Moore+Bruggink
Consulting Engineers

TECHNICAL MEMORANDUM

TO: Mr. Rob Hall

FROM: Jeff Landers, P.E.

DATE: January 10, 2019

SUBJECT: Missaukee Drain 2 – Process Equipment Evaluation/Project Update

Background:

Moore+Bruggink ("M+B") was contracted by Lake Township (the "Township") to design a septage receiving station for the Missaukee Sanitary Drain 2 wastewater lagoon facility. The goals of this project are to capture a revenue stream currently leaving the Township, and to prevent land application of septage that can lead to nutrient overloading of local water bodies.

The Township has collected septage samples from local haulers and tested them to determine waste strength and found them within normal ranges. Additionally, M+B analyzed this information, along with past plant flow documentation, to create a Basis of Design that would accommodate the additional septage flows and treat the additional organic loading. Since septage is typically 4-5 times stronger than normal domestic strength waste, this is particularly important to determine.

Through development of the Basis of Design, it was discovered that the plant discharge permit did not match the Discharge Management Plan and limited the plant annual discharge flow. M+B worked with Missaukee Drain 2 Personnel and the Michigan Department of Environmental Quality (MDEQ) to approve an updated Discharge Management Plan and change the Discharge Permit to match. This allowed the plant to handle the additional flows created from a Septage Receiving Station on site.

M+B began discussions with MDEQ personnel in charge of the Septage Program to determine the requirements for an approvable project. During these discussions, it was discovered that in order to eliminate land application of septage within the Township (through ordinance), the MDEQ would require the Septage Receiving Station be sized to accept and treat all septage created. This created two options for the Township moving forward: (a) Build a smaller facility and do not eliminate land application; or (b) Build a larger facility capable of handling all septage created within the Township and eliminate all land application by institution of an ordinance (900 Treatment System Users, 930 Septic System Users – Missaukee County Health Department on 12/21/2018).

As the Basis of Design was created, it became clear that there is insufficient loading capacity at the plant in its current state. An increase in aeration equipment is needed in the lagoons to properly treat any additional load. M+B began discussions with vendors of lagoon aeration equipment to determine the technology that best works with the Township's needs and the current plant infrastructure. Below is an explanation of each and a cost comparison.

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Aeration Technologies:

M&B contacted several vendors with different technologies to evaluate initial capital costs, lifetime operations costs, and typical maintenance. The technologies analyzed were Air-Induced Surface Aeration Units and Forced-Air Subsurface Distribution. It should be mentioned that the analysis was created assuming the lagoons must handle all the septage from the Township. A summary of our findings are provided below with our recommendations following.

1. **Aeration Industries International (Air-Induced Surface Aeration Units)**

   These units are larger updated versions of the existing surface aerators currently in use at the plant. Each unit is a floating raft with a drive tube extending below the surface of the lagoon. The surface aspirator aerator offers a rotating propeller that forces water outward horizontally past the end of the shaft at high velocity. This creates a vacuum, drawing air down the shaft into the water. Above the water line, atmospheric air is drawn through intake ports and travels through the hollow drive shaft to be dispersed in a large plume throughout the water. Being diffused into fine bubbles, about 2.0 mm in diameter, the oxygen has extended contact time with the water. The size of the plume varies with the size of the aspirator aerator. Properly positioned, the Aire-O2 Aspirator Aerator units can create a "flow linkage" that delivers mixing and oxygen dispersion evenly and thoroughly throughout an entire basin, regardless of its size or shape. Dead spots are eliminated. The Aeration Industries' proposal includes 10 HP units.

   Pros: The units are familiar, and the current staff would not be required to learn a new technology. Low to moderate risk of not meeting limits if one unit fails. 3-Year Warranty. Can de-sludge the lagoons easily. One point of location retrieval for service.

   Cons: This option is the higher cost of the two surface aeration treatment systems. The estimated 20-year total operations, maintenance, and replacement ("OM&R") is the highest of all the technologies analyzed. Units rebuilt every 3-5 years and likely replaced at 6-10 years ($15-18K per unit).

