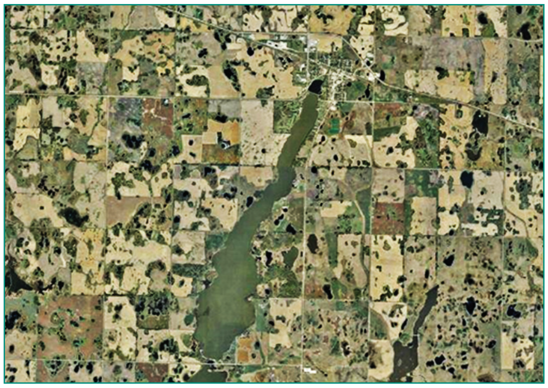
Shoal Lake - MICROBE-LIFT® Reduces Final Effluent BOD, COD, and Nitrate, to Achieve Discharge Requirements, while Desludging the Lagoon Series and Reducing Odor.

Location: **Shoal Lake, Western Manitoba, Canada**

Background: Shoal Lake is a small town of less than 1,000 people in western Manitoba. The wastewater generated by the town is treated in a series of three aerated facultative lagoons to lower key pollutant discharge parameters prior to discharge to the lake. The lagoons are in series and referred to as Cell #1, #2, and #3. Cells #1 and #2 are both 49 years old with a surface area of 5 acres and a depth of 6 feet with an approximate volume of 10 million gallons (MG). Cell #3 has been in service for 26 years and is 7 acres by 6 feet deep with an approximate volume of 14 MG. Normal inflow into the series of lagoons is approximately 0.22 million gallons per day (MGD). There is an estimated 2 feet of sludge in each lagoon. This sludge build-up reduces the working volume of the lagoons and the hydraulic retention time (HRT) of the system by about 30%.



Shoal Lake and lagoon system

Before the winter weather arrives, the lagoons are pumped down so that water can be collected during the winter months when no water is discharged. When the warmer weather arrives in the spring, water is discharged to the lake from the 3rd Cell after the water has been shown to be below discharge limits. The city's permit requires that the following parameters be met before discharge: BOD <30 mg/L; and total phosphate <1.0 mg/L. The lagoons also must keep offensive odors minimized.

Since the biological activity slows down dramatically while the load is continually fed to the system over the winter months, it is desirable that the biological activity increases as quickly as possible in the spring to take advantage of the time frame when ambient temperatures are warm enough to effect adequate treatment.

Objective: In 2012, the city made the decision to evaluate a biological additive that would increase the biological activity quickly to achieve high levels of treatment as soon as possible. Samples for key operating parameters commonly monitored for wastewater discharge were taken monthly to effectively monitor the system efficiency. These included: BOD, COD, TSS, TKN, ammonia, nitrite, nitrate, total and reactive phosphorous. The additive evaluated was MICROBE-LIFT® formulation, produced by Ecological Laboratories, Inc. in Cape Coral, FL and supplied by Gerald Wiebe and Associates, of Manitoba. This product has been used successfully worldwide to improve the efficiency of biological systems, including lagoon systems, producing a high quality effluent and at the same time reducing odors, and breaking down organic sludge that has built up on the bottom of the lagoon resulting in significant overall cost savings.

CELL 1

Limited historical data on this system was available. More comprehensive monitoring was performed this year in order to better evaluate the impact of the bioaugmentation program. Performance of the individual Cells was monitored. The primary wastewater monitoring parameters for Cell #1 can be found in Figure 1.

