



CENTRAL FLORIDA CASE STUDY

Accelerated Evaporation Pond Closure Project - Zellwood, FL



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COMPANY PROFILE

OVERVIEW

Evaporation King LLC is a U.S. Florida and Colorado based designer, manufacturer, and global distributor of a proprietary line of evaporation equipment for the Mining, Energy, Food & Beverage, Bio & Pharma, Textile, and Waste Management industries. EK produces various models for high and lower-volume applications and distributes them through an international network of independent dealers, strategic partners, and distributors.

Kevin King started Evaporation King in April 2021 after pioneering two other rotary atomizer technologies. Kevin has sold and commissioned over 90 systems globally to Fortune 1000 companies.

GLADIATOR ENHANCED EVAPORATION SYSTEM

The Gladiator Evaporative System stands out as the most efficient and cost-effective solution for managing processed or excess water. By utilizing cutting-edge technology, the Gladiator system accelerates the evaporation of wastewater by atomizing it into droplets with the best spectra in the industry. This innovative evaporation technology from EK ensures that pure water is returned to the natural hydrologic cycle.

One of the main challenges with natural evaporation is the need for a large water surface area. Evaporation ponds have been used for centuries, but their performance varies depending on local climate conditions. In dry conditions, evaporation ponds perform well, but during rainy periods and colder temperatures, their efficiency decreases.

Recognizing the need for a new approach to global wastewater disposal, EK engineered and designed the most effective evaporative



technology available. Our engineered design can handle the most demanding water conditions in industries such as energy, mining, food and beverage, oil and gas, domestic wastewater, and landfills.

The Gladiator System operates by mechanically breaking down water into small droplets and dispersing them into the surrounding air. These fractured water droplets can quickly transition from liquid to vapor (**Figure 1**), cooling the air and maximizing the evaporation process.

Competitive evaporators generate droplets by pressurizing the water discharge, resulting in larger droplets that hinder diffusion and vaporization. These larger droplets simply fall back into the pond. In contrast, the Gladiator system achieves high efficiency by breaking the water into significantly smaller droplets that rapidly vaporize. In fact, EK's average droplet spectra range from 20 to 80 microns, as shown in **Figure 2**.

EK's atomizer technology is manufactured using state-of-the-art materials, making it resistant to chemicals and requiring minimal maintenance for thousands of trouble-free operating hours. It eliminates the risk of clogged nozzles, wear issues, and high maintenance requirements, ensuring smooth and efficient operation.