2. **Fluence Corporation (Air-Induced Surface Aeration Units)**

   In order to provide the Township with the best available option, a second surface vendor was contacted. These aerators are technically comparable to Aeration Industries, though a different strategy was utilized in their proposal to provide better mixing within the cells. Using more, smaller units, some additional infrastructure would be needed electrically.

   Pros: Lowest Capital Cost option. The units are familiar, and the current staff would not be required to learn a new technology. Least risk of not meeting limits if one unit fails. Can de-sludge the lagoons easily. One point of location retrieval for service, though more service points than Option 1. Lowest 20-year OM&R cost.

   Cons: 1-Year Warranty. Units rebuilt every 3-5 years and likely replaced at 6-10 years ($9-10K per unit)

3. **Triplepoint MARS (Forced-Air Subsurface Distribution)**

   The MARS Aeration System provides wastewater mixing and aeration in one portable aerator. Utilizing fine bubble diffusers for oxygen transfer and coarse bubble technology for mixing, the MARS achieves the most efficient aeration in the industry. Each self-weighted unit is connected to an on-shore air supply via flexible weighted tubing and lowered into the water. Any maintenance to the aerator can be completed from the surface without incurring system downtime.

Pros: Best mixing and aeration performance. Blower service is on shore. 20-year life.

Cons: Highest capital cost. More site-work required to lay the air distribution header and build blower pads. 1-Year Warranty. Membranes on distributors must be replaced every 3-5 years (10 membranes per module, 36 modules) out in the lagoon.

Project Estimates:

Using all the available information, M+B has created three scenarios for consideration moving forward. Below are details on each.

Scenario 1 – The Original Plan – $675,000

The project, as originally presented, included the purchase and reuse of a 10,000 gallon fiberglass tank for septic storage, a pre-purchased septage receiving structure, and a pre-purchased submersible pump with control panel. A concrete approach and electric entrance gate would provide space and access for haulers.

Using this plan, the Township *could not* create an ordinance to eliminate land application of septage and be limited to 10,000 gallons per day of available capacity. An increase in aeration and passive odor control equipment are included to treat additional loading.

Scenario 2 – The Original Plan (Alternate) – $766,000

This option sees all aspects of the original plan retained, except that a prefabricated suction-lift station is included in lieu of the pre-purchased submersible pump. Upon review of the submersible pump layout, there were a few potential concerns. The need to pull the pump up to perform service requires lifting equipment, and any potential connection issues within the fiberglass tank would create a dangerous enclosed space condition. Both of these can be eliminated by installing pumps at the surface elevation. A vendor was contacted to provide pricing for a fiberglass-enclosed duplex suction lift pump station package, which has been included in this scenario.

Scenario 3 – Township SRS – $980,000 (AI: $1,403,000, MARS: $1,432,000)

M+B collected information from the Township to estimate the amount of septage required to treat all of Lake Township. Budget proposals were collected from the three vendors described above. Through these proposals and discussions with the vendors, the aeration systems were analyzed for installation costs, operation and maintenance costs and requirements, and life expectancy. Following this, we are recommending the Fluence surface inductors and have provided the estimate to implement.

This project includes a new 25,000 gallon, mixed, septage storage tank, using the existing septage receiving structure and a new pump station, and remote gate access to the site. This system would allow the Township to create the land application ordinance acceptable by the MDEQ.

Conclusion:

The only option meeting all goals of the Township is Scenario 3. As the price difference is significant between the aeration technologies, our recommendation is to move forward with design using the Fluence system. If the Township would like to bid this project out, all three technologies could be made available to the bidding contractors, with the lowest bid selecting the technology.

To give an idea of payback, a quick analysis of funding was created as well as an estimated prediction of required volumes to cover payments on Scenario 3. Given a 20-year loan at 3.125% interest, the payment for $980,000 is $66,628.21 per year. Using the proposed $0.05/gal rate for septage, and considering septage is taken an average of 20 days per month, the SRS would need

to take in at least 5,500 gallons per day to cover the payments. (Note: in Scenario 1, this number is 3,800 gals/day.)

