APPENDIX C — MFLS STATUS ASSESSMENT

CURRENT AND FUTURE STATUS ASSESSMENT AND UFA FREEBOARD CALCULATION

MFLs status was assessed by comparing the MFLs condition (i.e., the minimum hydrologic regime necessary to protect a criterion) with the current-pumping condition to determine if there is currently water available for withdrawal (freeboard), or if recovery is necessary (deficit) for each environmental criterion. MFLs are considered to be currently achieved if the freeboard is greater than or equal to zero. If there is currently a deficit of water, a water body is in recovery. If a deficit is projected within the 20-year planning horizon the water body is in prevention (future status assessment is described below). No-pumping and current-pumping condition lake and UFA level datasets developed for the Lake Butler (described in *Hydrological Analyses* section and Appendix B) were used to calculate freeboard or deficit and determine whether each lake is in recovery, prevention or neither.

CURRENT STATUS ASSESSMENT

Current MFLs status for the Lake Butler was assessed for all criteria described in the MFLs Determination section in main report. The MFLs and current-pumping conditions were compared, resulting in a freeboard or deficit for each environmental metric. Freeboards/deficits were then compared to determine the most constraining environmental metric for the Lake Butler. The following briefly summarizes the calculation of freeboard/deficit each environmental metric.

EVENT BASED METRICS

The IH MFLs is an event-based criterion. The hydrologic event for this MFLs criterion is defined as the stage at or exceed 24.1 ft NAVD over 30 consecutive days (24.1 feet, duration of 30 days; see the determination section in main report for more details). The current status of the MFLs was assessed by comparing the frequency of event defined by the IH (occurs once in every 25 years) and its frequency under the current-pumping condition.

Calculating the frequency (probability of exceedance) of the IH defined event for the current-pumping condition involved the following three steps:

1. Determine the annual maximum elevation continuously exceeded for the specified duration (30 days) for each water year in the POR.

2. Rank annual maximums from step 1 in descending order.

3. Use Weibull plotting position formula to calculate the probability of exceedance.

$$P(S \geq \hat{S}_m) = \frac{m}{n+1}$$

where $\quad$ P $(S \geq \hat{S}_m)$ = probability of S equaling or exceeding $\hat{S}_m$

$\qquad$ m = rank of event

$\qquad$ n $\,$ = number of water years

Based on the Weibull plot (Figure 1) the Lake Butler IH, with a duration of 30 days and a return interval of 25 years, is achieved under the current pumping condition. Under the current-

pumping condition, the IH event (24.1 feet, duration of 30 days) has an exceedance probability of 10% (9.6-year return interval) compared to the recommended exceedance probability of 4% (25-year return interval) for the MFLs condition. Under current-pumping conditions the elevation exceeded at the recommended MFL frequency is approximately 24.9 ft NAVD. When compared to the IH elevation (24.1 ft), the difference yields a lake freeboard of approximately 0.8 ft (Figure 1). The following describes the method for determining the UFA freeboard for the IH.

UFA Freeboard/Deficit Calculation

For event-based metrics (i.e., the IH), frequency analysis was used to determine whether there is water available for withdrawal (freeboard) or whether water is needed for recover of the UFA (deficit). Freeboard is defined as an UFA reduction (ft) that is allowable before an MFL is no longer achieved.

Freeboard / deficit calculation involves the following steps:

1. UFA elevations (i.e., water levels at an UFA well) in the surface water model are increased or decreased by small increments (depending on Weibull plot results);

2. The surface water model is run iteratively after each change to UFA elevations, to simulate a new lake stage time series;

3. Frequency analysis and Weibull plotting is repeated using the new lake stage time series;

4. Steps 1 through 3 are repeated until MFL (IH) is just met (i.e., within 0.1 ft);

5. The amount of water added (or subtracted) to UFA elevation represents the amount of water available for consumptive use (i.e., freeboard), or amount of water needed to be recovered (i.e, deficit).

