiving subsidies. Alternatively, where the perverse effects of subsidies are estimated to exceed their benefits, consider their elimination.

TFI disagrees with these recommendations. Nutrients must be applied at agronomic levels to maintain soil fertility. The panel has not provided evidence that existing subsidy programs are drivers of Gulf hypoxic conditions nor that elimination or changes to existing subsidy programs would "achieve N and P reductions at minimum cost." TFI requests that these recommendations be deleted from the final report.

Best Management Practices

p. 143. Table 11 summarizes the extent of five major conservation buffer practices installed in 21 states of the MARB in 1999-2006 (USDA-NRCS-Performance Results System, http://ias.sc.egov.usda.gov/prshome). An estimated 2.35 M acres of conservation buffers were installed in these 21 states in 1999-2006. If each acre of conservation buffer treats on average 5 acres of source area, an estimated 11.72 M acres of agricultural land has been treated by these 5 conservation buffer practices.

TFI again would request that greater discussion be provided on those best management and conservation practices, like the passage above, that have been implemented to date and how these may have impacted water quality, especially in regard to reductions in nitrogen loss discussed earlier in the report.

Cropping System Section

p. 147. If farmers could be encouraged to switch to a rotation of perennial crops as compared to the predominant cropping system of corn-soybean rotation, significant N and P reductions would result... The current system of agricultural support payments needs to be re-structured to create incentives for perennial crops.

TFI believes that this discussion does not account for the significant gains in NUE made by U.S. farmers over the past two decades. Further, TFI believes that the panel has not made provided cost/benefit data necessary to make the recommendation for subsidies for perennial crops. TFI requests that this section be reviewed and that the recommendations be changed accordingly. Further, research indicates (Mulla, 2001) that corn-corn rotations do not necessarily increase N losses; and other research (IPNI, accepted for publication in *Better Crops* 2007) indicates that corn-corn rotations may significantly increase carbon sequestration in soil, an important factor in N retention, increased soil organic matter over time, and decreased GHG emissions.

Consistency of Voluntary Programs Message

p 150. The success of non-profit programs supported by watershed agricultural councils, industry, and state agencies, should provide valuable demonstration models... Continuing educational efforts with farmers and the public regarding the importance and impact of BMPs will be essential to reach environmental goals.

These two examples seem to contradict the earlier discussion regarding the ineffectiveness of voluntary programs.

Fall Application Timing

p. 154. Application timing. The risk of N loss with corn is greatest when fertilizer is applied some time before the period of rapid plant growth (late May or June in the MARB). The UMRSHNC report indicates acceptance of ~ 15% overall N load reduction for changing from fall N application to Spring application. This is estimated to produce only a 3% total load reduction for Iowa because as little as 25-30% of the corn land in Iowa may be receiving fall application. This is probably an underestimate of the fall application because fertilizer sales data shows 54% of NH3 sales are in July-December, implying fall application.

While TFI agrees with the concept of the importance of application timing, we strongly disagree with the speculative discussion of underestimating fall application based on fertilizer sales data. As we have explained in previous comments, fertilizer sales data will include transfers from wholesalers to distributors and distributors to retailers as well as sales to farmers. Therefore, sales from July to December will include transfers made in preparation for the spring application season, as well as forward-pricing sales to farmers (i.e., farmers prepaying for spring fertilizer in the fall to lock in lower prices) as well as fall application sales. In addition, given these multiple transfers between wholesale and retail entities there is a degree of double counting in these sales numbers. Therefore, these data do not imply fall application. TFI requests that this statement be removed from the final report.

BMP Section

p. 159. An assessment is needed of the socioeconomic barriers to successful adoption of nutrient management planning strategies in the MARB, as well as the N and P loss reductions achievable. Such an assessment has been done in a drinking water supply watershed for New York City that claims a 93% participation in volunteer conservation programs (Watershed Agricultural Council, 2004). A survey of CREP participants showed they were generally older and more likely to obtain information from extension agents, consultants, and watershed council personnel than non-participants, but there was no difference in educational level or farming status (full or part time) (James, 2005). Overall, negative attitudes toward voluntary adoption of BMPs were a result of the loss of productive land and loss of being able to decide independently what to do on their own land. These survey results illustrate the difficulties in gaining adoption of nutrient management BMPs by farmers in any watershed, transferring new BMP technology, and the socioeconomic pressures faced.

This discussion needs to be rewritten for clarity. One survey indicates 93 percent participation in volunteer conservation programs. The James study seems to indicate some negative attitudes towards voluntary adoption of BMPs without referencing participation rate. Neither would seem to support the conclusion that there will be "*difficulties in gaining adoption of nutrient management BMPs by farmers in any watershed, transferring new BMP technology, and the socioeconomic pressures faced.*"

Include Data on Urban/Suburban Nonpoint Source Improvements

p. 164. Although controlling urban non-point sources can provide significant benefits from improvements to local water quality, these non-point sources are not significant determinants of hypoxia in the Gulf of Mexico, both because concentrations tend to be lower than those from agricultural sources, and because the urban land comprises less than 1% of the Mississippi River Basin (e.g., Mitsch et al, 1999). Thus, although actions to reduce urban non-point sources may be justified, these control actions will not likely contribute significantly to reductions in the size of the Gulf of Mexico hypoxic zone. Since control of urban non-point sources will not have an important role in reducing hypoxia, we do not focus on actions to reduce urban non-point sources of nutrients in this report.