Taking in septage creates the possibility for additional odors. Most of this will be mitigated with enclosed tankage and passive odor control, although operational considerations such as pumping rates and times of day will need to be considered. If odors become a nuisance, chemical treatment can be considered, but is not factored into this analysis.

It should also be mentioned that the MDEQ believes the Township may open itself up to litigation if an Ordinance is passed to prohibit land application, as there is a current agreement in place to land apply. The Township should consult with an attorney before moving forward to determine the best course of action to implement.

Aeration Technologies Cost Analysis - Original Plan

Aeration Industries	
Surface Aerators	
System Cost	
$ 431,945.80	Capital Costs
$ 86,389.16	Installation Costs (20%)
$ 30,000.00	Sitework
$ 103,666.99	Electrical (20%)
$ 130,400.39	Contingency (20%)
$ 782,402.34	Total Capital Cost
$ 117,360.35	Engineering Cost
$ 899,762.69	**System Cost**
20-yr Energy Cost	
12	units
10	HP/Unit
24	Hrs/d
0.9	Operating Efficiency
2592	BHP-h/d
0.75	(kWh)/(HP-h/d)
1944	kWh-d
365	d/y
20	years
14,191,200	kWh/20 years
$ 0.10	$/kWh
$ 1,419,120.00	**20-year Energy Cost**
20-yr Maintenance and Replacement Cost	
10	Design Life in years
2.00	Full system replacements
$ 2,542,781.25	20-year Replacement costs
$ 254,278.12	General maintenance (10%)
$ 2,797,059.37	**Total M&R Cost**
20-yr System Cost	
$ 5,115,942.06	**20-yr OM&R**
Total HP	120

Fluence Corporation	
Surface Aerators	
System Cost	
$ 203,100.00	Capital Costs
$ 40,620.00	Installation Costs (20%)
$ 30,000.00	Sitework
$ 48,744.00	Electrical (20%)
$ 64,492.80	Contingency (20%)
$ 386,956.80	Total Capital Cost
$ 58,043.52	Engineering Cost
$ 445,000.32	**System Cost**
20-yr Energy Cost	
18	units
7.5	HP/Unit
24	Hrs/d
0.9	Operating Efficiency
2916	BHP-h/d
0.75	(kWh)/(HP-h/d)
2187	kWh-d
365	d/y
20	years
15,965,100	kWh/20 years
$ 0.10	$/kWh
$ 1,596,510.00	**20-year Energy Cost**
20-yr Maintenance and Replacement Cost	
10	Design Life in years
2.00	Full system replacements
$ 1,207,054.08	20-year Replacement costs
$ 120,705.41	General maintenance (10%)
$ 1,327,759.49	**Total M&R Cost**
20-yr System Cost	
$ 3,369,269.81	**20-yr OM&R**
Total HP	135

Triplepoint MARS	
Subsurface Aerators	
System Cost	
$ 296,700.00	Capital Costs
$ 59,340.00	Installation Costs (20%)
$ 30,000.00	Sitework
$ 71,208.00	Electrical (20%)
$ 91,449.60	Contingency (20%)
$ 548,697.60	Total Capital Cost
$ 87,791.62	Engineering Cost
$ 636,489.22	**System Cost**
20-yr Energy Cost	
3	units
50	HP
24	Hrs/d
0.9	Operating Efficiency
3240	BHP-h/d
0.75	(kWh)/(HP-h/d)
2430	kWh-d
365	d/y
20	years
17,739,000	kWh/20 years
$ 0.10	$/kWh
$ 1,773,900.00	**20-year Energy Cost**
20-yr Maintenance and Replacement Cost	
20	Design Life in years
1.00	Full system replacements
$ 887,663.23	20-year Replacement costs
$ 88,766.32	General maintenance (10%)
$ 976,429.56	**Total M&R Cost**
20-yr System Cost	
$ 3,386,818.77	**20-yr OM&R**
Total HP	150