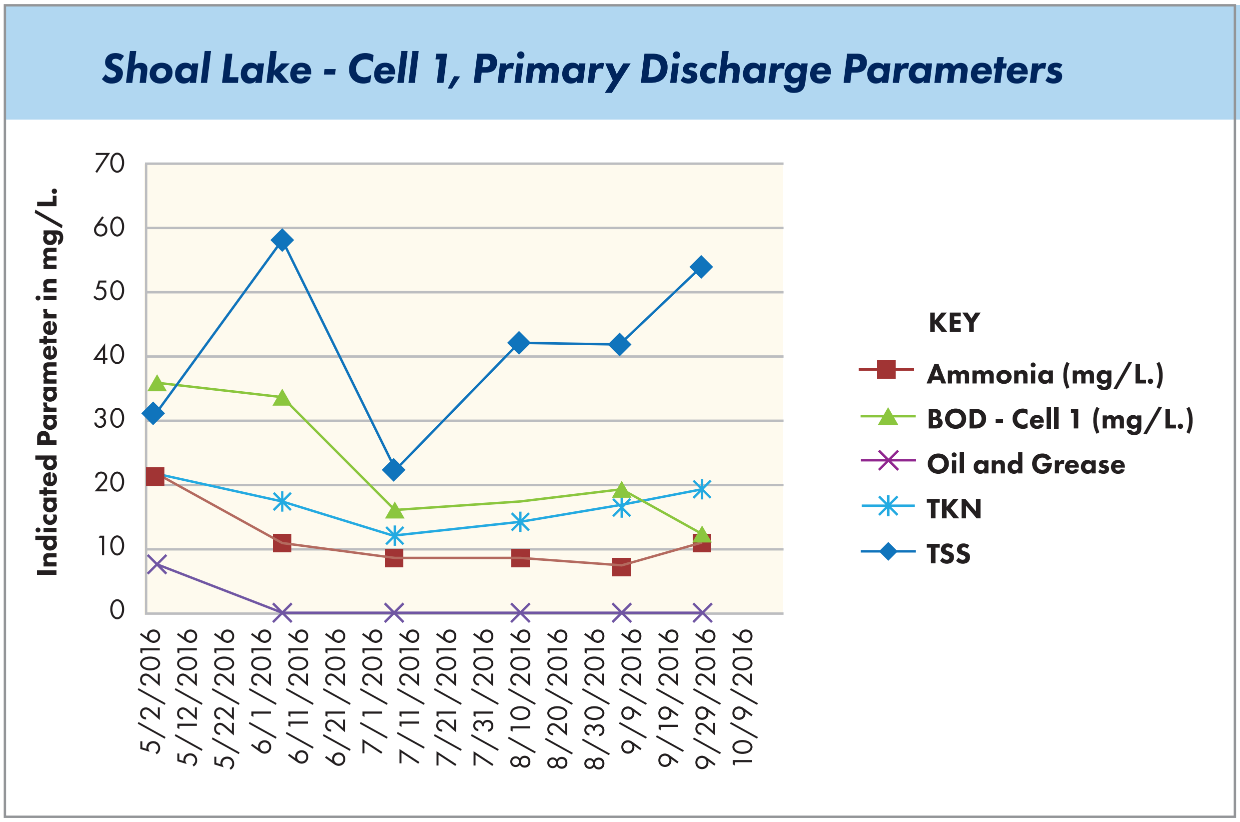


Fig.1: *Operating results for Shoal Lake Cell #1.*

The most dramatic drop was observed in BOD from the May through July time frame, with a total reduction of over 50% to below 20 mg/L. Similar results were observed with ammonia, TKN, and oil & grease. The only parameter, which increased was the TSS, which is to be expected as the bacterial population grows to handle the organic load. However, once their source of substrate was depleted, or stabilized, a drop in the TSS was observed in July. A later increase in TSS was likely due to the bacteria beginning to digest the accumulated organic solids in the lagoon bottom as a food source.

