September 8, 2016

James Harris
Utah Division of Water Quality
P.O. Box 144870
Salt Lake City, UT 84114-4870

Re: Comments on the 2016 Integrated Report

Dear Mr. Harris:

I have attached my comments for Utah's Draft 2016 Integrated Report from the Utah Department of Environmental Quality, Water Quality.

Sincerely,

Richard Mickelsen

Richard Mickelsen
Provo City Environmental & Laboratory Compliance Manager

Utah's Draft 2016 Integrated Report
Comments Provided by:
Richard Mickelsen

Thank you for the opportunity to comment on Utah's Draft 2016 Integrate Report. I have worked in the laboratory environment for the last 28 years, 11 of those directing NELAC Certified labs for the wastewater systems. This is my first opportunity to read, learn and comment on an Integrated Report. I have attended multiple meetings where Utah Department of Water Quality (UDWQ) staff have presented and defended the Integrated Report this summer.

My conversations and interaction with Walter Baker, Erica Gaddis, and Jake Vander Laan have been helpful in obtaining references, learning and understanding the process and the importance of the Integrated Report. I have tried to be thorough but find the vast information will require more time to complete. My comments are what I have learned and observed.

<u>EDITING COMMENTS</u>

Chapter 1 page 13 (Chapter 2 page 58) narrative lists 137 lakes and reservoirs in the state. On the next page the sum of the number of Lakes is 142. Counting the number of lakes in Chapter 4 resulted 145 lakes and reservoirs. The document should be consistent. Why isn't the Great Salt Lake identified as a lake or reservoir? If it is a lake or a reservoir it would bring the count to 146.

Chapter 1 page 14 Figure 4 sum of streams count is 769 yet the count of streams in Chapter 3 is 767. Which two streams are missing?

What is Table 13 mentioned in Chapter 2 page 90?

Chapter 4 page 11 of 16 lists Assessment Unit ID UT-L-14060004-004_00 Lake Canyon Lake, Impaired Parameter arsenic, Dissolved list the IR cycle first listed as "2106". Most likely this should be "2016".

Chapter 5 Table 1. "WHO recommended thresholds of human health risk for cyanobacteria, microcystin-LR and chlorophyll a" should replace Chapter 2 Table 10. "World Health Organization thresholds of human health risk associated with potential exposure to cyanotoxins" because it is more complete.

The conceptual diagram (Figure 1. Chapter 5) should utilize all three characteristics of a HAB (speciation, cyanobacteria cell counts, and cyanotoxins,) to claim it really is a harmful algal bloom. Otherwise it is just an algal bloom, a plant, and has no health risk to the public. An example is green algal blooms which have not been found to be toxic to date. Add algae speciation as a primary indicator. Chlorphyll-a concentration can continue to be a supplemental indicator.

REFERENCES

Chapter 2 page 37 references Ostermiller et al. 2014 and points to the UDWQ's website for updates on this document. I went to the website and found several references to Ostermiller. Please be specific to this reference.

Chapter 5 page 21 references Bolland 1974 but has no reference in the literature cited. I was able to obtain the reference from Mr. Vander Laan. The reference should be included in the Literature cited.

2016 INTEGRATED REPORT CHAPTER 2 COMMENTS

Stream Mileage:

Stream Mileage Calculation is suspect if two streams are not listed in Chapter 3 in the summary Chapter 1 page 14. The same could be said of the lake and reservoirs acres.

Biological Assessment:

The introduction of the empirical model for Biological Assessments compared to the historically used chemistry and associated standards protective of aquatic organisms needs additional time for comment. The River Invertebrate Prediction and Classification System (RIVPACS) and the observed over the expected (O/E) looks like a clever and useful tool. However, my conversation with other experts express concern about listing Assessment Unit's (AU) as impaired using only this screening technique. The sample size listed in Table 9 page 57 seems like a very low threshold, it barely meets the Student T statistical criteria. I request additional time to learn of this Biological Assessment. A discussion would be helpful with UDWQ and others to adequately vet this new technique.

