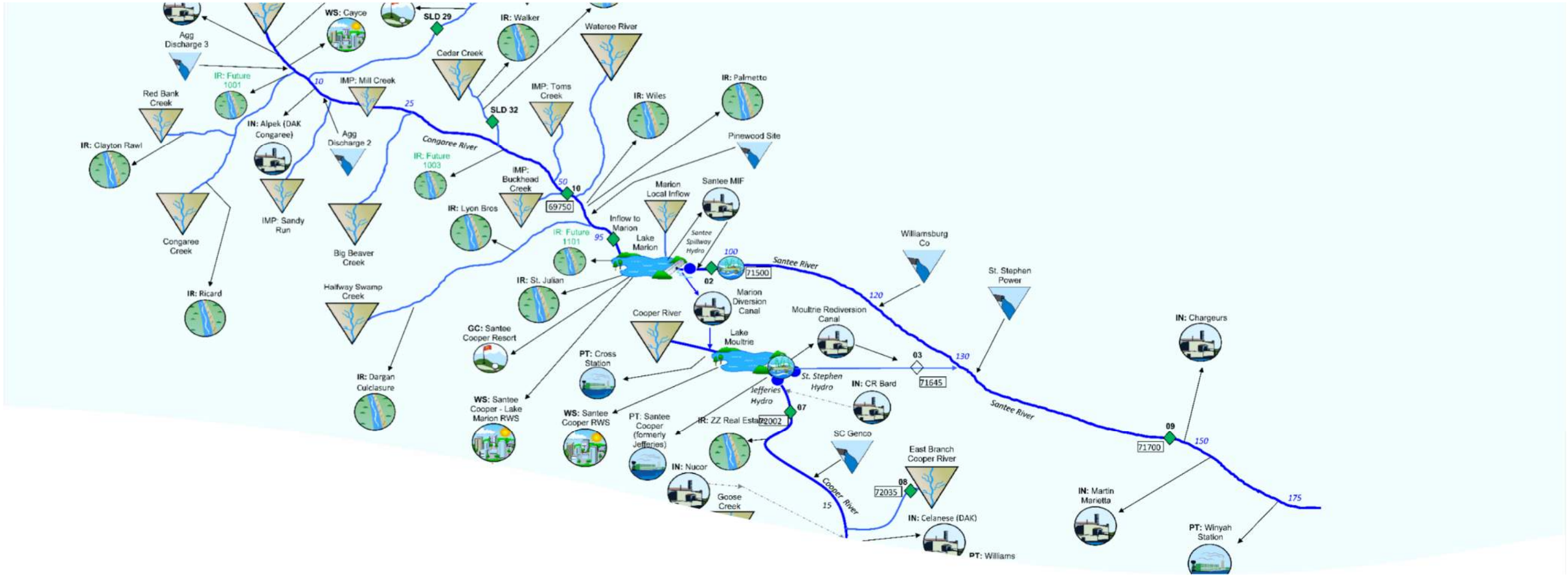


Updated Surface Water Availability Results and Discussion

John Boyer and Camren Shea

Agenda Item 4

a. Updated Current, Moderate, and High Demand Scenario Results

Surface Water Scenarios

Base Scenarios

- Current Surface Water Use Scenario
  - *Uses most recent 10-yr average withdrawals (as reported by month) in most cases*
- Moderate Water Demand Projection Scenario
  - *Future water demand projection based on moderate growth and normal climate*
- High Water Demand Projection Scenario
  - *Future water demand projection based on high growth and hot/dry climate*
- Permitted and Registered (P&R) Surface Water Use Scenario
  - *Uses current fully-permitted and registered amounts*

What's Changed Since August RBC Meeting

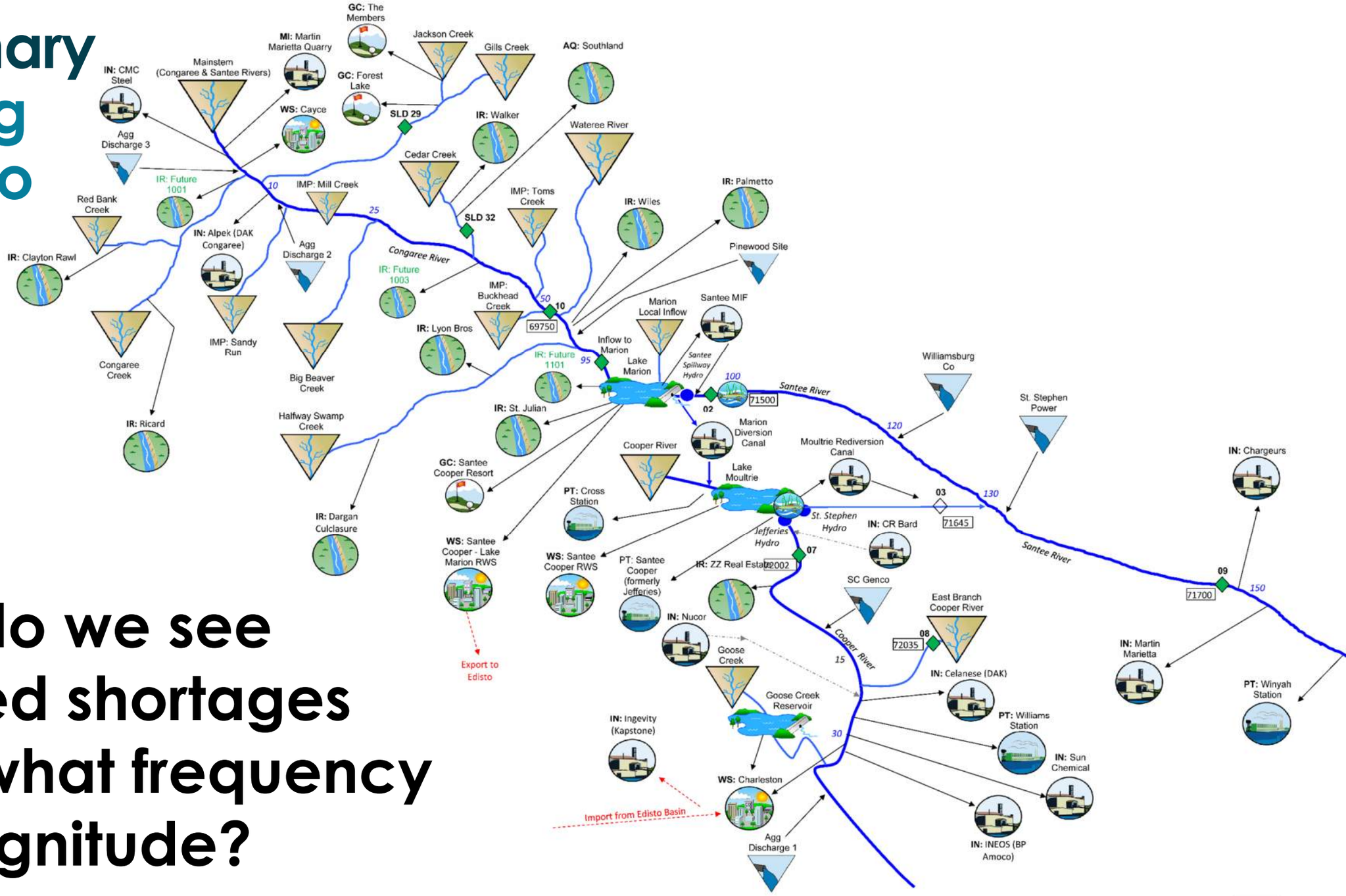
- Adjustments to the deadpool elevation for Lakes Marion and Moultrie, based on feedback from Santee Cooper. **The dead pool elevation has been set to 66 ft for both reservoirs** (previously was 60 ft).
- Adjustments to the rules, conditions, and triggers for releasing water from Lake Marion to the Santee River and the Diversion Canal to better represent likely operations, especially during low inflow.
- Adjustments to the **2070 Moderate** and **High Demand Scenario** Mainstem inflows to account for **VC Summer expansion in 2035**. A 62 CFS reduction was made to the **Moderate Scenario** inflows and a 69 CFS reduction for the **High Demand Scenario** inflows.

Summary of Average Annual Surface Water Demands by Scenario (in MGD)

Surface Water Use Sector	Current Use	2070 Moderate	2070 High Demand[1]
Mining	0.0	0.0	0.0
Agriculture	0.5	0.5	1.3
Aquaculture	0.1	0.1	0.2
Golf Courses	0.3	0.3	0.6
Industrial/Manufacturing	67.5	128.6	234.8
Public Water Supply	117.5	233.3	378.7
Thermoelectric[2]	373.6	26.5	30.6
Total all Sectors[3]	559.4	389.2	646.3
Total without Thermoelectric[3]	185.8	362.8	615.7

1. Seven Water User Objects' demands were increased to above current permitted limits for 2070 HD Scenario
2. The Williams and Winyah Power Stations are anticipated to be decommissioned by 2030
3. Rounded to nearest MGD

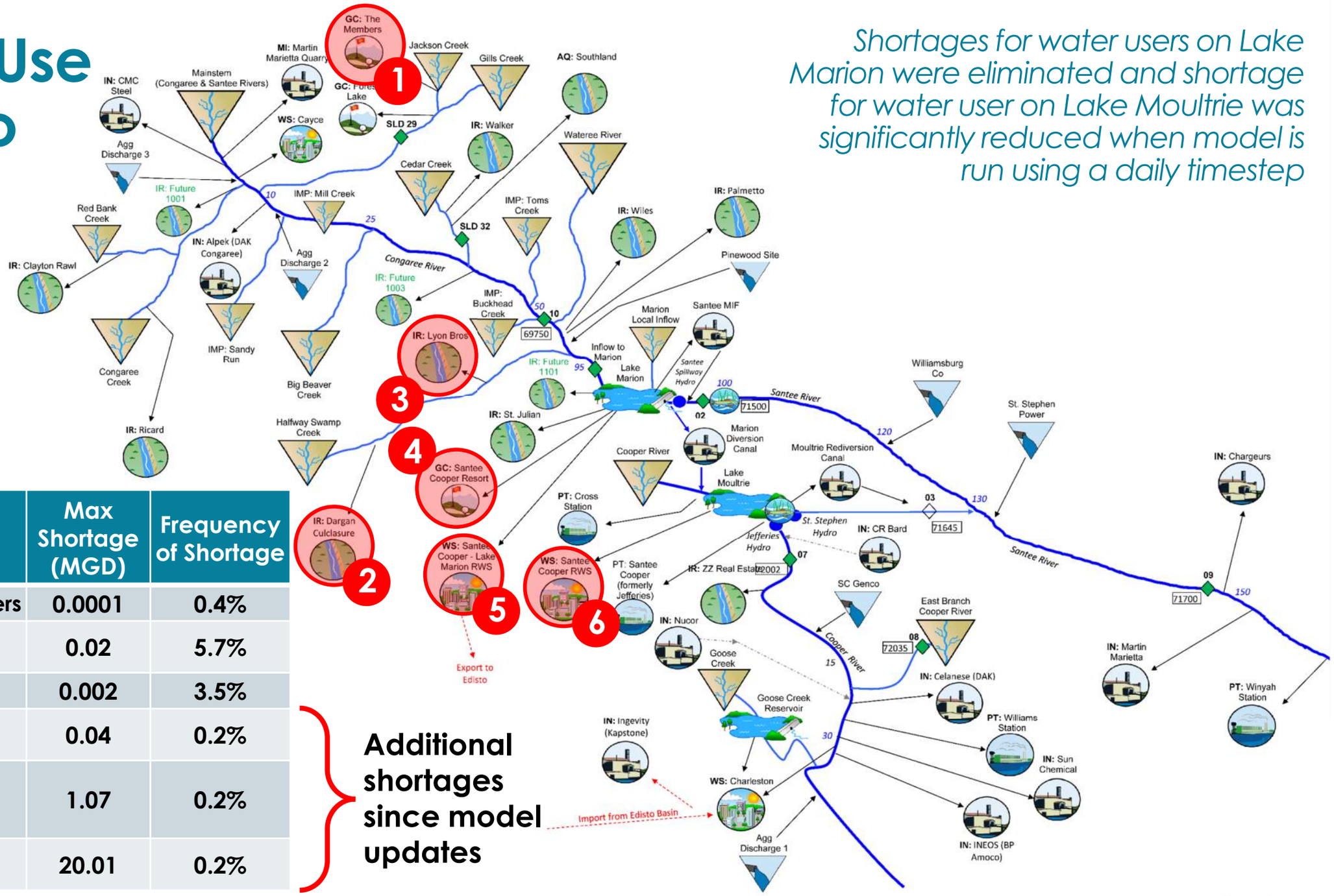
Preliminary Planning Scenario Model Results (monthly timestep)



Where do we see simulated shortages and at what frequency and magnitude?