CELL 1

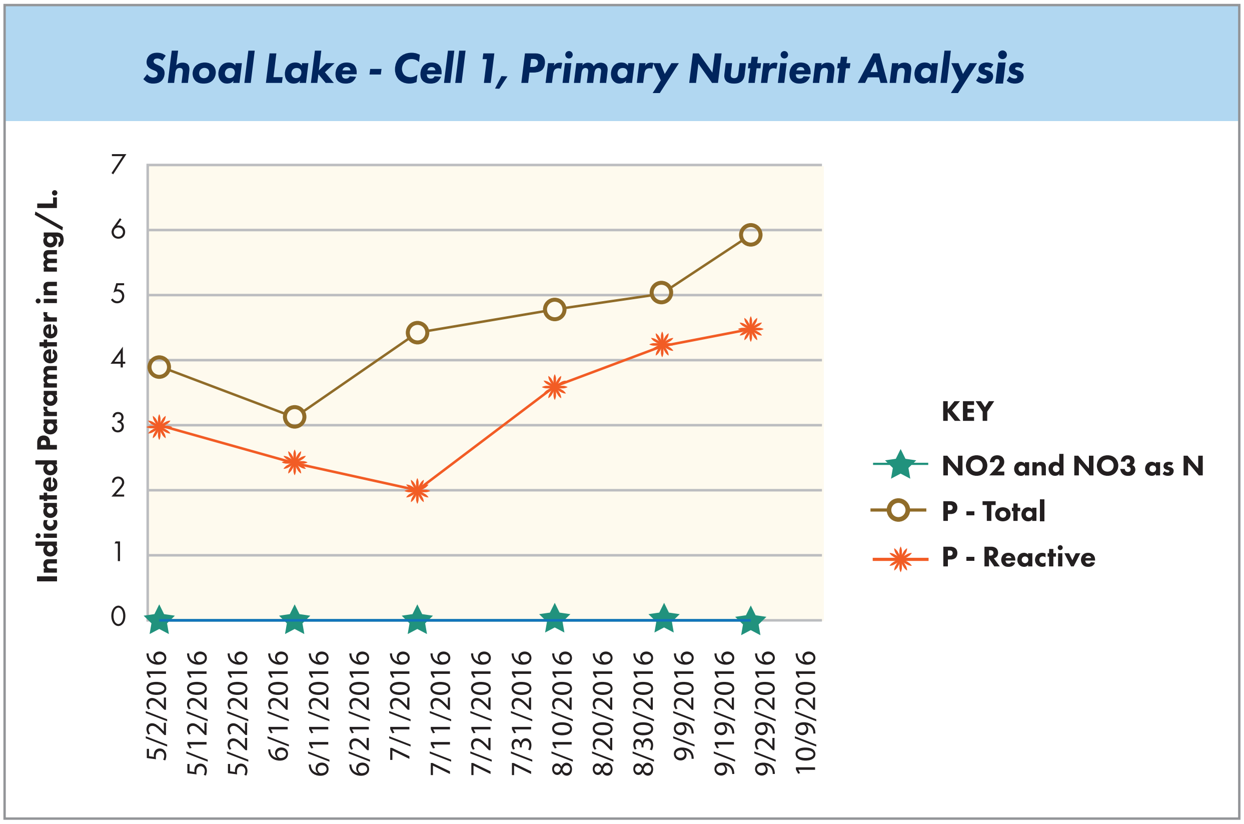


Fig. 2: *Shoal Lake Cell #1 Nutrient Data*

The nutrient analyses for Cell #1, which appear in Figure 2, show negligible levels of nitrites and nitrates throughout. It is possible that the primary mechanism for ammonia reduction, this early in the application, is a result of heterotrophic uptake of ammonia as a source of nitrogen for Cell synthesis. This is supported by the initial increase in TSS. Reactive phosphorous was also reduced, and again the probable mechanism is heterotrophic uptake to meet phosphorous requirements of the bacterial growth. The slight increase in total phosphorous is likely due to breakdown of biological solids on the bottom of the lagoon, but it should not be as great a concern since the non-reactive fraction of the phosphorous is less likely to create water quality issues like green water events.