Frequency analysis showed that the IH was achieved at the highest drawdown assessed (0.5 ft of UFA drawdown in addition to the current-pumping condition). This drawdown is equal to the projected withdrawal from the current-pumping condition to the 20-year planning horizon. Therefore, the freeboard for the IH is described as greater than 0.5 ft (i.e., the precise freeboard was not calculated because the IH was met at the 20-year planning horizon).
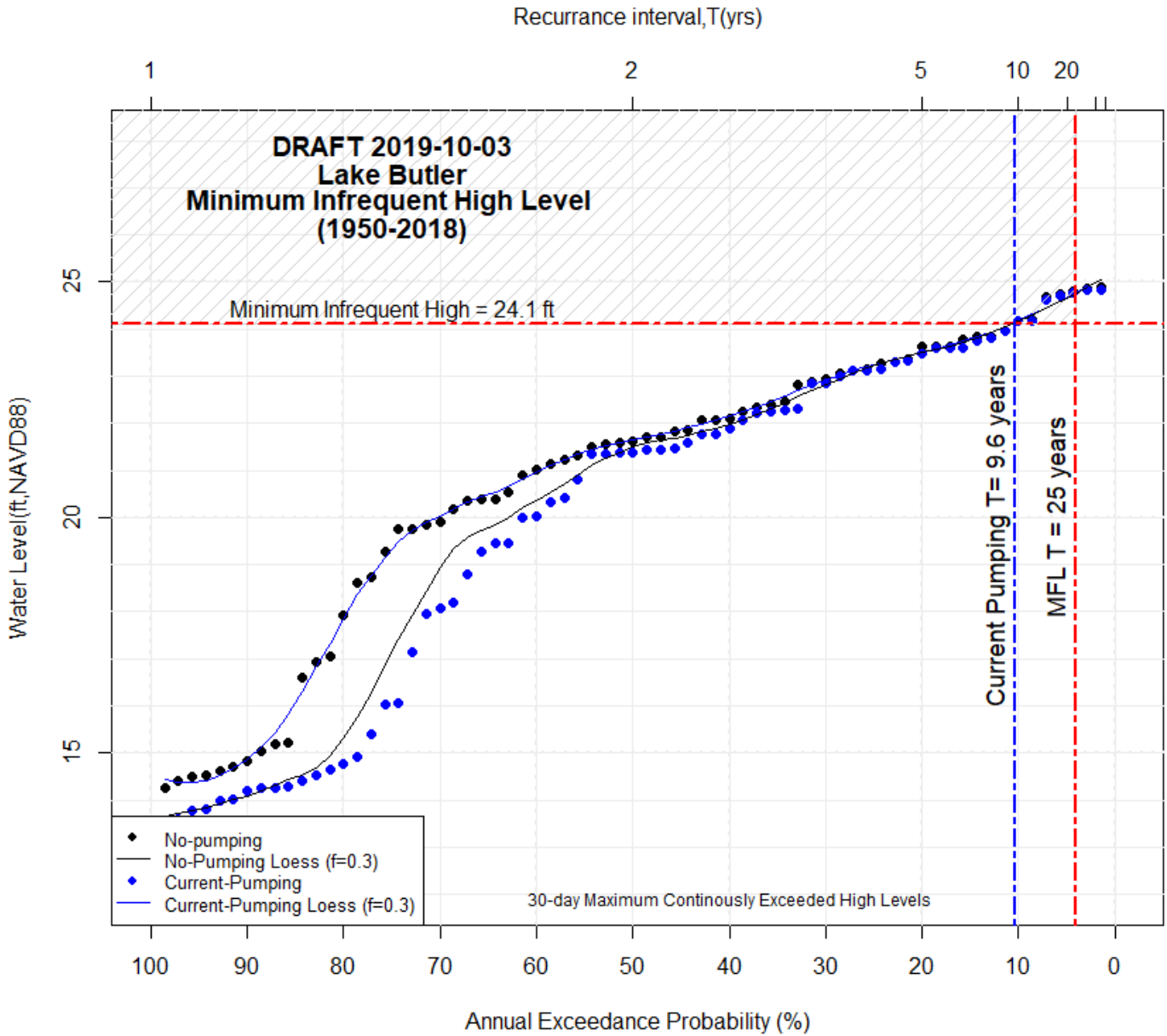
Figure 1. Frequency analysis plot for Infrequent High for Lake Butler, showing the return interval and exceedance probability for the 30-day continuous inundation, for the no-pumping and current-pumping conditions, as compared to the MFL (red vertical and horizontal lines).