Current Use Scenario

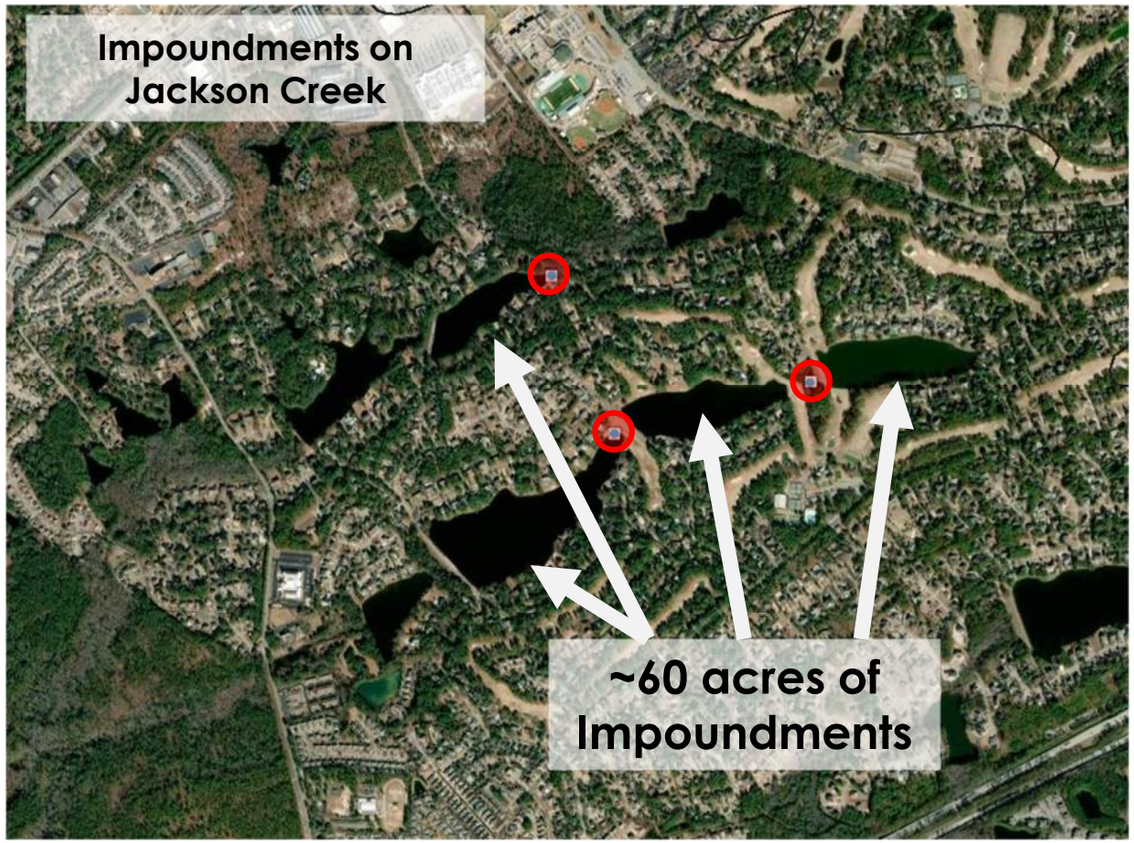
Shortages for water users on Lake Marion were eliminated and shortage for water user on Lake Moultrie was significantly reduced when model is run using a daily timestep

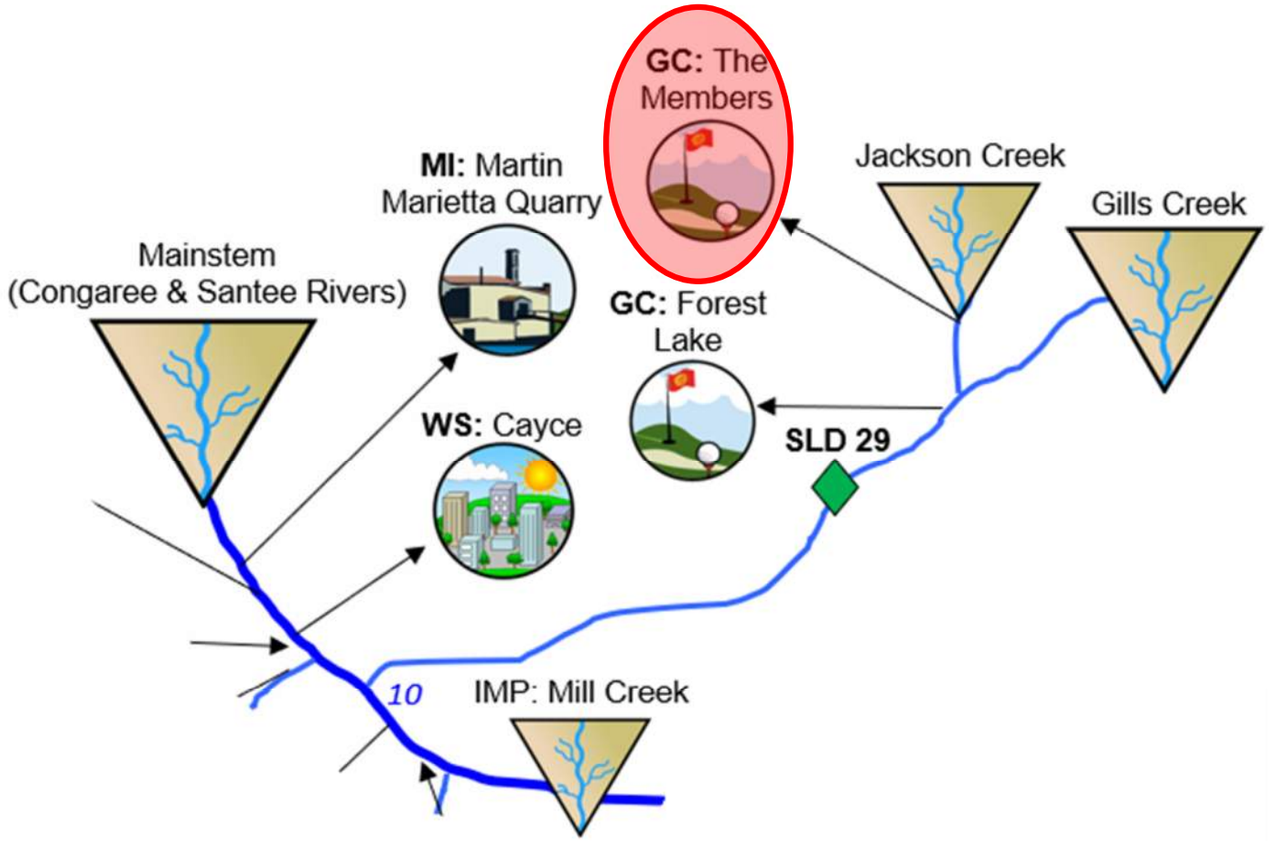


Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
1	GC: The Members	0.0001	0.4%
2	IR: Dargan Culclasure	0.02	5.7%
3	IR: Lyons Bros	0.002	3.5%
4	GC: Santee-Cooper Resort	0.04	0.2%
5	WS: Santee Cooper - Lake Marion RWS	1.07	0.2%
6	WS: Santee Cooper RWS	20.01	0.2%

GC: The Members
Impoundments totaling ~60 acres

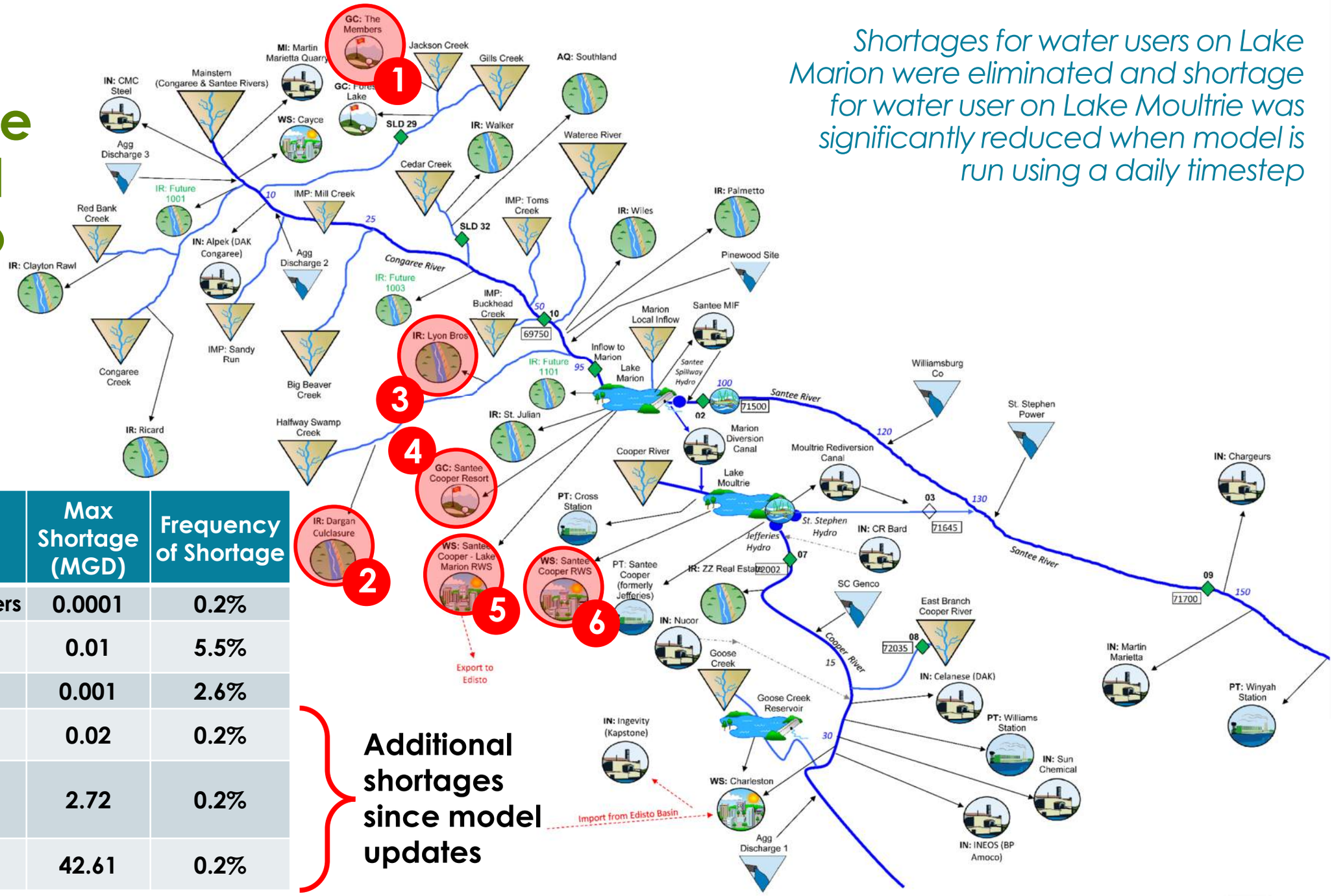
Surface water user with storage not included in the model





2070 Moderate Demand Scenario

Shortages for water users on Lake Marion were eliminated and shortage for water user on Lake Moultrie was significantly reduced when model is run using a daily timestep



1 Physical Shortage

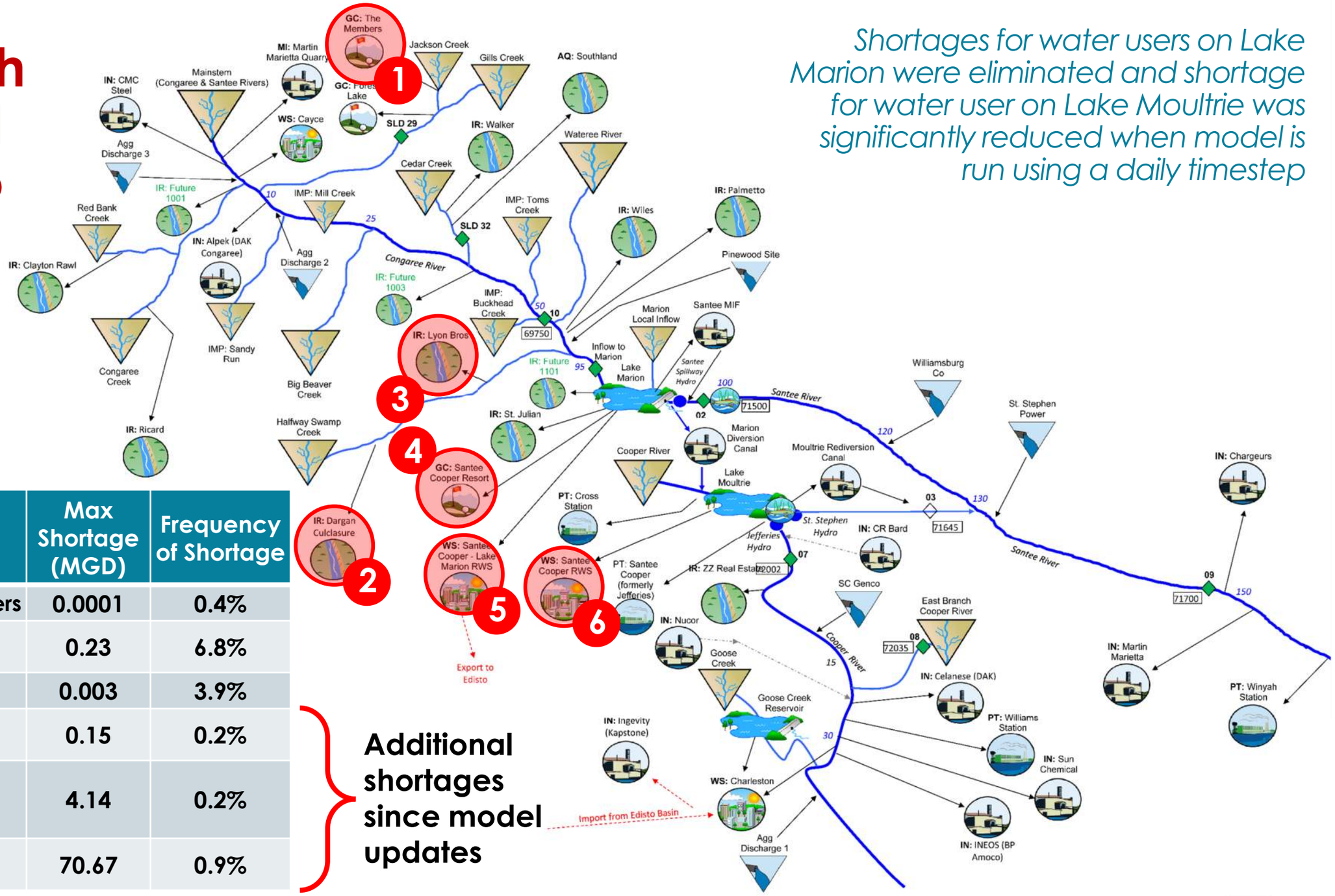
Surface Water Shortage Table

Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
1	GC: The Members	0.0001	0.2%
2	IR: Dargan Culclasure	0.01	5.5%
3	IR: Lyons Bros	0.001	2.6%
4	GC: Santee-Cooper Resort	0.02	0.2%
5	WS: Santee Cooper - Lake Marion RWS	2.72	0.2%
6	WS: Santee Cooper RWS	42.61	0.2%

Additional shortages since model updates

2070 High Demand Scenario

Shortages for water users on Lake Marion were eliminated and shortage for water user on Lake Moultrie was significantly reduced when model is run using a daily timestep