CELL 2

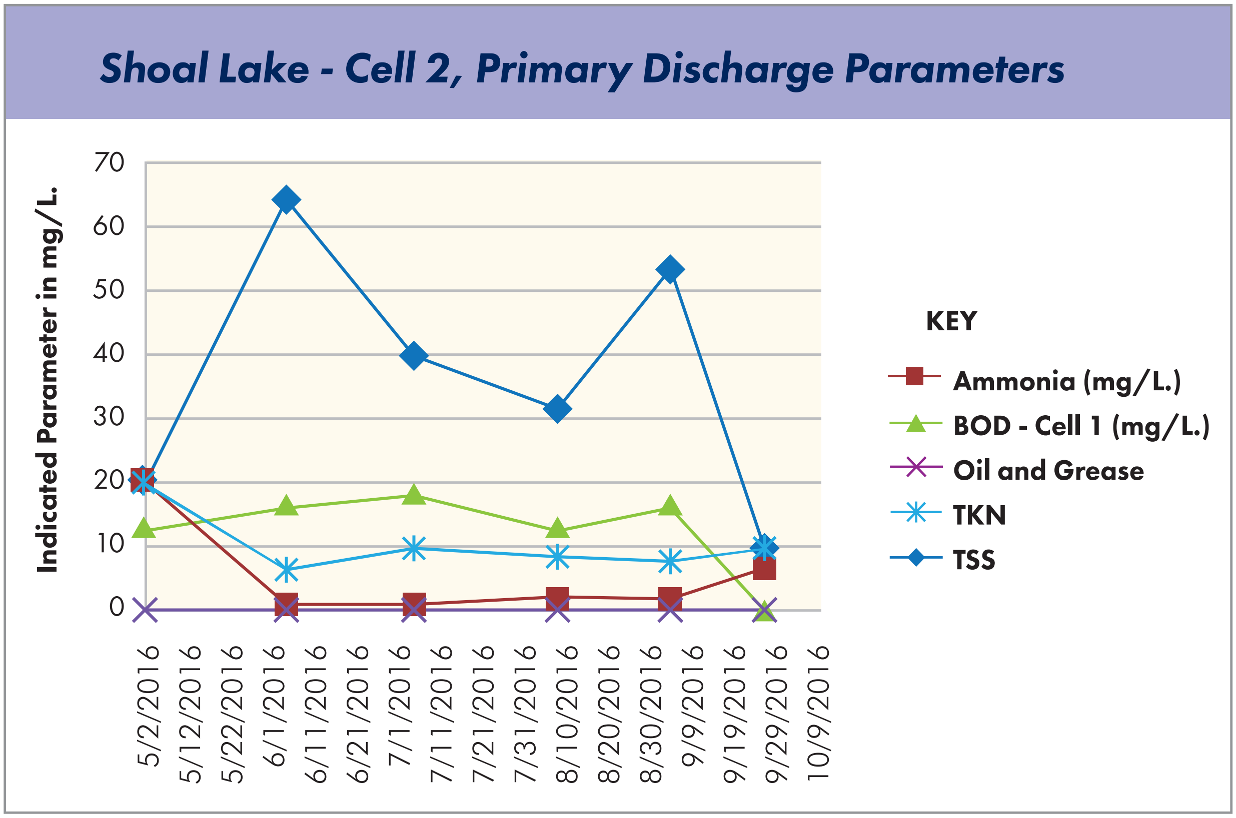


Fig. 3 : *Operational results for Shoal Lake Cell #2*

Proceeding to the primary discharge data in Cell #2 (Figure 3), all parameters with the exception of BOD have been reduced significantly. The BOD has risen slightly, and this is something that has been observed in many lagoon applications worldwide. This increase is due to the breakdown of solids that have accumulated on the bottom of the lagoon once the soluble organics have been lowered significantly. In documented cases, it has been demonstrated that from 1" to 3" of organic solids, which have accumulated on the bottom of a lagoon, can be digested per month. This usually results in substantial savings in dredging costs.