TFI disagrees with the absence of discussion on urban/suburban nonpoint sources and the conclusion that "*these control actions will not likely contribute significantly to reductions in the size of the Gulf of Mexico hypoxic zone.*" TFI requests that the panel include some data on urban/suburban nonpoint source improvements. In addition, nutrients are used on suburban lands, golf courses, and publicly owned lands which comprise far more than 1 percent of the MARB.

Finally, many lawn and garden fertilizer companies have developed advanced efficiency or slow release products that are tailored to limit nutrient losses and protect watersheds. Phosphate free products (or low P) are now widely available and the N formulations for lawns typically include significant percentages of a variety of slow release compounds. These formulary changes have the potential to significantly reduce environmental losses.

Source Contribution from CSO in MARB

p. 166. Sewage treatment plants and industrial dischargers represent a more significant source of N and P in the MARB than was originally identified in the Integrated Assessment. They may offer some of the most certain short-term and cost-effective opportunities for substantial nutrient reductions.

TFI requests that the panel include some discussion of the source contribution from CSO events in the MARB and that some recommendation be made for potential reductions from CSO nutrient contributions.

Rewrite Ethanol Section

pp. 166-174. Ethanol and Water Quality in the MARB

As currently written, this section reads more like a propaganda piece against increased ethanol production and farm subsidies than a serious discussion of the future of biofuel markets and their potential to impact water quality in the MARB. At a minimum, land conversion, nutrient use and loss, cattle increase, and ethanol concentration scenarios in this section should be labeled as "worst-case" projections. A preferred alternative is that the panel rewrite this section incorporating more of the available credible literature on biofuel projections. The table below indicates possible efficiencies of corn to ethanol production given varying energy sources and techniques; and energy input estimates are accurately characterized therein (McElroy, 2007, *Capturing Carbon Opportunities*):

Corn-Ethanol System	Emission Reduction	Carbon Offset (Mt)*	Carbon Credit ($)**
Industry aggregrate estimate (Farrell 2006)	13%	76,370	305,481
Natural gas-fired dry-mill plant w/ drying DG	40%	234,986	939,943
Natural Gas-fired dry-mill plant w/ wet DG	70%	411,225	1,644,900
Closed-loop plant w/ feedlot & an. digestion	80%	469,971	1,879,885

*Based on a 100 million gallon ethanol plant; fermentation CO_2 not included (nuetral)
**$4 per metric ton CO_2, Dec. 2006, http://www.chicagoclimateexchange.com/

SOURCE: Adam J. Liska, University of Nebraska Department of Agronomy and Horticulture, Nebraska Center for Energy Sciences Research.

In addition, this work estimates significant overall emission reductions in GHG pollutants depending on the corn-ethanol system utilized.

For example, the USDA projects production capacity in the industry to exceed 12 billion gallons within a few years, with further expansion in ethanol output during the next decade is expected to be more moderate. Even with less than full capacity utilization in the industry, USDA expects ethanol production grows to more than 12 billion gallons by 2015. USDA's 2007 long-term projections indicate that more than 30 percent of the corn crop will be used to produce ethanol by

2009/10, remaining near that share in subsequent years. A roughly 33 percent increase in biodiesel use by 2017 will increase soybean demand and prices. USDA projects that increased corn prices will have a dampening effect on the number of cattle and chickens raised in the United States. Increased commodity prices projected over the next 10 years translate into smaller government payments under current farm commodity programs. (Wescott, P. *Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust*? USDA. May, 2007).

This would result in an increase of 55 million kg N (120 million lb) annually to the MARB if fertilization and other management practices remain the same. Assumptions such as "other management practices remain the same" are both vague and misleading. Again, U.S. farmers have greatly decreased nutrient use per bushel of corn produced over the last two decades. This trend is expected to increase as more precise best management practices are implemented across the landscape. Biotechnology advances paired with more sophisticated management techniques are currently increasing genetic yield potential by an estimated 3 percent per year. Targeted conservation practices should further minimize nutrient losses to the MARB, as suggested by current flux trends.

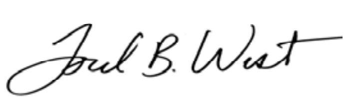
Farrell et al. (*Science*, Jan. 27, 2006) note that the two studies (Patzek, Pimental, references 11, 12 in article) *stand apart from others by incorrectly assuming that ethanol coproducts should not be credited with any of the input energy and by including some input data that are old and unrepresentative of current processes*… As an example, Patzek uses the assumption that all corn grown in the Midwest is fertilized with ammonium nitrate (AN); whereas in reality anhydrous ammonia is typically the preferred N source. This assumption compounds the error in net energy calculations not only by the conversion of anhydrous to AN but also the efficiency of N uptake within the cropping system.

Longer-term advances in commercial cellulosic ethanol production and further increases in efficiency in the corn-ethanol system will also change nutrient use and loss projections in the MARB. TFI strongly encourages the panel to rewrite this entire section with an eye towards a more robust data set, more realistic assumptions and some discussion of the uncertainty of the projections provided.

Conclusion

TFI is pleased to have the opportunity to comment on this important issue. If you have further questions regarding these comments, please do not hesitate to contact me at (202) 515-2700 or via e-mail at fwest@tfi.org.

Sincerely,



Ford B. West