



Additional Surface Water Availability Modeling Results

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Surface Water Scenarios

Base Scenarios

- Current Surface Water Use Scenario
 - *Uses most recent 10-yr average withdrawals (as reported by month)*
- Permitted and Registered (P&R) Surface Water Use Scenario
 - *Uses current fully-permitted and registered amounts*
- **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*

Additional Scenarios

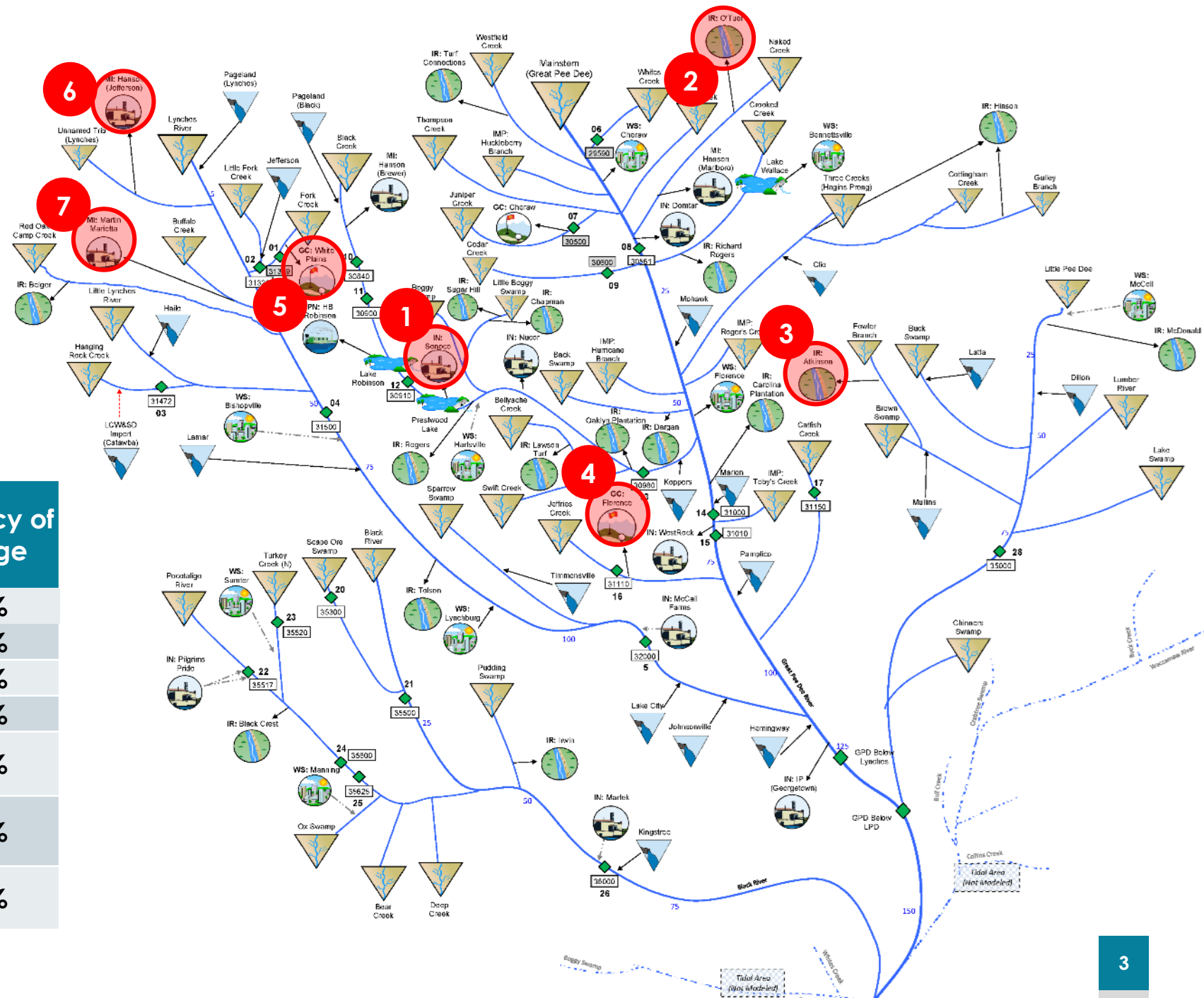
- Unimpaired Flow (UIF) Scenario
 - *Naturalized conditions (no surface water withdrawals, discharges, or reservoirs)*

2070 High Demand Scenario

Physical Shortage

Surface Water Shortage Table

Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
1	IN: Sonoco	21.0	1.3%
2	IR: O'Tuel	0.3	0.4%
3	IR: Atkinson	0.05	1.2%
4	GC: Florence	0.1	0.3%
5	GC: White Plains	0.1	8.2%
6	MI: Hanson (Jefferson)	0.1	7.1%
7	MI: Martin Marrietta	1.1	1.3%