Aeration Technologies Cost Analysis - Full Township

Aeration Industries	
Surface Aerators	
System Cost	
$ 431,945.80	Capital Costs
$ 86,389.16	Installation Costs (20%)
$ 30,000.00	Sitework
$ 103,666.99	Electrical (20%)
$ 130,400.39	Contingency (20%)
$ 782,402.34	Total Capital Cost
$ 117,360.35	Engineering Cost
$ 899,762.69	**System Cost**
20-yr Energy Cost	
15	units
10	HP/Unit
24	Hrs/d
0.9	Operating Efficiency
3240	BHP-h/d
0.75	(kWh)/(HP-h/d)
2430	kWh-d
365	d/y
20	years
17,739,000	kWh/20 years
$ 0.10	$/kWh
$ 1,773,900.00	**20-year Energy Cost**
20-yr Maintenance and Replacement Cost	
10	Design Life in years
2.00	Full system replacements
$ 2,542,781.25	20-year Replacement costs
$ 254,278.12	General maintenance (10%)
$ 2,797,059.37	**Total M&R Cost**
20-yr System Cost	
$ 5,470,722.06	**20-yr OM&R**
Total HP	150

Fluence Corporation	
Surface Aerators	
System Cost	
$ 236,950.00	Capital Costs
$ 47,390.00	Installation Costs (20%)
$ 30,000.00	Sitework
$ 56,868.00	Electrical (20%)
$ 74,241.60	Contingency (20%)
$ 445,449.60	Total Capital Cost
$ 66,817.44	Engineering Cost
$ 512,267.04	**System Cost**
20-yr Energy Cost	
20	units
7.5	HP/Unit
24	Hrs/d
0.9	Operating Efficiency
3240	BHP-h/d
0.75	(kWh)/(HP-h/d)
2430	kWh-d
365	d/y
20	years
17,739,000	kWh/20 years
$ 0.10	$/kWh
$ 1,773,900.00	**20-year Energy Cost**
20-yr Maintenance and Replacement Cost	
10	Design Life in years
2.00	Full system replacements
$ 1,404,629.76	20-year Replacement costs
$ 140,462.98	General maintenance (10%)
$ 1,545,092.74	**Total M&R Cost**
20-yr System Cost	
$ 3,831,259.78	**20-yr OM&R**
Total HP	150

Triplepoint MARS	
Subsurface Aerators	
System Cost	
$ 445,050.00	Capital Costs
$ 89,010.00	Installation Costs (20%)
$ 30,000.00	Sitework
$ 106,812.00	Electrical (20%)
$ 134,174.40	Contingency (20%)
$ 805,046.40	Total Capital Cost
$ 128,807.42	Engineering Cost
$ 933,853.82	**System Cost**
20-yr Energy Cost	
2	units
75	HP
24	Hrs/d
0.9	Operating Efficiency
3240	BHP-h/d
0.75	(kWh)/(HP-h/d)
2430	kWh-d
365	d/y
20	years
17,739,000	kWh/20 years
$ 0.10	$/kWh
$ 1,773,900.00	**20-year Energy Cost**
20-yr Maintenance and Replacement Cost	
20	Design Life in years
1.00	Full system replacements
$ 1,325,734.85	20-year Replacement costs
$ 132,573.48	General maintenance (10%)
$ 1,458,308.33	**Total M&R Cost**
20-yr System Cost	
$ 4,166,062.16	**20-yr OM&R**
Total HP	150