Field Method Overview:

The "Surface samples are collected from a depth of 0.5 meter." This portion of this section is in conflict with the "Standard Operating Procedure for Collection of Phytoplankton Samples During Harmful Algal Blooms" (SOP Revision 2, August 3, 2015). The SOP surface grab sample in part states "tilting the bottle parallel to the water surface with the goal to capturing only the top 1-2 inches of the surrounding surface water/scum". Similar conflicts exist with the composite sample at two times the depth of the Secchi disk reading listed in the 2016 IR and the SOP sampling at elbow-depth.

Harmful Algal Blooms (HAB) Defined:

This is the first time an AU has been listed as impaired for HAB. Utah Lake, minus Provo Bay, is introduced in the 2016 IR impaired for HAB recreational use (2A or 2B depending on 2016 Integrated Report). The introduction of the HAB into this 2016 Integrated Report warrants additional public comment on HAB.

The World Health Organization (WHO) uses speciation, cell count and toxicity to determine HAB.

In most cases, the identification of an algal or cyanobacterial species is not sufficient to establish whether or not it is toxic, because a number of strains with different toxicity may belong to the same *species. As a consequence, in order to ascertain whether the identified species includes toxic strains, there is a need to characterize the toxicity*.

The World Health Organization used *Microcystis* species and the toxin microcystins to develop their guidelines. (WHO 1998) *Microcystins* is responsible for most incidents of toxicity in most countries. Due to the significant cost for toxin testing, the cell count is an inexpensive alternative to toxin testing. The UDWQ has recently obtained a method that uses test strips to screen the toxins Anatoxin-a, Cylindosperm-opsin, and Microcystin at 10 µg/L. This is a great technology development; this indicator method should be vetted against other methods.

<u>HAB Sampling</u>:

The sampling of HAB in the UDWQ's standard operating procedure (SOP) seems to selectively sample the source. The whole Utah Lake is not being sampled. Selective sampling screening includes noticing evidence of potential bloom or where potential exposure is greatest such as shorelines, especially in areas that are frequented by recreationists (SOP Revision 2, August 3, 2015). This is a good thing as it gives the public the best information available. It is noted that Oregon had about 15 or more recreational health advisories (from cell count only data) each year which was causing undue strain on the recreational use of their water bodies. The Oregon Health Authority (OHA) now uses toxicity to determined public risk because cell count only data caused undue economic burden on water recreation-related tourism. The Oregon recreational health advisories are currently about 9 each year based on toxic data. Their paper does not mention whether it was the water column or scum that they sampled, however, in a personal conversation with the author (Farrer 2015) he confirmed the testing of the scum to best protect the public.

The World Health Organization provided a nice visual summary of algal bloom concentration in Figure 8.1 (WHO 2003). It is included here to show the way samples could be collected to best protect the public as well as showing why the differences exist in a large water body, such as Utah Lake. For example, initial algae cell count in a water body shows the cell count at 100,000 in about 4 meters of water resulting in moderate risk. Algae then floats, concentrating by a factor of 100 at the surface (4 cm or 1.6 inch) resulting in high risk. Then the wind blows the algae concentrating it by a total factor of 1,000 on the shore resulting in a very high risk. It would be of interest to know the approximate size of the accumulated mat on the shoreline. The samplers could also take note of the shoreline mat size.

