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DRAFT MEMORANDUM

TO: Todd Weinheimer, Streets and Stormwater Manager

DATE: May 31, 2019

FROM: Tim Lackey, PE

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SUBJECT: Lab Result Synopsis

Executive Summary

Residents of the neighborhood have reported pond odors and overall poor appearance to the Town of Addison in Les Lacs pond prior to 2014, prompting the Town to take action to improve the water quality. Besides odor and poor aesthetics, the pond also had accumulated foam and there are occasional fish kills. The well recirculation has not been individually effective at improving the water quality in Les Lacs pond.

The City has implemented numerous tasks for the lake water quality improvements inclusive of directing staff from blowing yard clippings in to lake, signage for no feeding of ducks, signage and receptacles for pick up of pet wastes, rehabilitation of the recirculation system, rehabilitation of the water well for makeup water, and redirecting water from well to the south end.

Water quality testing at Les Lacs pond began in limited form in 2014 and is more consistently tested since January of 2018. A combination of EPA and TCEQ guidelines and other references were used to establish optimum ranges for the water quality parameters tested in order to improve the condition of the pond. This memorandum outlines trends and concerns observed from the lab data from January 2, 2018 to April 11, 2019. The duration of data accumulated will help detect seasonal trends for different parameters.

Trophic statuses classify water bodies and helps indicates the overall health of the pond. While oligotrophic and mesotrophic bodies are generally considered healthy, eutrophic and hypereutrophic water bodies are often considered unhealthy. Eutrophic and hypereutrophic water bodies can have odors, poor water appearance, foam accumulation, and fish kills – all of which have been reported in the Les Lacs pond.

The process of eutrophication within urban environments is typically man-made. The lab results indicate that the pond has high biological productivity due to excess nutrients,

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specifically nitrogen and phosphorus. High levels of these nutrients correlate with eutrophic and hypereutrophic conditions.

The phosphorus, nitrogen, fecal coliform levels have increased since the 2014/2015 levels. Although the pond has had no foaming or fish kill events since the improvements have been installed.

Due to the unique characteristics of the pond (eutrophic to hypereutrophic state, shallow depth, small drainage basin, and hard edge bottom) recommendations have been made in the conclusion of the memo. The recommendations are based around a consistent public complaint system implementation, ongoing strategic testing for being proactive for deteriorating water quality events. Additionally, efforts are recommended to increase public and staff awareness for reduction of nutrients such as phosphorous and nitrogen fertilizers, yard wastes in storm sewer system, pet wastes in the entire drainage basin. Also recommended are planning for plant buffers for harvesting of nutrients and monitoring of the silt for chemical and volumes for planning future treatments.

Introduction

The Les Lacs pond is located within an urban residential area of Addison, Texas and is an isolated, manmade pond with a concrete capped poly liner. The pond receives urban runoff through overland flow and through concrete storm water culverts located on the east and south sides of the pond. The pond receives water from an upstream 48" storm sewer system that drains from the neighborhood. The outflow of the pond discharges to the Town of Addison's storm sewer system through a 4'x4' box culvert outfall located at the northern end of the pond where the water eventually enters Rawhide Creek. The box culvert outfall has a screen around it to help keep animals and debris out. The pond is approximately 2.2 acres in size and ranges in depth from approximately 2 to 7 feet.

The pond contains infrastructure to help recirculate water within the pond. A water well located at the northern end of the pond pumps makeup water. Three pumps recirculate the water to the scenic overlooks with cascades at the western and southern ends of the pond to promote water flow. As detailed lab analysis will show later in the report, the well recirculation has not been individually effective at improving the water quality in Les Lacs pond. The pond also has three decorative fountains and two overlook areas. The decorative fountains also serve a practical purpose to disrupt water at the pond surface and accelerate the diffusion of oxygen into water. The well has been rehabbed, and well water is now pumped to south end of pond for freshening upstream conditions at twelve hour increments.

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Water Quality Goals

Figure 1 shows the locations, Sample Point 1 (SP1) and Sample Point 2 (SP2), where water samples were collected for analysis.