1 Physical Shortage

Surface Water Shortage Table

Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
1	GC: The Members	0.0001	0.4%
2	IR: Dargan Culclasure	0.23	6.8%
3	IR: Lyons Bros	0.003	3.9%
4	GC: Santee-Cooper Resort	0.15	0.2%
5	WS: Santee Cooper - Lake Marion RWS	4.14	0.2%
6	WS: Santee Cooper RWS	70.67	0.9%

Additional shortages since model updates

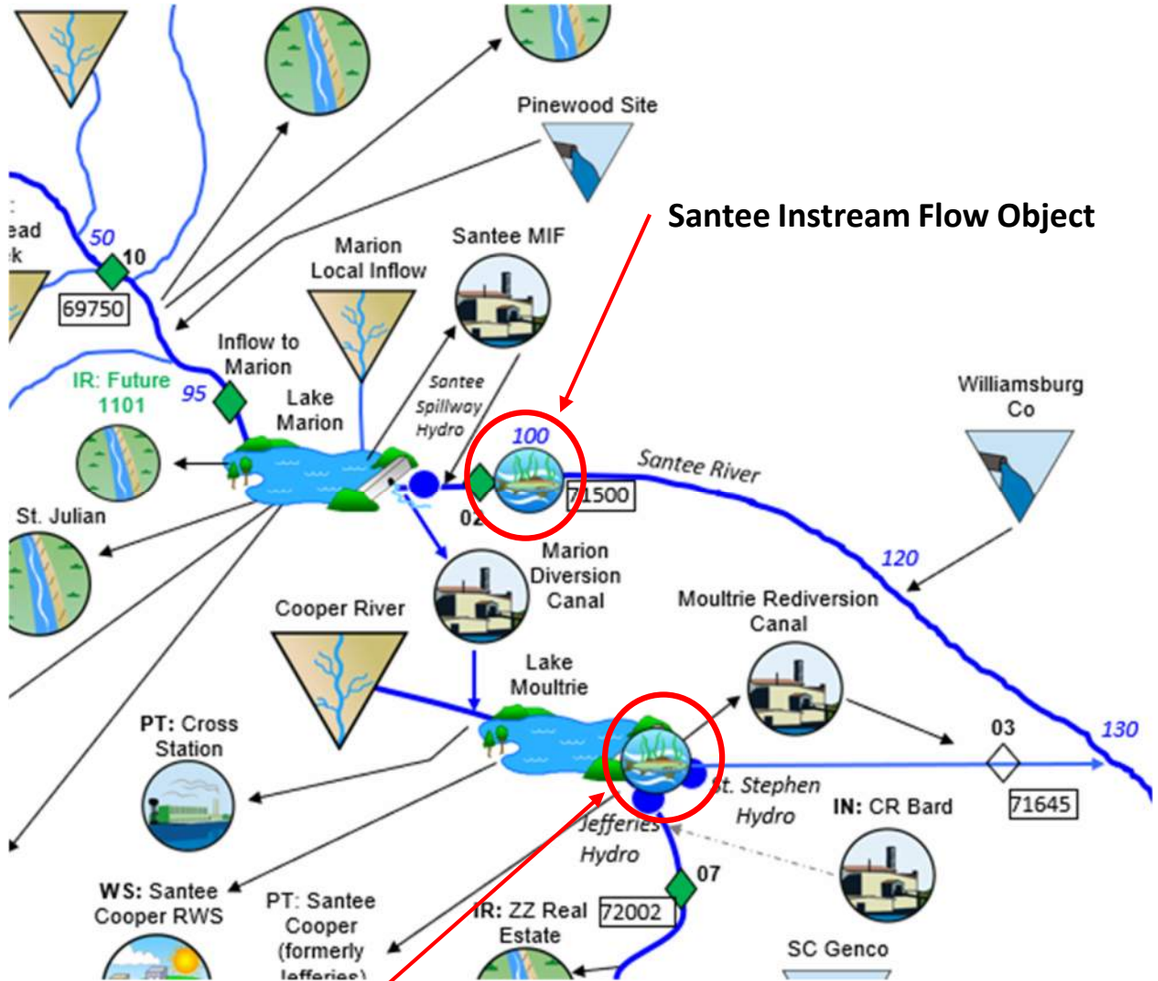
Summary of Water Supply Shortages

Supply Shortage Metric	Current Use	2070 Moderate	2070 High Demand
Total basin annual mean shortage (MGD)	0.06	0.11	0.53
Maximum water user shortage (MGD)	21.68	45.92	76.07
Total basin annual mean shortage as a percentage of total water demand	0.011%	0.029%	0.081%
Percentage of surface water users experiencing a shortage	18.2%	18.2%	18.2%
Average frequency of shortage (%)	0.3%	0.3%	0.4%

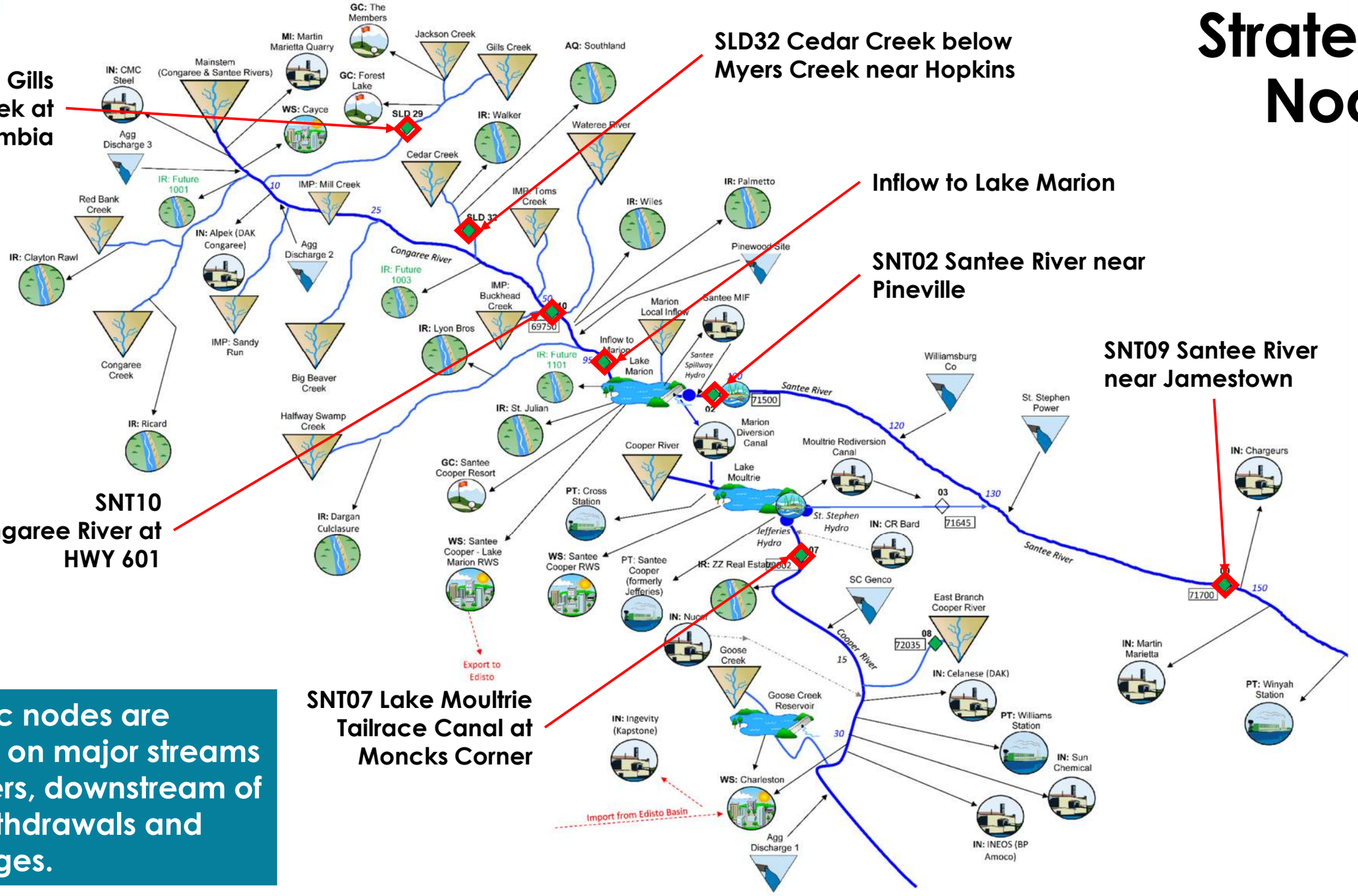
This is Table 4 of the memo

Instream Flow Shortages

Instream Flow Object		Current Use Scenario Flow	2070 Moderate Demand Scenario	2070 High Demand Scenario
Santee	Max Shortage (MGD)	1,163	1,163	1,163
	Frequency of Shortage	22.1%	23.5%	24.3%
Jeffries Hydro	Max Shortage (MGD)	3,619	3,619	3,619
	Frequency of Shortage	8.6%	9.0%	10.5%
Jeffries Hydro Frequency of Shortages for Different Criteria				
Frequency of shortage for fish passage		8.1%	8.6%	9.3%
Frequency of shortage for saltwater intrusion		0.4%	0.4%	1.2%



Strategic Nodes



Strategic nodes are located on major streams and rivers, downstream of most withdrawals and discharges.

Hydrologic Performance Measures at Strategic Nodes

Performance Measure	SNT10 CONGAREE RIVER AT HWY 601	INFLOW TO LAKE MARION	SNT02 SANTEE RIVER NEAR PINEVILLE, SC	SNT09 SANTEE RIVER NR JAMESTOWN, SC	SLD29 GILLS CREEK AT COLUMBIA	SLD32 CEDAR CREEK BELOW MYERS CREEK NR HOPKINS	SNT07 LAKE MOULTRIE TAILRACE CANAL AT MONCKS CORNER, SC
	All values in CFS						
Current Use Scenario							
minimum flow	1,515	2,679	1	7	2	7	4,502
mean flow	7,411	13,576	1,809	8,408	67	54	5,168
median flow	5,693	10,482	1,202	5,542	56	42	5,087
25th percentile flow	3,843	6,995	1,201	1,653	34	27	4,841
10th percentile flow	2,775	5,528	601	642	20	17	4,653
5th percentile flow	2,187	4,501	601	628	15	14	4,546
Moderate Demand 2070 Scenario							
minimum flow	1,465	2,655	56	63	2	7	4,504
mean flow	7,351	13,322	1,780	8,117	67	54	5,170
median flow	5,637	10,286	1,202	5,162	56	42	5,087
25th percentile flow	3,795	6,983	1,201	1,240	34	27	4,843
10th percentile flow	2,697	5,495	601	640	20	17	4,655
5th percentile flow	2,136	4,511	601	625	15	14	4,548
High Demand 2070 Scenario							
minimum flow	1,492	2,679	1	8	2	7	3,905
mean flow	7,330	12,996	1,741	7,754	67	54	5,168
median flow	5,644	9,979	1,201	4,515	56	41	5,089
25th percentile flow	3,798	6,902	1,201	1,229	33	27	4,841
10th percentile flow	2,698	5,299	601	637	20	17	4,648
5th percentile flow	2,155	4,321	601	624	15	13	4,550

This is Table 5 of the memo

Difference in Simulated Flows for Current Use and 2070 Mod Scenarios at Strategic Nodes

Performance Measure	SNT10 CONGAREE RIVER AT HWY 601	INFLOW TO LAKE MARION	SNT02 SANTEE RIVER NEAR PINEVILLE, SC	SNT09 SANTEE RIVER NR JAMESTOWN, SC	SLD29 GILLS CREEK AT COLUMBIA	SLD32 CEDAR CREEK BELOW MYERS CREEK NR HOPKINS	SNT07 LAKE MOULTRIE TAILRACE CANAL AT MONCKS CORNER, SC
Current Use Scenario flow (cfs)							
minimum flow	1,515	2,679	1	7	2	7	4,502
mean flow	7,411	13,576	1,809	8,408	67	54	5,168
median flow	5,693	10,482	1,202	5,542	56	42	5,087
25th percentile flow	3,843	6,995	1,201	1,653	34	27	4,841
10th percentile flow	2,775	5,528	601	642	20	17	4,653
5th percentile flow	2,187	4,501	601	628	15	14	4,546
2070 Moderate Demand Scenario minus Current Use Scenario flow (cfs)							
minimum flow	-50	-24	56	55	0.0	0.0	2
mean flow	-60	-254	-28	-291	0	0	2
median flow	-56	-196	0	-381	0	0	0
25th percentile flow	-49	-12	0	-414	0	0	2
10th percentile flow	-78	-33	0	-2	0	0	2
5th percentile flow	-52	10	0	-3	0	0	2
Percent Difference between 2070 Moderate Demand Scenario minus Current Use Scenario flow							
minimum flow	-3.3%	-0.9%	6993.6%	752.0%	0.1%	0.5%	0.0%
mean flow	-0.8%	-1.9%	-1.6%	-3.5%	0.0%	0.0%	0.0%
median flow	-1.0%	-1.9%	0.0%	-6.9%	0.0%	0.1%	0.0%
25th percentile flow	-1.3%	-0.2%	0.0%	-25.0%	0.1%	0.2%	0.0%
10th percentile flow	-2.8%	-0.6%	0.0%	-0.3%	0.0%	0.2%	0.0%
5th percentile flow	-2.4%	0.2%	0.0%	-0.5%	0.1%	0.3%	0.0%

Negative percent differences indicate lower flow in the 2070 Moderate Demand Scenario, compared to the Current Use Scenario

This is a portion of Table 6 of the memo

Difference in Simulated Flows for Current Use and 2070 HD Scenarios at Strategic Nodes