HYDROPERIOD TOOL METRICS

The SJRWMD GIS-based hydroperiod tool was used to evaluate the effect of water level decline on the following criteria:

- Emergent marsh habitat area;
- Game fish spawning habitat area;
- Large wading bird habitat area;
- Small wading bird habitat area;
- Sandhill crane nesting habitat area;

For each metric, habitat area was calculated at 0.1 ft intervals for the no-pumping lake level timeseries, using stage/habitat area output from the hydroperiod tool. Current status was assessed by comparing the percent reduction of average habitat area (i.e., averaged across the entire POR) under the current-pumping condition, relative to the no-pumping condition. Metrics that exhibited less than or equal to a 15% reduction in average habitat area, relative to the no-pumping condition, are described as meeting the MFL.

Based on this comparison, all five habitat metrics were met under the current-pumping condition, and therefore they are not in recovery (Table 12 in main report). The following describes the method for determining the UFA freeboard for hydroperiod tool metrics.

UFA Freeboard/Deficit Calculation

Using the Lake Butler surface water model, groundwater level reduction was simulated in 0.05 ft increments. UFA reductions were repeated until the average acreage of a given habitat metric equaled the average area allowed for the MFLs condition (i.e., until a 15% reduction in no-pumping condition area was reached). The amount of UFA reduction (or increase) from the current-pumping condition, necessary to obtain the MFLs-condition average area for a given habitat metric, equals the UFA freeboard (or deficit) for that metric. The specific steps in the process are as follows:

1. UFA water levels in the surface water model (i.e., the groundwater level boundary conditions) are decreased (or increased) by 0.05ft;

2. The surface water model is run iteratively after each change to UFA elevations, to simulate a new lake stage time series;

3. Metric habitat area, relative to no-pumping area, is calculated;

4. Steps 1 through 3 are repeated until MFL is just met, resulting in a habitat area that matches the area specified for each of five MFLs metrics;

5. The UFA reduction (or increase) necessary to meet each MFL-specific average habitat area, equals the UFA deficit (or freeboard) and represents the amount of water needed for recovery (or available for consumptive use).

UFA freeboards for Lake Butler are presented below and in Table 14 of the main report.

Table 1. UFA freeboard values for Lake Butler hydroperiod tool metrics

Fish and wildlife habitat metric	Habitat area (acres)			
	MFLs Condition	CP Condition	MFLs – CP	UFA freeboard (ft)
Emergent marsh habitat	128.1	131.3	3.2	0.3
Large wading bird forage habitat	88.2	91.3	3.1	0.4
Small wading bird forage habitat	30	31.5	1.5	0.5
Sandhill crane nesting habitat	13.1	13.7	0.6	0.5
Game fish spawning habitat	16.7	17.7	1	0.5

LAKE LOBE CONNECTIVITY METRICS

Current status of the lake lobe connectivity metrics was assessed by comparing the percent exceedance at critical lobe connection elevation under the current-pumping condition and the MFLs condition. The MFLs condition for this metric is defined as a 15% reduction of exceedance at the minimum boat passage elevation relative to no-pumping condition. If the percent exceedance at critical lake lobe connectivity elevations is greater under current pumping than the MFL conditions, then the current hydrologic condition is considered to be met for this metric. The comparison results indicate that the current pumping condition meets this MFL metric (Table 2). The following describes the method for determining the UFA freeboard for the lake lobe connectivity metric.

Table 2. Minimum lobe Connection elevations and allowable shift in exceedance for Lake Butler.