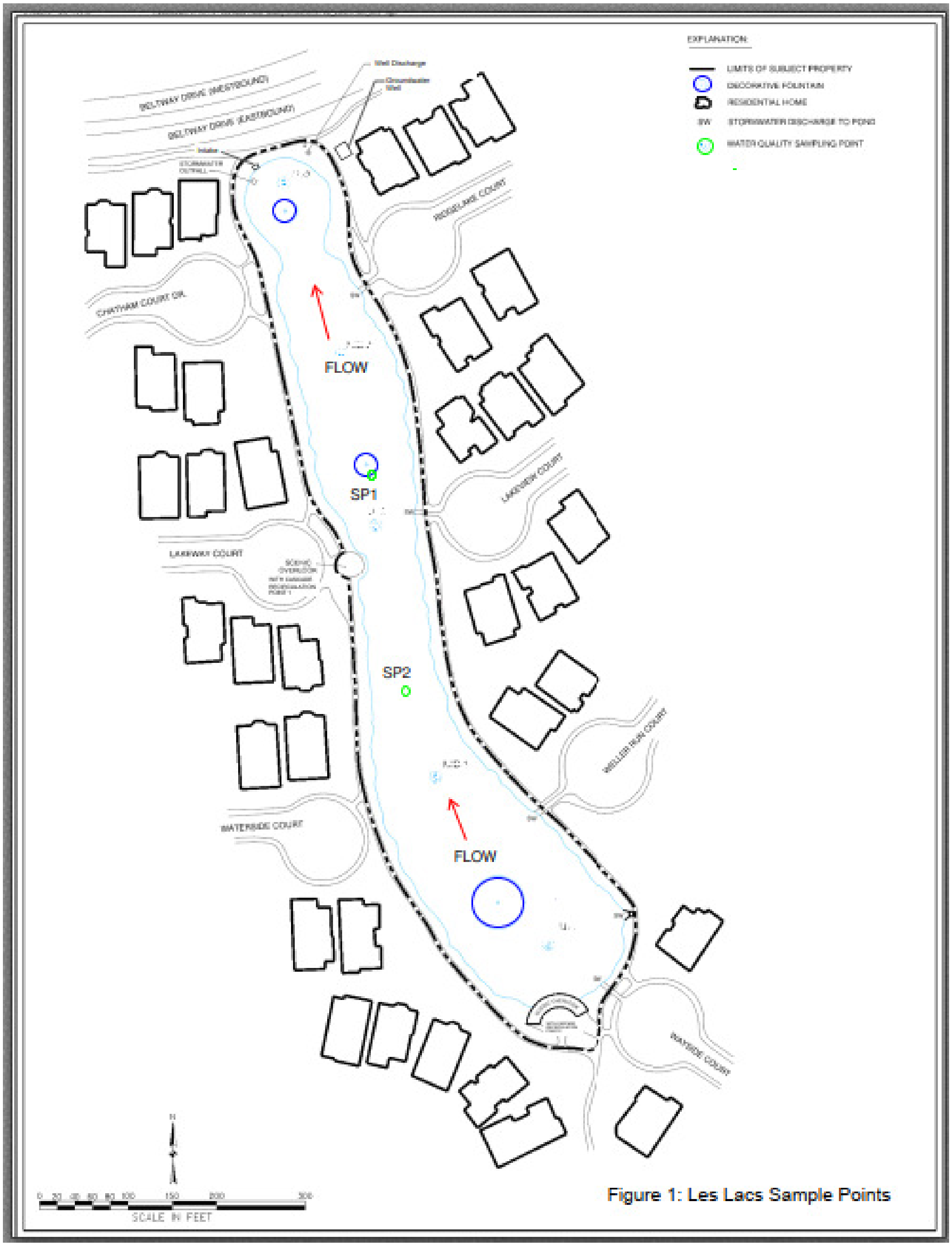

Figure 1: Les Lacs Sample Points

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Contributors to Pollutant Events

- *Total Phosphorus*

Total phosphorus in Les Lacs pond consistently reflects eutrophic and hypereutrophic conditions and indicates an overload of phosphorus. Excessive amounts of phosphorous are levels over 0.036 mg/L and indicate eutrophic water conditions. [1] Eutrophic conditions describes the chemistry of a pond that has an abundant nutrients and high rates of growth by primary plants. Hypereutrophic water bodies typically have visibilities of less than 3 feet, have chlorophyll-a values of 13 ug/L or higher, and total phosphorous values of greater than 0.036 mg/L. This correlates with lab results showing the Les Lacs also contains eutrophic to hypereutrophic levels of phosphorus. Phosphorus is usually a limiting factor in aquatic systems. When excess phosphorus levels are available, algae grows rapidly. As more algae grows, others die and become dead organic material which feeds bacteria – in turn driving up the BOD. Excess phosphorus can also contribute to the formation of foam on pond surfaces.

Figure 2 shows total phosphorus concentrations and rainfall over the sampling period.

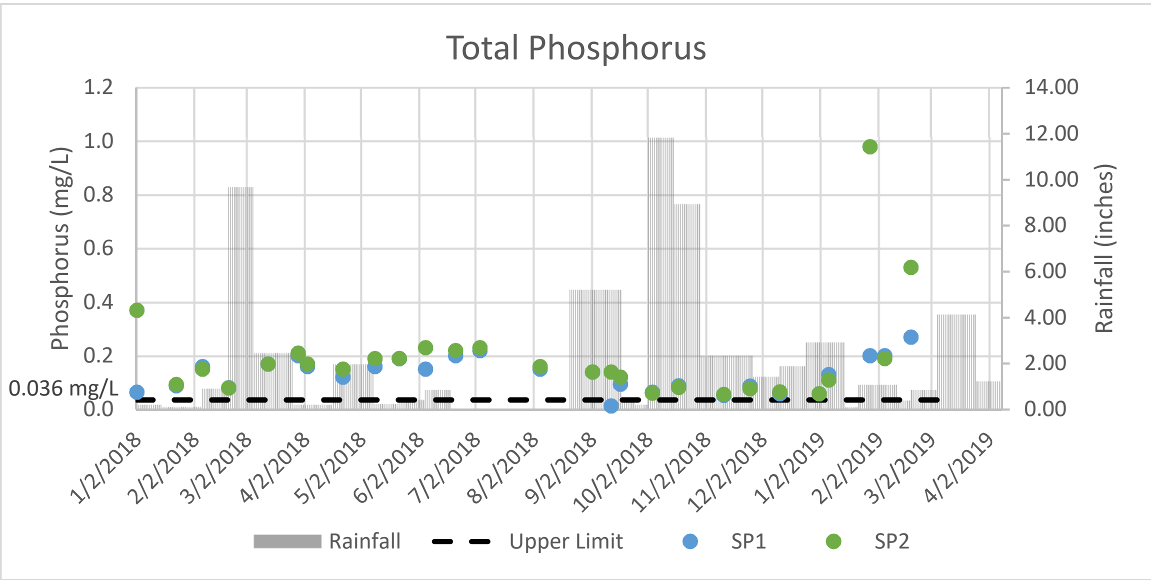

Figure 2: Total Phosphorus

- *Total Nitrogen*

Nitrogen levels in the water may increase in the Les Lacs pond during the summer season due to runoff from fertilized lawns and yards. Since total nitrogen consistently falls within an acceptable concentration, the results indicate that phosphorus is the parameter causing the poor conditions in Les Lacs Pond. Total nitrogen values in excess of 6 mg/L may be indicative of pollution from fertilizers, manures, or other nutrient-rich wastes. [2] High nitrogen values may be indicative of pollution from fertilizers, manures, or other nutrient-rich wastes.

Total nitrogen only exceeds 6mg/L on two occasions, both at sample point 2. Both nitrogen and phosphorus can contribute to nutrient overloading which then in turn creates eutrophic water conditions. Figure 3 shows total nitrogen concentrations and rainfall over the sampling period.