Figure 1: Project Site Liquid to Vapor Cooling Effect

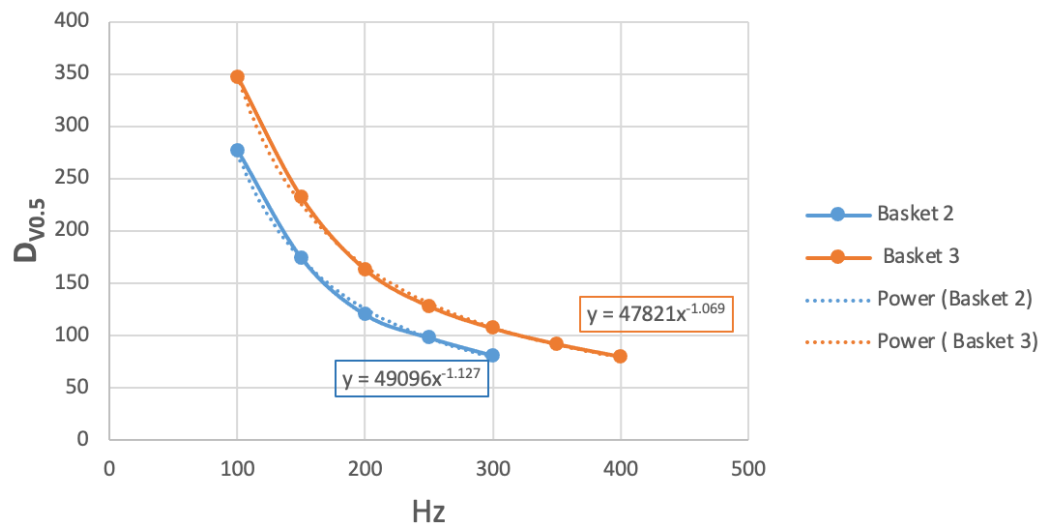


Figure 2: EK Micron Spectra



EXECUTIVE SUMMARY

Our Confidential client in Central FL chose Evaporation King's two Gladiator 80 systems to comply with the Florida Department of Environmental Protection (FDEP) Abandonment Plan for their two evaporation ponds. By utilizing two Gladiator 80 systems with a throughput of 160 gallons per minute (GPM) and operating around the clock, Evaporation King's cutting-edge evaporators boosted the natural evaporation process by 85 times, all while meeting the FDEP-approved abandonment plan. The project was completed within our clients' expected timeframe of approximately 90 days. The Gladiator 80 systems from Evaporation King replaced outdated mechanical evaporators, which were ineffective in meeting the requirements of the abandonment plan.



BACKGROUND

The client managed the Facility's industrial wastewater using a non-discharging, closed-loop recycle system (System) under Department Industrial Wastewater Facility Permit, valid until September 30, 2026. During Facility operations, the System efficiently collected and recycled all process water generated and utilized on-site. The industrial wastewater was directed to one of the two recycle basins (lined reclaimed water ponds), sized and permitted according to storage and reuse requirements.

ABANDONMENT PLAN

“Continue using evaporators - The Permit includes the following paragraph in the Wastewater Treatment description: *“The facility has implemented an Emergency Water Minimization Plan (EWMP) based on a Consent Order issued December 3, 2020. The facility will use strategically placed evaporators operated under specific conditions. The evaporation mist shall be contained to the ponds and not discharge to the ground surface.”*

“The EWMP “triggers” no longer apply because client discontinued growing and processing operations and the associated industrial wastewater- generating activities in February 2024, but using evaporators to reduce the volume and ultimately nearly empty the two lined ponds is an effective activity that continues. The volume of water in both lined ponds has decreased since the operations have ceased and evaporation has continued. The estimated current pond volumes are presented.”

“Empty and render inoperable the north pond – client proposes to first empty and render the north pond inoperable for storing or treating wastewater. Rendering the north pond inoperable will reduce the



surface area that is exposed to rain. This will help reduce the potential volume that could be added to the System for management.”

“To accomplish this step, client will concurrently reduce the water depth in both ponds via evaporation. Client proposes to assess transferring water from the north pond to the south pond, considering the south pond volume availability and weather conditions. client will consider transferring water from the north pond when the south pond water surface elevation is approximately 136.0 feet, which is 5.5 feet below the north pond emergency discharge weir elevation (El 141.5) and 2 feet below the maximum design water surface elevation of 138.0 feet as shown on the pond construction drawings included with this AP. To quantify the volume and support this step, a volume calculation for the south pond between elevation 136.0 and 138.0 feet results in approximately 485,000 gallons. The transfer of water from the north pond to the south pond will be repeated as determined prudent based on the south pond volume availability and weather conditions.”

“Both ponds are sloped to drain. When water has been removed from the north pond and the liner has been rinsed, client will puncture the liner to render the north pond inoperable for storing or treating wastewater.”

WATER QUALITY

The water quality in the ponds comprises the byproducts from previous composting operations, which undergo a pre-treatment process before being transferred to the evaporation ponds. **Figure 3** illustrates the water sample report submitted to FDEP, while **Figure 4** displays images of the wastewater taken from the evaporation pond just before treatment.