Connection between Lobes	Lake Lobe Connectivity elevation (ft NAVD 88)	MFL condition percentile	Current-pumping condition percentile
L2 – L3	20.4	47.2	47.4
L3 – L4	22.5	18.0	19.9

UFA Freeboard/Deficit Calculation

Similar to the hydroperiod tool analysis, UFA reductions were simulated at 0.05 ft increments using the Lake Butler surface water model. The groundwater level boundary conditions were reduced (or increased) until a 15% reduction (relative to the no-pumping condition) in temporal exceedance of lake lobe connection (i.e., boat passage) elevations was observed. Freeboard / deficit calculation for lake lobe connectivity metrics involved the following steps:

> 1. UFA water levels in the surface water model (i.e., the groundwater level boundary conditions) are decreased (or increased) by 0.05ft;

> 2. The surface water model is run iteratively after each change to UFA elevations, to simulate a new lake stage time series;

> 3. Lake lobe connection elevation exceedance, relative to no-pumping lake lobe connection elevation exceedance, is calculated;

> 4. Steps 1 through 3 are repeated until MFL is just met, resulting in a 15% reduction, relative to no-pumping condition, in lake lobe connection elevation exceedance;

> 5. UFA freeboard equals the difference between the maximum allowable UFA reduction calculated under the MFL condition (i.e., the amount of reduction from the no-pumping condition, defined by the MFL) and the amount of UFA level decline under the current-pumping condition.

Under the current-pumping condition, UFA level has been lowered 1.75 ft due to pumping. The MFLs condition for the boat passage elevation between lobes L2 and L3 allows a UFA reduction of 1.85 ft. Therefore, the UFA freeboard equals 0.1 ft (1.85 ft – 1.75 ft). For the connection between lobes L3 and L4 the UFA freeboard is greater than 2.0 ft and is therefore less constraining criterion.

UFA Freeboard Summary

UFA freeboards for the event-based IH, the five hydroperiod tool metrics, and the lake lobe connectivity metric are presented in Table 3. The lake lobe connectivity metric allows the smallest reduction in UFA level and is therefore the most constraining. The recommended minimum level for Lake Butler is based on this most constraining metric to ensure all other metrics are protected; see below for details.

Table 3. UFA freeboards for environmental criteria developed for Lake Butler, Volusia County, Florida

Environmental Criterion	UFA freeboard (ft)
Minimum Infrequent High	> 0.5
Emergent Marsh (0-6ft)	0.3
Gamefish Spawning (0-4ft)	0.4
Large Wading Bird Foraging Habitat (0-1ft)	0.5
Small Wading Bird Foraging Habitat (0-0.5ft)	0.5
Sandhill Crane Nesting Habitat (0.5-1ft)	0.5
Minimum Lake Lobe Connectivity	0.1

Future / Projected Status

The status assessment for Lake Butler show that all metrics evaluated have positive UFA freeboard, and therefore this water body is not in recovery (Table 4). If the MFLs are currently being achieved but are projected to not be achieved within the 20-year planning horizon, then a waterbody is in "prevention," and a prevention strategy must be developed concurrently with the MFLs. Whether MFLs are being achieved within the planning horizon is determined by comparing the UFA freeboard of the most constraining environmental criterion to the amount of projected UFA drawdown at the planning horizon. The most constraining criterion for Lake Butler is the lake lobe connectivity metric, with 0.1 ft of UFA freeboard (Table 4).

The projected UFA drawdown at the 20-year planning horizon was estimated for Lake Butler using the SJRWMD 2015 Volusia groundwater model. The predicted UFA drawdown resulting from projected water use for the 20-year planning horizon is 0.5 feet. Because this is greater than the available water (i.e., 0.1 ft of UFA freeboard), the Lake Butler MFLs are in prevention and a prevention strategy must be developed concurrently with the MFLs.

Table 4. UFA freeboards for environmental criteria developed for Lake Butler, Volusia County, Florida

Environmental Criterion	UFA freeboard (ft)
Minimum Infrequent High	> 0.5
Emergent Marsh (0-6ft)	0.3
Gamefish Spawning (0-4ft)	0.4
Large Wading Bird Foraging Habitat (0-1ft)	0.5
Small Wading Bird Foraging Habitat (0-0.5ft)	0.5
Sandhill Crane Nesting Habitat (0.5-1ft)	0.5
Minimum Lake Lobe Connectivity (L3-L4)	0.2
Minimum Lake Lobe Connectivity (L2-L3)	0.1