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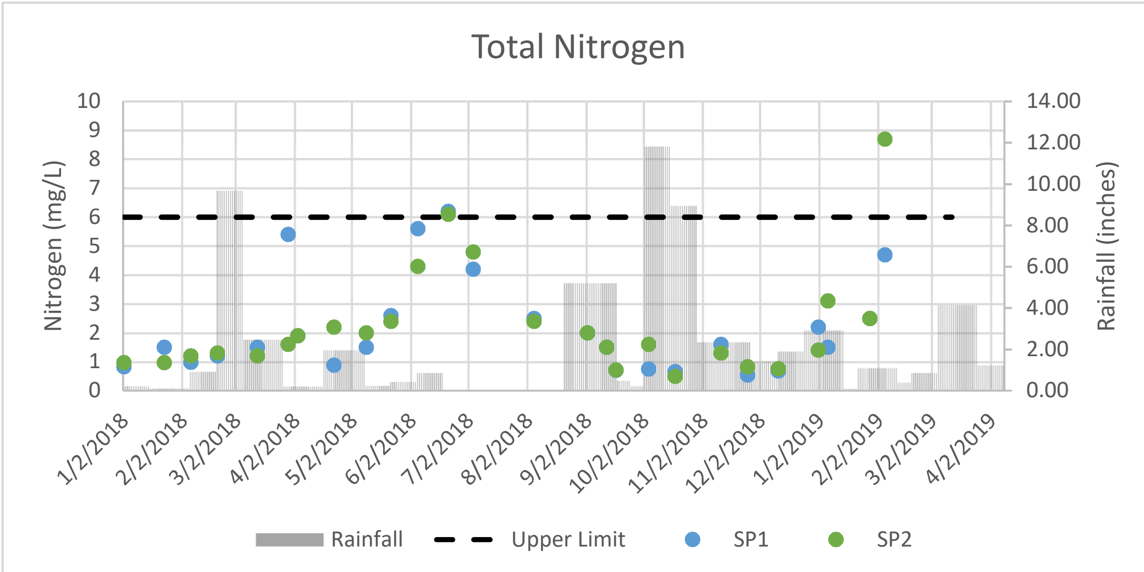

Figure 3: Total Nitrogen

- *Total Organic Carbon*

  The higher concentration of TOC in summer months may make foam presence more likely, but overall the concentrations of TOC observed in Les Lacs pond are within acceptable ranges. Groundwater typically has TOC values below 2 mg/L, pristine lakes and rivers typically have TOC values less than 10 mg/L while wastewater effluents range from 10 mg/L to 100 mg/L.[3] Total organic carbon does not identify specific organic contaminants, but does detect the presence or organic contaminants such as insecticides, herbicides, and agricultural chemicals. Excess organic material can also contribute to the formation of foam on pond surfaces.

  TOC levels only exceed 10 mg/L in the months of June, July and August. Figure 4 shows total organic carbon concentrations and rainfall over the sampling period.

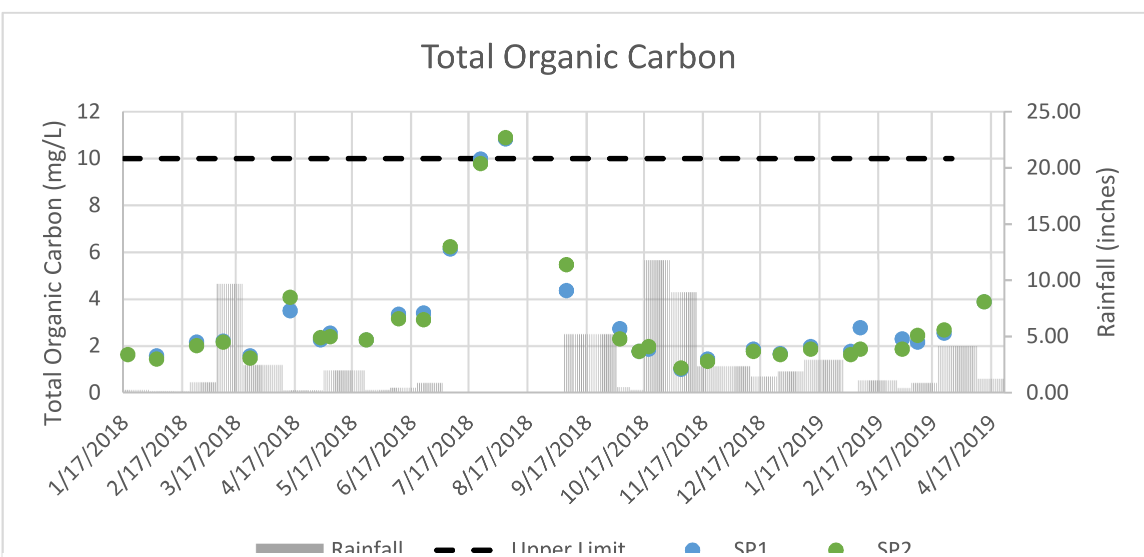

Figure 4: Total Organic Carbon

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- *Fecal Coliform*

  Les Lacs pond is not used for primary or secondary recreation, so concentrations of fecal coliform above 2,000 cfu/100 mL are not a primary concern. Fecal coliform contains nitrogen and phosphorus and can contribute to nutrient overloaded of the pond. Fecal coliform values that exceed 200 colony forming units per 100 milliliters (cfu/100mL) are potential concern for primary contact recreation activities and values over 2,000 cfu/100mL are a potential concern for secondary contact recreation activities [4]. Primary contact recreation, such as swimming, surpasses the needs for Les Lacs pond. Secondary contact recreation activities include fishing, boating, and limited body contact activity. The higher concentration levels found in the pond can cause diarrhea in dogs who may drink from the pond and illness in humans who come into contact with it.

  Monitoring fecal coliform is beneficial when determining the source of nutrient overloading. Concentrations over 10,000 cfu/100 mL are considered immensely high. Further testing may be needed if concentrations are over 10,000 cfu/100 mL. Figure 5 shows fecal coliform concentrations and rainfall over the sampling period.