Client Sample Results

Client: Monterey Mushrooms Inc
 Project/Site: Emergency Discharge Parameters

Job ID: 670-12287-1

Client Sample ID: AEO5759-02

Lab Sample ID: 670-12287-1

Date Collected: 01/03/23 16:15

Matrix: Wastewater

Date Received: 01/04/23 07:00

Method: FL-DEP FL-PRO - Florida - Petroleum Range Organics (GC)									
Analyte	Result	Qualifier	PQL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Petroleum Hydrocarbons (C8-C40)	3.9	U	7.7	3.9	mg/L		01/05/23 06:36	01/06/23 19:02	1
Surrogate	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
<i>o</i> -terphenyl (Surr)	97		66 - 139				01/05/23 06:36	01/06/23 19:02	1
C35 (Surr)	98		40 - 129				01/05/23 06:36	01/06/23 19:02	1
Method: 40CFR136A 200.7 Rev 4.4 - Metals (ICP) - Total Recoverable									
Analyte	Result	Qualifier	PQL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Iron	6.5		0.50	0.50	mg/L		01/06/23 08:55	01/09/23 15:00	1
Manganese	2.1		0.30	0.30	mg/L		01/06/23 08:55	01/09/23 15:00	1
Sodium	310		5.0	1.0	mg/L		01/06/23 08:55	01/09/23 15:00	1
Method: EPA 200.8 - Metals (ICP/MS) - Total Recoverable									
Analyte	Result	Qualifier	PQL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	0.0022	U	0.0022	0.0022	mg/L		01/06/23 08:58	01/06/23 17:49	1
Lead	0.0011	U	0.0022	0.0011	mg/L		01/06/23 08:58	01/06/23 17:49	1
General Chemistry									
Analyte	Result	Qualifier	PQL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrogen, Kjeldahl (MCAWW 351.2)	200		40	18	mg/L		01/14/23 16:33	01/18/23 18:37	200
Nitrate as N (EPA 353.2)	0.020	U	0.040	0.020	mg/L			01/04/23 16:31	1
Nitrate Nitrite as N (MCAWW 353.2)	0.51		0.040	0.020	mg/L			01/04/23 16:37	1
Nitrite as N (MCAWW 353.2)	0.69		0.040	0.020	mg/L			01/04/23 16:37	1
Sulfate (MCAWW 375.2)	1600		200	100	mg/L			01/20/23 15:43	20
Total Dissolved Solids (SM 2540C)	8500		130	130	mg/L			01/05/23 12:48	1
Total Suspended Solids (SM 2540D)	9700		800	200	mg/L			01/10/23 09:14	1
Chloride (SM 4500 Cl- E)	400	I	480	240	mg/L			01/13/23 15:54	60
pH (SM 4500 H+ B)	7.6	Q	0.02	0.01	SU			01/10/23 17:28	1
Temperature (SM 4500 H+ B)	19.7	Q	0.1	0.1	Deg. C			01/10/23 17:28	1
Total Organic Carbon (SM 5310C)	1700		300	150	mg/L			01/14/23 00:08	150
Nitrogen, Total (EPA Total Nitrogen)	200		0.040	0.020	mg/L			01/26/23 15:29	1

Figure 3: Water Sample Results



Figure 4: Wastewater from Evaporation Ponds

INITIAL POND LEVELS UPON INSTALLATION

The installation of the two Gladiator 80 systems commenced on April 5th, 2024. Throughout the installation process, Evaporation King conducted meticulous monitoring of both pond levels, documenting an elevation range of approximately 138.0 feet to 138.5 feet. For a visual representation, please refer to Figure 5.



**Water level
138.5'**

Figure 5: Initial Pond Level

Figure 6 illustrates the variations in elevation compared to the initial construction plans.