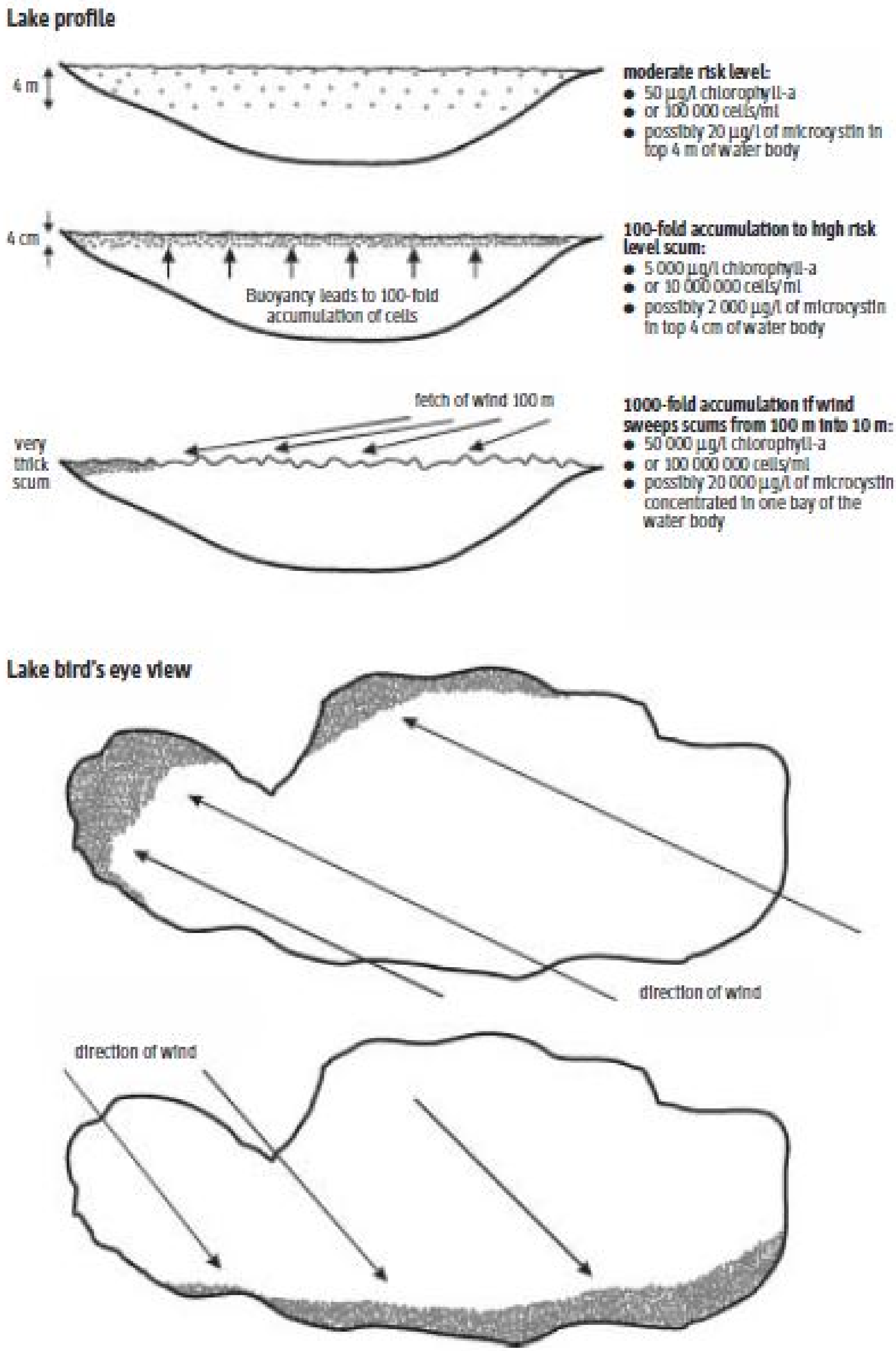


FIGURE 8.1. SCHEMATIC ILLUSTRATION OF SCUM FORMATION CHANGING THE CYANOTOXIN RISK FROM MODERATE TO HIGH (CHORUS & BARTRAM, 1999)

While looking into sampling, I noted that the UDWQ did not have a sampling protocol until August 3, 2015. This gives rise to the question what procedure was followed to sample 2014 data collected in Chapter 5 of the 2016 Integrated Report. Pictures in Chapter 5 clearly show the sampler taking samples without gloves and skimming off the surface. It is also noted that the note from the Microbiologist reporting data for five samples taken 10/22/14 had a comment:

I'm very curious to see what values the other lab is obtaining. If they are significantly higher, we may need to re-examine our protocol and sonication process.

I don't suspect lab significant error. There is a need for additional technical and financial support. The HAB's should be reviewed more to determine the best sampling, testing and public notification methods.

<u>HAB Trigger</u>:
The Utah Lake algal bloom starting July 14, 2016 triggered the UDWQ's decision making guide resulting in the local Health Department sufficiently alerting the public of the Harmful Algal Blooms. Nearly all I talk to now think Utah Lake is toxic. The narrative and explanation in Chapter 2, Chapter 5, and the "Utah Guidance for Local Health Departments Harmful Algal Blooms and Human Health" have set a very conservative approach. I think the risk level adopted by UDWQ is unwarranted using only cell count. UDWQ seems to understand the importance of toxicity when they state in Chapter 2 page 60 of the 2016 IR "risk when exposed to algal toxins through skin contact, inhalation, or ingestion". From the papers I have read the recreational health risk is more like an allergy (WHO 2003, WHO 1998, Farrer 2015, Cronberg 1999, Hudnell 2005). The major risk is through ingestion, not skin contact or inhalation. The toxins are water soluble and do not penetrate the skin (WHO 1998). The UDWQ is putting additional caution on top of the 1000 safety factor already accounted for by the World Health Organization for Microcystin in drinking water and a 20,000 safety factor for recreational use.