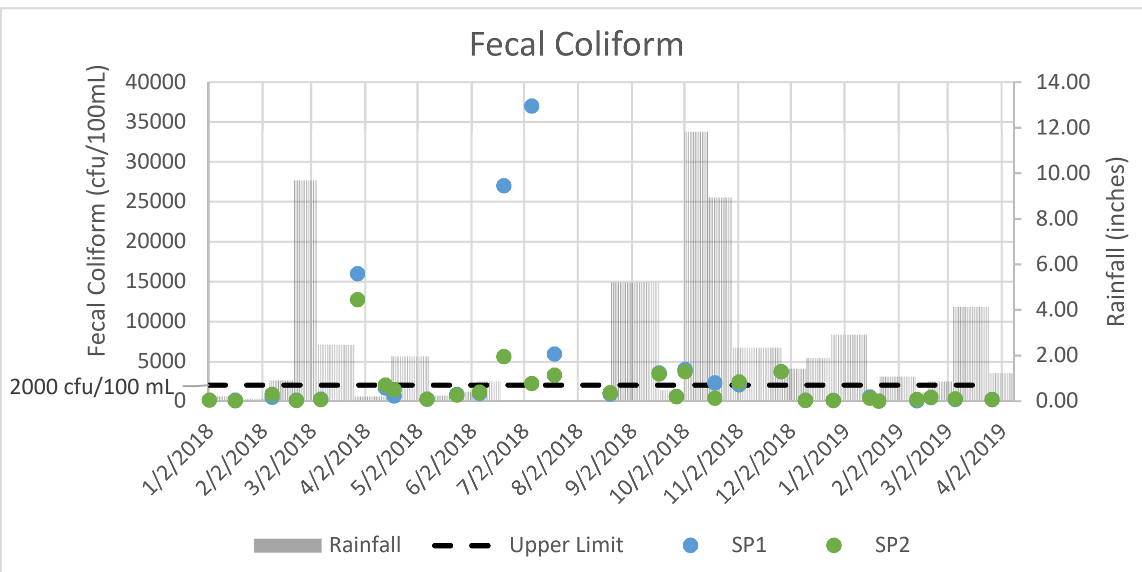

Figure 5: Fecal Coliform

<u>Indicators of Pollution Events</u>

- *BOD, 5 Day*

  BOD levels are high during the early summer season. Pristine water bodies typically have BOD values less than 2 mg/L, moderately polluted water bodies typically have BOD values in the 2 mg/L to 8 mg/L range, and efficiently treated sewage typically has BOD values between 20 mg/L and 30 mg/L. A value of 30 mg/L for BOD is considered very high. The goal should be to keep BOD levels below 20 mg/L. [5] High productivity often correlates with high BOD levels. BOD is the amount of oxygen consumed by bacteria in the decomposition of organic material such as plant decay and leaf debris. Excessive BOD can decrease dissolved oxygen levels which detrimentally affects other aquatic organisms which rely on the oxygen in the water for survival.

  Figure 6 shows BOD5 concentrations and rainfall over the sampling period.

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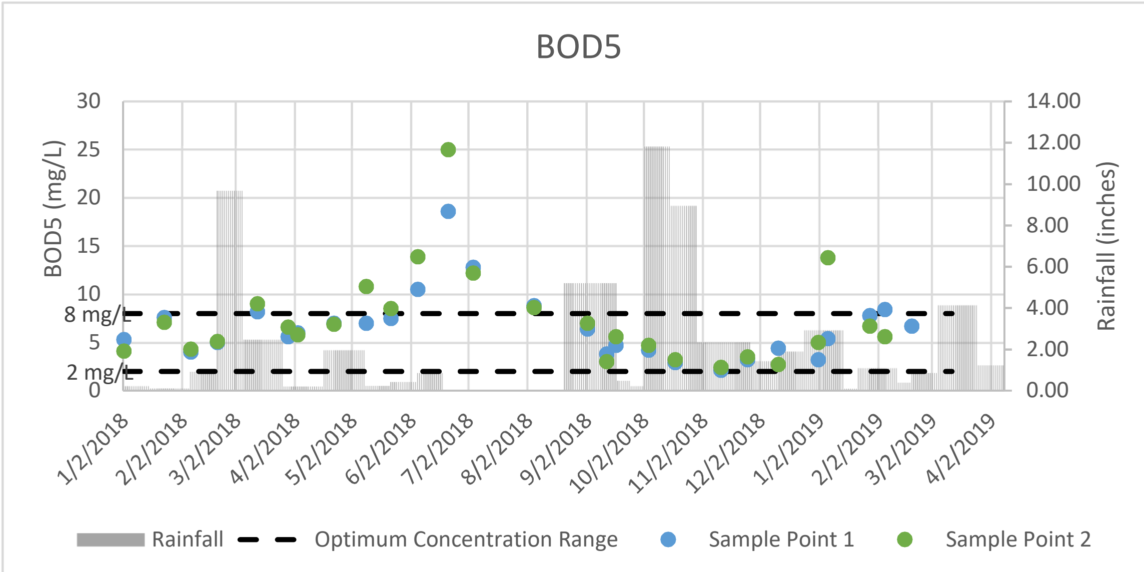

Figure 6: BOD, 5-Day

- *Total Suspended Solids*

TSS levels are higher during the early summer season, and their concentration pattern is very close to that of BOD5. High TSS values are levels are greater than 45 mg/L [6]. This level is based on the typical maximum daily effluent limitation for treatment facilities. High total suspended solid values can block light from reaching submerged vegetation within water bodies and may indicate that high levels of bacteria, nutrients, pesticides, and/or metals are present in the water. Homeowners and municipalities apply fertilizer and pesticides more in the summer months, both of which can enter the pond by runoff.

Figure 7 shows TSS concentrations and rainfall over the sampling period.