Scenario 1: FRP tank, existing pump, 10,000 gal septage air treatment

Item No.	Description	Estimated Quantity	Unit	Unit Price	Amount
1	Mobilization, Overhead, Bonding, Legal and Profit	1	LSUM	$72,700.00	$72,700.00
2	Grading	1	Ac.	$5,000.00	$5,000.00
3	Engineered Fill	550	Cyd	$20.00	$11,000.00
4	8" Agg Base	1000	SYD	$10.00	$10,000.00
5	6" Concrete Approach	30	CYD	$400.00	$11,875.56
6	Automatic Gate and Access	1	LSUM	$25,000.00	$25,000.00
7	Site Piping	1	LSUM	$15,000.00	$15,000.00
8	Electrical	1	Ea	$70,000.00	$70,000.00
9	FRP Equalization Tank (Purchase, Deliver, Test)	1	LSUM	$12,000.00	$12,000.00
10	Septage Receiving Structure	1	LSUM	$0.00	$0.00
11	Existing System Pump	1	LSUM	$0.00	$0.00
12	Aeration System	1	LSum	$323,000.00	$323,000.00
13	Passive Odor Control	1	LSUM	$2,000.00	$2,000.00
				Sub Total	$558,000.00
				Design Engineering (6%)	$33,500.00
				Construction Engineering (5%)	$27,900.00
				Contingency (10%)	$55,800.00
				Project Estimate Total	**$675,200.00**
				Loan PMT (20 years, 3.125%)	($45,910.16)
				avg gal/day to cover ($0.05/gal, 20 days/mo)	3,826

Scenario 2: FRP tank, GR lift station, 10,000 gal septage air treatment

Item No.	Description	Estimated Quantity	Unit	Unit Price	Amount
1	Mobilization, Overhead, Bonding, Legal and Profit	1	LSUM	$82,500.00	$82,500.00
2	Grading	1	Ac.	$5,000.00	$5,000.00
3	Engineered Fill	550	Cyd	$20.00	$11,000.00
4	8" Agg Base	1000	SYD	$10.00	$10,000.00
5	6" Concrete Approach	30	CYD	$400.00	$11,875.56
6	Automatic Gate and Access	1	LSUM	$25,000.00	$25,000.00
7	Site Piping	1	LSUM	$15,000.00	$15,000.00
8	Electrical	1	Ea	$70,000.00	$70,000.00
9	FRP Equalization Tank (Purchase, Deliver, Test)	1	LSUM	$12,000.00	$12,000.00
10	Septage Receiving Structure	1	LSUM	$0.00	$0.00
11	Package Lift Station	1	LSUM	$65,000.00	$65,000.00
12	Aeration System	1	LSum	$323,000.00	$323,000.00
13	Passive Odor Control	1	LSUM	$2,000.00	$2,000.00
				Sub Total	$633,000.00
				Design Engineering (6%)	$38,000.00
				Construction Engineering (5%)	$31,700.00
				Contingency (10%)	$63,300.00
				Project Estimate Total	**$766,000.00**
				Loan PMT (20 years, 3.125%)	($52,084.10)
				avg gal/day to cover ($0.05/gal, 20 days/mo)	4,340

Scenario 3: Full Township Septage Receiving

Item No.	Description	Estimated Quantity	Unit	Unit Price	Amount
1	Mobilization, Overhead, Bonding, Legal and Profit	1	LSUM	$97,500.00	$97,500.00
2	Grading	1	Ac.	$5,000.00	$5,000.00
3	Engineered Fill	550	Cyd	$20.00	$11,000.00
4	8" Agg Base	1000	SYD	$10.00	$10,000.00
5	6" Concrete Approach	30	CYD	$400.00	$11,875.56
6	Automatic Gate and Access	1	LSUM	$25,000.00	$25,000.00
7	Site Piping	1	LSUM	$15,000.00	$15,000.00
8	Electrical	1	Ea	$70,000.00	$70,000.00
9	25,000 gal septage storage tank	1	LSUM	$57,500.00	$57,500.00
10	Septage Receiving Structure	1	LSUM	$0.00	$0.00
11	Package Lift Station	1	LSUM	$65,000.00	$65,000.00
12	Aeration System	1	LSum	$371,208.00	$371,208.00
13	Passive Odor Control	1	LSUM	$8,500.00	$8,500.00
				Sub Total	$748,000.00
				Design Engineering (6%)	$44,900.00
				Construction Engineering (5%)	$37,400.00
				Contingency (20%)	$149,600.00
				Project Estimate Total	**$979,900.00**
				Loan PMT (20 years, 3.125%)	($66,628.21)
				avg gal/day to cover ($0.05/gal, 20 days/mo)	5,552