Cyanobacteria produce compounds in their cell wall when exposed to sensitive or allergic individuals can cause skin rashes (Farrer 2015). Even the World Health Organization describes it "*Bathing suits and particularly wet suits tend to aggravate such effects by accumulating cyanobacterial material and enhancing disruption of cells and liberation of cell content. It is probable that these symptoms are not due to recognized cyanotoxins but rather to currently largely unidentified substances."* (WHO 2003). *The reported instances of illnesses are few, but, because they are difficult to diagnose, such illnesses may in fact be more common than has been reported* (WHO 1998).

No human deaths have been documented, to date, due to cyanobacterial (WHO 1998). However, I did find a paper that reported 60 human deaths when dialysis water was contaminated with Microcystin-LR (Cronberg 1999). Animal deaths have been documented, including two dog deaths during the Oregons six year study (Farrer 2015). It is noted that the dog deaths at Utah Lake Lindon Harbor listed in Chapter 5 of the 2016 Integrated Report died from a heart attack and a tumor. They did not die because of cyanobacteria or cyanotoxins (Veterinarian report).

It has been my experience in the laboratory that living organisms can have an accuracy within one order of magnitude. There are different kinds of variables to account for this uncertainty, error, deviation, or safety factor (however named). For algal blooms, there is interspecies variability, sampling, and laboratory limitations such as analyst and dilutions. Counting one cell could as well be ten. This continues to be the case for 10 to 100, 100 to 1,000 etc. For example cell count for one sample could be 300 another sample from the same location same time could be 700. This is natural random variation in the distribution of the live organism and not the laboratory performance. The lab typically performs quality control to account for this uncertainty. For example, since live cell count distributions are not necessarily symmetrical and rarely fit a normal (bell shape) distribution curve, a log-normal distribution curve may be used to determine precision (Standard Methods 22nd ed.)

Escherichia coli (E. coli) is a live organism. E. coli samples use geometric means instead of averages to account for the distribution variations. E. coli recreation assessment is described in detail (Chapter 2 page 39 to page 44). HAB's could be handled in a similar manner after a healthy public discussion. For example, testing during the recreation season from May 1 through October 31. This should be done with or without algal blooms present. It has been noted that cyanotoxins can be present even without algal blooms (Coronberg 1999). The change from cell count to toxins would be needed. The strip test would be a good indicator with confirmation by other quantitative means. I don't know if using this criteria would list Utah Lake as being impaired but it seems to be a reasonable approach.

It looks like the World Health Organization has also taken this into account by putting a 1000 safety factor (uncertainty) for drinking water, accounting for 100 for intra- and interspecies variation and 10 for limitations in the database (WHO 1998). Then WHO added an additional 20 safety factor for recreational use (Chapter 5 Table 1). The end result is a 20,000 recreation safety factor mentioned earlier.

The Water Quality Health Advisory Panel probably needs to meet again and discuss some of the thoughts mentioned above. My personal communication with one of the committee members (Theron Miller) said he missed the importance of the "Toxic" part of the HAB equation. Taking the above mentioned thoughts would minimize false closing of the lake when toxins are not present. This economic/public health issue has been address before in Oregon (Farrer 2015).

<u>HAB Nutrients</u>:
I have heard the different opinions regarding the algal blooms. On one hand Dr. Lavere Merritt (retired BYU professor) has stated that there is enough phosphorus in the natural environment to feed the algal blooms. Alternatively, UDWQ say that Utah Lake needs to limit its nutrients initiating the Technology-Based Limits limiting total phosphorus to less than 1.0 mg/L and total inorganic nitrogen to less than 10 by 2020 and 2025 respectively.

