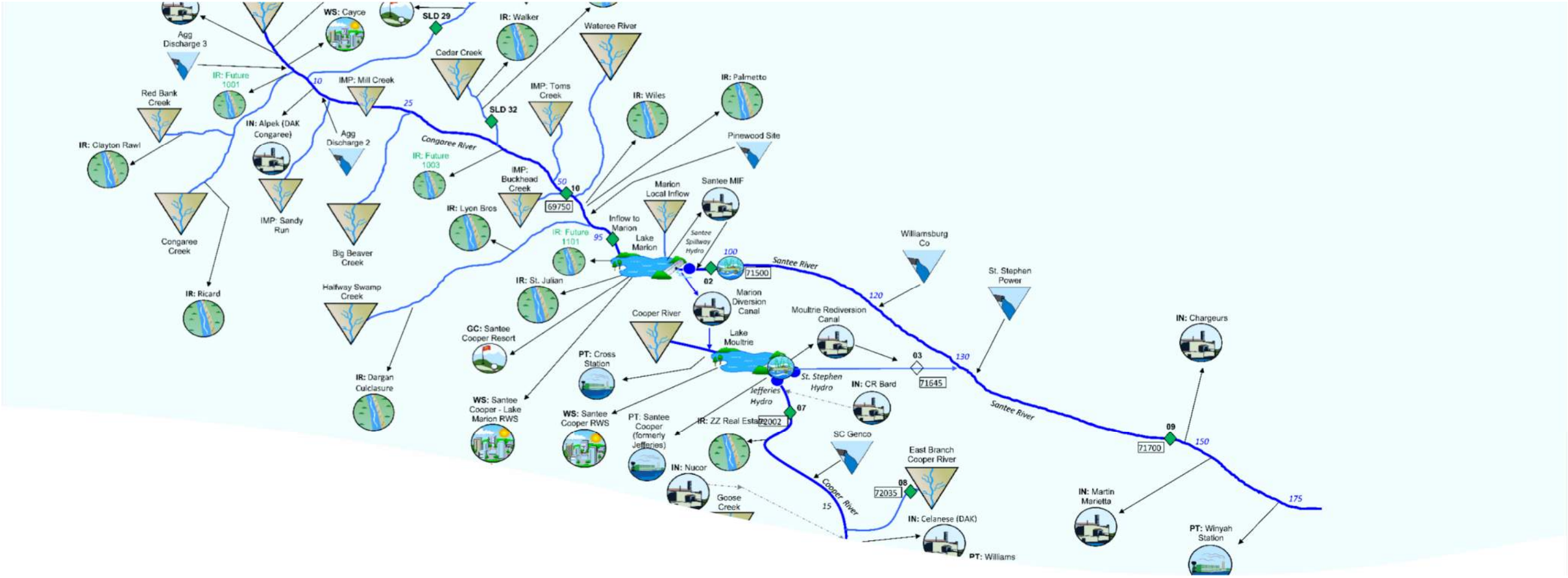


Surface Water Availability Results and Discussion

John Boyer

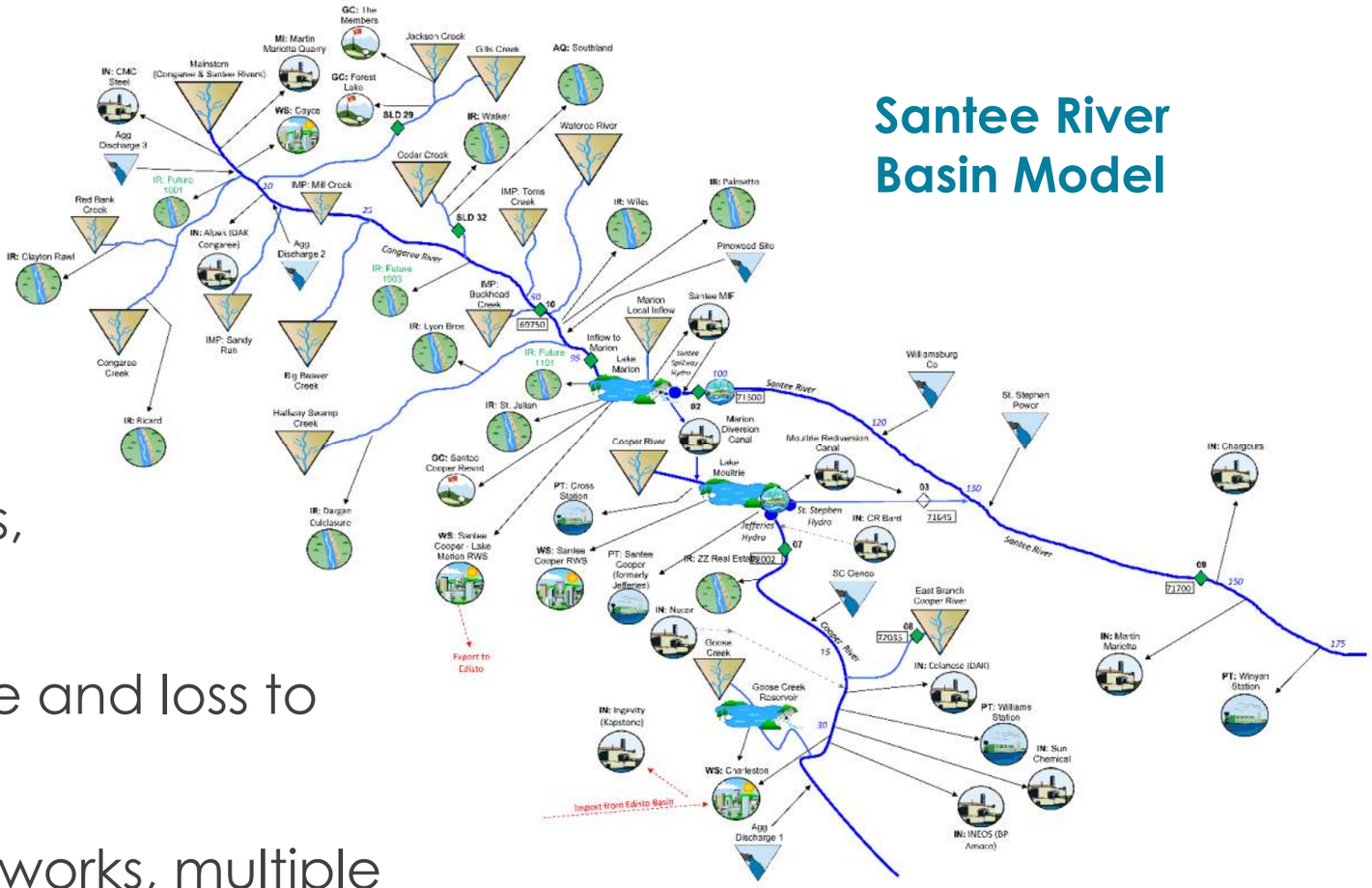
Agenda Item 4

Refresher of Santee River Basin Model

Surface Water Model Overview

Water Allocation Modeling ***is***:

- Water balance calculations of physical flow
- Water rights calculations of legally available flow
- Accounting of water demands, withdrawals, and return flows
- Accounting of reservoir storage and loss to evaporation
- A representation of stream networks, multiple "nodes"



Surface Water Model Overview

Water Allocation Modeling ***is not***:

- Rainfall-runoff calculations
- Hydrologic routing calculations
- Groundwater modeling
- Water quality modeling

Model Inputs and Supporting Information

Model Inputs

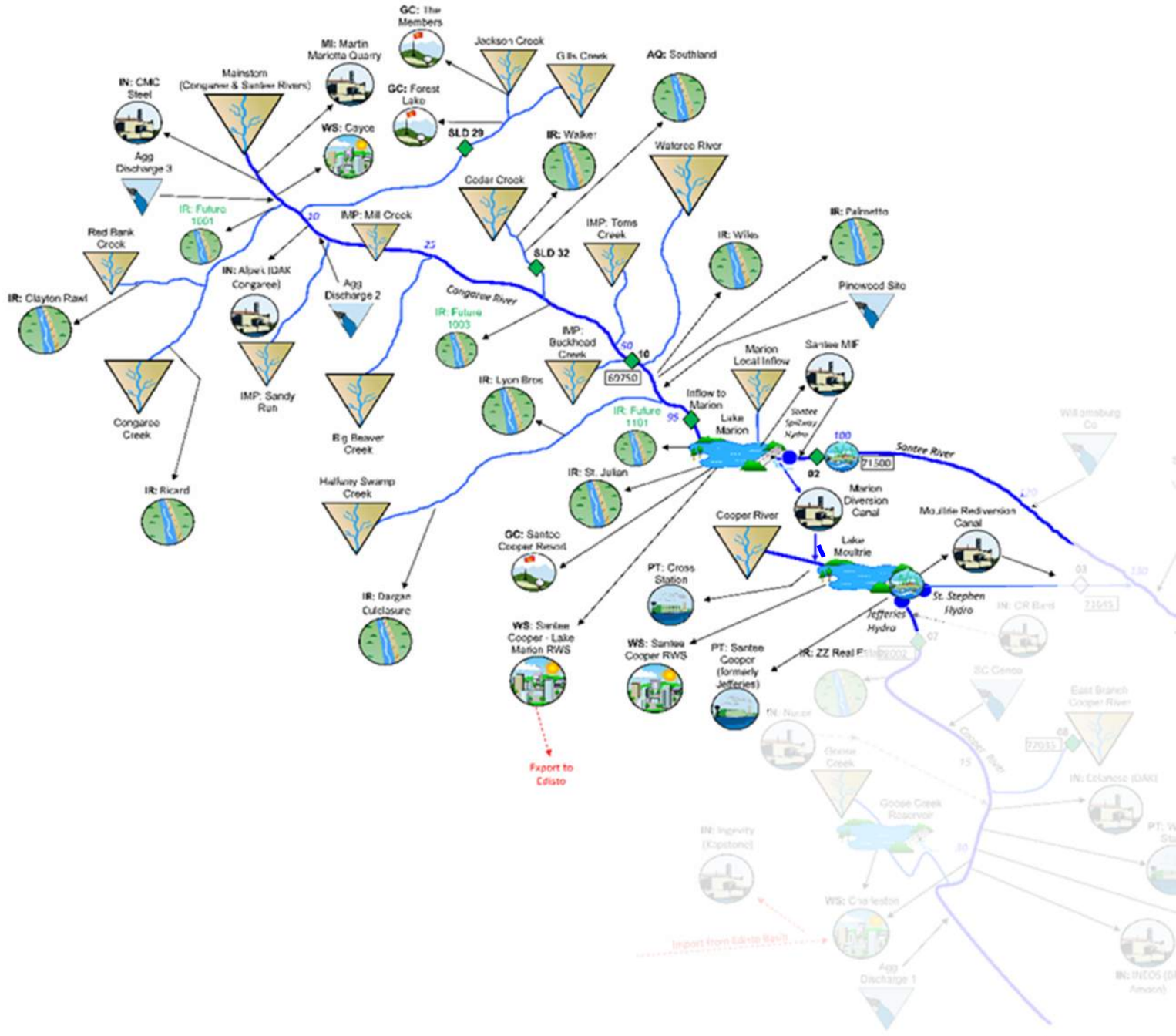
- USGS daily flow records
- Historical operational data
  - Withdrawals (municipal, industrial, thermoelectric, agricultural, golf courses, hatcheries)
  - Wastewater discharges and return flows
  - Transfers in and out of the basin
- Reservoir characteristics and operating rules