CELL 2

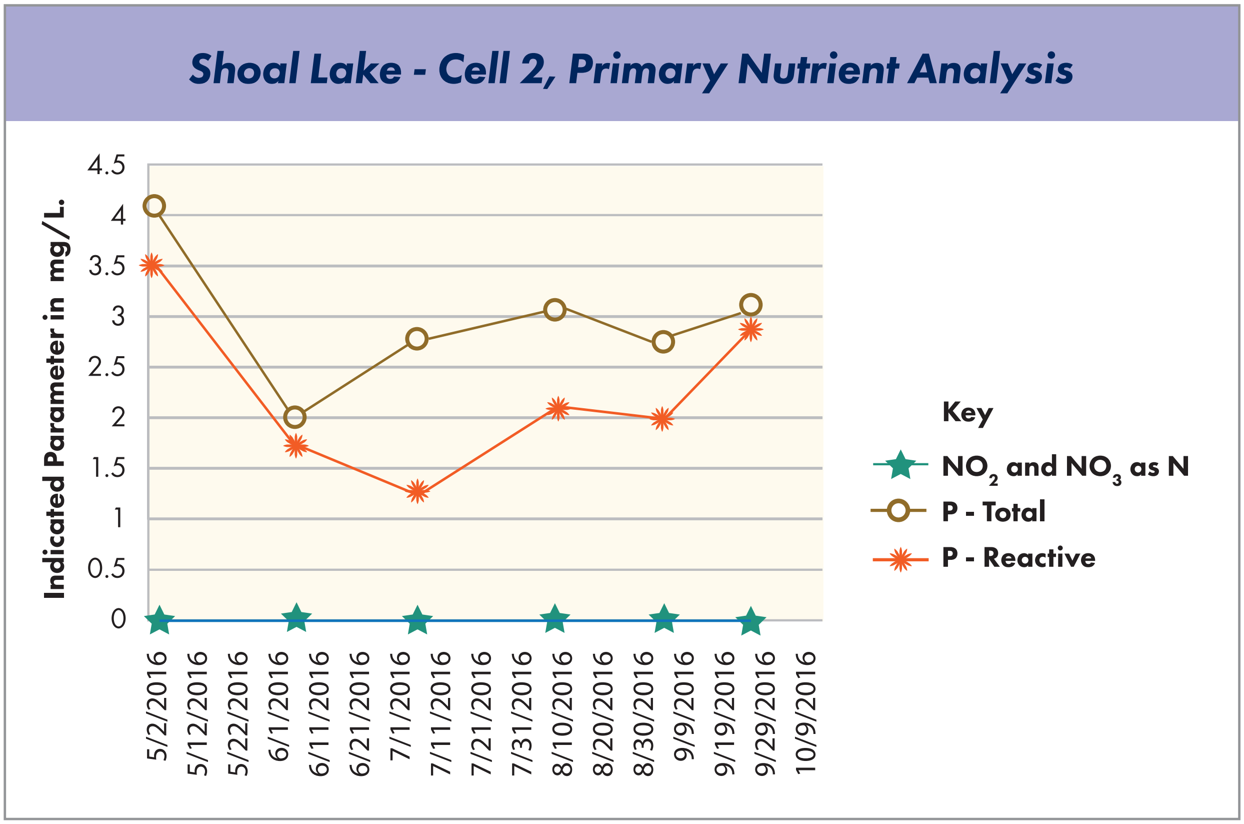


Fig. 4: *Shoal Lake Cell #2, nutrient data*

Nutrient levels (Figure 4) show that nitrite and nitrate levels continue to be very low. Total and reactive phosphorous are somewhat higher but the more important reactive phosphorous being reduced to almost 1/0 mg/L. There will be less heterotrophic uptake of nutrients as the organics are reduced as a result of removal in Cell #1.