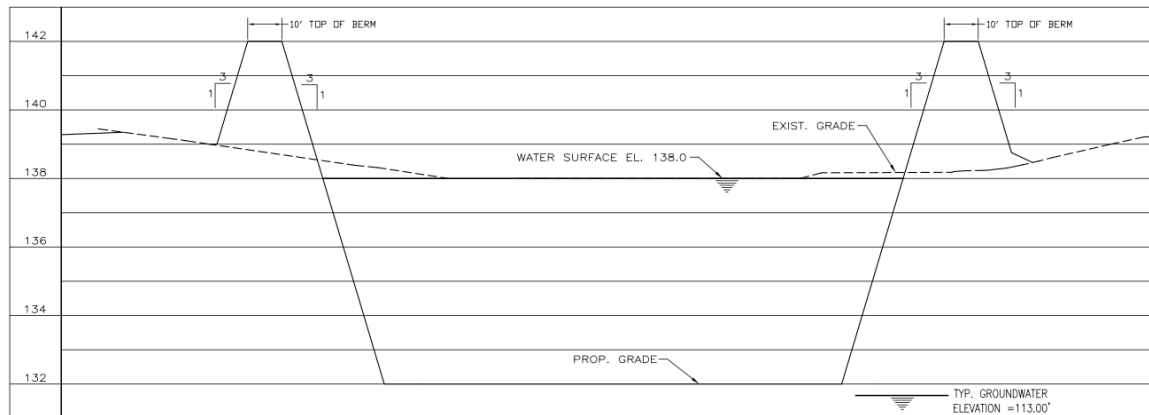


Figure 6: Pond Elevations

DOWNTIME FOR UPGRADES

Both Gladiator 80 systems underwent upgrades and were temporarily offline for maintenance for 12 days in April, starting on the 16th.

INITIAL POND VOLUMES UPON INSTALLATION

The initial volume of the South Pond at 138.5 feet elevation was approximately **1,456,997** gallons (**Figure 7**) which uses CAD. For this study, EK uses the average gallons from Appendix A totaling **1,557,129** gallons. The South Pond was successfully closed off on July 20, 2024.