Additional Analyses Requested in March

1. Incorporate estimated Lumber River inflows for **Moderate** and **High Demand** Projections and rerun those scenarios.
2. Compare all scenario flows to 7Q10 flows
3. Develop graphs comparing all scenario flows during the drought of record
4. Add operating rules to Lake Robinson to see if the simulated 2070 Sonoco shortage (Prestwood Lake) can be eliminated.
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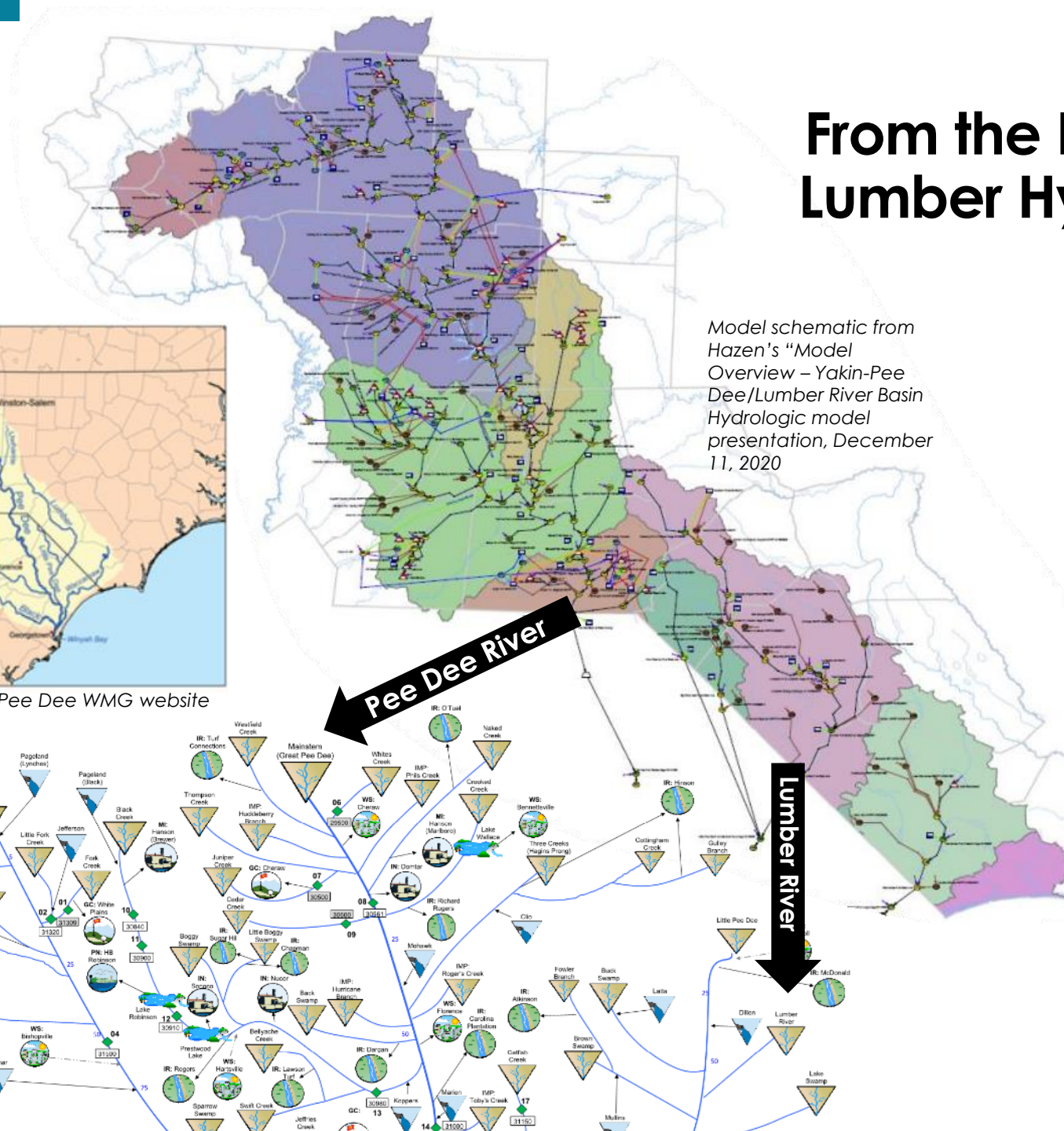
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North Carolina Inflows From the NC Yadkin-Pee Dee and Lumber Hydrologic Model (OASIS)



Image source: Yadkin-Pee Dee WMG website



Model schematic from Hazen's "Model Overview - Yakin-Pee Dee/Lumber River Basin Hydrologic model presentation, December 11, 2020