CELL 3

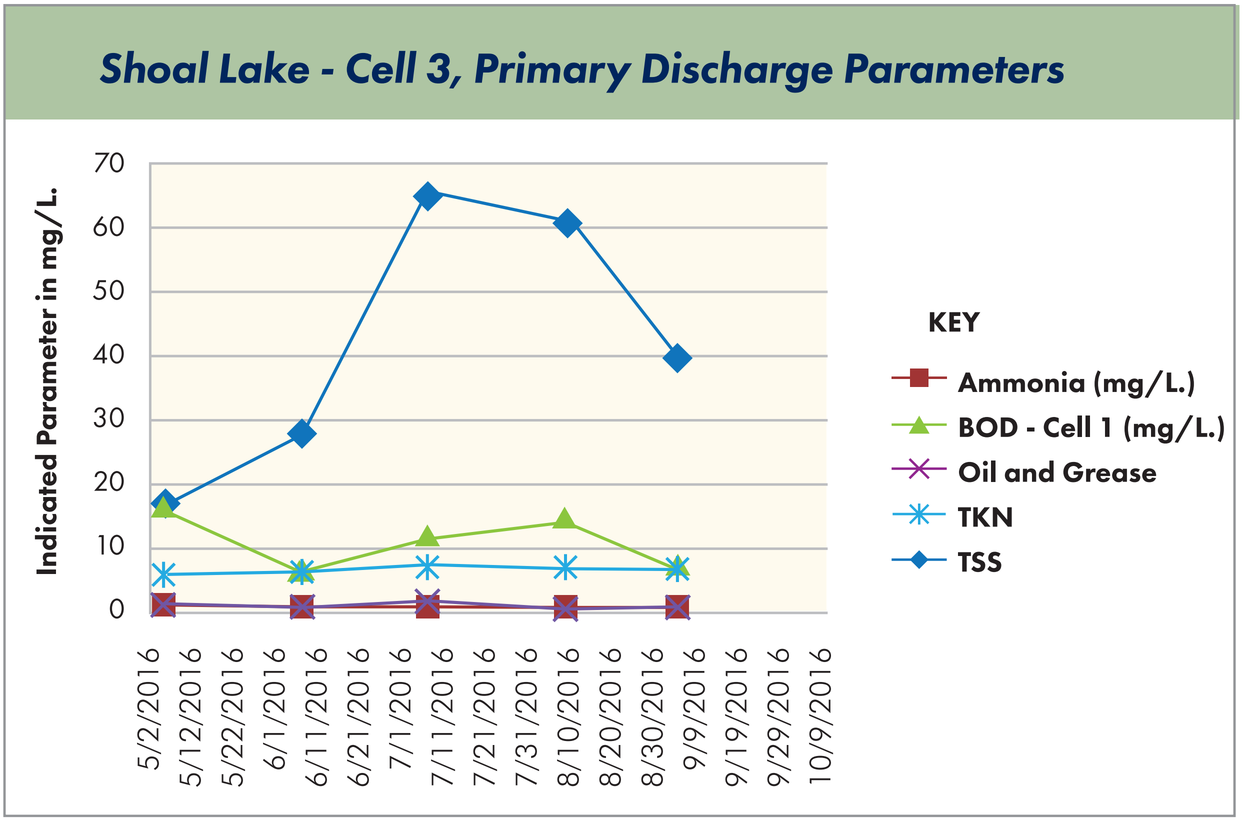


Fig. 5: *Shoal Lake Cell #3 performance data.*

In Cell #3 (Figure 5) the primary discharge levels have been reduced, with the exception of TSS. All permitted discharge parameters have been reduced to below allowable discharge limits for most bodies of water. Our experience shows that most lakes will have background levels below what is observed here. Again, there is a slight rise in TSS values, as the beneficial bacteria multiply in the process of breaking down the organic pollutants. Eventually, the equilibrium levels of organics will be reduced to a level where the bacteria will go into endogenous respiration and the TSS levels will drop.

There were no detectable results for nitrite and nitrate reported for Cell #3 (Figure 6) . The reactive phosphorous levels did decline but then rose slightly due to the run-off to the influent, while the total phosphate level remained unchanged due to celllular uptake.