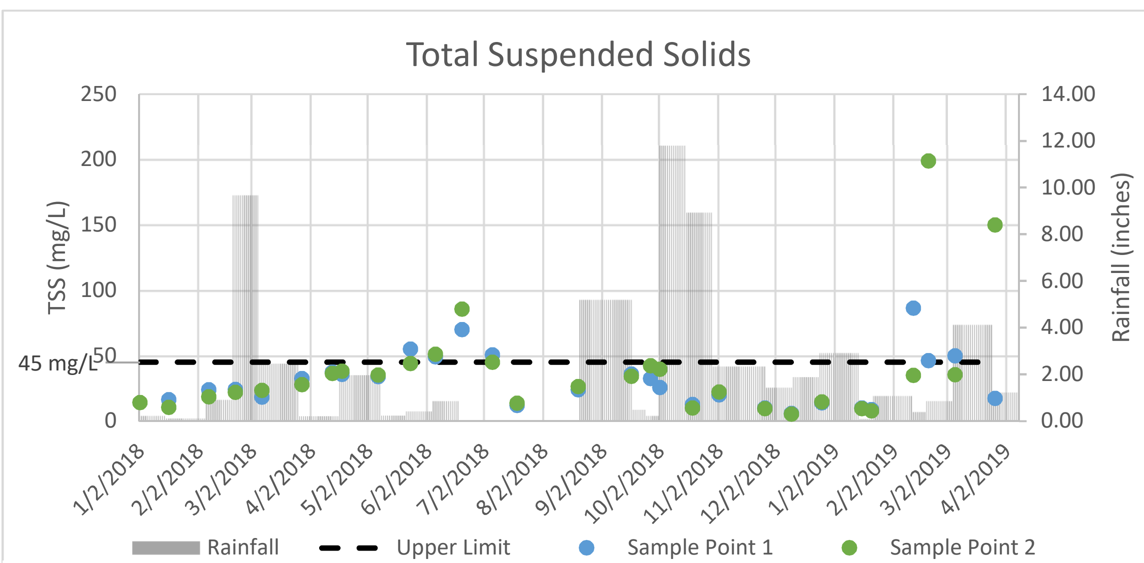

Figure 7: Total Suspended Solids

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- *Chlorophyll-a*

Chlorophyll-a in Les Lacs pond consistently reflects eutrophic and hypereutrophic conditions and indicates high productivity within the water column. Chlorophyll-a concentration trends indicate that levels increase with higher temperatures and increased nutrient loading. Chlorophyll-a values below 10 ug/L are typically indicative of good water quality while values over 13 ug/L are more indicative of high productivity within the water column and eutrophic conditions [7].

Chlorophyll-a indirectly measures the amount of photosynthesizing plants within a body of water such as algae. Abnormally large chlorophyll-a levels typically indicate that a body of water is high in nutrients. Eutrophic water bodies have high biological productivity due to excessive nutrients, especially nitrogen and/or phosphorous. Aquatic plants or algae typically dominate eutrophic water bodies, and when dominated by algae, eutrophic water bodies are darker and murkier and can occasionally have large algal blooms.

Figure 8 shows total phosphorus concentrations and rainfall over the sampling period.

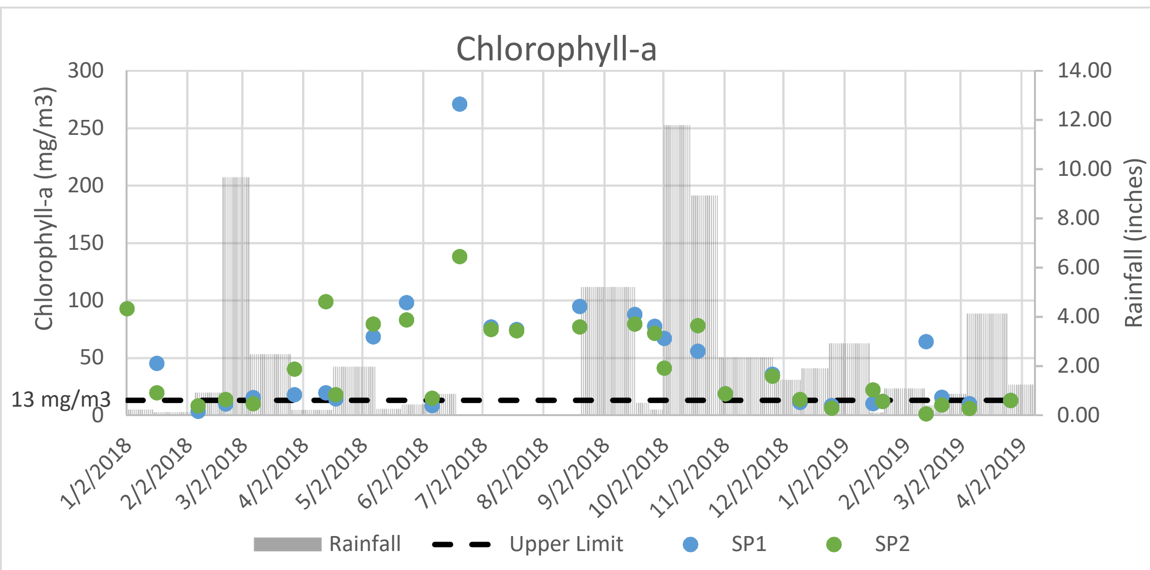

Figure 8: Chlorophyll-a

Function of Groundwater

Regional subsurface geology determines typical characteristics of groundwater in a given area. Groundwater's chemical makeup heavily influence parameters such as total dissolved solids and alkalinity. The pond is pumped with groundwater during times of low rainfall. Therefore, the pond will have higher concentrations of alkalinity and total dissolved solids during times where the well is pumped at higher rates.

- *Total Dissolved Solids*

TDS values are expected to increase to 800 mg/L or higher whenever rainfall is limited and the well is pumped consistently to fill the pond. Total dissolved solids are produced by both natural and human produced sources. A natural source is water hardness. The

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groundwater in the Dallas area is known to have moderately hard water, meaning it contains minerals such as calcium and magnesium. Calcium and magnesium are measured as a part of total dissolved solids. Human produced sources can also contribute to high dissolved solid levels such as salts for de-icing roads, lawn treatments, and fertilizer runoff. Total dissolved solids levels observed in the Les Lacs pond exceed the limits for extremely hard water. The lack of natural areas with runoff, areas such as hard edged streets, storm sewers, roofs, and other impermeable surfaces contribute to the high total dissolved solid levels.

Texas Water Development Board (TWDB) runs an interactive water data website that shows the wells in Texas and a well report from when the well was first registered with the TWDB. For the Les Lacs well, well number 33-02-406, the 1982 Well Report documents a TDS level of 708 mg/L. This is not irregular since the TWDB determined that TDS concentrations in Dallas County groundwater can range from under 1,000 mg/L to 5,000 mg/L [8]. Taking into an account a safety factor for natural variances, values under 800 mg/L are considered typical for the Les Lacs pond. Values over 800 mg/L indicate that additional non-natural sources are also contributing to high TDS values.

Figure 9 reflects this trend and sees higher TDS values at times were rainfall is low.