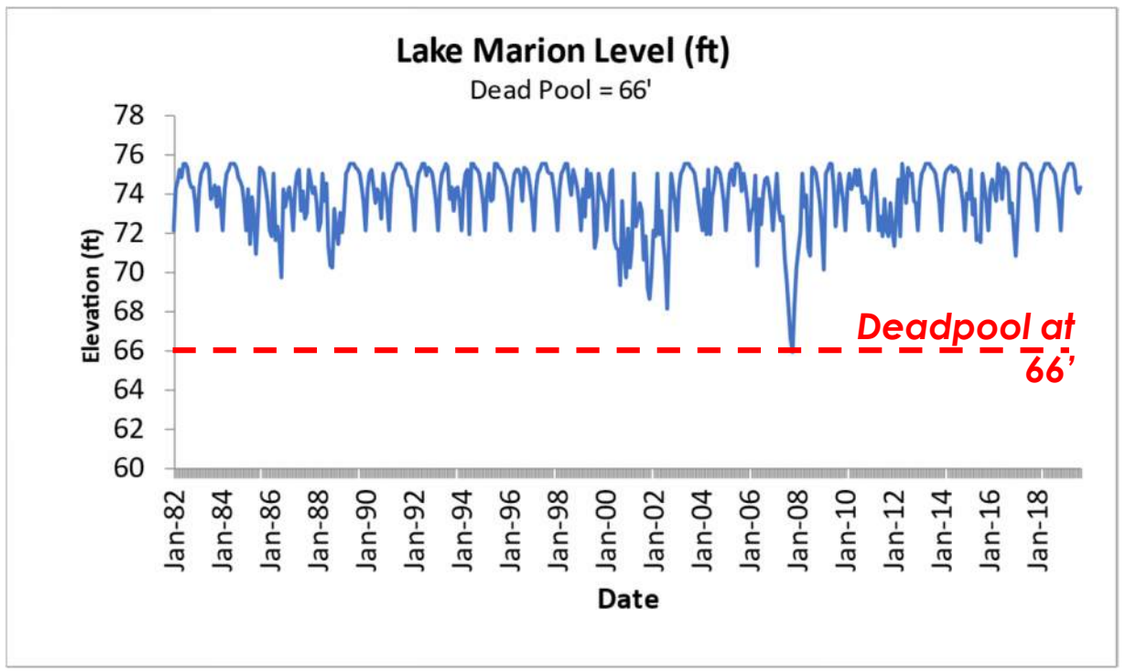
Performance Measure	SNT10 CONGAREE RIVER AT HWY 601	INFLOW TO LAKE MARION	SNT02 SANTEE RIVER NEAR PINEVILLE, SC	SNT09 SANTEE RIVER NR JAMESTOWN, SC	SLD29 GILLS CREEK AT COLUMBIA	SLD32 CEDAR CREEK BELOW MYERS CREEK NR HOPKINS	SNT07 LAKE MOULTRIE TAILRACE CANAL AT MONCKS CORNER, SC
Current Use Scenario flow (cfs)							
minimum flow	1,515	2,679	1	7	2	7	4,502
mean flow	7,411	13,576	1,809	8,408	67	54	5,168
median flow	5,693	10,482	1,202	5,542	56	42	5,087
25th percentile flow	3,843	6,995	1,201	1,653	34	27	4,841
10th percentile flow	2,775	5,528	601	642	20	17	4,653
5th percentile flow	2,187	4,501	601	628	15	14	4,546
2070 High Demand Scenario minus Current Use Scenario flow (cfs)							
minimum flow	-23	0	1	0	0	0	-597
mean flow	-81	-581	-68	-654	0	0	0
median flow	-49	-503	0	-1,028	0	0	2
25th percentile flow	-45	-94	0	-424	0	0	0
10th percentile flow	-77	-229	0	-4	0	0	-4
5th percentile flow	-32	-181	0	-4	0	0	4
Percent Difference between 2070 High Demand Scenario minus Current Use Scenario flow							
minimum flow	-1.5%	0.0%	87.2%	5.3%	-12.5%	-3.4%	-13.3%
mean flow	-1.1%	-4.3%	-3.7%	-7.8%	-0.5%	-0.4%	0.0%
median flow	-0.9%	-4.8%	0.0%	-18.5%	-0.3%	-0.8%	0.0%
25th percentile flow	-1.2%	-1.3%	0.0%	-25.7%	-1.0%	-0.9%	0.0%
10th percentile flow	-2.8%	-4.1%	0.0%	-0.7%	-2.1%	-1.4%	-0.1%
5th percentile flow	-1.5%	-4.0%	0.0%	-0.6%	-2.1%	-2.3%	0.1%

Negative percent differences indicate lower flow in the 2070 High Demand Scenario, compared to the Current Use Scenario

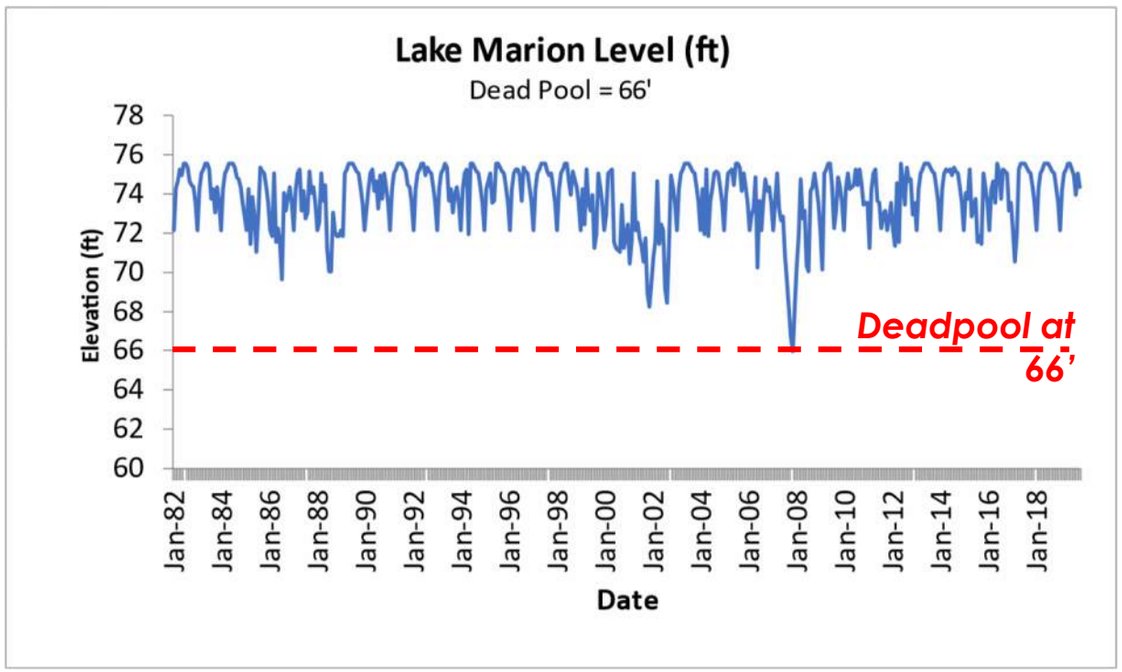
This is a portion of Table 6 of the memo