It seems logical to me that if you feed the algae it will grow. I personally have seen this with the Dunaliella algae in the Great Salt Lake. We were harvesting the Dunaliella for its beta carotene content. It was important to have a food source (nutrients: phosphorus and nitrogen). Without the food our harvest would be low. It is also noted that the brine shrimp (sea monkeys) in the Great Salt Lake prefer to eat the Dunaliella as a food source too. Great Salt Lake Brine Shrimp Cooperative, Inc. has over 60% of the world's supply of brine shrimp. Brine Shrimp is used as fish food.

I am from the understanding that the nutrients are helpful for providing life downstream. If there is no basic food (nutrients: nitrogen & phosphate), then no phytoplankton (algae), then no zooplankton, then no fish or birds. But we will have clean water to recreate and drink. Utah is a wonderful place for birds to stop and eat, weather migrating or not, from the rich producing wetlands full of food from nutrients. Excess nutrients produces excess algae produces algal blooms. The adaptive approach adopted by the State of Utah (P mg/L < 1 and TIN < 10 mg/L by 2025) is an attempt to control algae blooms by controlling excess nutrients.

Sweden has a lake (Ringjon) similar to Utah Lake. They saw an increase in algal blooms in 1940 from increased nutrient supply and went to task to eliminate it. They decrease 30 tons of phosphorus loading per year to 10 tons per year (1980). They removed cyprinid fish (1988 to 1992) and saw increased water transparency. Then in 1994 and 1995 the blue-green algal blooms still appeared with toxin production at its highest in July. Their conclusion "It appears that there is no relation between the trophic state of the lake and algal toxicity". (Cronberg 1999)

Is this because there is enough natural occurring phosphorus in atmospheric deposition as seen in other world locations? There is supporting information from the atmospheric deposition affecting the annual percentage of a lake's total phosphorus load. The range is from 8% Lake Biwa, Japan to 75% in the Rainy River Catchment, Canada and USA (IJC 2014). This is significant if Utah Lake is similar to the lakes reference in this document. If it is, then the algal blooms will continue even if the point sources remove all the nutrients from their discharge.

Another concern is an unintended consequences. If the nitrogen is removed as part of the nutrient removal program the blue-green (toxin producing) algae will dominate green algae because most blue-green algae can fix nitrogen from the air and green algae can't.

<u>EAST BAY RESEARCH</u>

Provo sponsored research studying the Provo Golf course as a wetland to reduce nutrients before the water reached Provo Bay. The study shows a reduction of phosphate from about 3 mg/L to 1 mg/L and nitrate from about 25 mg/L to about 10 mg/L. Figures 3 and Figure 4 are included to chart the improvement. (Randall and Carling, 2015)

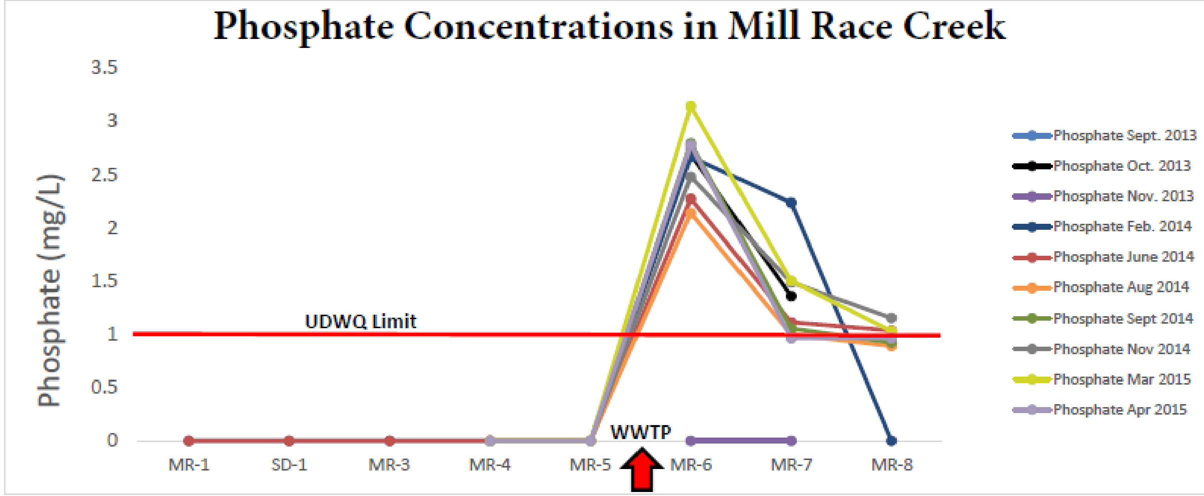


Figure 3: Phosphate concentrations along the transect of MRC showing similar trends as nitrate concentrations (figure 2). Increase in phosphate concentrations are found downstream of the WWTP. MR-7 and MR-8 represent the effluent discharging into Provo Bay after meandering through the golf course. The red line shows the new Utah Division of Water Quality (UDWQ) limitations on phosphate concentrations in the WWTP effluent (1 mg/L of phosphate).