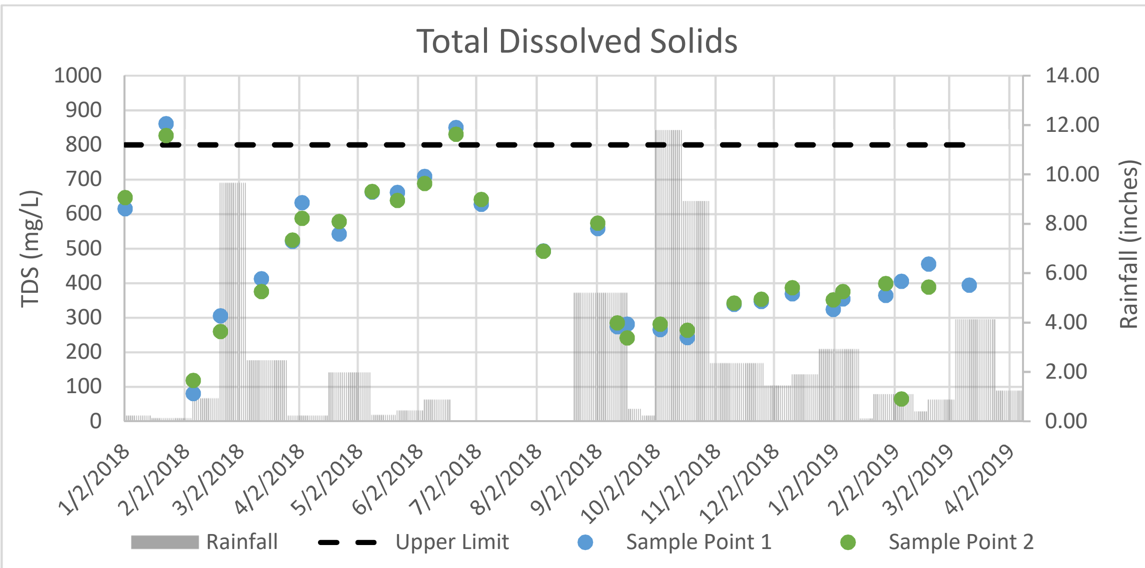

Figure 9: Total Dissolved Solids

- *Alkalinity*

The alkalinity levels in Les Lacs pond consistently reflects sufficient buffering capacity for maintaining ph. Of the discrete sampling parameters tested, alkalinity is the only parameter that remained within the optimum levels. Alkalinity is the buffering capacity of a body of water and reflects how well it can resist changes in pH. Measurable alkalinity above 20 mg/L provides a buffer that helps maintain a water body's pH while values below 20 mg/L can result in reduced buffering capacity and stunted aquatic life population. [9]

Running the well for makeup water has helped water quality by resisting changes in the ph..

Figure 10 shows alkalinity levels and rainfall over the sampling period.

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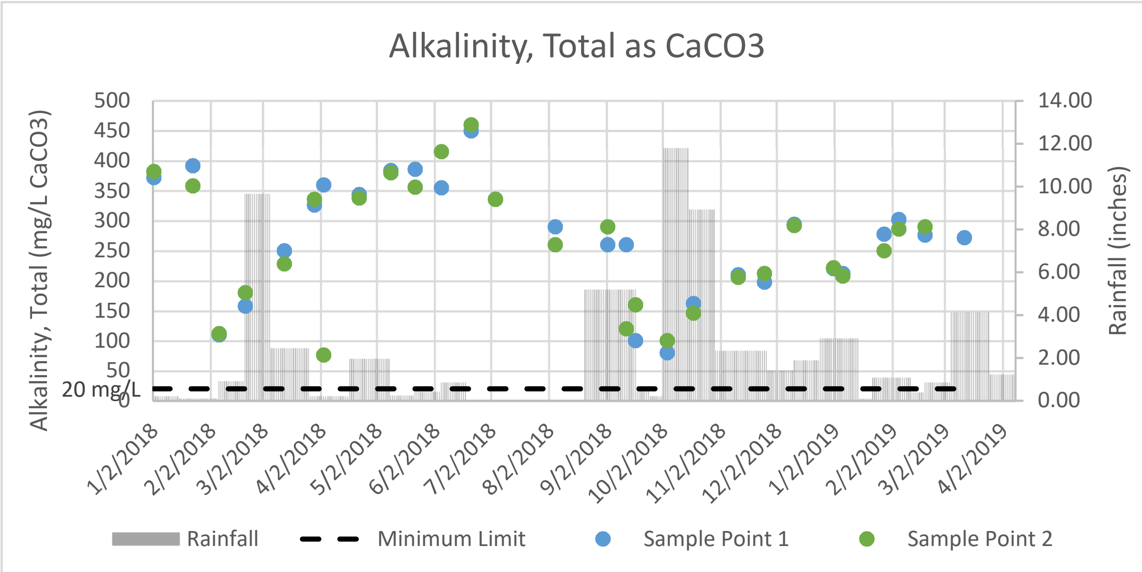

Figure 10: Alkalinity, Total as CaCO3

Tables of each parameter are included in Appendix A.

Although in-situ parameters such as temperature, dissolved oxygen, pH, and clarity were requested, their results were not provided at the time of this report.

Rainfall was also considered to impact certain parameters. Rainfall stations in Johnston Park in Farmer's Branch, Downtown Carrollton, and Dallas Love Field were used to estimate rainfall for monthly rainfall during the sampling. Table 1 shows the rainfall measured in inches.