Supporting Information

- Subbasin characteristics
  - Drainage area, land use, and slope

USGS Streamflow Gaging Station

Santee River Basin (Upper Portion)
Surface Water Model Framework



Model Objects

- Tributary
- Discharge
- Reservoir
- Current or Former USGS Stream Gage *(with last 5 to 6 digits of Gage ID)*

Water User Objects

- Municipal
- Agriculture (Irrigation)
- Thermoelectric or Nuclear
- Industrial or Mining
- Golf Course (Irrigation)

- Import or Export (Interbasin Transfer)
- Discharge from a Groundwater User*

** The associated Water User Object does not have a Surface Water Withdrawal.*

Santee River Basin (Lower Portion) Surface Water Model Framework

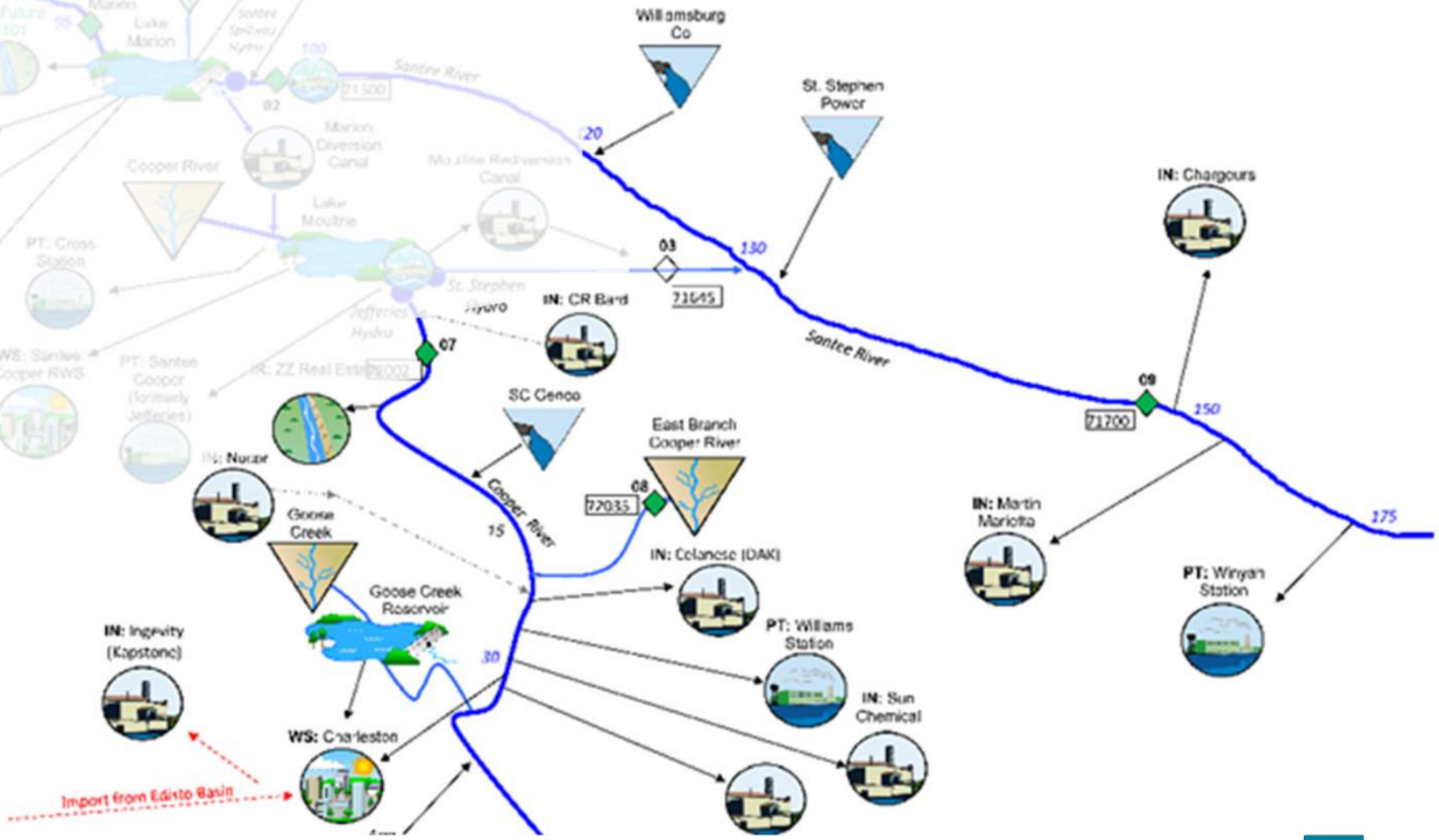
Model Objects

- Tributary
- Discharge
- Reservoir
- Current or Former USGS Stream Gage
  (with last 5 to 6 digits of Gage ID)

Water User Objects

- Municipal
- Agriculture (Irrigation)
- Thermoelectric or Nuclear
- Industrial or Mining
- Golf Course (Irrigation)
- Import or Export (Interbasin Transfer)
- Discharge from a Groundwater User*

** The associated Water User Object does not have a Surface Water Withdrawal.*



2024-5 Surface Water Model Updates

- Updated the hydrologic period of record to be 1982-2019
- Updated inflows from Catawba and Saluda River basins
- Updated monthly mean water demands based on recent water use data
- Updated permit and intake location information
- Removed inactive permittees
- Added new registrations
- Adjusted stage-storage relationships for Lakes Marion and Moultrie
- Revised rules governing releases from Lake Marion and Moultrie
- Software updates

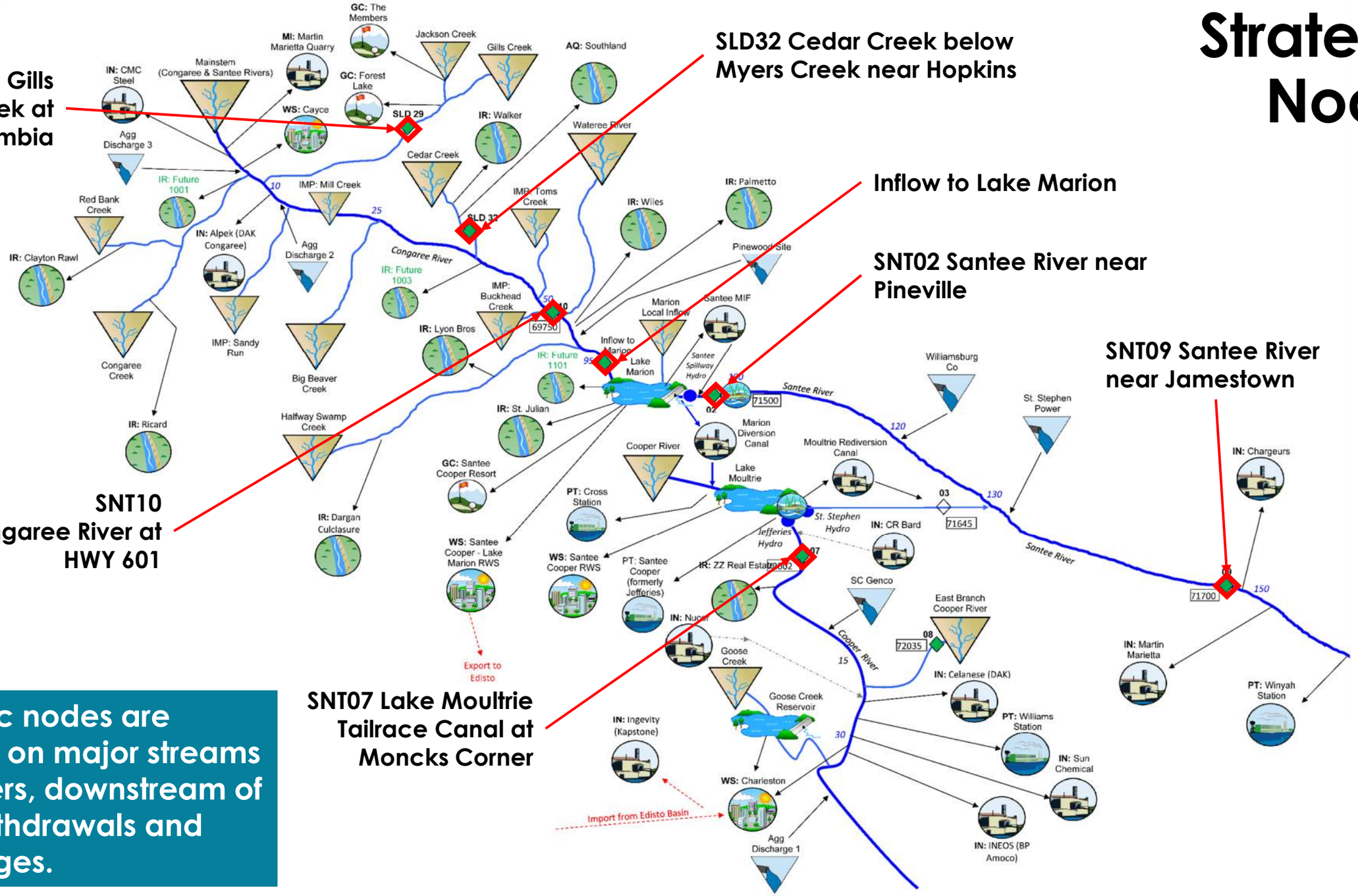
Performance Measures

Assessment of simulation results will focus on quantifying key performance measures for strategic nodes and reaches of interest across the basin.

Examples:

- Percent change in a monthly minimum flow, 5th percentile flow, mean, and/or median flow
- Percent change in seasonal or monthly flows
- Percent change in surface water supply
- Percent change in mean annual shortage or mean percent shortage
- Change in the number and magnitude of excursions below minimum instream flow or other selected metrics
- Change in number of water users that experience a shortage
- Change in the average frequency of shortage
- Percent of time recreational facilities were unavailable on a stream reach