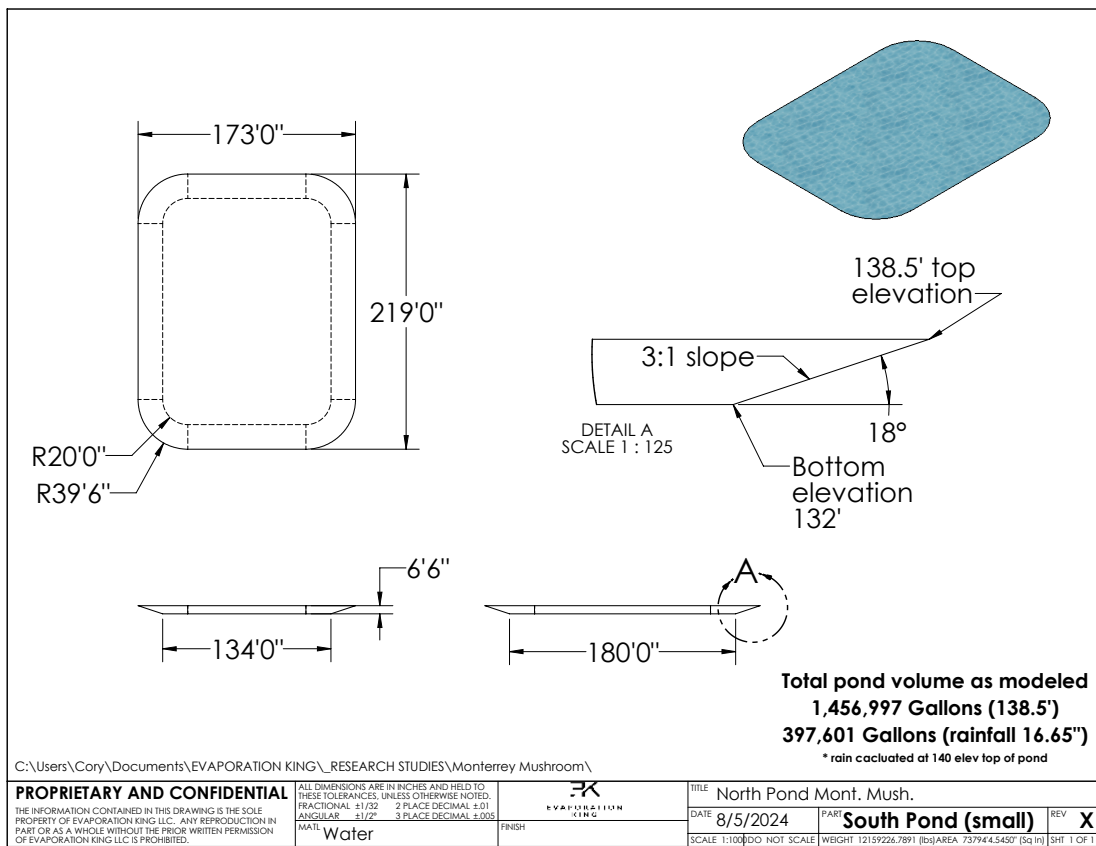


Figure 7: Volumes South Pond

The initial volume of the North Pond at an elevation of 138.5 feet was approximately **2,558,942** gallons (**Figure 8**) which uses CAD. For this study, EK uses the average gallons from Appendix A totaling **2,689,051** gallons. The closure of the North Pond was successfully completed on June 20, 2024.