Reservoir Storage – Lake Marion

Current Use Scenario

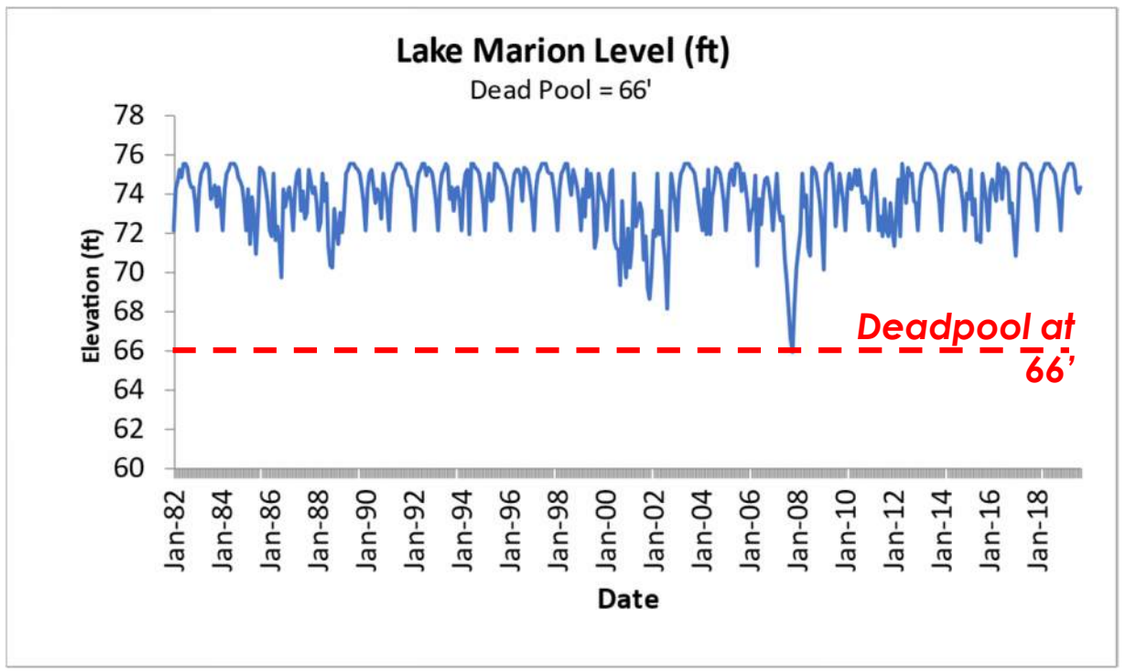


Moderate Demand Scenario

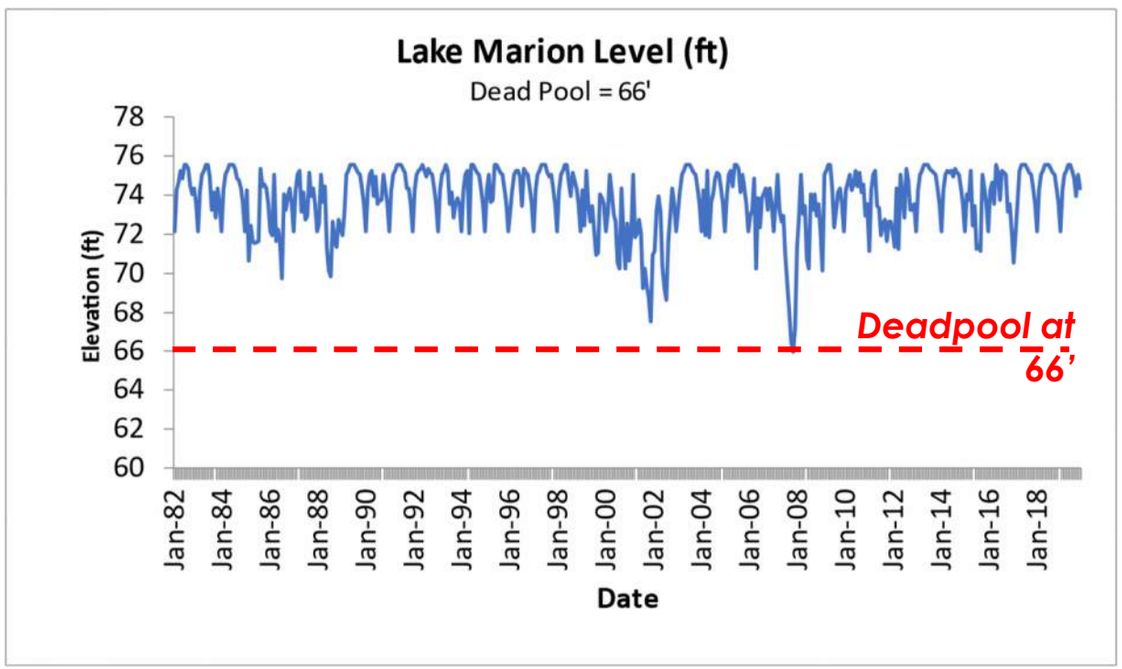


Reservoir Storage – Lake Marion

Current Use Scenario

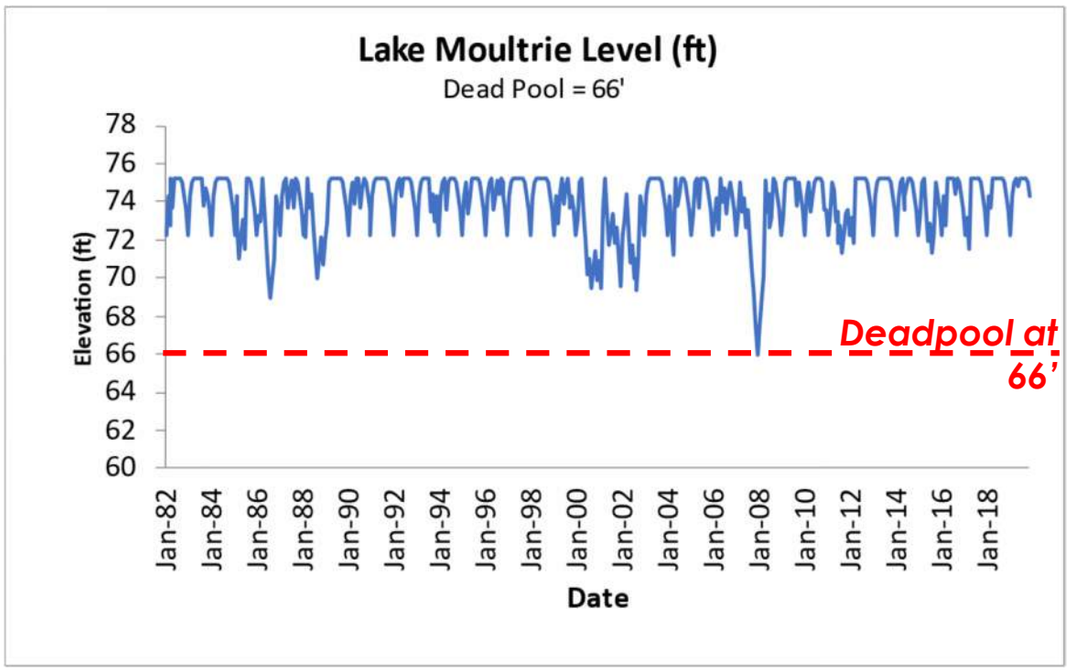


High Demand Scenario

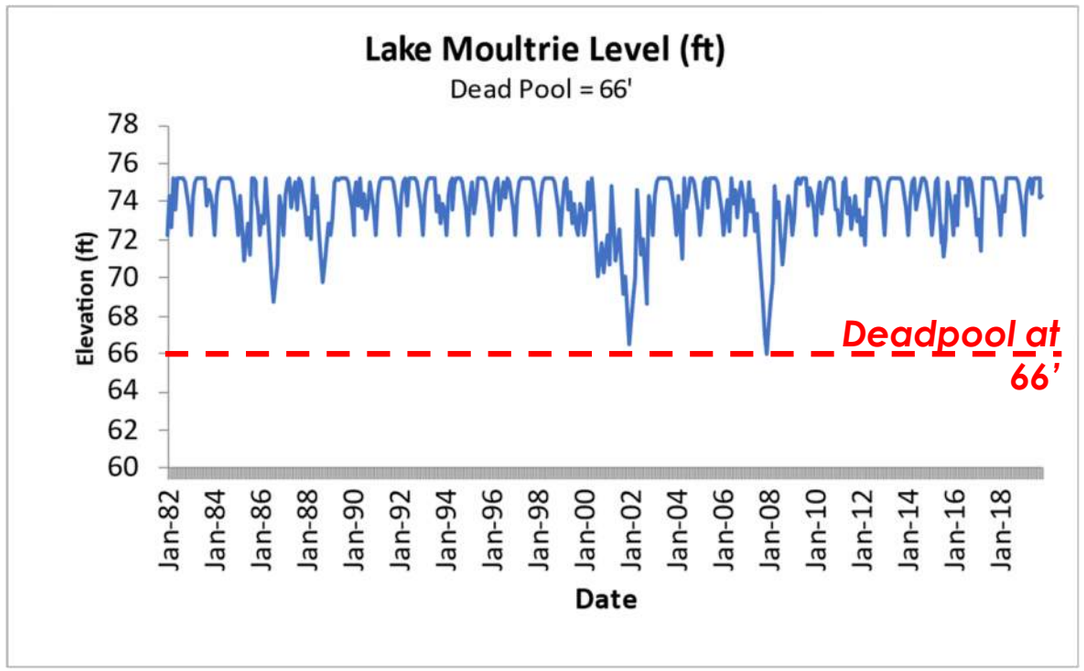


Reservoir Storage – Lake Moultrie

Current Use Scenario

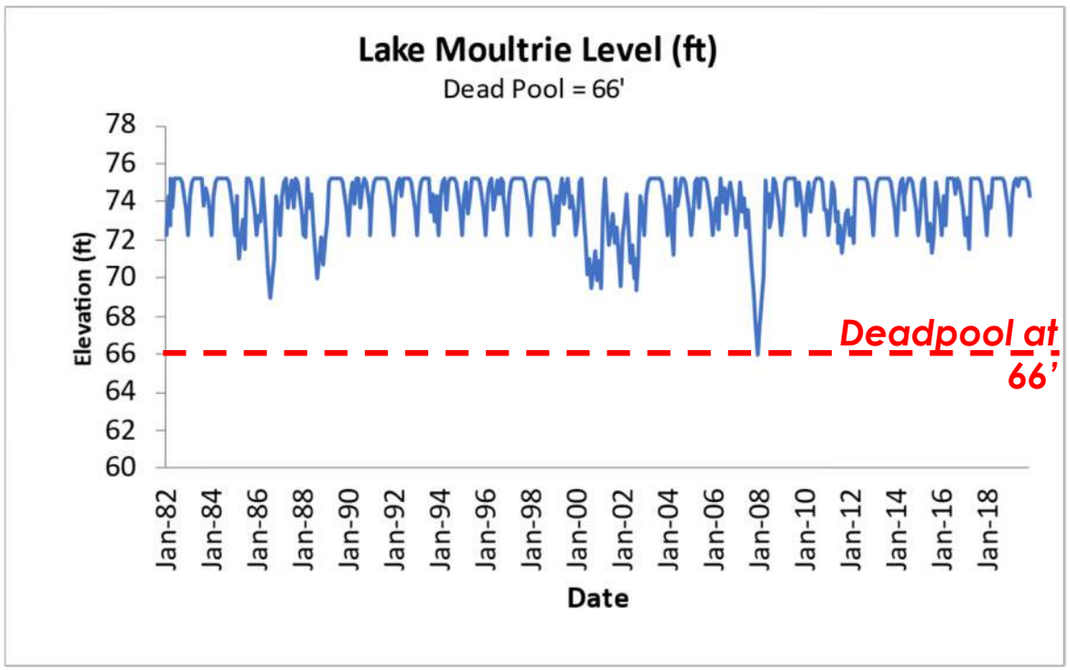


Moderate Demand Scenario

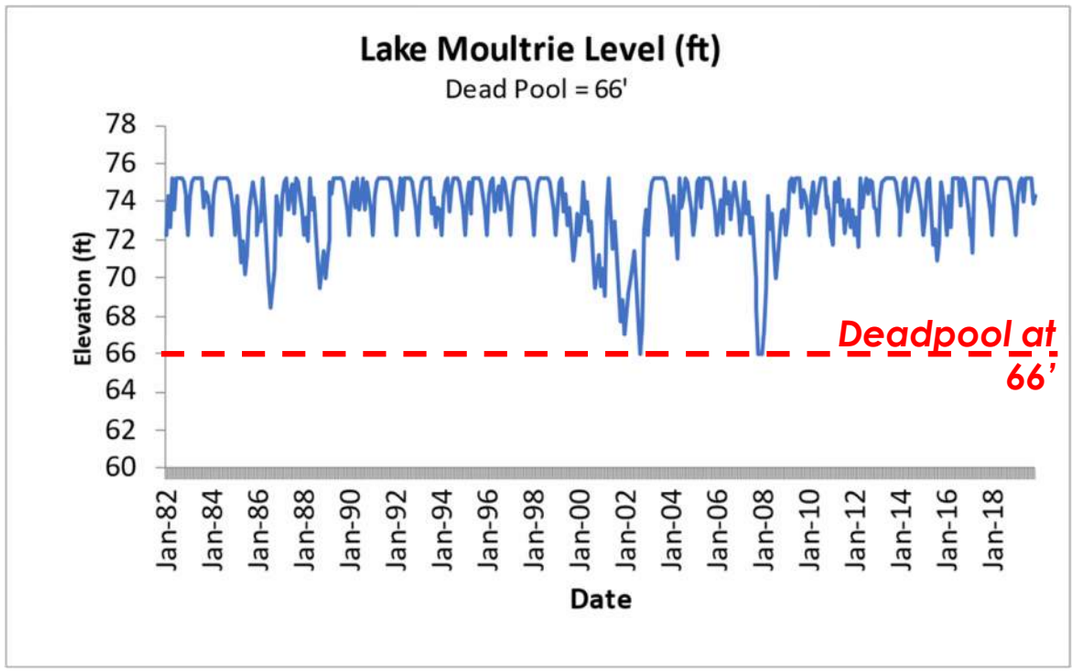


Reservoir Storage – Lake Moultrie

Current Use Scenario



High Demand Scenario



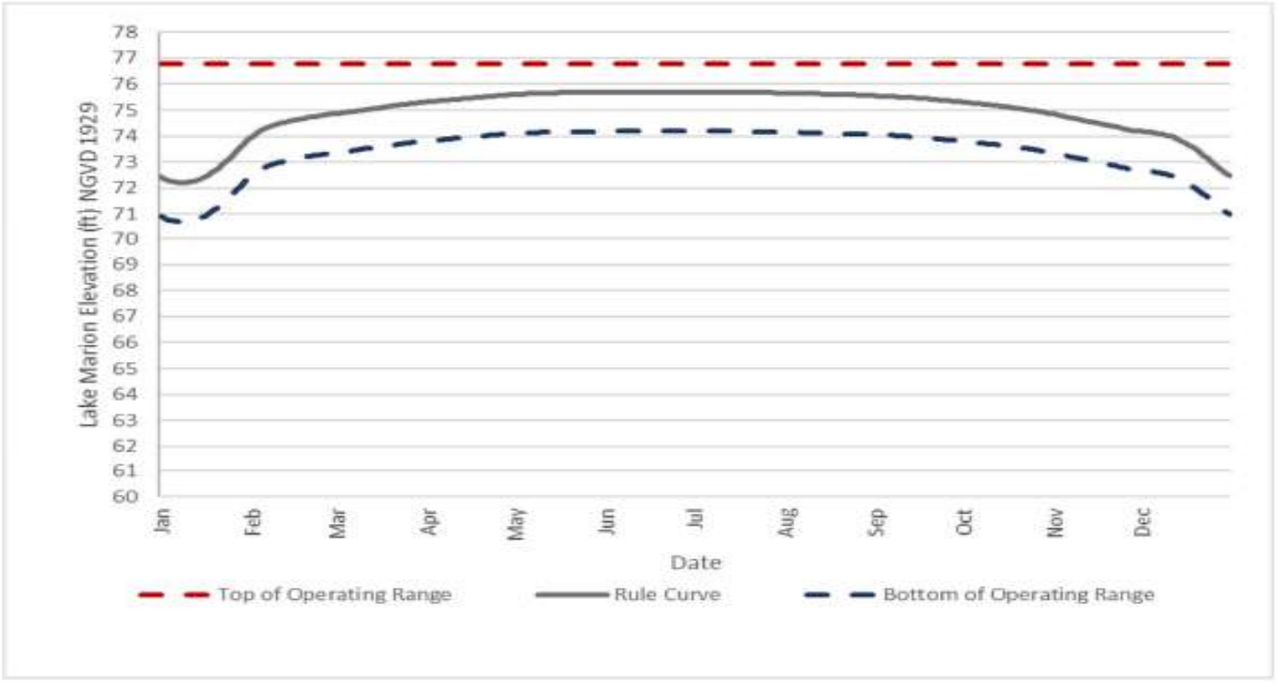


Figure 3.2 – Lake Marion Rule Curve with Target Operating Range

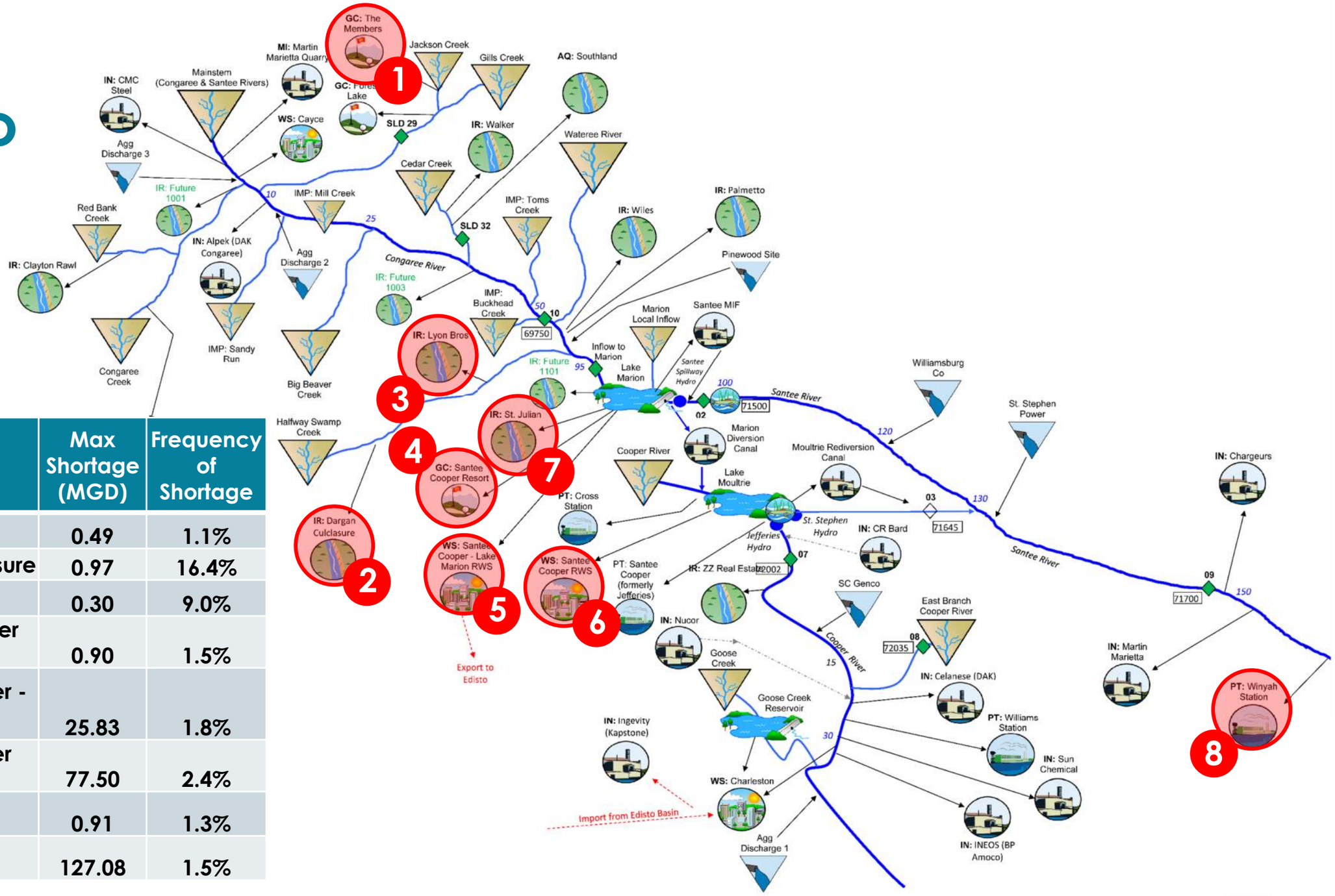
b. Permitted and Registered Scenario Results

