Submission number: HP4-A8SR-86DBG, Bear Lake aeration
Comments from Eric Calabro, WLSU, EGLE

Aeration is a short-term tool that has been used to reduce internal nutrient loading and prevent the growth of cyanobacteria in certain situations in certain waterbodies. However, it doesn't appear that aeration will address the primary underlying cause of these issues in Bear Lake, and the project as currently designed poses a risk to human health, water quality, and fishing and recreational opportunities. Currently, the applicant has not demonstrated that the potential negative impacts of this proposed project have been avoided and minimized to the maximum extent, and a feasible and prudent alternative is not available.

Anoxic or hypoxic conditions at the sediment-water interface can result in the release of phosphorus from sediments. However, previous research and data submitted by Restorative Lake Sciences (RLS) has shown no impairment in dissolved oxygen concentrations in Bear Lake. Steinman and Ogdahl 2013 state the following,

> *"both our daytime and diel measurements clearly indicate that Bear Lake is mostly oxic throughout the water column, at least to the near-bottom, which is as close to the sediment-water interface that our probes could be deployed without disturbing the sediment layer."*

Steinman and Ogdahl 2013 goes on to say,

> *"Although the lake does not typically stratify, shallow eutrophic lakes such as Bear Lake are often subject to diel fluctuations in water column dissolved oxygen (DO) concentrations. High rates of primary production from abundant algal communities can result in elevated daytime DO due to photosynthesis, but then respiration can cause depleted nighttime and early morning DO, especially under calm conditions, which in turn could lead to* ***short-term*** *release of P from the sediments (cf. Premazzi and Provini 1985, Nürnberg 2009, Nürnberg et al. In Press)."*

RLS, in their 2019 report, captured some low DO data in July of 2019 in a very localized area of Bear Lake. This is likely a very localized, short-term depletion as Steinman and Ogdahl 2013 described. This temporary, fleeting, localized oxygen depletion in one small area of the lake during a very short period in the summertime is likely not the largest contributing source of P fueling cyanobacterial blooms. Steinman and Ogdahl 2013 sampling and research found that internal loading was determined to be of lower importance than what the 2008 TMDL model had predicted, and recommended management be focused on controlling the external phosphorus load. Steinman and Ogdahl 2013 stated aeration appears unnecessary due to the lake already being well oxygenated.

Anoxic or hypoxic conditions at the sediment-water interface are not the only mechanism that can result in the release of phosphorus from sediments. Another mechanism that can result in phosphorus release is the suspension of sediment into the water column. Warmer water and suspended sediments resulting from aeration could potentially exacerbate internal loading and cyanobacteria blooms – especially during the summer months when the water is already warm and there is higher boat traffic. Bear Lake is a shallow lake and the sediments are already susceptible to resuspension. Aeration will result in additional sediment resuspension and could make internal loading worse. RLS states,

> *"The lake has a semi-consolidated lake bottom with a thick layer of black, organic flocculent material on the top layer. (Restorative Lake Sciences, 2017 Feasibility Study, p.14)."*

Submission number: HP4-A8SR-86DBG, Bear Lake aeration
Comments from Eric Calabro, WLSU, EGLE

Placing diffusers in the flocculent organic material will suspend this black muck into the water column resulting in a risk of degradation to public trust waters through the suspension of nutrients and contaminants into the water column and the uncontrolled placement of fill. Increased nutrients in the water column can encourage the growth of algae and cyanobacteria, which impairs water quality, aesthetics, and peoples' use and enjoyment of the water (Hunt et al. 2006, Cross and Jacobson 2013).

Avoidance of risks to human health have also not been demonstrated by the applicant. The applicant has not done a thorough investigation to ensure historical petroleum operations in Bear Lake will not pose a safety risk to people or resources. Craters that will be created by the proposed diffuser operation may exacerbate existing risks to public health and environment. An assessment of the Lower Muskegon River Watershed Oil Field states:

> *"The presence of old pits or borings presents risks for cave-in, unstable soil conditions (e.g., sinkholes) and falling hazards. Old petroleum exploration or production equipment may present risks to children, or construction and utility workers in cases where it may not be visible on the land surface." (Westshore Consulting, 2010 Lower Muskegon River Watershed Oil Field Assessment)*

Westshore Consulting goes on to say:

> *"Potential risks to human health and the environment associated with these borings and related facilities include soil, groundwater and surface water contamination, drinking water contamination, ecological, fish and wildlife impacts, indoor vapors, cave-in and falling hazards, and hurdles to economic development and job creation. The vast majority of these borings have never been investigated and the actual risks to human health and the environment are unknown. When borings have been investigated as a result of drinking water well permitting, private investments or other reasons, cases of both minimal risk, and unacceptably high risk have been identified. While most borings likely present a limited concern, the potential remains for high risks to exist and be unknown to the community." (Westshore Consulting, 2010 Lower Muskegon River Watershed Oil Field Assessment)*