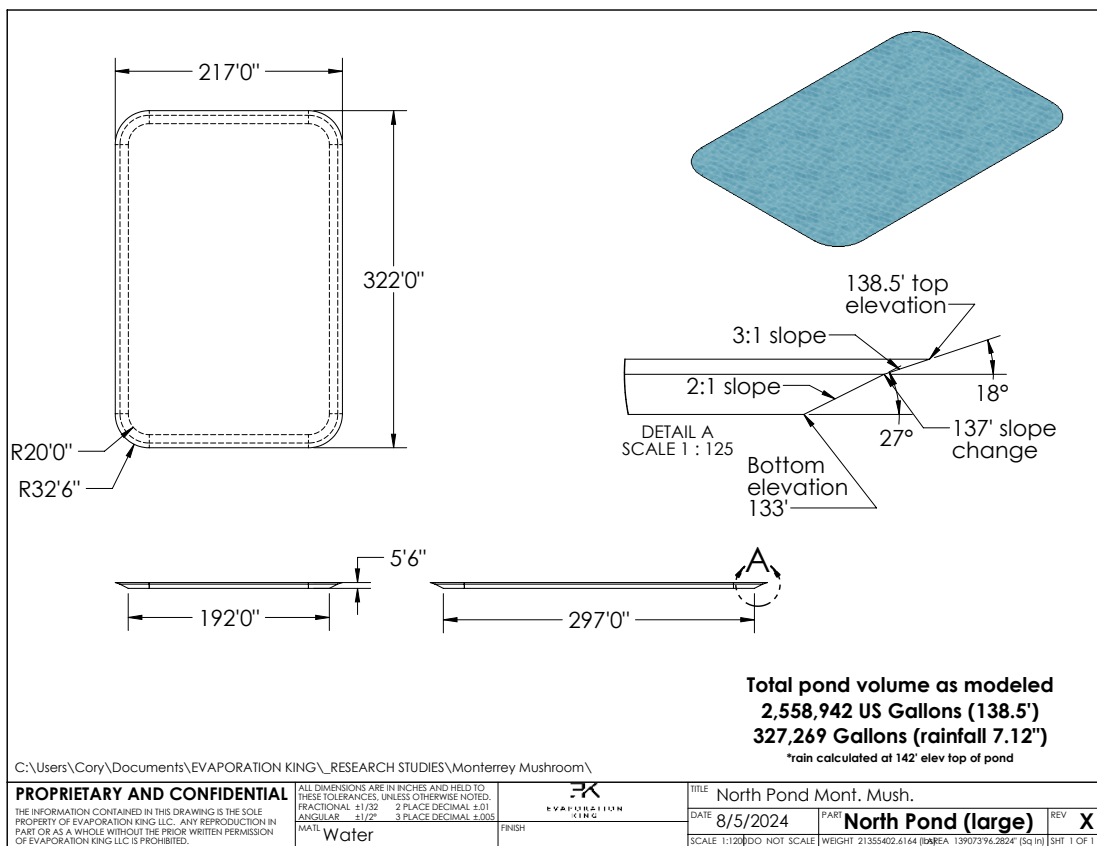


Figure 8: Volumes North Pond

The combined initial volume of the ponds, not including rainfall, totals approximately **4,246,180** gallons.



OPERATIONAL TIMEFRAMES

Both Gladiator 80 systems ran continuously for 24 hours a day over a period of **98 days**.

TOTAL THROUGHPUT

The combined flow rate of the two Gladiator 80 systems is **160 gallons** per minute (GPM). Over a span of 98 days, the total flow rate amounts to **22,579,200** gallons.

RAINFALL DURING OPERATION

Rainfall measurements over a **64-day** period in the North Pond totaled **7.12** inches or **327,269** gallons, while the South Pond received **16.65** inches or **397,601** gallons of rainfall over a **98-day** period.

NATURAL EVAPORATION (ET)

The North Pond experienced an evapotranspiration rate of **8.7** inches over a **64-day** period, resulting in a loss of **324,834** gallons. Similarly, the South Pond had an evapotranspiration rate of **12.29** inches over a **98-day** period, leading to a loss of **244,049** gallons. See Appendix A.

EVAPORATION CALCULATIONS

After calculating the total volume of water in the ponds, including rainfall, we found it to be 4,971,050 gallons. By subtracting the evapotranspiration (ET) of 568,883 gallons, we are left with 4,402,167 gallons. Dividing this by the total throughput of 22,579,200 gallons reveals a **19.5%** evaporation efficiency over a 24-hour period.

Taking into account that evaporation mainly occurs during daylight hours, having an average of 10 hours of sunlight, we are able to determine that the total volume of water evaporated (4,402,167



gallons) divided by the total throughput for 10-hour days amounts to 9,408,000 gallons. This signifies a **47%** daily evaporation efficiency over 10-hour days.

ACCELERATED EVAPORATION VERSUS NATURAL ET

The comparison below illustrates the significant increase in evaporation rates achieved by utilizing Evaporation King's two Gladiator 80 systems in comparison to natural evapotranspiration. It is clear that the Gladiator 80 systems greatly expedite the natural evaporation process by an impressive factor of **85**.

Natural Evaporation (to pond closure)		
Water depth (for closure) (row 3)	6.50	ft
	78.00	inches
Rain (from FAWN data)	44.49	inches
ET (from FAWN data)	47.91	inches
Net Evaporation = ET - Rainfall	3.42	inches/year
Nat. Evap. to pond closure (row 23 / row 26)	22.81	years
Compare EK Gladiator 80s (2 units) to Natural Evaporation		
EK Gladiator to pond closure	0.27	years
Nat. Evap. to pond closure	22.81	years
		times
EK Gladiator vs Nat. Evap	84.94	faster

Figure 9: Natural ET vs G-80s

WEATHER CONDITIONS DURING GLADIATOR OPERATIONS

For the purpose of this case study, Evaporation King utilized the closest weather station to the project site. The Apopka, FL FAWN weather station is approximately 9 miles away from the project site. You can access the weather data at <https://fawn.ifas.ufl.edu/data/reports/>



MONTHLY WEATHER DATA

The average monthly humidity for the project site during operation was **75%**.