P&R Scenario

1 Physical Shortage

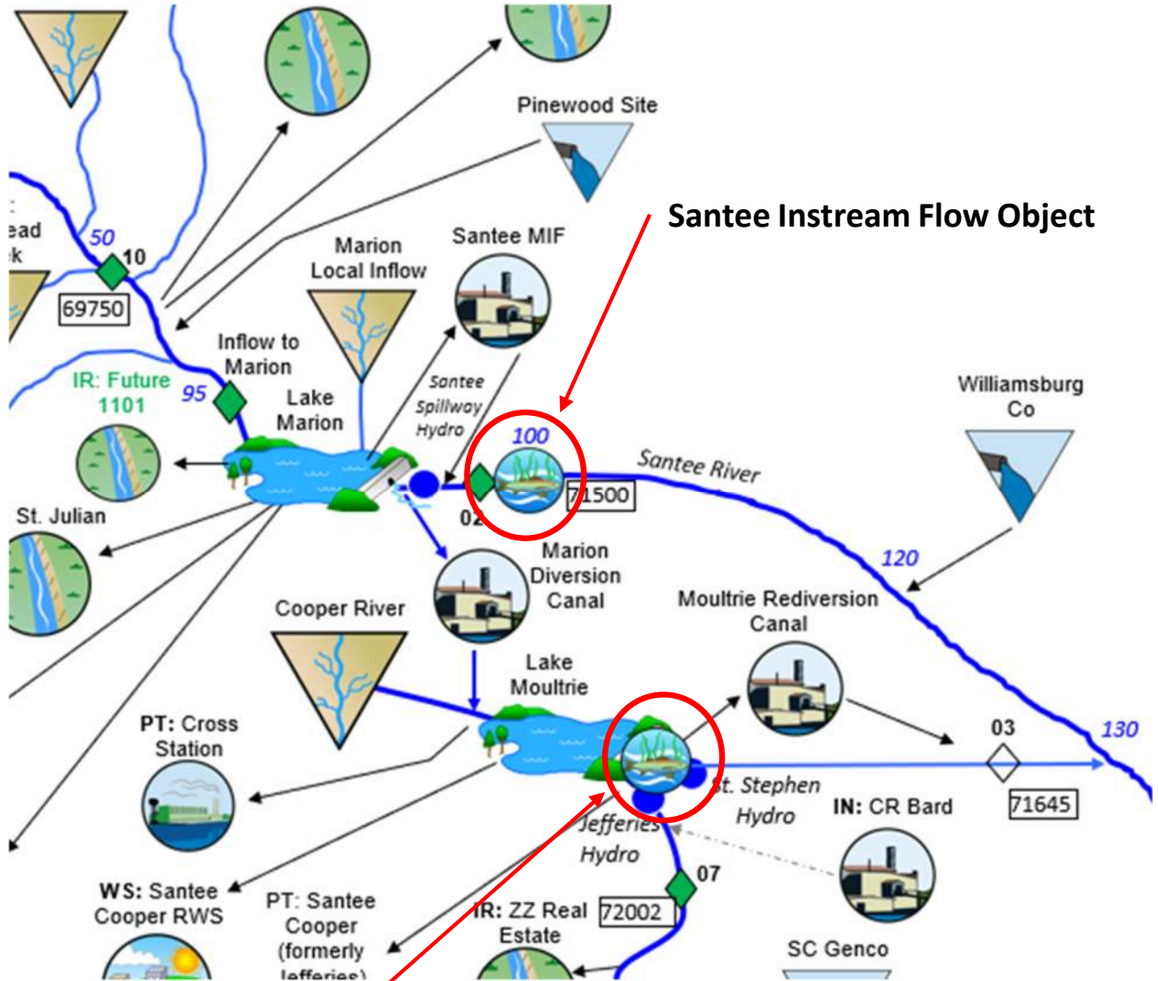
Surface Water Shortage Table

Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
1	GC: The Members	0.49	1.1%
2	IR: Dargan Culclasure	0.97	16.4%
3	IR: Lyons Bros	0.30	9.0%
4	GC: Santee-Cooper Resort	0.90	1.5%
5	WS: Santee Cooper - Lake Marion RWS	25.83	1.8%
6	WS: Santee Cooper RWS	77.50	2.4%
7	IR: St. Julian	0.91	1.3%
8	PT: Winyah Station	127.08	1.5%



Instream Flow Shortages

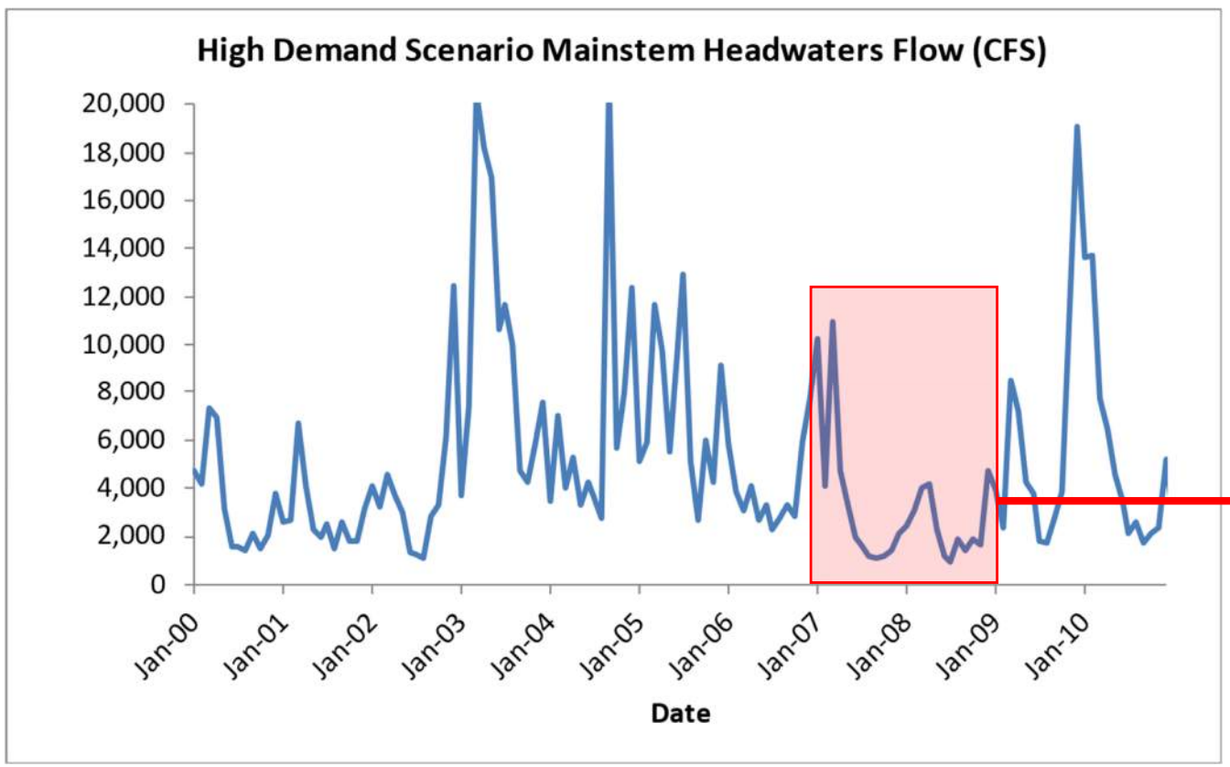
Instream Flow Object		Current Use Scenario Flow	Permitted and Registered Scenario
Santee	Max Shortage (MGD)	1,163	1,551
	Frequency of Shortage	22.1%	31.8%
Jeffries Hydro	Max Shortage (MGD)	3,619	3,619
	Frequency of Shortage	8.6%	12.5%
Jeffries Hydro Frequency of Shortages for Different Criteria			
Frequency of shortage for fish passage		8.1%	10.1%
Frequency of shortage for saltwater intrusion		0.4%	2.4%

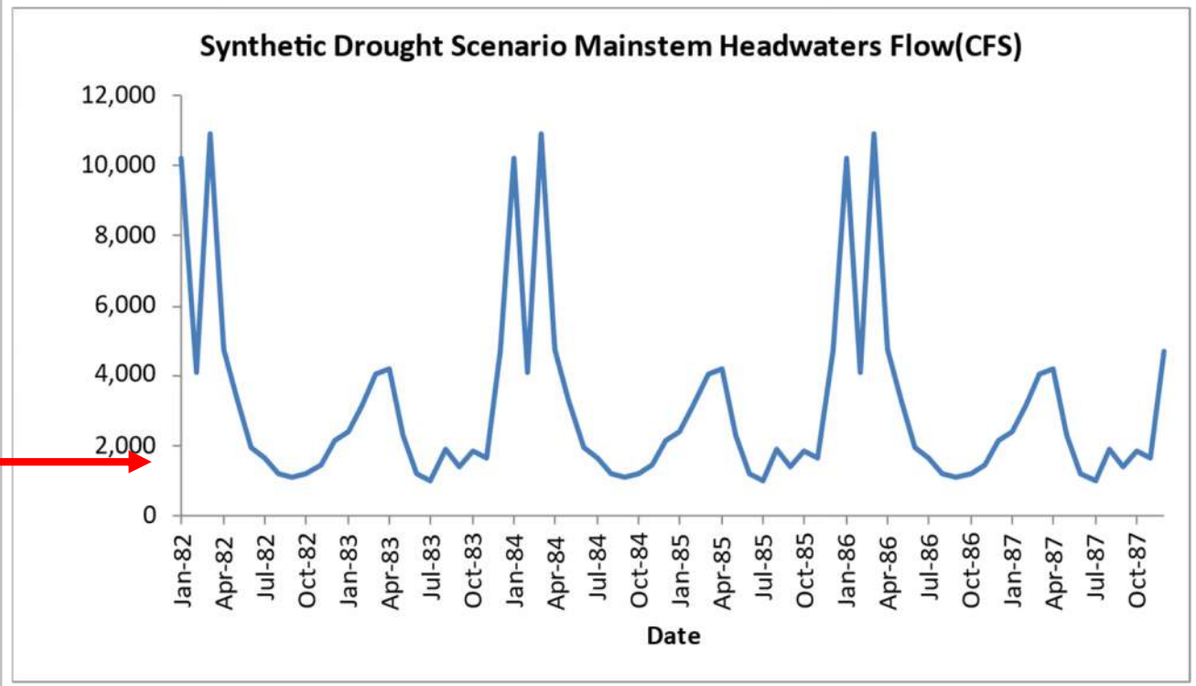


c. Synthetic Drought Scenario

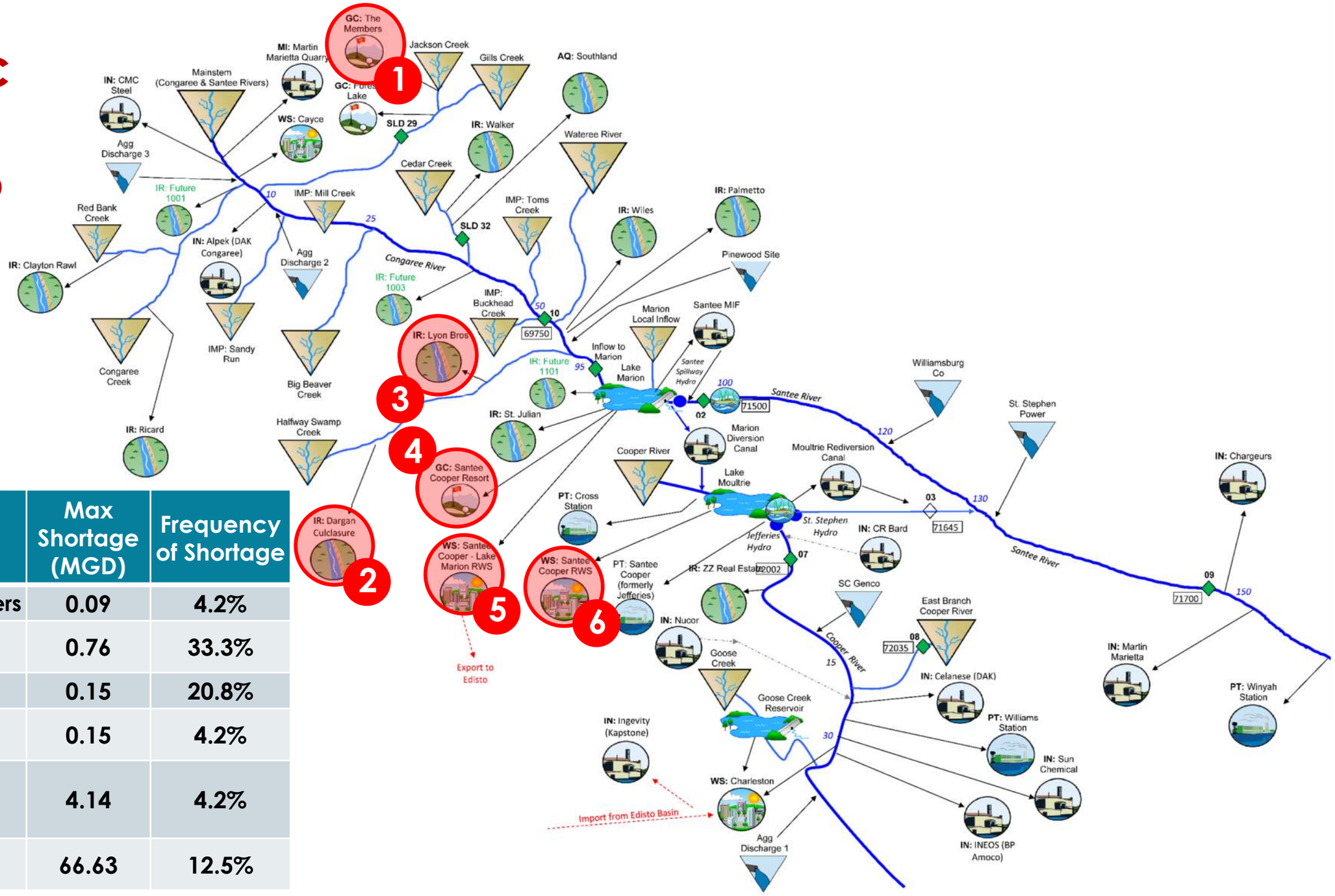
Synthetic Drought Scenario Development

- Synthetic Drought Scenario repeats the hydrology of 2007 and 2008
  - *Developed using SWAM Scenario Planner tool*
- Uses 2070 High Demand Scenario