RLS stated concerns regarding petroleum contamination in their 2017 report, noted petroleum odor emitted from benthic samples, and presented data showing elevated ORO and DRO samples which were found throughout the lake. Additional sampling is required to determine the extent and severity of petroleum contamination. There is the risk of currents created by diffusers suspending petroleum-contaminated sediments and keeping the oil contamination entrained in the water column. This contamination could then move to downstream waterbodies, creating a larger-scale petroleum contamination issue. WLSU feels this is an unacceptable risk, especially when there is not a demonstrated need for this project, and when alternatives are available. Suspending petroleum-laden sediments may compromise progress currently being made through watershed management and other mitigatory improvements. Again, additional sampling is required to determine the extent of petroleum contamination.

WLSU feels watershed improvements should be made before any in-lake management strategy, as any potential benefits of aeration will be outweighed by external inputs. Focusing only on in-lake management techniques and ignoring watershed management and shoreline Best Management

Submission number: HP4-A8SR-86DBG, Bear Lake aeration
Comments from Eric Calabro, WLSU, EGLE

Practices (BMPs) may produce only short-term benefits at the expense of long-term negative consequences (Michigan Chapter NALMS). Ogdahl et al. 2014 state,

> *"Costly attempts to reduce nutrient loading may not improve water quality if the appropriate contributing source (i.e. lake sediments or watershed inputs) is not targeted for management action, thereby resulting in setbacks in lake restoration and frustration on the part of stakeholders…Even when sediments are implicated as a major source of nutrients, reductions in external P load must be included in any lake management strategy for alleviating eutrophication, since external inputs of P ultimately accumulate in the sediments and fuel future internal loading."*

The idea of reducing external loads before implementing in-lake management is widely supported by the peer-reviewed science. For example, Sondergaard et al. 2001 states that,

> *"An important prerequisite for achieving long-term benefits to water quality is a sufficient reduction in the external P loading."*

Additionally, Visser et al. 2016 in their review paper examining artificial mixing to control cyanobacterial blooms state,

> *"Reducing the external nutrient input in the lake or reservoir, however, should still be the main focus in restoration studies to improve the water quality on the long term."*

Welch and Cooke in their 2005 paper state,

> *"As for longevity, the consensus is that internal load will eventually decline following external load reduction (Sas et al. 1989), but the time required may be long (Søndergaard et al. 1993, 1999; Chapra and Canale 1991)."*

The consensus in the peer-reviewed literature is that the external nutrient loads should not be ignored, as this could undermine in-lake treatments.

RLS states in their 2017 report,

> *"The best way to reduce algae is with nutrient reduction into the lake." (Restorative Lake Sciences, 2017 Feasibility Study, p.71)*

RLS goes on to say, with reference to phosphorus-inactivation products, that

> *"external phosphorus loads must be significantly reduced since these inputs would compromise phosphorus-inactivation formulas (Nürnberg, 2017)." (Restorative Lake Sciences, 2017 Feasibility Study, p.83)*

This same idea applies to lake aeration. Reducing external inputs and implementing a watershed management strategy with BMPs is a critical prerequisite to in-lake management for water quality improvement.

The Department would be in support of implementing the Best Management Practices that RLS recommends starting on page 84, Section 7.3.1, 7.3.2, 7.3.3 of their 2017 Improvement Feasibility Study and Lake Restoration Plan. RLS stated that the tributaries entering Bear Lake are a source of elevated

phosphorous concentrations (Restorative Lake Sciences, 2017 Feasibility Study, p.88). This coincides with other research from Steinman and Ogdahl who say,

> *"As the primary tributary to Bear Lake, Bear Creek and its watershed are the focal point for the phosphorus load reduction needed to improve conditions in Bear Lake, remove the BUI, and meet the TMDL target."*

Continued effort should be made toward watershed improvements to control the external phosphorous load.

The current project and strategy to reduce nutrients and cyanobacterial blooms in Bear Lake do not appear to align with the peer-reviewed science on the topic and the lake management plan developed by Restorative Lake Sciences. The Wetlands, Lakes and Streams Unit does not support issuance of a permit for the project as currently designed due to the risk for adverse impacts when alternatives are available. The applicant has not demonstrated that adverse impacts to the public trust and the environment have been avoided and minimized to the maximum extent practicable, and that a feasible and prudent alternative is not available to minimize impacts to the resources of Bear Lake.

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Submission number: HP4-A8SR-86DBG, Bear Lake aeration
Comments from Eric Calabro, WLSU, EGLE

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