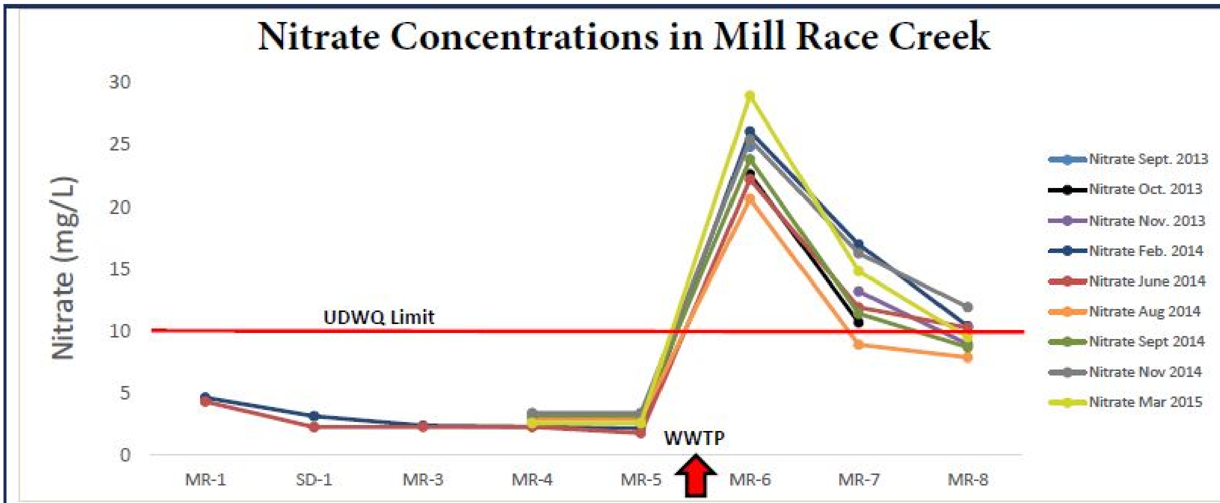
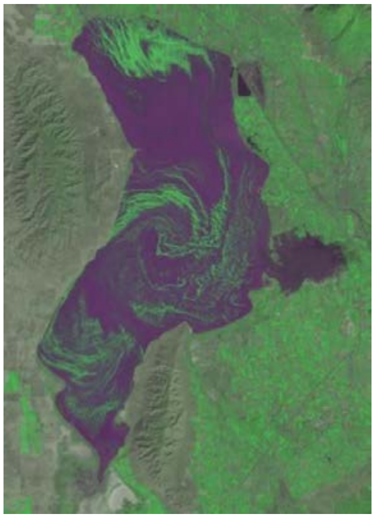


Figure 2: Nitrate concentrations along the transect of Mill Race Creek (MRC). The large spike from MR-5 to MR-6 represents the discharge of the WWTP entering MRC. MR-7 and MR-8 represent the effluent of MRC out into Provo Bay after meandering through the East Bay Golf Course. The red line shows the new Utah Division of Water Quality (UDWQ) limitations on nitrate concentrations in the WWTP effluent (10 mg/L of nitrate). After MR-6, concentrations decrease to near or below the UDWQ limit.