Table 1: Rainfall in Inches

Date	Rainfall (in.)	Date	Rainfall (in.)
12/31/2017 - 1/13/2018	0.23	9/16/2018 - 9/22/2018	0.50
1/14/2018 - 2/3/2018	0.12	9/23/2018 - 9/29/2018	0.23
2/4/2018 - 2/17/2018	0.92	9/30/2018 -10/13/2018	11.80
2/18/2018 - 3/3/2018	9.66	10/14/2018 - 10/27/2018	8.92
3/4/2018 - 3/24/2018	2.47	10/28/2018 - 11/24/2018	2.35
3/25/2018 - 4/14/2018	0.22	11/25/2018 - 12/8/2018	1.44
4/15/2018 - 5/6/2018	1.97	12/9/2018 - 12/22/2018	1.90
5/7/2018 - 5/19/2018	0.25	12/23/2018 - 1/12/2019	2.92
5/20/2018 - 6/2/2018	0.43	1/13/2019 - 1/19/2019	0.11
6/3/2018 - 6/16/2018	0.87	1/20/2019 - 2/9/2019	1.09
6/17/2018 - 6/30/2018	0.00	2/10/2019 - 2/16/2019	0.40
7/1/2018 - 7/14/2018	0.02	2/17/2018 -3/2/2019	0.87
7/15/2018 - 8/4/2018	0.00	3/3/2018 - 3/23/2019	4.13
8/5/2018 - 8/18/2018	0.02	3/24/2019 - 4/6/2019	1.24
8/19/2018 - 9/15/2018	5.20		

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February and October 2018 saw the highest rainfall, while the summer months saw the least amount of rainfall. The higher rainfall helps to prevent higher pond concentration levels by flushing. Low rainfall events will wash phosphorus and nitrogen into the pond.

One main purpose of the extensive lab testing in 2018 and part of 2019 was to determine if pumping well water into Les Lacs pond improved overall water quality. The only data available before the well improvement project was a 2015 sampling report that tested many of the same parameters. The 2015 report had two sampling events, once in the summer (August 2014), and once in the winter (January 2015),at multiple locations throughout the pond. Below is a comparison of those report levels compared to existing lab results.

- Total Phosphorus – Existing phosphorus levels were similar but slightly lower to the summer sample (August 2014) but no phosphorus was detected in the winter of 2015 sample (January 2015). Therefore phosphorus is increasing during winter months.
- Total Nitrogen – Existing total nitrogen levels were higher since the 2015 report but remained similar in the winter months.
- Total Organic Carbon – Existing total organic carbon levels are lower in both the summer and winter month since the 2015 report.
- Fecal Coliforms – Existing fecal coliform levels were considerably higher during both winter and summer months compared to the 2015 report.
- BOD, 5-day – Existing BOD levels decreased in the summer months (August 2019), but levels remained similar in the winter month (January 2015).
- Total Dissolved Solids – Existing TDS levels were higher in the summer months since the 2015 report but remained similar in the winter months. This can be attributed to running the well water more frequently.
- Total Suspended Solids – Existing TSS levels were higher in the summer month (August 2014) but lower in the winter month (January 2015).
- Chlorophyll-a – Existing chlorophyll-a summer levels were higher than the August 2014 sample but lower in the winter month of January 2015.
- Alkalinity – Existing alkalinity levels were higher in both the summer and winter months since the 2015 report. This can be attributed to running the well water more frequently.

Although alkalinity and TDS have both drastically increased since 2015's report, it does not necessarily mean these parameters are degrading the pond water. The well water naturally has high levels of alkalinity and TDS. Alkalinity is a measure of buffering capacity, and higher levels only help the water body's ability resist drastic changes in pH. Natural occurring elements can contribute to TDS levels. If ground water has high TDS levels, it can be as a result of high levels of natural elements in the subsurface geology – as in the case of the well water pumped into Les Lacs pond. Although nitrogen and phosphorus are measured in TDS, high levels of nitrogen and phosphorus are not common in groundwater. Therefore, when the water in the pond exceeds the natural well water TDS levels, it is most likely due to human caused nutrient overloading.

In months where the well pumps longer to make up for lack of rainfall, TDS and alkalinity levels in the pond will likely increase. TDS and alkalinity levels alone do not reflect the quality of the water in the pond and should be compared to other values such as total nitrogen and phosphorus to determine impact on the pond.

The lab results also show that the levels of TSS and fecal coliforms have increased in the summer months since the 2015 report. While fecal coliform can pose health risks if humans or animals come in to

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contact with the water, increased TSS levels can impact clarity and overall aesthetics of the pond. Even though TSS levels have increased since 2015, they are still on average below 45 mg/L.

Recommendations

The Town of Addison will need to implement other Best Management Practices (BMP's) to improve water quality. The shallow depth of the pond poses a challenge for healthy ecological pond system. Recommended BMP's are:

1. Implement a consistent program to document and record complaints from citizens and staff of the pond water quality consistently.
2. Enforce mandatory use of phosphorus-free fertilizers by Town worker's in public areas including adjacent areas and also in upstream drainage basin such as in Photon Drive.
3. Increase public education of residences of using phosphorous free fertilizers in lawn care, and wastes entering storm sewer inlets in adjacent residences along adjacent streets, as well as the entire drainage basin including Bentwater Court, portions of Photon Drive, and portions of Les Lacs Drive.
4. Begin a regimented chemical water testing program based around phosphorus, nitrogen, dissolved oxygen, ph, chlorophyll-a, and fecal coliform, to be proactive to water quality irregularities, and trigger corrective actions such as stricter enforcement of polluted runoff, chemical treatments, or water body quality controls.
5. Chemical treatment to help precipitate phosphorus and decrease its levels. This can be done with phosphorus reducing chemical treatments, and special type algaecide and herbicide treatments.
6. Plant and maintain vegetation buffers around pond to help filter pollutants carried in runoff and to adsorb excess nutrients such as nitrogen and phosphorus
7. Post signs during High levels of nutrients in water for increase public awareness and input on reducing fertilizing, yard waste disposal in storm sewers.
8. Flush pond during hazardous periods with supplemental water supply.
9. Increase frequency of basket cleanings of the recirculation system to remove waste and nutrients from system.
10. Monitor chemical properties of silt in bottom as well as depth on 5-year program to determine rate of increase of nutrients concentrations and volume, and develop planning for future removal if need develops.

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Citations

[1] "Trophic Classification of Texas Reservoirs – 2010 Texas Water Quality Inventory and 303(d) List," Texas Commission of Environmental Quality, last modified on November 18, 2011, https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/10twqi/2010_reservoir_narrative.pdf
[2] "Total Nitrogen," Environmental Protection Agency, last updated June 4, 2013, https://www.epa.gov/sites/production/files/2015-09/documents/totalnitrogen.pdf
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[8] "Texas Aquifers Study – Groundwater Quantity, Quality, Flow, and Contributions to Surface Water", Bech Bruun & Kathleen Jackson & Peter Lake & Jeff Walker, December 31, 2016, http://www.twdb.texas.gov/groundwater/docs/studies/TexasAquifersStudy_2016.pdf
[9] "National Recommended Water Quality Criteria – Aquatic Life Criteria Table," Environmental Protection Agency, https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

Les Lacs Pond
Water Quality Program

APPENDIX A
Parameter Lab Results Tables

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Table A.1 shows the concentrations for total dissolved solids, BOD5, total phosphorus, chlorophyll-a, total nitrogen, fecal coliform, total organic carbon, and total suspended solids.