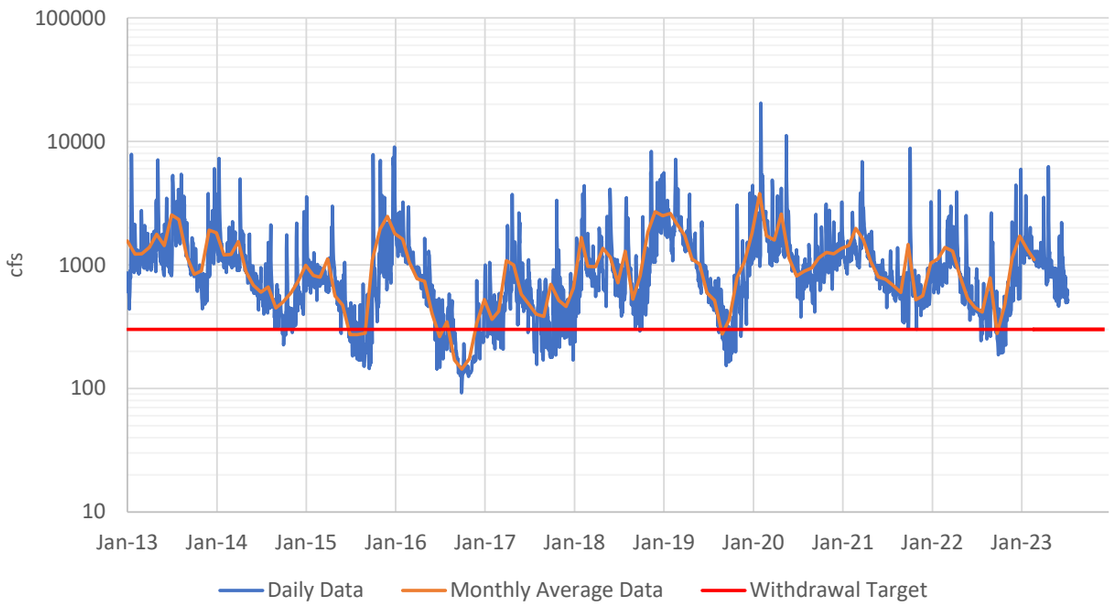
Strategic Nodes



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

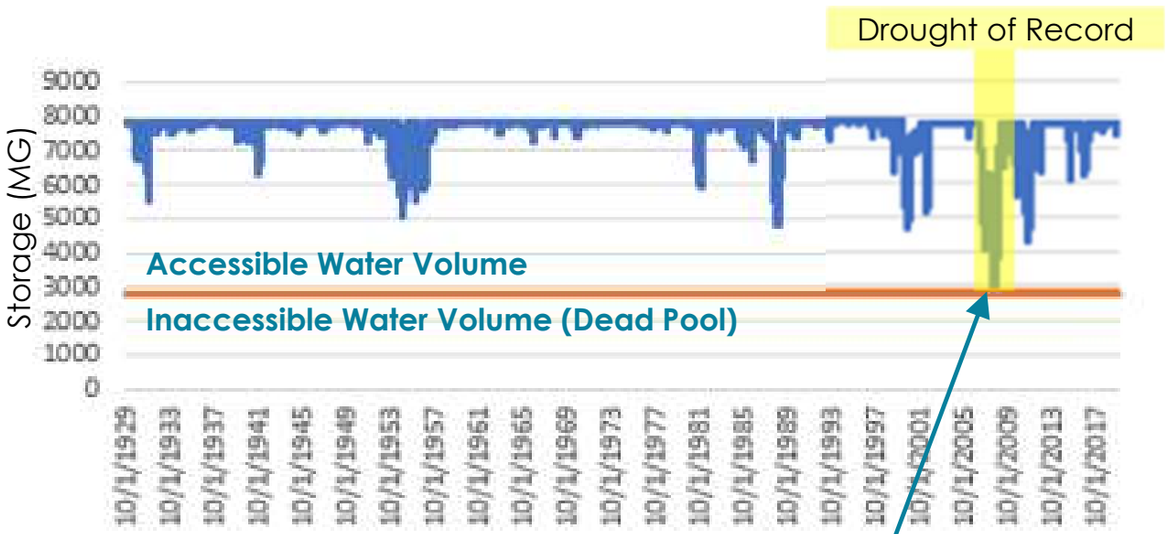
Water Availability

Direct River Withdrawal



Water is limited to the flow in the stream at any point in time

Reservoir Withdrawal



Reservoir "Safe Yield" is the amount of water that can be continuously withdrawn from a reservoir through the period or record without depletion. Generally higher than river withdrawals because storage buffers low flows.

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*

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

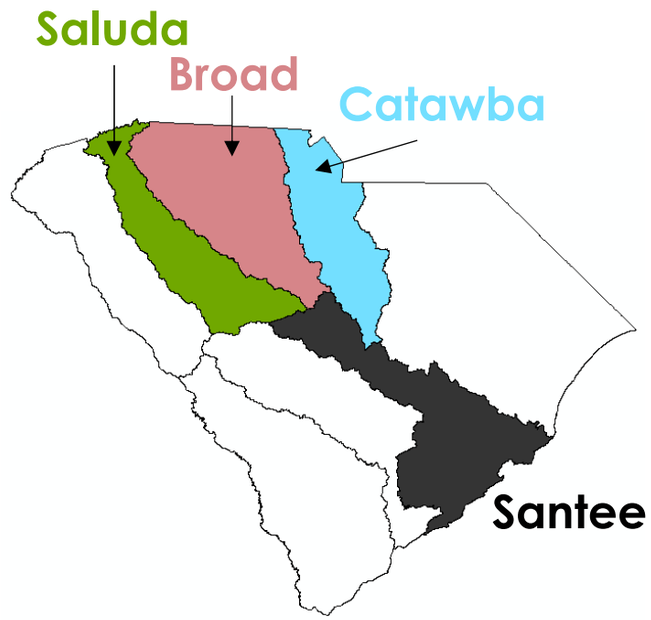
Surface Water Use Sector	Current Use	2070 Moderate	2070 High Demand[1]
Mining	0.0	0.0	0.0
Agriculture	0.5	0.5	1.3
Aquaculture	0.1	0.1	0.2
Golf Courses	0.3	0.3	0.6
Industrial/Manufacturing	67.5	128.6	234.8
Public Water Supply	117.5	233.3	378.7
Thermoelectric[2]	373.6	26.5	30.6
Total all Sectors[3]	559.4	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

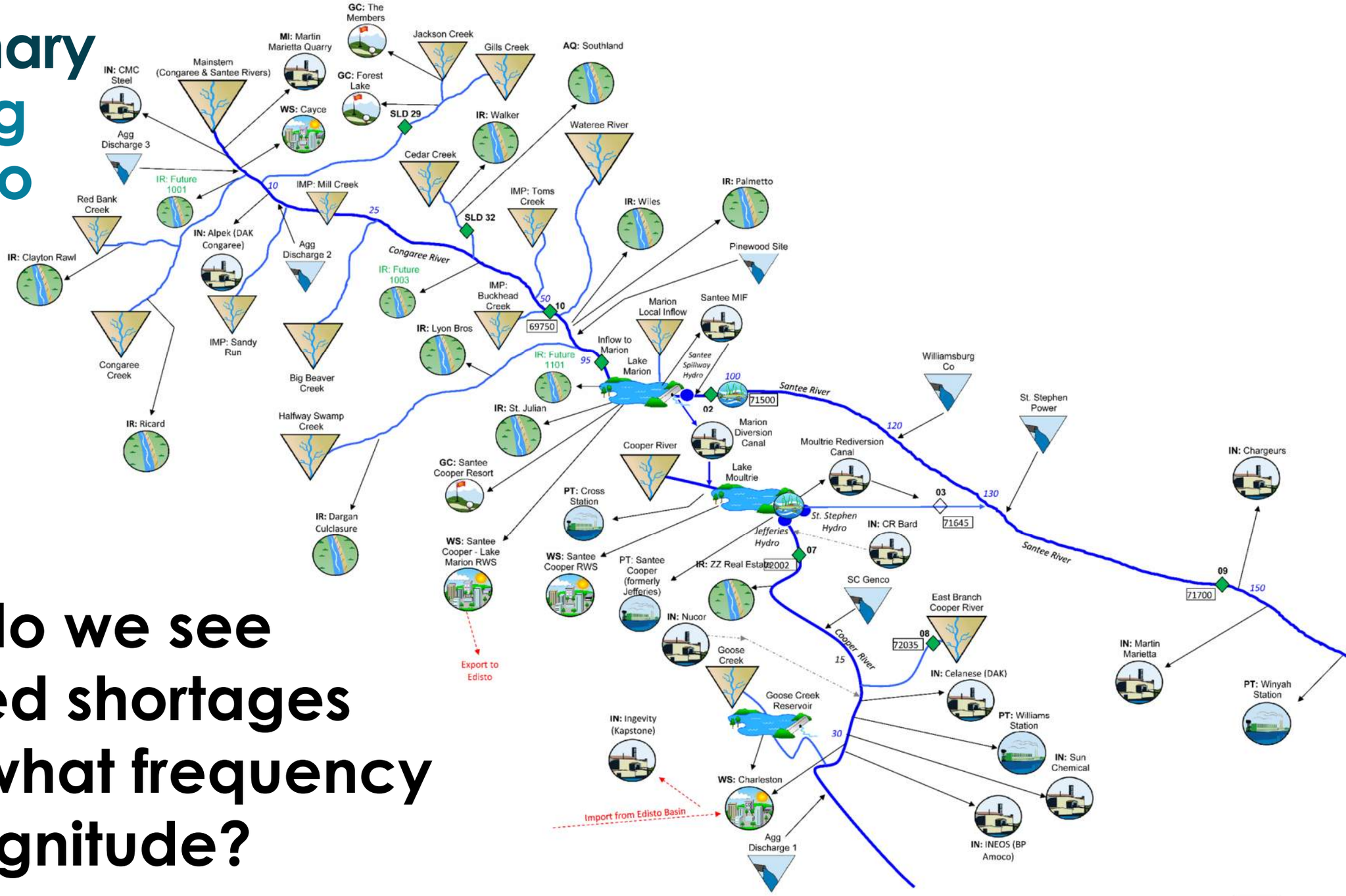
This table was updated following the RBC Meeting. The updates are reflected above.

Summary of Major Inflows to Model by Scenario (Monthly Results)

Major Inflow to Model Source		Current Use Scenario Flow (cfs)	2070 Moderate Deman Scenario		2070 High Demand Scenario	
			Flow (cfs)	% Diff. vs Current Use	Flow (cfs)	% Diff. vs Current Use
Mainstem (Saluda and Broad basins)	**Mean**	6,314	6,301	-0.2%	6,248	-1.1%
	Median	4,847	4,835	-0.2%	4,781	-1.4%
Wateree (Catawba basin)	**Mean**	5,187	4,993	-3.7%	4,686	-9.7%
	Median	3,925	3,623	-7.7%	3,360	-14.4%



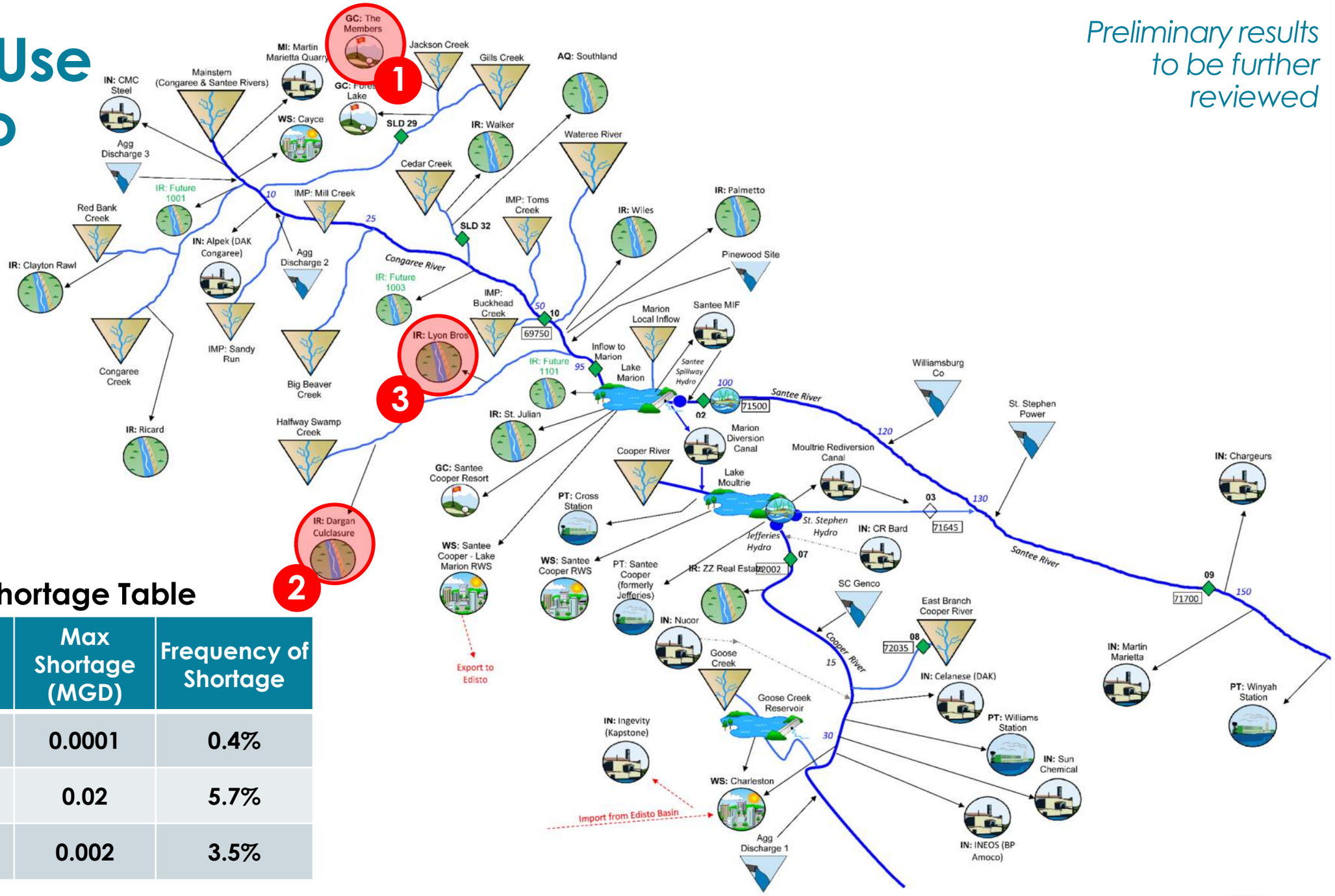
Preliminary Planning Scenario Model Results (monthly timestep)