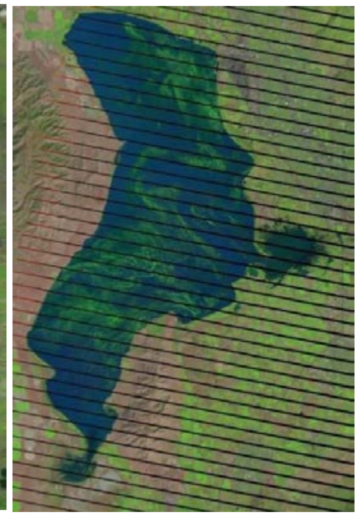
It is my understanding that Orem has met the nutrient removal since 2012 and Timpanogos in 2014. The East Bay study shows Provo has essentially been meeting the nutrient removal established for the adaptive approach. The 2014 algal bloom listed in Chapter 5 seems to illustrate the results seen in Sweden's Ringjon lake; the algal blooms continue after nutrient removal.

Satellite images available from the United State Geological Survey between March and October of each year were looked at to see if algal blooms were present. There were a total of 46 images over the 44 years. The earliest bloom was 8/7/1972. I do not have cell count or toxicity data for the satellite images. If the light green is truly an indicator of algae as presented by the State, there was a bloom as early as 9/12/1972.   Others are available up to the present, with the very productive years of 1988 and 2006 shown. Satellite data supports the PSOMAS 2007 TMDL study that states “Utah Lake is a highly productive lake that experiences extensive algal blooms in the late summer and fall”.



9/12/1972

8/7/1988



9/19/2006

10/18/2014

7/18/2016

The 2014 year has supporting cell count and toxic data. Unfortunately there is not similar data for the previous years. It is possible that previous years would be similar to 2016.

<u>Provo Bay Wetland</u>:
Provo Bay is more identified as a wetland. It is inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Provo Bay water level 2 out of the last 17 years is so low (1 to 5 inches) no recreation is going on. See Theron Millers Utah Lake and Tributaries Provo Bay Listing comments.

Carlson's Trophic State Index (TSI):
The use of the Carlson TSI is one tool used to provide information as to the state of an AU. Dr. Carlson has stated in his own paper the sample size was too small to illustrate the total variation in the background attenuation coefficient (Carlson 1980). He also said *it is apparently impossible to obtain an accurate biomass-based classification using either transparency or total phosphorus in turbid lakes and reservoirs* (Carlson 1991). His discussion to try to provide another tool to classify AU's has merit. UDWQ should collect more data as suggested by Dr. Carlson. Impairment should not be listed by TSI alone.

2016 INTEGRATED REPORT CHAPTER 5 COMMENTS
I think the HAB indicators for recreational use should be revisited as mentioned previously in my comments.

Recreational use is expected to increase as mentioned by UDWQ but Figure 2 clearly shows a 40% reduction in 2014 and 2015. This could be due low water levels and possibly to the UDWQ's guidance document that puts undue fear about Utah Lake. Toxins should be the driving indicator as previously mentioned. All the Tables and Figures not exceeding the World Health Organizations recommended 20 mg/L are undue warnings/cautions. Again sampling should continue as previously mentioned. Take note that others have noticed toxins without visible algae. It is again recommended to test the recreation waters for toxins during the recreational months.

Cyanotoxins in Utah Lake outlet should be tested on a regular basis. As mentioned previously toxins can be present with and without algal blooms. Data should be collected year round to have sufficient information to support the Jordan River 1C drinking water classification. It is noted that Walt Baker (UDWQ Director) in the September 6, 2016 Provo City Council work session noted Jordan River as a drinking water source and that Utah Lake would not be held to the 1C standard.

The Utah lake dog deaths section show the blue-green algae fear/biases of UDWQ. For example the dead dogs section *says two dog deaths were potentially linked to algal toxins during the October 2014 HAB events in Utah Lake*. The Veterinary report ruled out blue green algae toxins as the cause of death which is later recognized. UDWQ does not accept the data that blue-green algae is not responsible for the dog death. This is an example where observation does not prove cause.

The explanation of not needing two monitoring cycles are no longer required should not apply to Utah Lake. The increased awareness and the budget increase should allow for data collection to properly list Utah Lake.

Other Chapters not reviewed due to time constraints.

CONCLUSION
It is noted that UDWQ sees the need for additional Utah Lake research with the request from the Utah Water Quality Board for $1,000,000 which was granted. The deficiencies mentioned in my comments and recognition of UDWQ need for additional Utah Lake research the listing of Utah Lake impaired for

HAB and Provo Bay should be postponed for at least another Integrated Report cycle. It is my hope that Provo City can work with UDWQ in a cordial way that will result in a healthy ecology and clean water.

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