Synthetic Drought Scenario

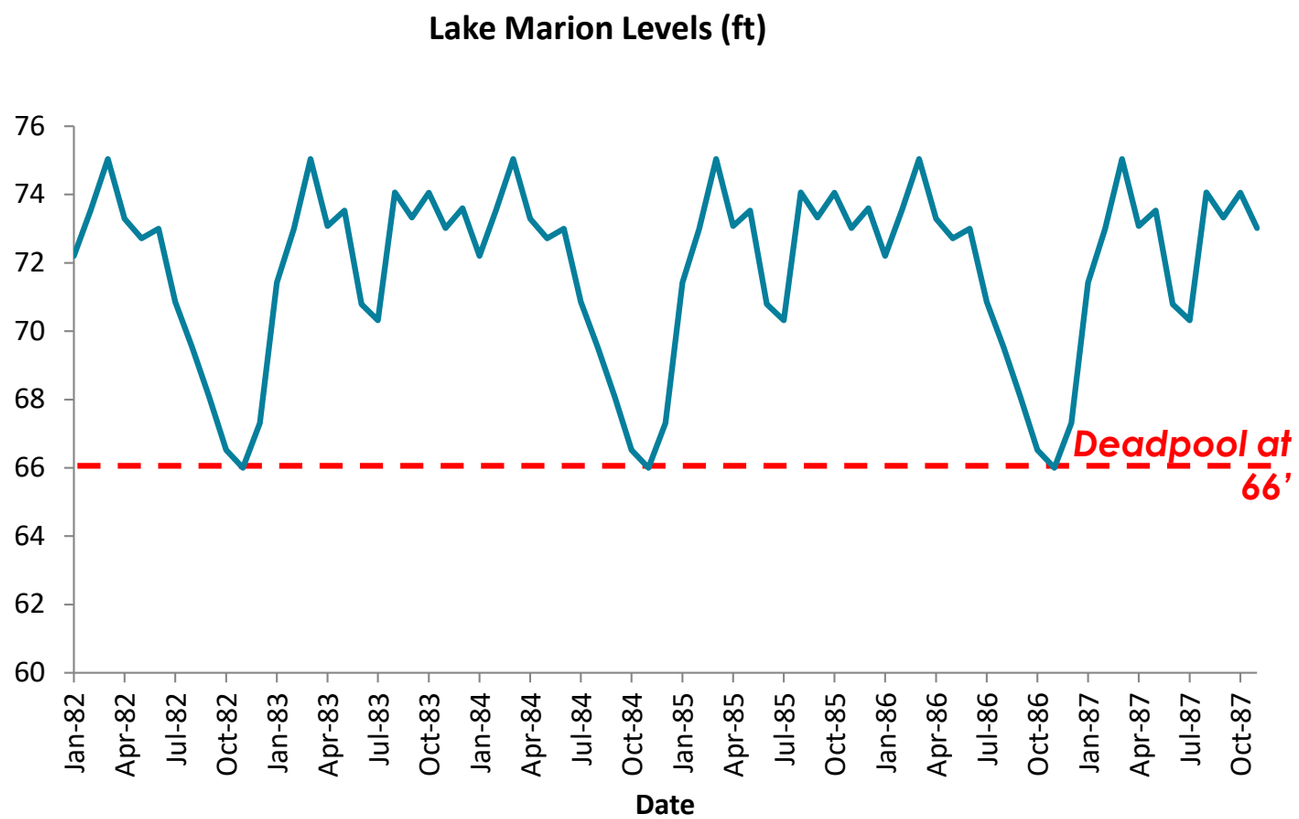


1 Physical Shortage

Surface Water Shortage Table

Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
1	GC: The Members	0.09	4.2%
2	IR: Dargan Culclasure	0.76	33.3%
3	IR: Lyons Bros	0.15	20.8%
4	GC: Santee-Cooper Resort	0.15	4.2%
5	WS: Santee Cooper - Lake Marion RWS	4.14	4.2%
6	WS: Santee Cooper RWS	66.63	12.5%

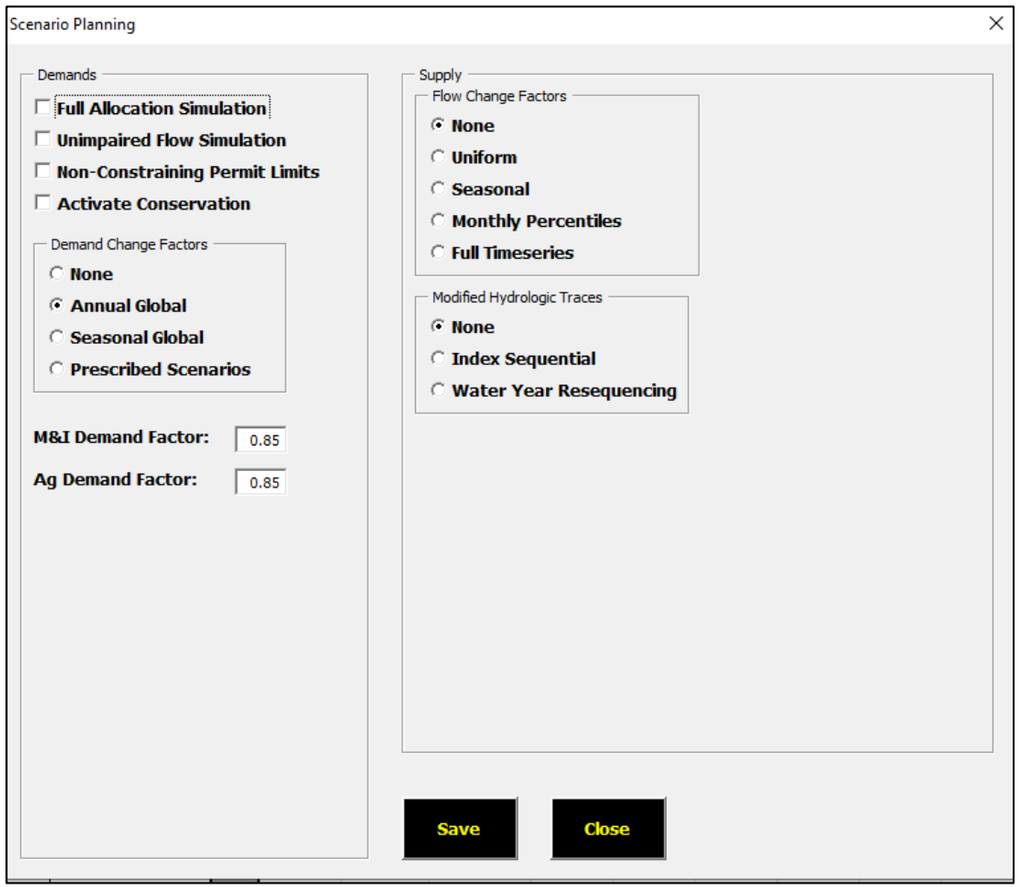
Lake Marion Elevation



d. Water Conservation Scenarios

Water Conservation Scenario Development

- Scenario 1 - 5% reduction in water demands for all users in Santee
- Scenario 2 - 15% reduction in water demands for all users in Santee

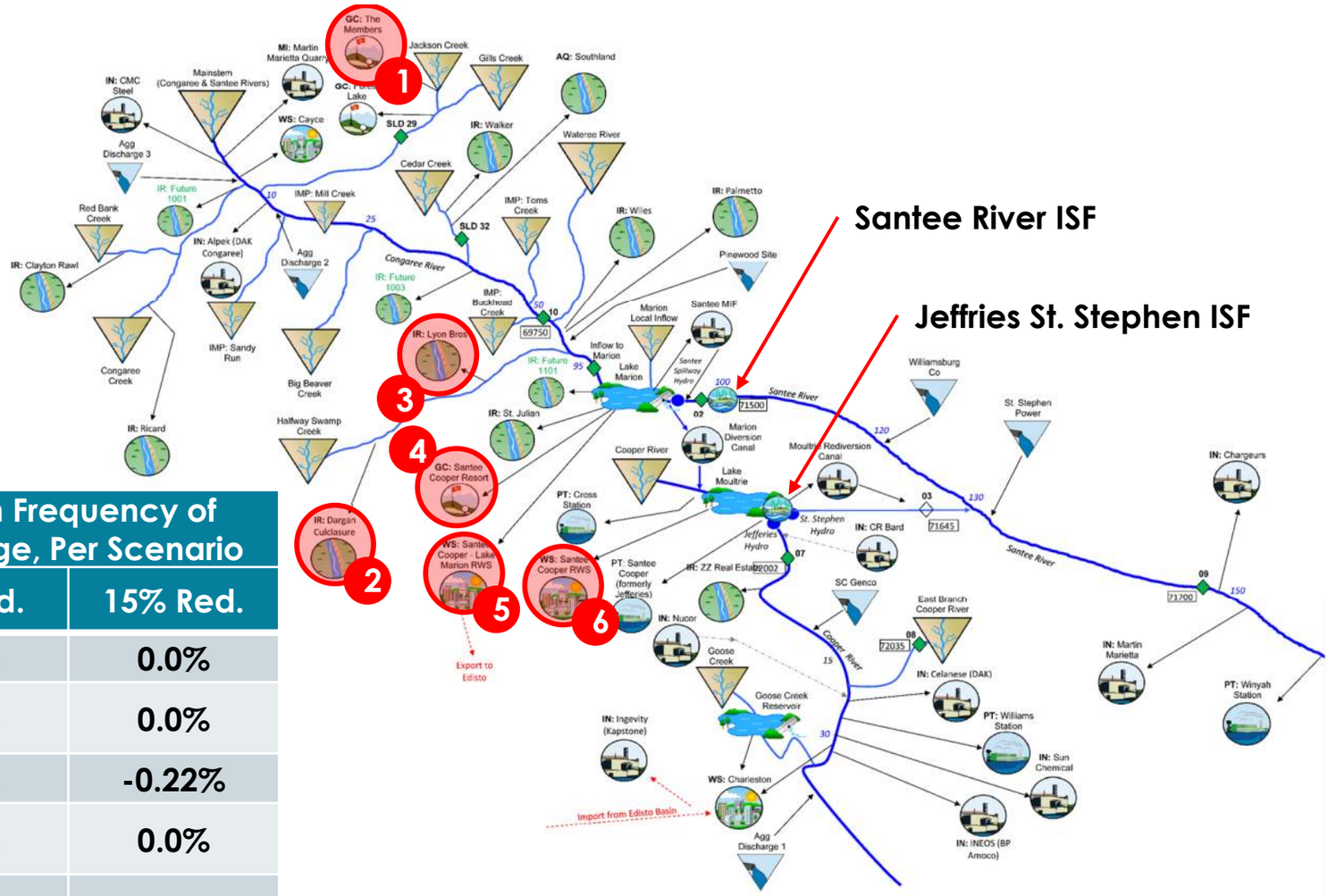


Water Conservation Scenarios

Surface Water Shortage Table

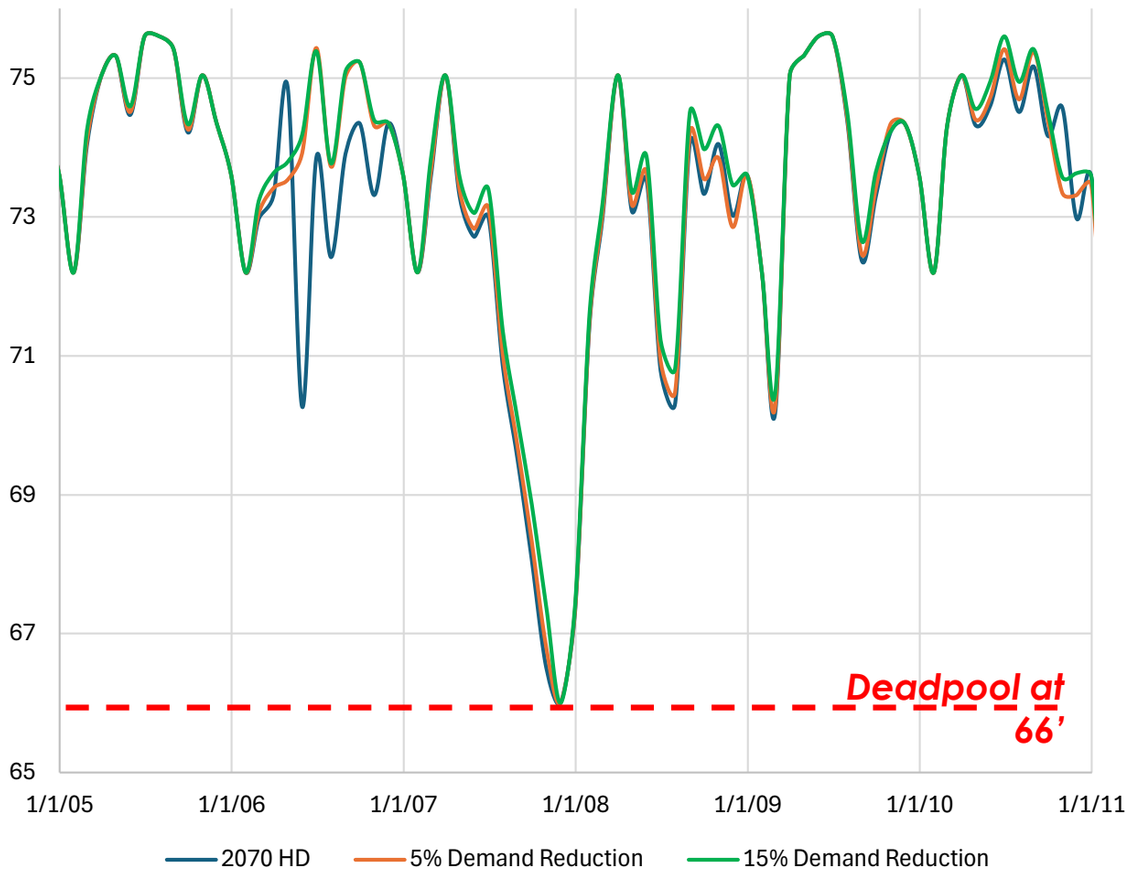
1 Physical Shortage

Map ID	Water User	2070 HD Frequency of Shortage	Diff in Frequency of Shortage, Per Scenario	
			5% Red.	15% Red.
1	GC: The Members	0.4%	0.0%	0.0%
2	IR: Dargan Culclasure	6.8%	0.0%	0.0%
3	IR: Lyons Bros	3.9%	0.0%	-0.22%
4	GC: Santee-Cooper Resort	0.2%	0.0%	0.0%
5	WS: Santee Cooper - Lake Marion RWS	0.2%	0.0%	0.0%
6	WS: Santee Cooper RWS	0.9%	-0.22%	-0.44%
In Stream Flow (ISF) Objects				
7	Santee River	24.3%	-0.4%	-2.0%
8	Jeffries St. Stephen	10.5%	-0.9%	-2.2%