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

Current Use Scenario

Preliminary results to be further reviewed



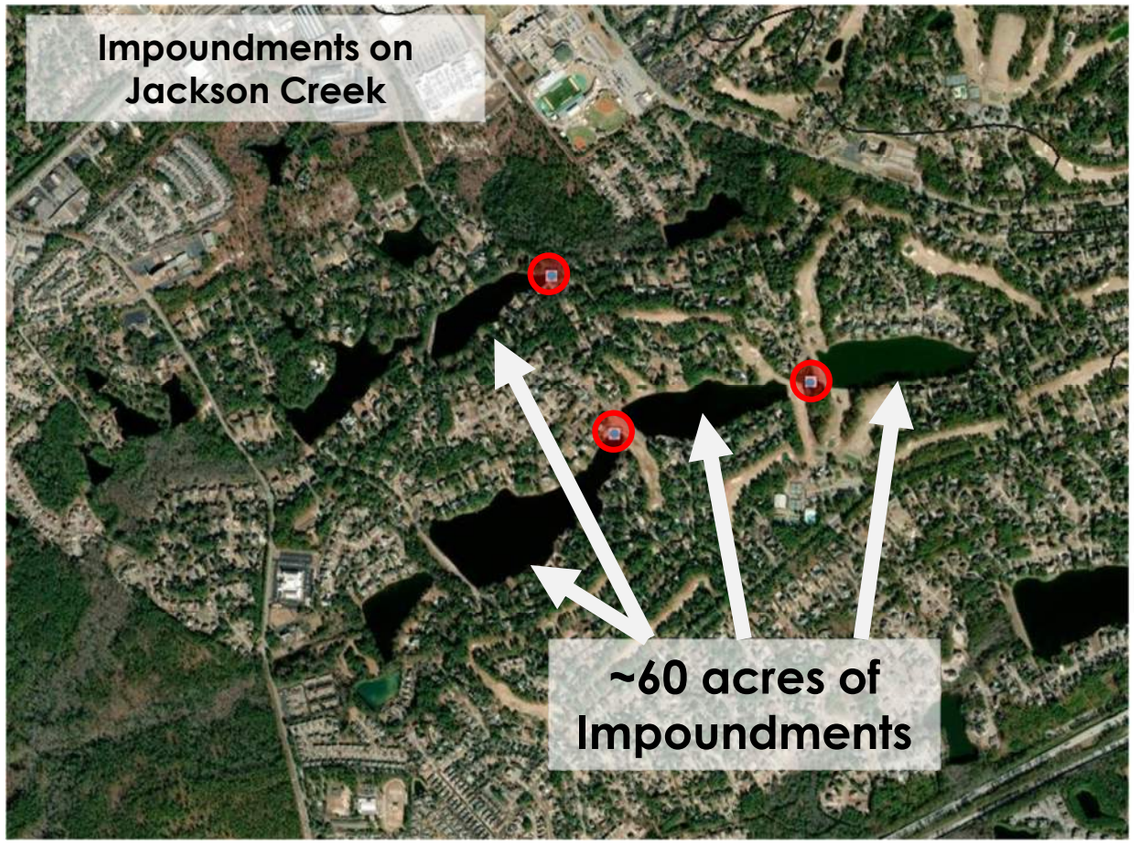
1 Physical Shortage

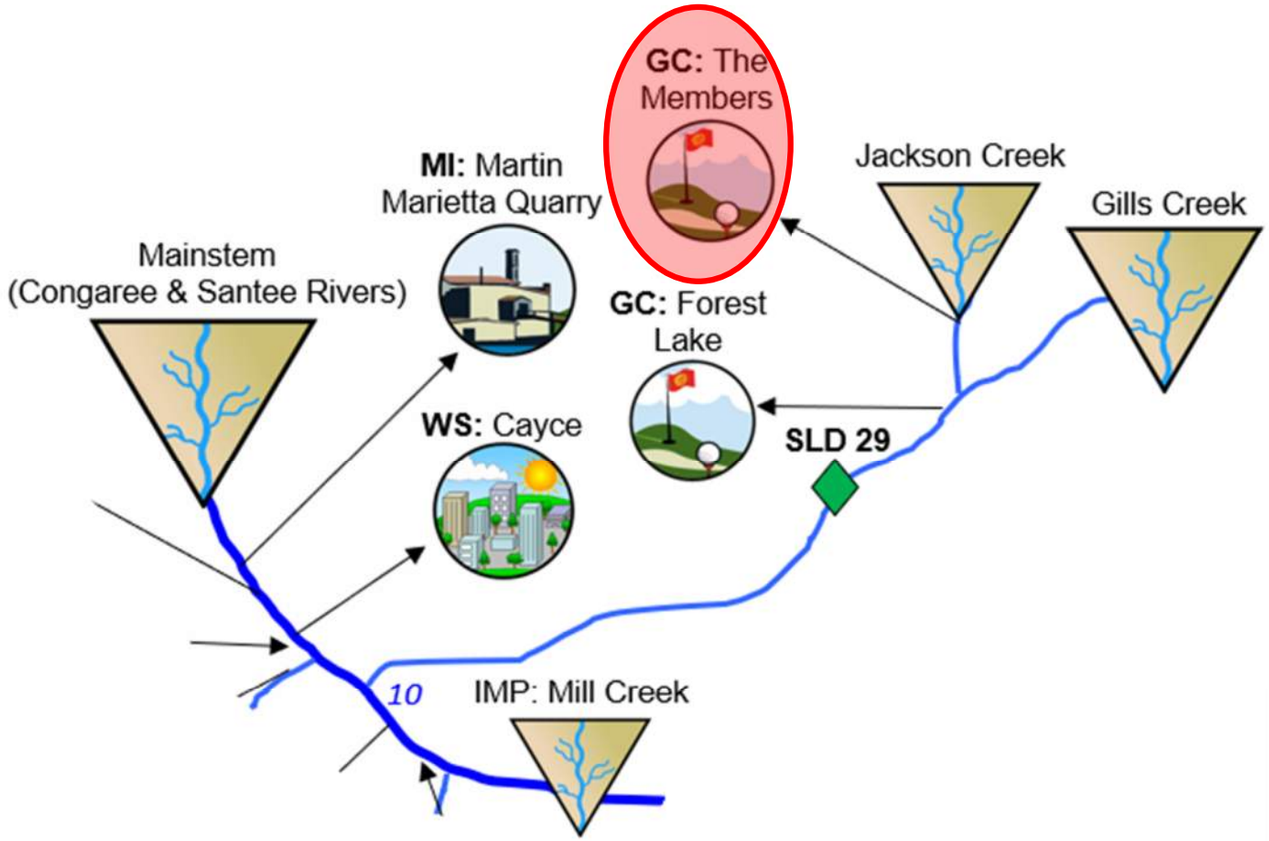
Surface Water Shortage Table

Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
1	GC: The Members	0.0001	0.4%
2	IR: Dargan Culclasure	0.02	5.7%
3	IR: Lyons Bros	0.002	3.5%

GC: The Members
Impoundments totaling ~60 acres

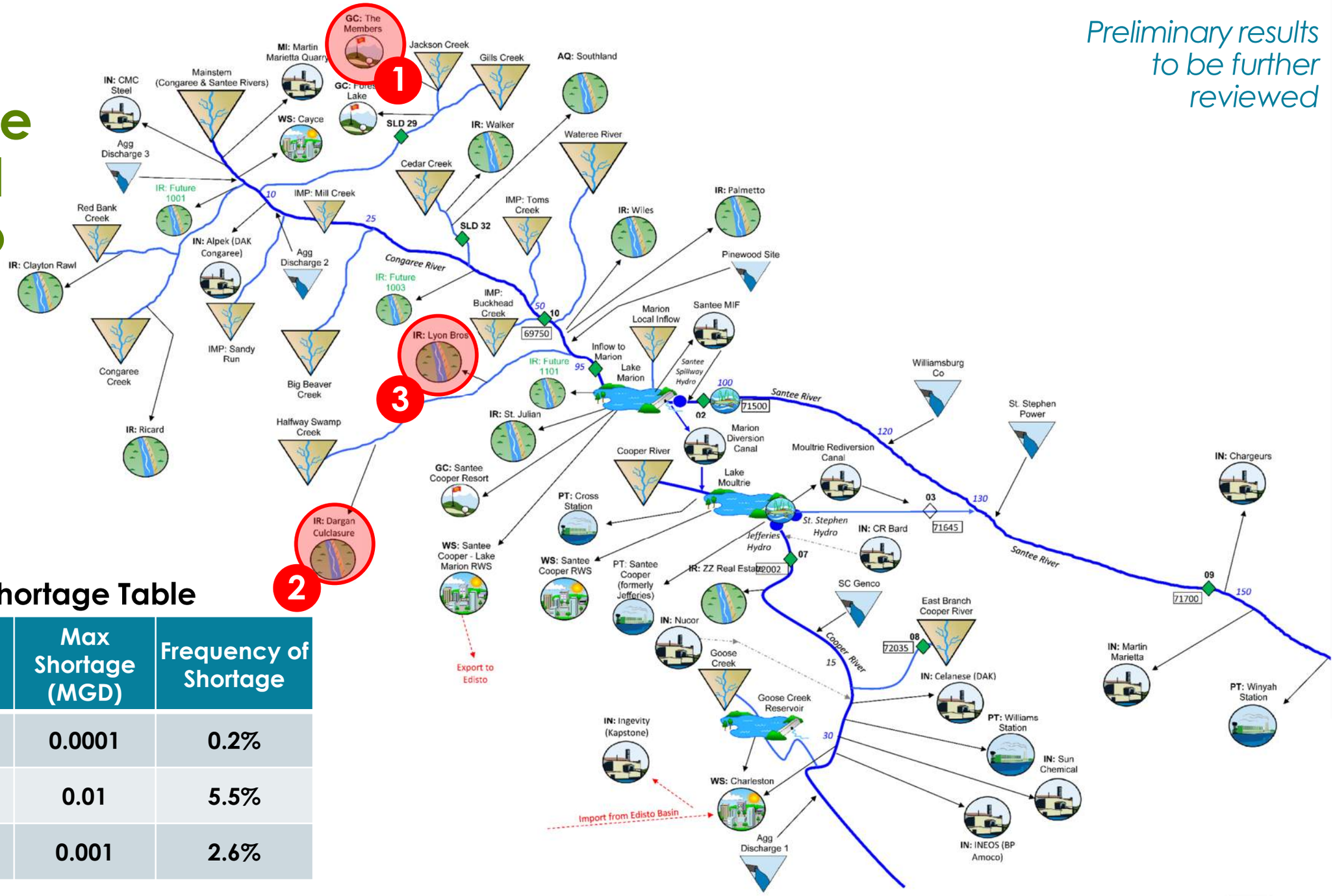
Surface water user with storage not included in the model