Table A.1: Parameter Concentrations

Date	Total Dissolved Solids (mg/L)		BOD, 5 Day (mg/L)		Total Phosphorus (mg/L)		Chlorophyll-a (ug/L)	
	SP1	SP2	SP1	SP2	SP1	SP2	SP1	SP2
1/2/2018		520		2.2		0.08		92.6
1/17/2018	615	647	5.3	4.1	0.06	0.37	45	19.3
2/7/2018	861	827	7.6	7.1	0.09	0.09	3.3	8
2/21/2018	80	118	4	4.3	0.16	0.15	9.6	13.4
3/7/2018	305	259	5	5.1	0.08	0.08	15.1	9.8
3/28/2018	412	375	8.2	9	0.17	0.17	17.8	40
4/13/2018	520	524	5.6	6.6	0.20	0.21	19.3	98.8
4/18/2018	632	587	6	5.8	0.16	0.17	14.1	17.8
5/7/2018	542	578	7	6.9	0.12	0.15	68.2	79.2
5/24/2018	663	665	7	10.8	0.16	0.19	97.9	82.8
6/6/2018	662	639	7.5	8.5	0.19	0.19	8.1	14.5
6/20/2018	708	688	10.5	13.9	0.15	0.23	271	138
7/6/2018	850	830	18.6	25	0.20	0.22	76.8	74.5
7/19/2018	628	642	12.8	12.2	0.22	0.23	74.5	73.4
8/6/2018							94.6	76.8
8/20/2018	493	492	8.8	8.6	0.15	0.16	87.5	79.2
9/17/2018	557	573	6.4	7	0.14	0.14	77.4	71.2
9/26/21018	273	284	3.8	3	0.01	0.14	66.8	40.9
10/1/2018	281	241	4.7	5.6	0.09	0.12	55.6	77.9
10/18/2018	265	281	0	0	0.07	0.06	18.5	18.5
11/2/2018	242	263	4.2	4.7	0.09	0.08	35.6	33.8
11/26/2018	338	342	2.9	3.2	0.00	0.00	11.1	13.4
12/10/2018	346	353	2.1	0	0.05	0.06	8.3	5.9
12/26/2018	369	386	3.2	2.4	0.09	0.08	10	21.8
1/16/2019	323		4.4	3.5	0.06	0.07	11.9	11.9
1/21/2019	354	351	3.2	2.7	0.06	0.06	64	1.1
2/12/2019	364	375	5.4	5	0.13	0.11	15.6	8.9
2/20/2019	405	398	7.8	13.8	0.20	0.98	10	5.8
3/6/2019	455	64	8.4	6.7	0.20	0.19	12.7	12.7
3/27/2019	394	388	6.7	5.6	0.27	0.53	36.5	68.5

Within Optimum Levels
Outside Optimum Levels
Outside Optimum Level but Not Excessive

HALFF

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Table A.1 (Continued): Parameter Concentrations

Date	Total Nitrogen (mg/L)		Fecal Coliform (cfu/100mL)		Total Organic Carbon (mg/L)		Total Suspended Solids (mg/L)	
	SP1	SP2	SP1	SP2	SP1	SP2	SP1	SP2
1/2/2018		0.8		118		3.4		14.3
1/17/2018	0.8	1.0	127	45	3.3	3	16.4	10.7
2/7/2018	1.5	1.0	490	855	4.5	4.2	24.1	18.7
2/21/2018	1.0	1.2	118	82	4.6	4.5	24.3	22.1
3/7/2018	1.2	1.3	250	209	3.3	3.1	18.5	23.5
3/28/2018	1.5	1.2	15,973	12,745	7.3	8.5	32.6	27.9
4/13/2018	5.4	1.6	1,636	2,009	4.7	4.9	37.6	36.4
4/18/2018	1.9	1.9	664	1,455	5.3	5	35.8	38.3
5/7/2018	0.9	2.2	240	250	4.7	4.7	34	35.2
5/24/2018	1.5	2.0	855	782	7	6.6	55	44.1
6/5/2018	2.6	2.4	982	1,127	7.1	6.5	49.2	51.1
6/19/2018	5.6	4.3	27,000	5,600	12.8	13	70	85.7
7/5/2018	6.2	6.1	37,000	2,200	20.8	20.4	50.8	45
7/18/2018	4.2	4.8	5,900	3,255	22.6	22.7	12	13.8
8/6/2018			895	1,048				
8/20/2018	2.5	2.4	3,555	3,400	9.1	11.4	24	26.6
9/17/2018			560	560				
9/26/21018	2.0	2.0	4,000	3,700	3.7	3.7	32.7	42.4
10/1/2018	1.5	1.5	2,300	370	3.9	4.1	25.7	39.6
10/18/2018	0.7	0.7	2,045	2,436	2.1	2.2	12.8	10.2
11/2/2018	0.8	1.6	3,700	3,700	3	2.8	20	22.4
11/26/2018	ND	0.5	109	73	3.9	3.7	10.2	9.7
12/10/2018	0.7	ND	91	100	3.5	3.4	6	5.4
12/26/2018	1.6	1.3	520	380	4.1	3.9	14	14.8
1/16/2019	0.5	0.8	10	10	3.7	3.4	10.2	9.6
1/21/2019	0.7	0.8	64	210	5.8	3.9	8.9	8
2/12/2019	2.2	1.4	470	480	4.8	3.9	86.4	35
2/20/2019	1.5	3.1	210	273	4.5	5.1	46.4	199
3/6/2019	2.5	2.5	220	220	5.3	5.6	50	35.6
3/27/2019	4.7	8.7	370	310	8.1	8.1	17.5	150

Within Optimum Levels
Outside Optimum Levels
Outside Optimum Level but Not Excessive