LOADS vs. CONCENTRATIONS:
Because this white paper will be used by managers and policy makers to develop targeted research and management actions, we encourage the authors to consider including a brief discussion in the introduction about the difference between nutrient “LOADS” versus “CONCENTRATIONS”. This distinction is key when considering the effects of nutrients on biological processes. For example, while upstream sources of N (and other nutrients) to the Delta may be substantial when considered on an annual basis, much of that N enters the system during winter storm events when transit times are short and biological activity low. In contrast, N entering the Delta during lower flow periods (summer/fall) from anthropogenic sources (e.g. WWTPs, agriculture, urban) when there is higher irradiance and higher temperatures may have a much larger ecosystem effect. Similarly, because of dilution by receiving waters, N loads from point sources may not be as important as the resulting concentration in Delta channels and habitats. This distinction is particularly critical when evaluating management actions and water quality criteria and determining the appropriate “level” of nutrient control. (Note: in the case of P and other nutrients, which remains in ecosystems longer than N, loads may be of greater importance).

PHYSICAL INFLUENCES:
We appreciate the attention this white paper gives to the role of physical dynamics in phytoplankton growth and community composition. However, we suggest that greater attention could be paid to the specific role of turbulence, which is currently not mentioned, on phytoplankton abundance and community composition. Turbulence in the Delta is one of the aspects of Delta hydrodynamics most altered by levee construction and channelization. Recent work suggests that the role of turbulence may be underappreciated in the Delta – particularly as it relates to resuspension/settling of phytoplankton, the role of facultative planktonic species like Melosira and Ulnaria, and the likelihood of phytoplankton being lost to grazers (especially clams). In many regions of the Delta, turbulence is not only determined by flow (discharge, velocity, water depth) but also by wind (e.g., shallow water habitats like Liberty Island). See for example Lucas et al. 2016, Kraus et al. 2017.

A recently published paper sheds some light on the potential role of turbulence in Delta systems:
This study found that declines in phytoplankton along the Sacramento River that were previously associated with WWTP inputs of ammonium occurred even when effluent inputs were halted. These findings also highlight the need to address drivers other than nutrients that might influence phytoplankton – especially in cases where the concentrations and ratios of NH4 and NO3 may co-vary with other drivers (like flow which influences residence time, turbulence, turbidity, light). See for example page 4 of the White Paper: Physical influences, and page 11. This study also serves as an example of ecosystem-scale, multidisciplinary research.
RESIDENCE TIME:
We strongly agree with the authors about the importance of residence time, and the little quantitative information we have about how residence time is related to biogeochemical processes. We draw the authors attention to a recent paper quantifying residence time in the Delta, and documenting its effect on nutrient concentrations:


We suggest to the authors that they further emphasize two points about residence time:
1) that residence time is related both to geomorphology and flow
2) that one of the elements lost in the present day Delta in comparison to the historic Delta is the near absence of smooth gradients in residence time.

BIOGEOCHEMICAL RATES:
We also strongly agree with the authors’ emphasis on improving knowledge about biogeochemical rates and nutrient cycling within the Delta. We agree that information about the role of bacteria and archaea would be interesting, however this information does not seem directly translatable in a way that would inform the biogeochemical modeling that the authors also call for. We suggest that it may be more appropriate to call for knowledge about rates and processes within environmental compartments such as wetlands, channels, sediments, etc. It seems to us that aggregating the information by environmental compartment would facilitate coupling hydrodynamic and biogeochemical models.

Given that this is intended to be a guidance document, it seems to us that it would be appropriate to identify the opportunities for gathering information about biogeochemical rates. One such example is the approach described in the residence time paper discussed above (Downing et al. 2016). We also see that there is additional knowledge obtainable using current data, such as where we calculated nitrification rates using continuous monitoring data:


Comparison of nitrate concentration data collected from paired, in situ, high frequency nitrate sensors located 30 km apart on the Sacramento River below Regional San’s WWTP discharge allowed us to gain novel insights into nutrient sources and transformation rates. There was also evidence for a significant positive benthic flux of nitrate (and ammonium, see Kraus et al. 2017) from sediment along this section of the Sacramento River immediately downstream of the WWTP. This addresses the need to understand “within system nutrient cycling” (Page 4 of the white paper). These results were written up in journal form at submitted to Water Resources Research in early May 2017. Other examples include modeling of continuous measurements of dissolved oxygen, and even discrete measures of ammonium.

NUTRIENT SOURCES AND SINKS:
The paper notes that it is important to have reliable information about nutrient sources and sinks to and within the Delta. It notes the finding of the recent report by Novick et al. (2015). We feel that in addition to the discussion and that is already in the paper, further discussion of DON sources and sinks is warranted. As a back of the envelope calculation, DOM contributions in the Delta could account for on
average 25 µM of DON that may or may not be recycled. This is particularly important as farming continues on Delta Peat Islands, liberating large quantities of DOM within the Delta.

**CONTROLS ON PHYTOPLANKTON GROWTH AND COMPOSITION:**
In addition to nutrients, the paper discusses the role of light, physical dynamics, residence time and grazers in the growth and composition of phytoplankton. However, we feel that the role of contaminants and — based on recent literature — phytoplankton viruses should also be at least mentioned as considerations.

**CHANGE:**
We read with interest the authors comments on the potential effects of climate change on the Delta. We feel that anticipating changes due to a changing climate is an important component of planning nutrient management strategies. But we also feel that an equally important change we will see in the Delta will be due to changes in land use and agricultural intensity. Population increases will alter the distribution of water in California, massively increase the amount of nutrients required for cropping, and potentially increase the discharge from municipal treatment plants. Although the many works of the Global NEWS project provide information about current and potential fluxes at the broader global scale, the effects related to prospective changes in population and land use are modeled and discussed at the regional level in this document:


Further, largescale management changes such as the re-routing water through tunnels, wetland restoration, barriers, reservoir releases etc., and potential changes associated with levee failures, also may warrant mention.

**EXAMPLES:**
Finally, given the authors’ broad perspective, we think it would be extremely useful if the authors could provide examples where the knowledge systems they have outlined in this paper have been successfully compiled and can be used a resource as we develop framework to understand the role of nutrients in the Delta.