2070 Moderate Demand Scenario

Preliminary results to be further reviewed



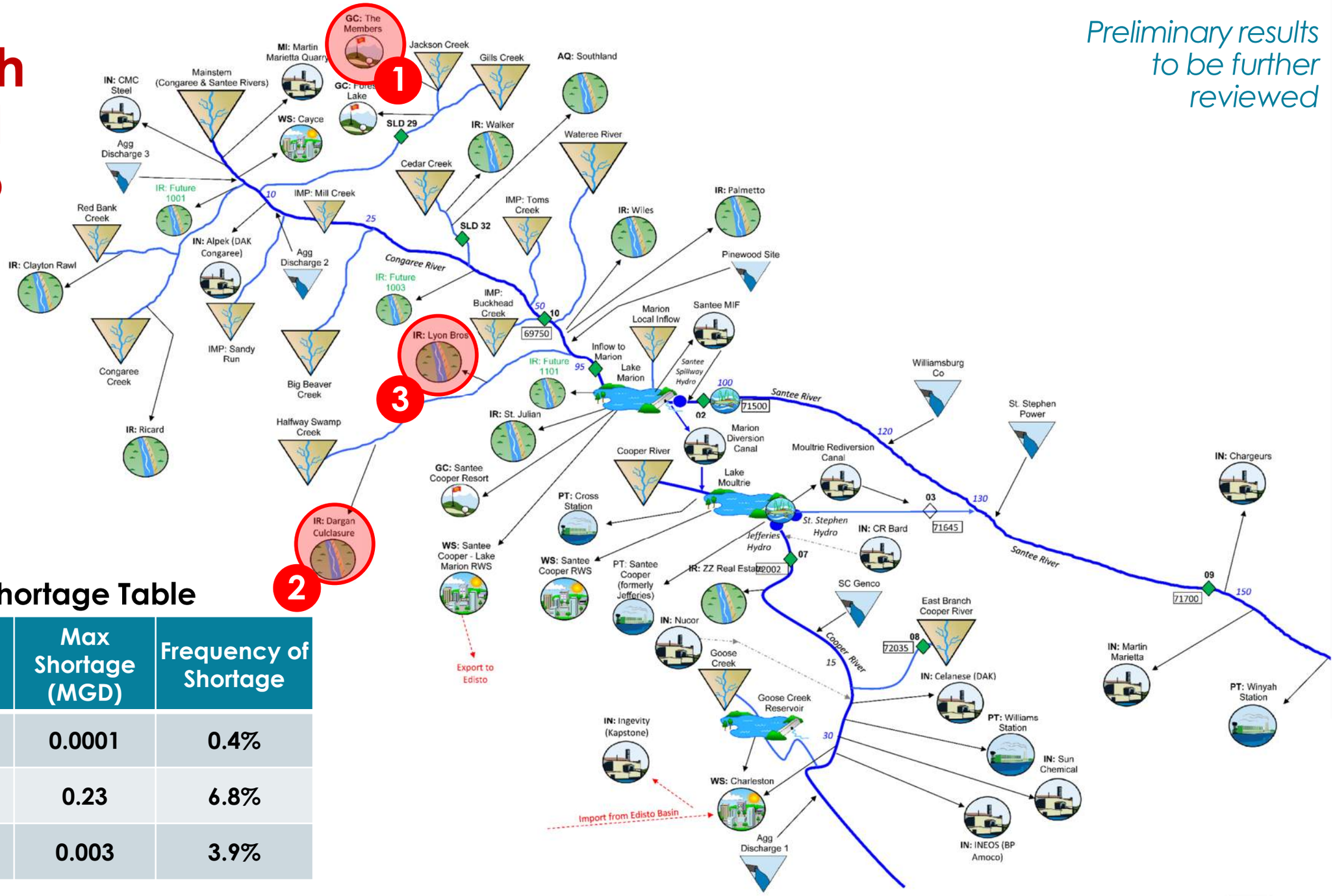
1 Physical Shortage

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%

2070 High Demand Scenario

Preliminary results to be further reviewed



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%

Summary of Water Supply Shortages

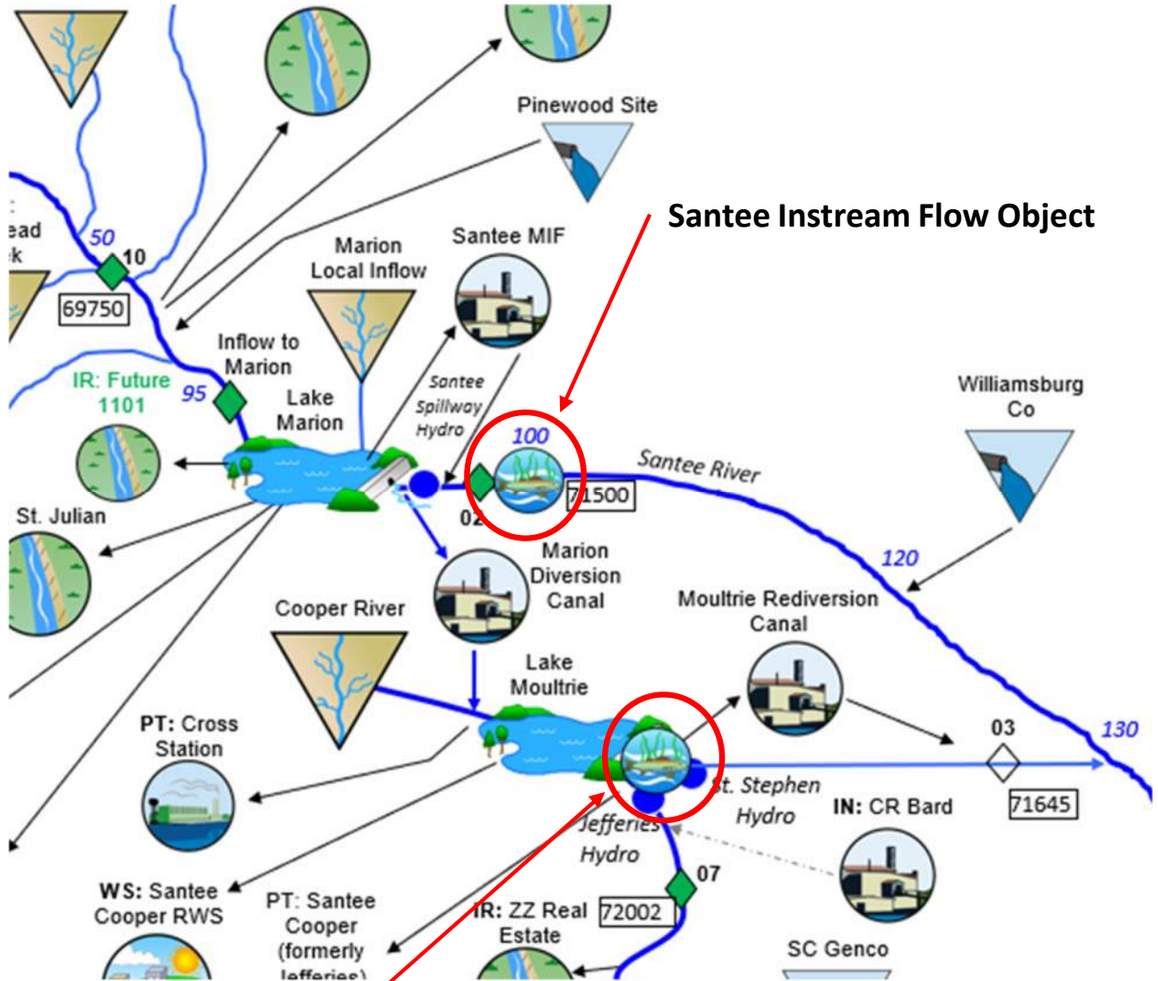
Supply Shortage Metric	Current Use	2070 Moderate	2070 High Demand
Total basin annual mean shortage (MGD)	0.02	0.02	0.04
Maximum water user shortage (MGD)	0.44	0.48	0.79
Total basin annual mean shortage as a percentage of total water demand	0.001%	0.002%	0.003%
Percentage of surface water users experiencing a shortage	9.1%	9.1%	9.1%
Average frequency of shortage (%)	0.3%	0.2%	0.3%

This is Table 4 of the memo

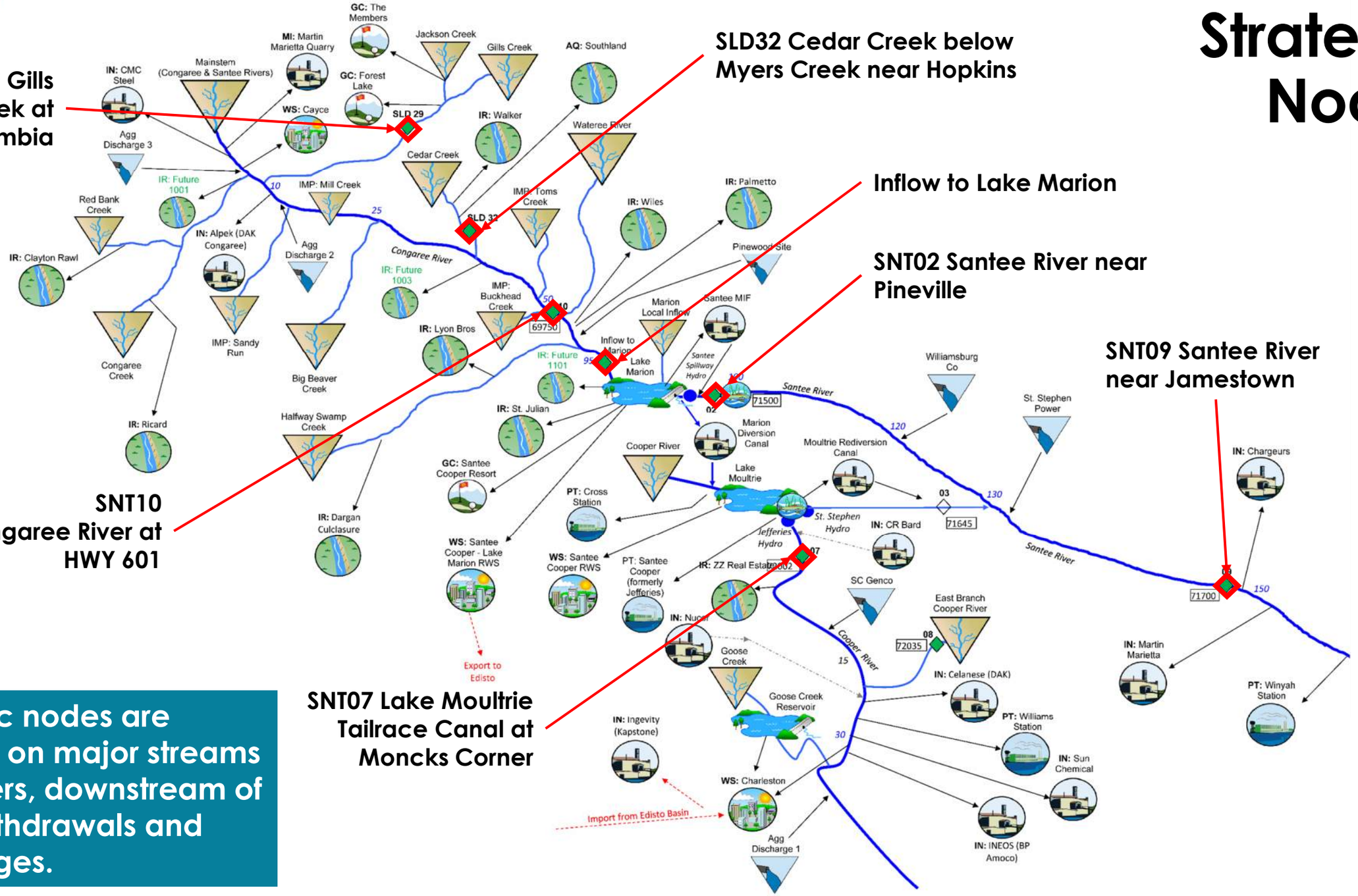
Instream Flow Shortages

Instream Flow Object		Current Use Scenario Flow	2070 Moderate Deman Scenario	2070 High Demand Scenario
Santee	Max Shortage (MGD)	1,163	1,163	1,163
	Frequency of Shortage	19.1%	18.6%	20.4%
Jeffries Hydro	Max Shortage (MGD)	3,296	3,296	3,296
	Frequency of Shortage	7.7%	8.1%	8.6%

In all scenarios at least 600 cfs (XX MGD) is flowing to Santee and 4500 cfs (XX MGD) is flowing to Cooper.