CELL 3

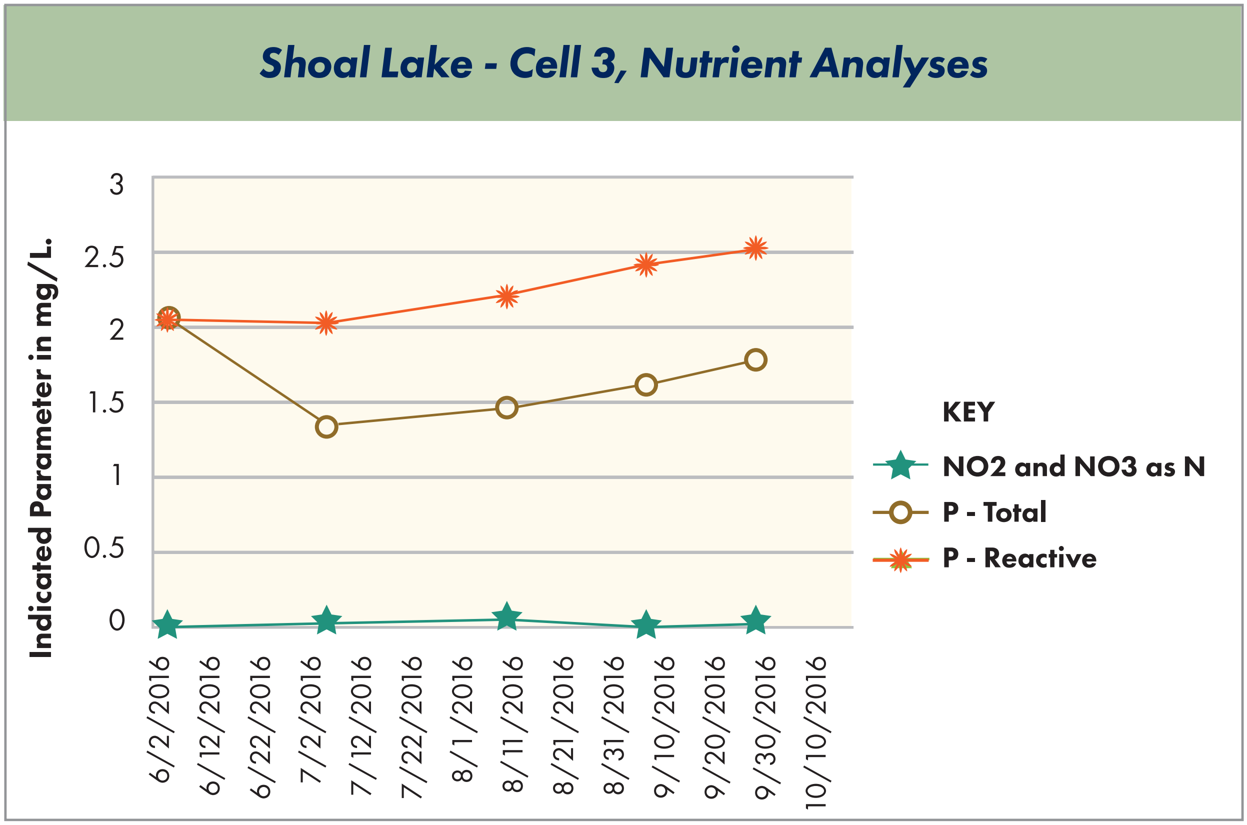


Fig. 6: *Shoal Lake Cell #3 nutrient analysis shows adequate levels.*

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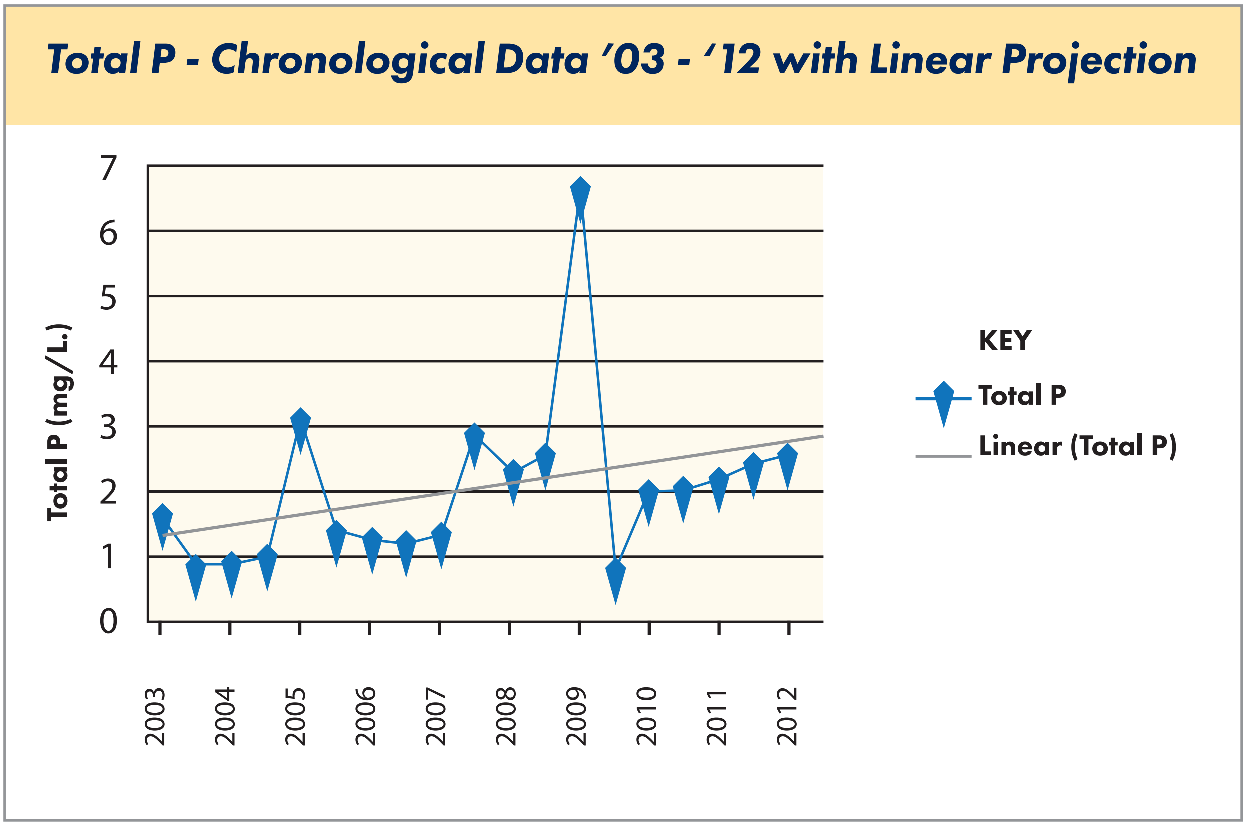

Fig. 7: *Chronological sequence of all total phosphate readings for Cell #3 from 2003 through 2012 with Linear Projection line*

Conclusions:

While comparisons of historical performance were limited, for certain parameters comparisons were made for performance data from 2012 relative to that of 2011. In addition, total phosphate data and BOD data trends were evaluated for all years for which data was available from 2003 to 2012. All significant discharge parameters were reduced over the monitoring period evaluated. As would be expected, there is some variability in the data from month to month and Cell to Cell. However, trends across the board for BOD, ammonia, TKN, O&G, nitrate-nitrite, are down. TSS values increased due to rain events during monitoring, and, as pointed out earlier, this is to be expected due to increases in the influent nutruents, biological activity and growth of the bacteria on the organics.

While slightly higher total phosphate values were observed, the historical values for total phosphate showed that there has been an increasing trend since 2003, possibly due to accumulation of bottom solids, nutrient runoff from rain events and release of phosphorous from the solids as they break down during the augmentation period. During the trial period the phosphate levels were stable and did not exhibit the fluctuations observed in historical monitoring periods.

While only subjective qualitative observations were made regarding odor, the control of which is mandated in the permit, the general consensus was that odors were reduced and no complaints regarding odors were reported.

Recommendations:

The analytical results recorded during the bioaugmentation trial indicate that better system efficiency and stability has been observed and we propose continuing the program in 2013. This will provide further data with respect to the improvements in efficiency and stability.

Based on observations in other lagoon systems, in the future it would be helpful to monitor bottom solids levels to determine what level of solids breakdown we are achieving. It was estimated that there are two feet of sludge in all three lagoons. Additional loading from sludge breakdown effects many of the monitoring parameters. Considering the impact that the breakdown of organic solids has on the water monitoring parameters like soluble BOD, COD, ammonia, nitrates and phosphates would help get a better picture of the impact of bioaugmentation on treatment.

Sludge data would also provide even more economic justification for the program as in many cases bioaugmentation with MICROBE-LIFT® technology has saved municipalities hundreds of thousands of dollars on dredging costs by biodegrading these solids and reducing the frequency of, or eliminating the need for, dredging.

For more information on MICROBE-LIFT® Technology contact
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CS13116