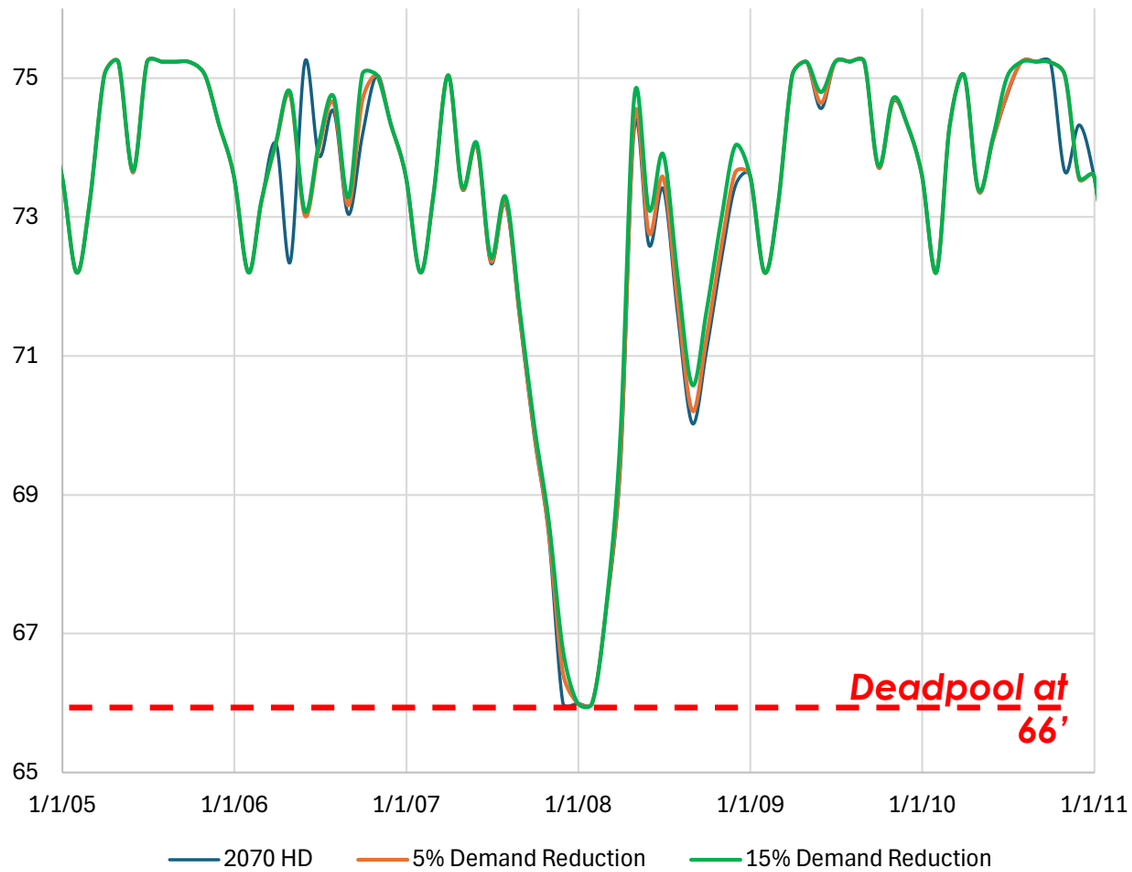


Water Conservation Scenarios – Reservoir Storage

Lake Marion Levels (feet)



Lake Moultrie Levels (feet)



Strategies to Consider

- Lower existing intake elevations in Lake Marion
  - Modeling the deadpool at 60’ showed no shortages
- Use temporary emergency intakes and pumping (which they have done already during drought)
- Reduce the release from Marion to the Santee River below 600 cfs between the operating curve elevation and deadpool elevation
- **25% reduction** in demands eliminates shortage for **Santee Cooper Lake Marion RWS** but still leaves one month shortage for **Santee Cooper RWS** (on Moultrie).

e. Safe Yield of Reservoirs

Safe Yield Definition

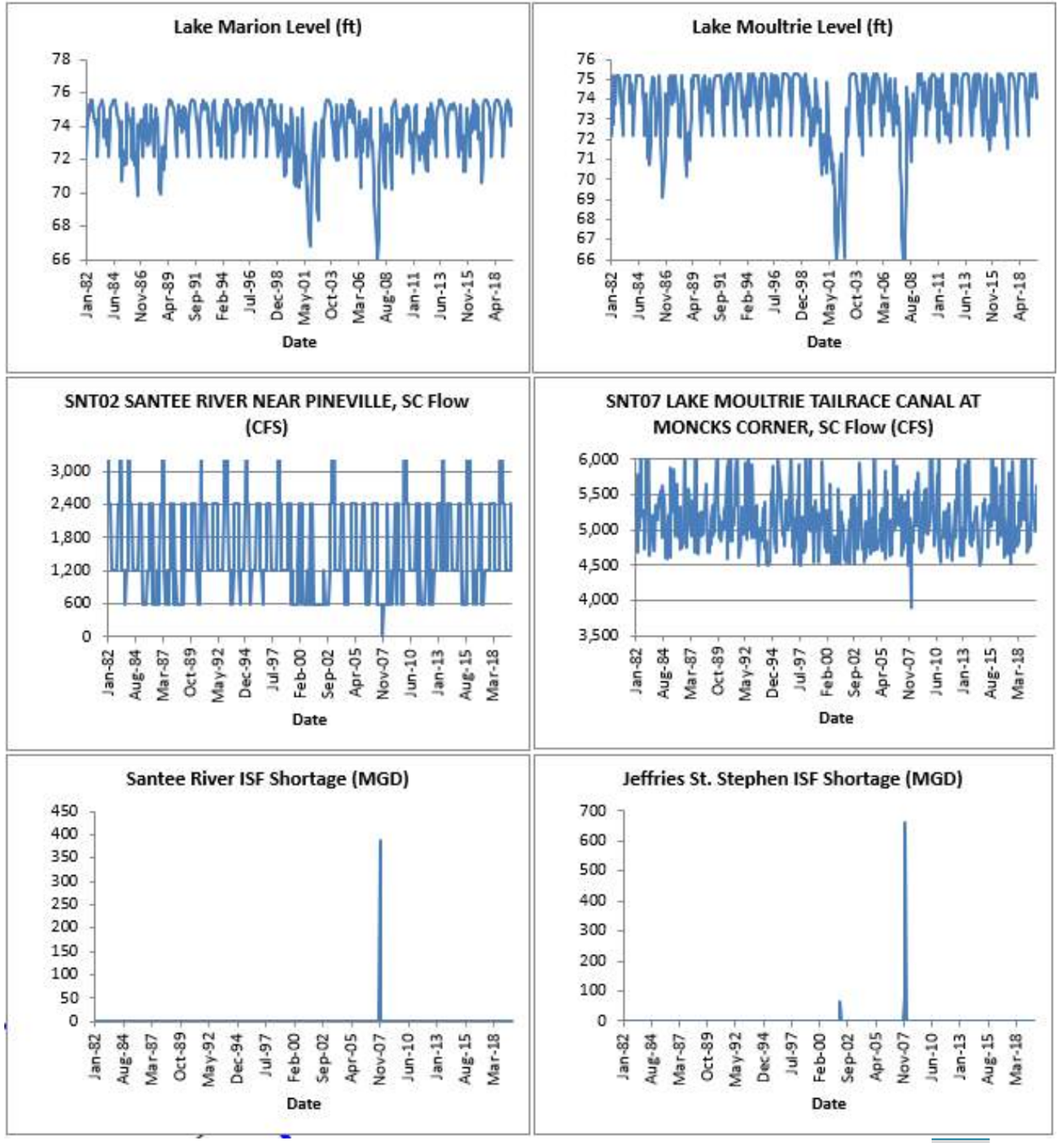
- Per Section 4.3.4 of the Planning Framework:
  - **Reservoir Safe Yield** is defined as the **Surface Water Supply** for a reservoir or system of reservoirs over the simulated hydrologic period of record.
    - **Surface Water Supply** is defined as the maximum amount of water that occurs 100% of the time at a location on a surface water body with no defined Surface Water Conditions applied on the surface water body.
  - Reservoir Safe Yield will be based on the shallowest intake (For Lakes Marion and Moultrie, the dead pool elevation of 66 feet was used).
  - Reservoir Safe Yield determinations will use current reservoir operating rules described in existing FERC licenses for hydropower projects or described in any other legal agreements …

Safe Yield Methodology

- Lake Marion and Moultrie examined as a single system
- All Marion and Moultrie water users were set to zero demand except for one in each reservoir, which represented composite (or total) reservoir yield
- Equal demands applied to each to maintain approximate balance
- All other model demands (and inflows) are based on the **2070 High Demand Scenario**.
- Target flows of 600/1,200/2,400 maintained in Santee River
- Target flow of 4,500 cfs maintained in Cooper River
- Yield considered sustainable if at least 600 cfs can be released to the Santee River from Lake Marion at all times, and 4,500 cfs release to the Cooper at all times.
- Fish passage flows in the rediversion canal were allowed to decrease to zero without affecting classification of yield.
- Withdrawals were set at a baseline and decreased incrementally to try to identify safe yield.

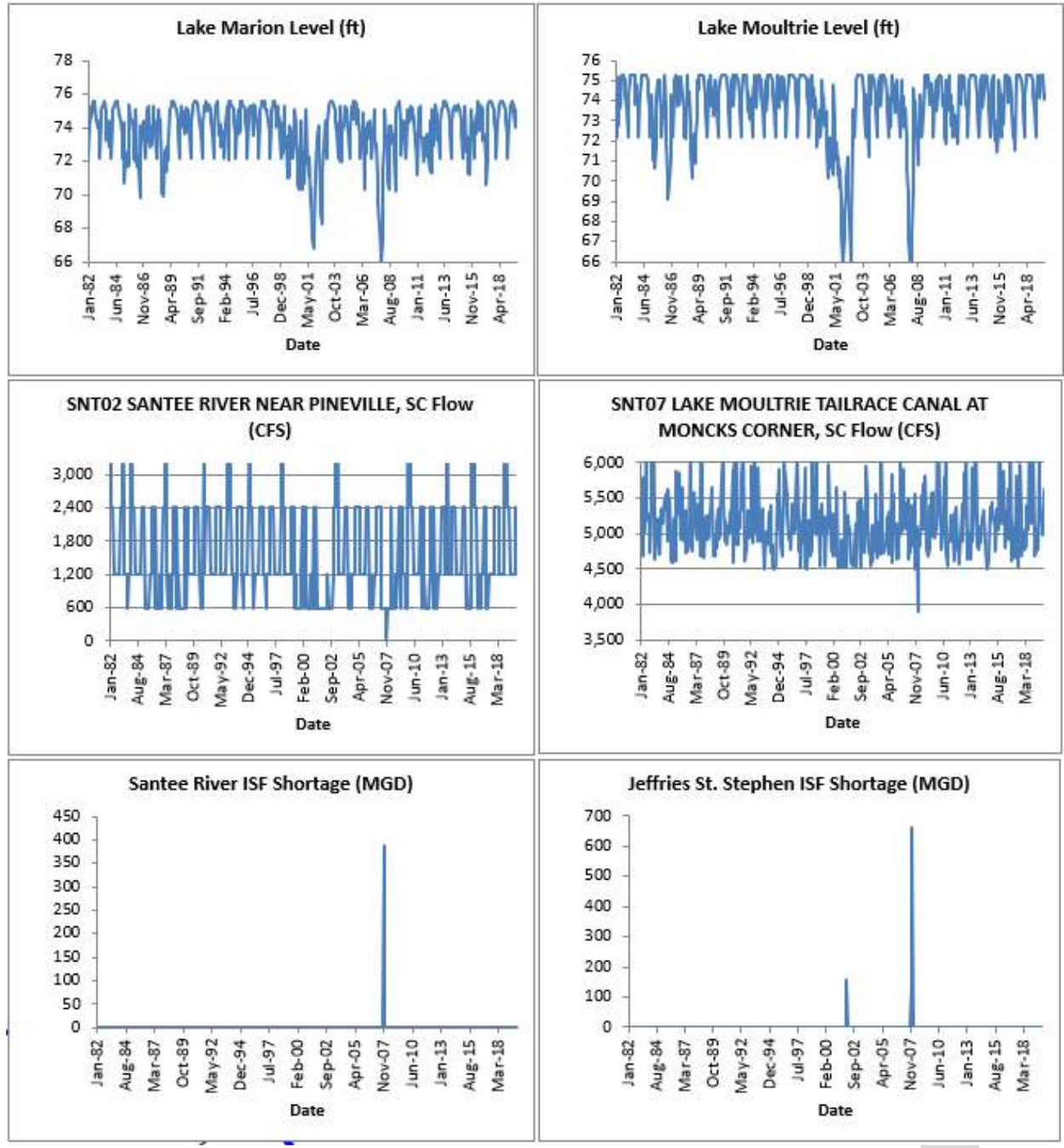
Preliminary Safe Yield Results

- The minimum instream flow requirements of 600 cfs in the Santee and 4,500 cfs in the Cooper cannot be satisfied 100% of the time even **with 0 withdrawal** from the reservoirs.
- Of note: Approximately 4 mgd could be sustainably withdrawn from each reservoir while producing approximately the same frequency and magnitude of instream flow shortages.
- Above 4 mgd from each reservoir, the frequency of instream shortages increases.



Results of 4 mgd from both reservoirs

- Approximately 4 mgd could be sustainably withdrawn from each reservoir while producing approximately the same frequency and magnitude of instream flow shortages.
- Above 4 mgd from each reservoir, the frequency of instream shortages increases.
- Using the **daily timestep**, shortages appear between 4 and 10 mgd.



Summary and Next Steps

- These results are preliminary and will be reviewed by CDM Smith and the RBC. Alternative scenarios may be warranted.
- Findings suggest that instream flow requirements on Marion and Moultrie do not allow for sustained withdrawal.
- This constraint is governed by very infrequent dry conditions
- Sensitivity experiments could be done with different streamflow thresholds or frequencies of attainment
- It may be worth examining contingency plans for the users of the reservoirs during the extreme low flow conditions that (in the model) restrict withdrawals.