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	2,676	600	601	2.2	6.8	4,502
mean flow	7,411	13,562	1,885	8,364	67	54	5,168
median flow	5,693	10,471	1,200	5,812	56	42	5,087
25th percentile flow	3,843	6,989	1,200	1,261	34	27	4,841
10th percentile flow	2,775	5,523	600	643	20	17	4,653
5th percentile flow	2,187	4,498	600	625	15	14	4,546
Moderate Demand 2070 Scenario							
minimum flow	1,530	2,717	600	601	2.2	6.8	4,504
mean flow	7,416	13,374	1,837	8,150	67	54	5,170
median flow	5,703	10,341	1,200	5,298	56	42	5,089
25th percentile flow	3,860	7,042	1,200	1,249	34	27	4,843
10th percentile flow	2,762	5,554	600	646	20	17	4,655
5th percentile flow	2,201	4,574	600	626	15	14	4,548
High Demand 2070 Scenario							
minimum flow	1,565	2,749	600	601	1.9	6.6	4,506
mean flow	7,403	13,054	1,793	7,793	67	54	5,173
median flow	5,717	10,039	1,200	4,886	56	41	5,092
25th percentile flow	3,871	6,968	1,200	1,227	33	27	4,845
10th percentile flow	2,770	5,367	600	646	20	17	4,657
5th percentile flow	2,227	4,390	600	626	15	13	4,551

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	2,676	600	601	2.2	6.8	4,502
mean flow	7,411	13,562	1,885	8,364	67	54	5,168
median flow	5,693	10,471	1,200	5,812	56	42	5,087
25th percentile flow	3,843	6,989	1,200	1,261	34	27	4,841
10th percentile flow	2,775	5,523	600	643	20	17	4,653
5th percentile flow	2,187	4,498	600	625	15	14	4,546
2070 Moderate Demand Scenario minus Current Use Scenario flow (cfs)							
minimum flow	15	41	0	0	0.0	0.0	2
mean flow	5	-188	-49	-213	0	0	2
median flow	9	-130	0	-513	0	0	2
25th percentile flow	17	53	0	-12	0	0	2
10th percentile flow	-13	31	0	3	0	0	2
5th percentile flow	13	76	0	1	0	0	2
Percent Difference between 2070 Moderate Demand Scenario minus Current Use Scenario flow							
minimum flow	1.0%	1.5%	0.0%	0.0%	0.1%	0.5%	0.0%
mean flow	0.1%	-1.4%	-2.6%	-2.6%	0.0%	0.0%	0.0%
median flow	0.2%	-1.2%	0.0%	-8.8%	0.0%	0.1%	0.0%
25th percentile flow	0.4%	0.8%	0.0%	-1.0%	0.1%	0.2%	0.0%
10th percentile flow	-0.5%	0.6%	0.0%	0.5%	0.0%	0.2%	0.0%
5th percentile flow	0.6%	1.7%	0.0%	0.1%	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

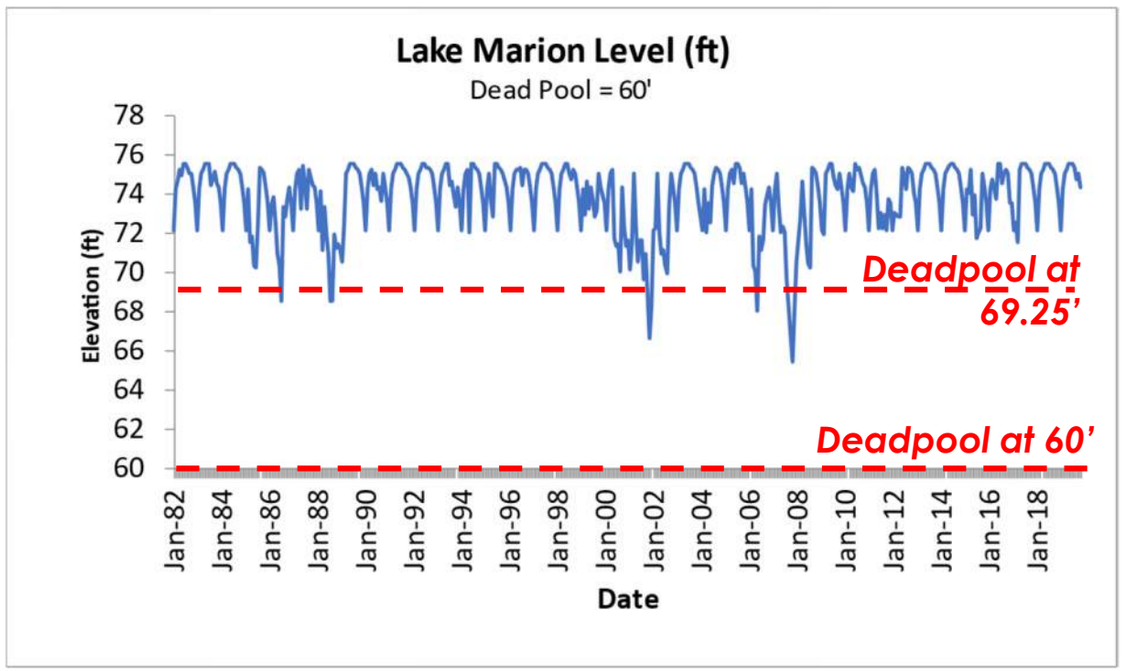
Performance Measure	SNT10 CONGAREE RIVER AT HWY 601	INFLOW TO LAKE MARION	SNT02 SANTEE RIVER NEAR PINEVILLE, SC	SNT09 SANTEE RIVER NR JAMESTOWN, SC	SLD29 GILLS CREEK AT COLUMBIA	SLD32 CEDAR CREEK BELOW MYERS CREEK NR HOPKINS	SNT07 LAKE MOULTRIE TAILRACE CANAL AT MONCKS CORNER, SC
Current Use Scenario flow (cfs)							
minimum flow	1,515	2,676	600	601	2.2	6.8	4,502
mean flow	7,411	13,562	1,885	8,364	67	54	5,168
median flow	5,693	10,471	1,200	5,812	56	42	5,087
25th percentile flow	3,843	6,989	1,200	1,261	34	27	4,841
10th percentile flow	2,775	5,523	600	643	20	17	4,653
5th percentile flow	2,187	4,498	600	625	15	14	4,546
2070 High Demand Scenario minus Current Use Scenario flow (cfs)							
minimum flow	50	73	0	0	0	0	4
mean flow	-8	-508	-92	-570	0	0	5
median flow	23	-433	0	-926	0	0	5
25th percentile flow	27	-21	0	-34	0	0	4
10th percentile flow	-5	-156	0	4	0	0	4
5th percentile flow	40	-108	0	1	0	0	4
Percent Difference between 2070 High Demand Scenario minus Current Use Scenario flow							
minimum flow	3.3%	2.7%	0.0%	0.0%	-12.5%	-3.4%	0.1%
mean flow	-0.1%	-3.7%	-4.9%	-6.8%	-0.5%	-0.4%	0.1%
median flow	0.4%	-4.1%	0.0%	-15.9%	-0.3%	-0.8%	0.1%
25th percentile flow	0.7%	-0.3%	0.0%	-2.7%	-1.0%	-0.9%	0.1%
10th percentile flow	-0.2%	-2.8%	0.0%	0.5%	-2.1%	-1.4%	0.1%
5th percentile flow	1.8%	-2.4%	0.0%	0.1%	-2.1%	-2.3%	0.1%

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

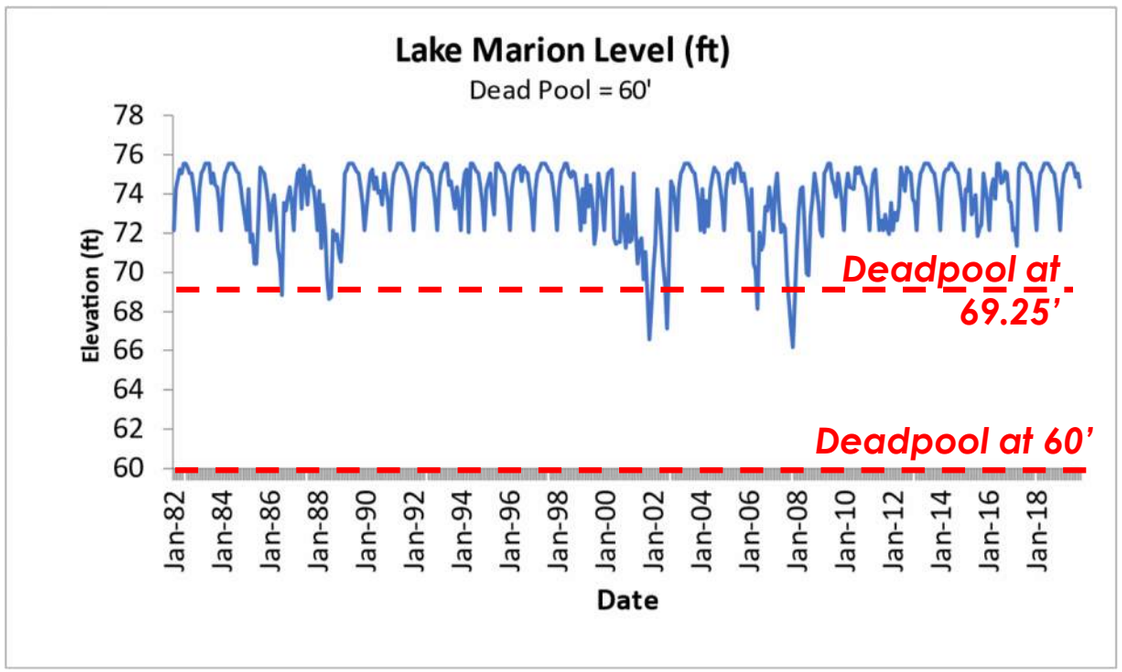
This is a portion of Table 6 of the memo