FAWN Station	Period	RelHum avg 2m (pct)
Apopka	Apr-24	68
Apopka	May-24	72
Apopka	Jun-24	78
Apopka	Jul-24	81

MONTHLY WEATHER AVERAGES

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	14.9 °C (58.8) °F	16.6 °C (61.9) °F	19 °C (66.1) °F	22 °C (71.5) °F	24.8 °C (76.7) °F	26.6 °C (79.9) °F	27.2 °C (80.9) °F	27.2 °C (81) °F	26 °C (78.8) °F	23.2 °C (73.8) °F	19.3 °C (66.8) °F	16.9 °C (62.4) °F
Min. Temperature °C (°F)	10.9 °C (51.7) °F	12.6 °C (54.7) °F	14.4 °C (57.9) °F	17.3 °C (63.1) °F	20.3 °C (68.5) °F	23.3 °C (73.9) °F	24.2 °C (75.5) °F	24.4 °C (76) °F	23.3 °C (74) °F	20 °C (67.9) °F	15.6 °C (60.2) °F	13.2 °C (55.8) °F
Max. Temperature °C (°F)	20.1 °C (68.2) °F	21.9 °C (71.4) °F	24.5 °C (76.2) °F	27.5 °C (81.5) °F	30.1 °C (86.2) °F	31.2 °C (88.1) °F	31.4 °C (88.5) °F	31.3 °C (88.3) °F	30 °C (86) °F	27.5 °C (81.6) °F	24.1 °C (75.5) °F	21.8 °C (71.3) °F
Precipitation / Rainfall mm (in)	58 (2)	52 (2)	62 (2)	57 (2)	68 (2)	147 (5)	148 (5)	164 (6)	133 (5)	68 (2)	36 (1)	54 (2)
Humidity(%)	72%	69%	66%	64%	65%	75%	79%	80%	79%	72%	71%	73%
Rainy days (d)	5	5	5	5	7	14	16	17	13	8	4	4
avg. Sun hours (hours)	6.8	7.1	8.5	9.5	10.1	10.3	10.2	9.5	8.6	7.8	7.0	6.5



APPENDIX A

Date: 8/3/24

North & South Pond Evaporation Estimates EK Gladiator 80s versus Natural ET Comparison

row			
1	Elevation pond level - start date	138.50	ft
2	Elevation pond level - emptied for closure	132.00	ft
3	Water depth (for closure) (Row 1 - Row 2)	6.50	ft
4	North & South Pond volumes	4,246,180	gal
5	Rainfall adjustment during Period of Perf.	724,870	
6	ET (natural evaporation) adjustment during Period of Perf.	568,883	gal
7	Est. Net Volume to be Mech. Evaporated (Row 4 + Row 5 - Row 6)	4,402,167	gal
8			
9	EK Gladiator 80 Evaporation (to pond closure)		
10	2 units at 80 gpm/unit	160	gpm
11		230,400	gpd
12	Start date	4/5/24	
13	Emptied for closure	7/24/24	
14	Days out of service (2 weeks for upgrades)	12	
15	North & South Ponds empty for closure	98	days
16		0.27	years
17	Total gallons pumped @ 24 hrs./day of operation	22,579,200	gallons
18	Evaporation Efficiency (row 7 / row 17)	19.50%	
19	Avg. daily EK Gladiator 80 Evaporation (2 units) (Row 7 / Row 15)	44,920	gpd
20			
21	Natural Evaporation (to pond closure)		



22	Water depth (for closure) (row 3)	6.50	ft
23		78.00	inches
24	Rain (from FAWN data)	44.49	inches
25	ET (from FAWN data)	47.91	inches
26	Net Evaporation = ET - Rainfall	3.42	inches/year
27	Nat. Evap. to pond closure (row 23 / row 26)	22.81	years
28			
29	Compare EK Gladiator 80s (2 units) to Natural Evaporation		
30	EK Gladiator to pond closure	0.27	years
31	Nat. Evap. to pond closure	22.81	years
32	EK Gladiator vs Nat. Evap	84.94	times faster