Reservoir Storage – Lake Marion

Current Use Scenario

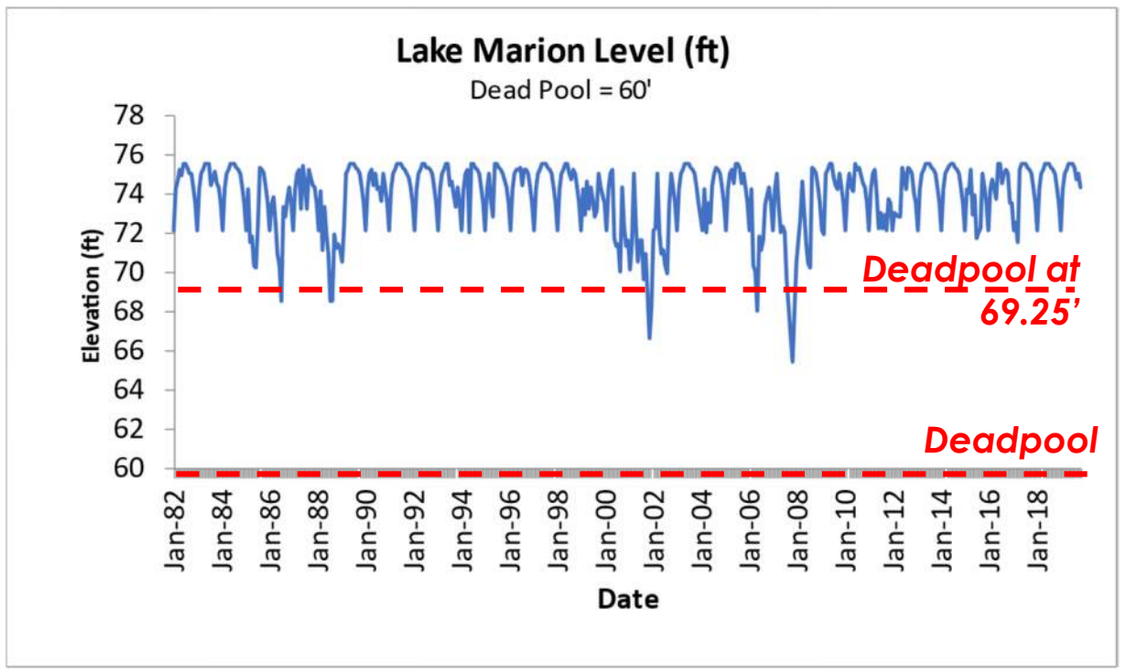


Moderate Demand Scenario

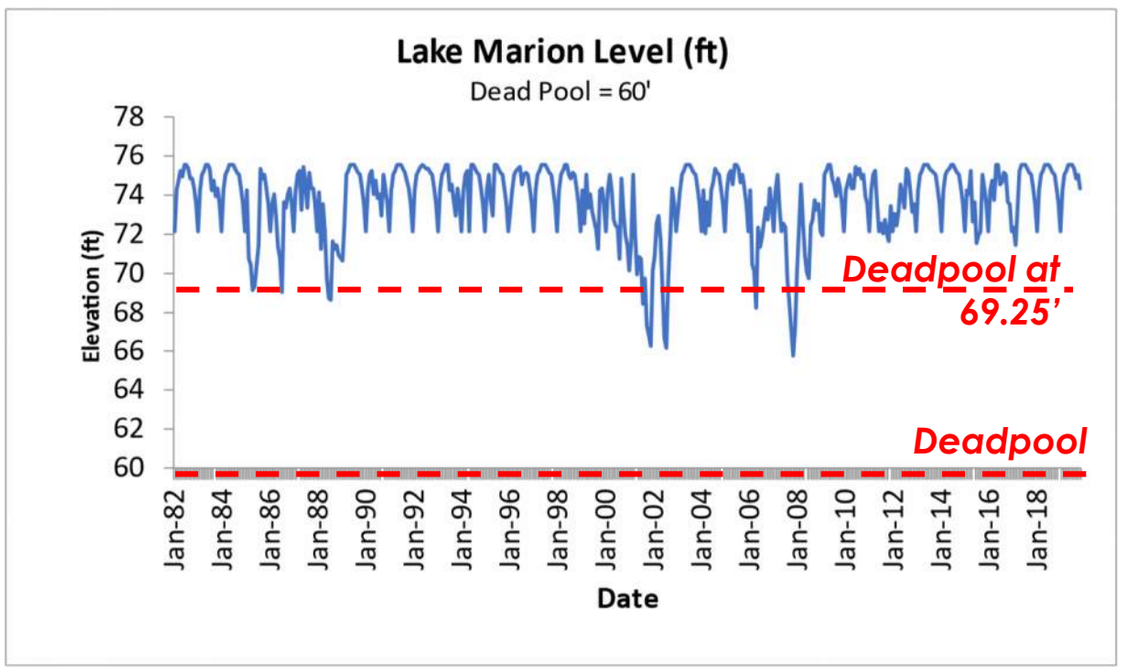


Reservoir Storage – Lake Marion

Current Use Scenario

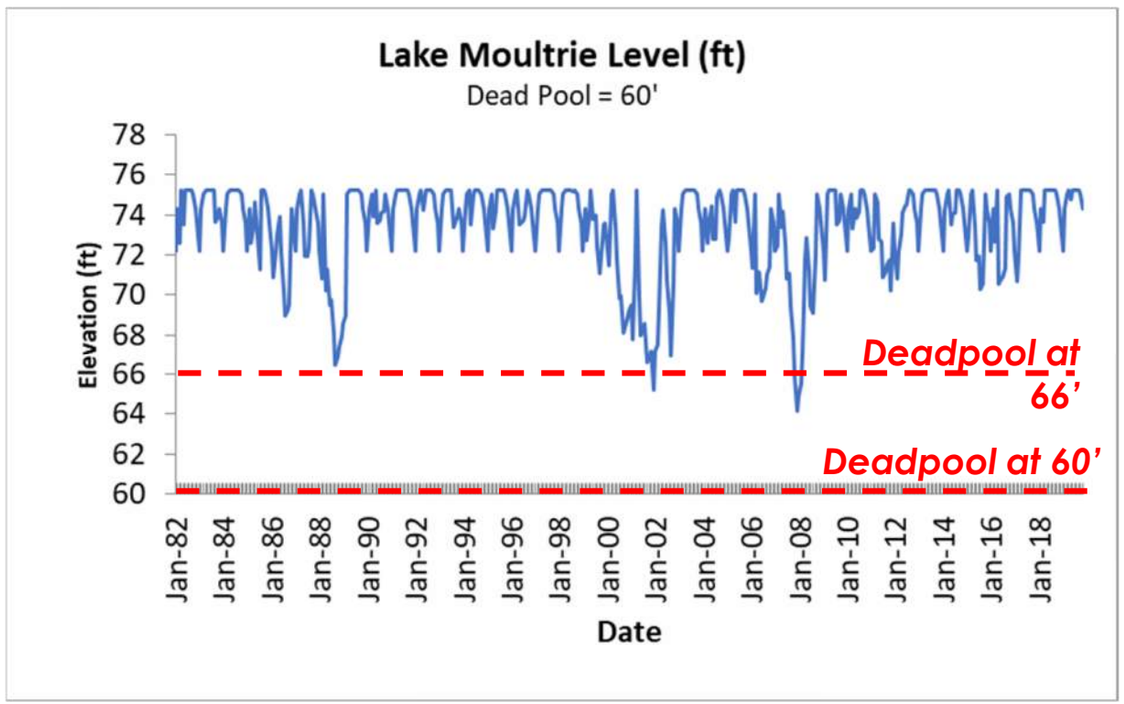


High Demand Scenario

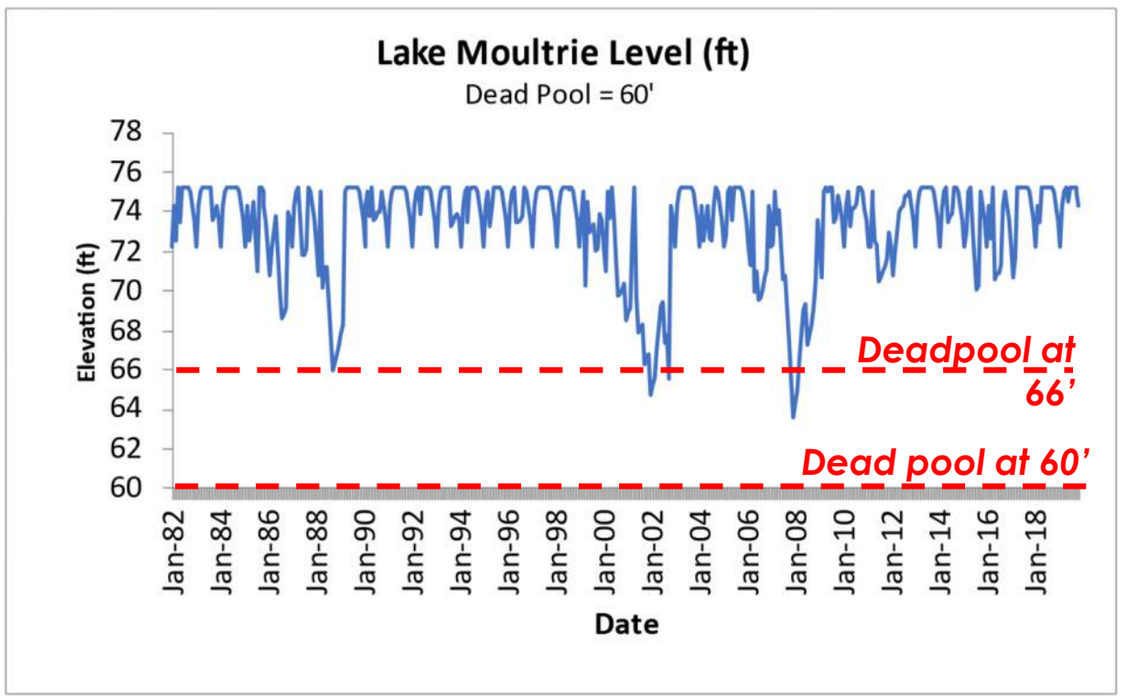


Reservoir Storage – Lake Moultrie

Current Use Scenario

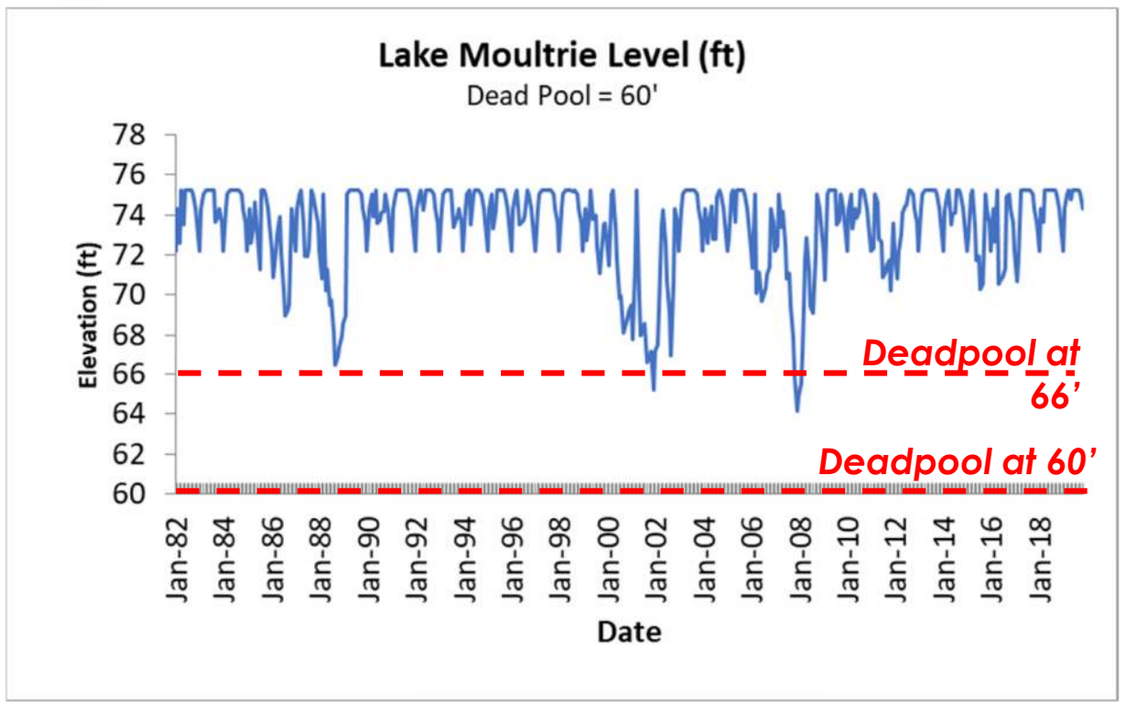


Moderate Demand Scenario

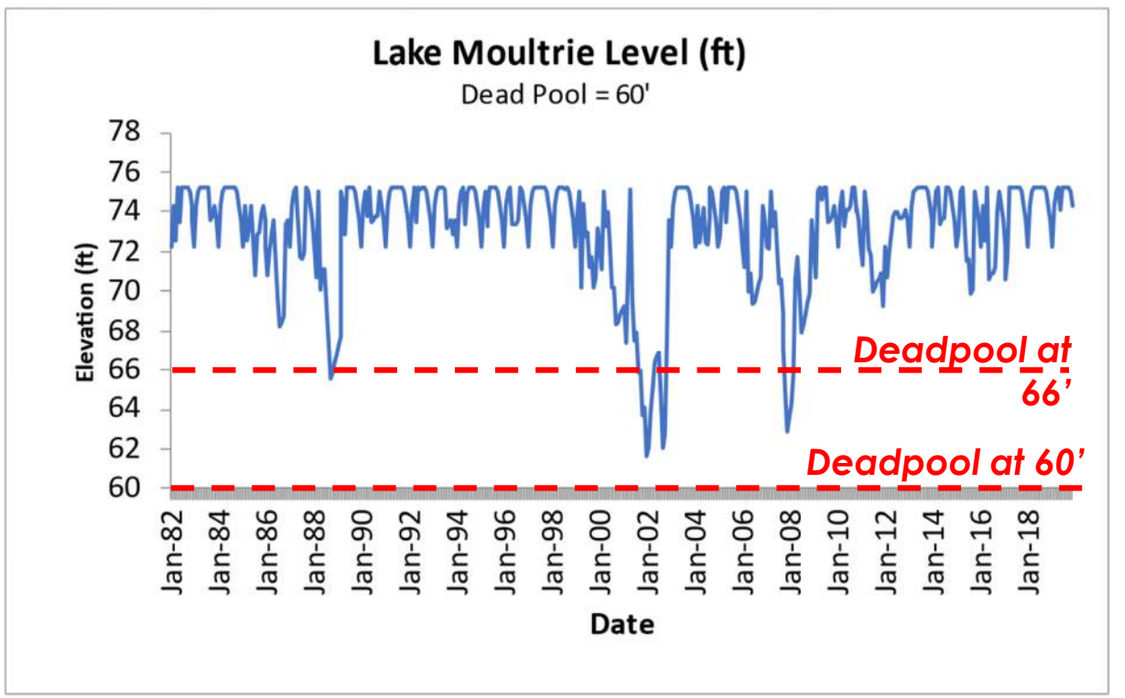


Reservoir Storage – Lake Moultrie

Current Use Scenario



High Demand Scenario



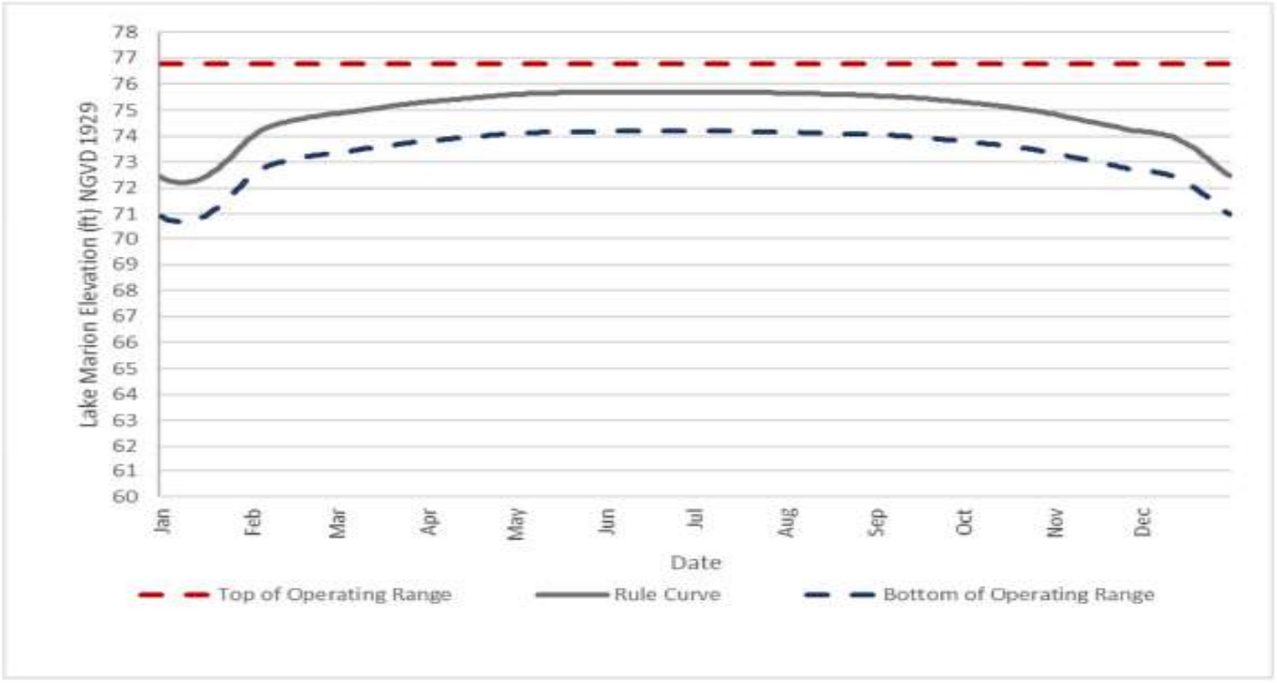


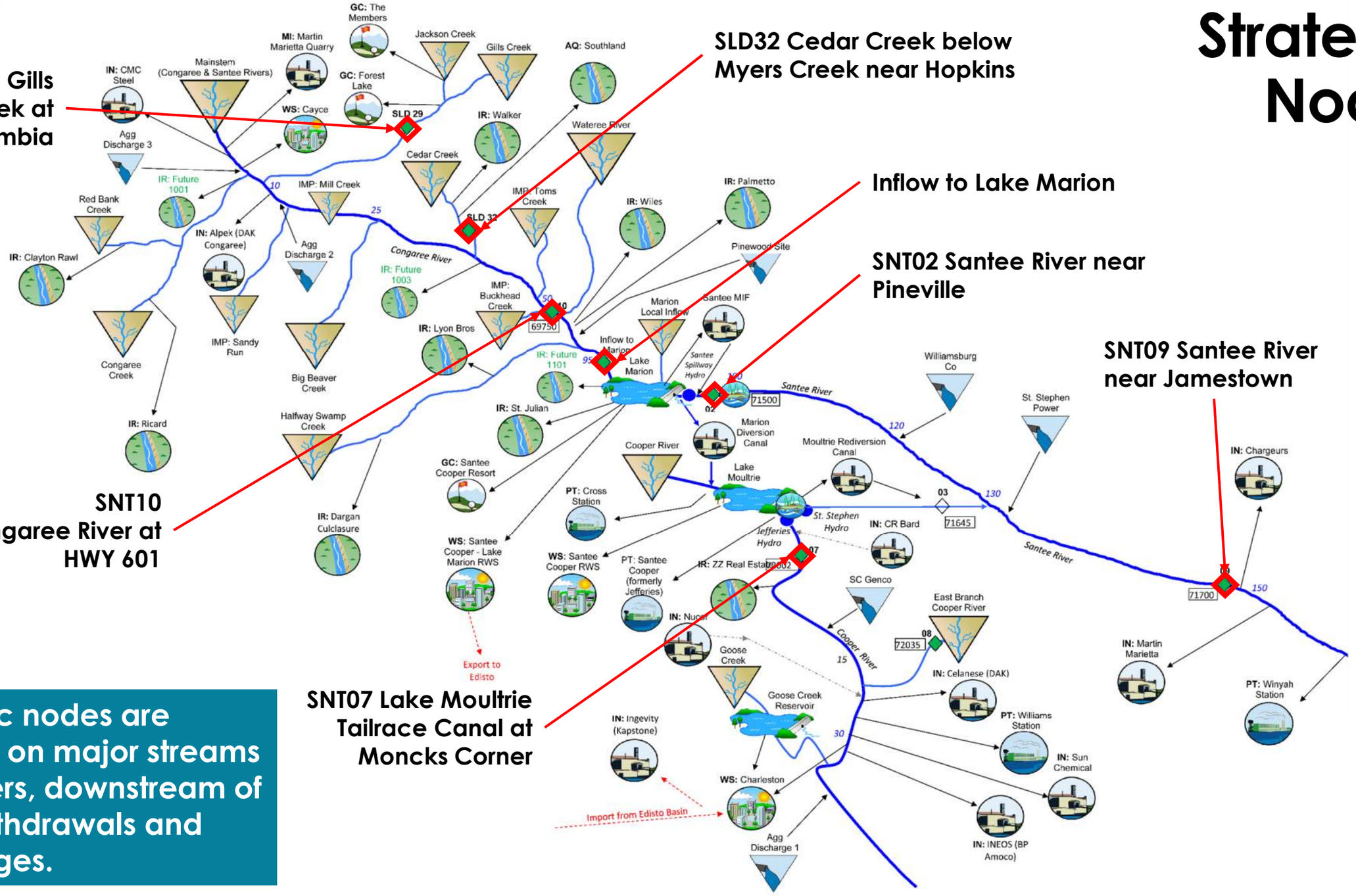
Figure 3.2 – Lake Marion Rule Curve with Target Operating Range

Discussion of Results and Selection of Possible Additional Scenarios

RBC Considerations Moving Forward

- Would the RBC like to revise or add to the list of **Strategic Nodes**… i.e. evaluate flows at different points in the basin?
- Is there any desire to to establish a **Surface Water Condition** at any location?
- As additional information is presented, the RBC should continue to consider if there is reason to establish one or more **Reaches of Interest**.
- Would the RBC like to investigate any additional scenarios?

Strategic Nodes



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

Next Steps

- Continue to review the preliminary modeling scenario results
- Adjust reservoir release rules to maintain lake elevations above the deadpool *(but at the expense of maintaining minimum downstream flow targets)*
- Build and run the Permitted and Registered Scenario
- Evaluate water management strategies
  - Example: *What would be the impact of demand-side reductions that reduce demands by 5, 10, or 15 percent?*
- Other actions, as identified by RBC