- Daily and monthly inflows provided by HDR for the **UIF, Current Use, Moderate** and **High Demand Scenarios** for the **Pee Dee River**.
- Daily and monthly inflows provided by HDR for the **UIF, and Current Use Scenarios** for the **Lumber River**.
- For the **Lumber River, Current Use Scenario** inflows were used for the **Moderate** and **High Demand Scenarios** (for now)

Strategic Nodes

PDE04
LYNCHEs RIVER NEAR
BISHOPVILLE

PDE13
BLACK CREEK NEAR QUINBY

PDE15
PEE DEE RIVER BELOW PEE DEE

PDE05
LYNCHEs RIVER AT
EFFINGHAM

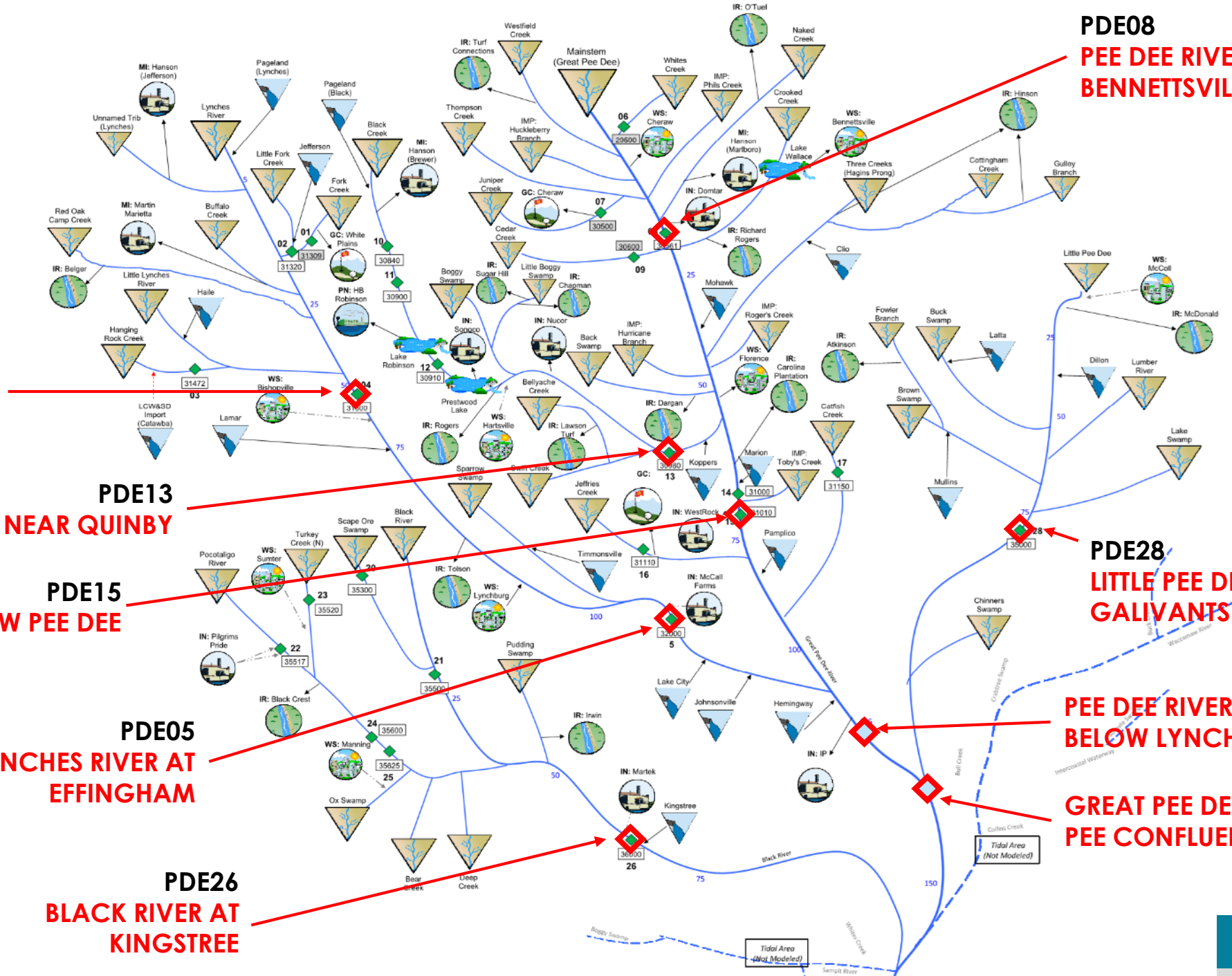
PDE26
BLACK RIVER AT
KINGSTREE

PDE08
PEE DEE RIVER NEAR
BENNETTSVILLE

PDE28
LITTLE PEE DEE R. AT
GALIVANTS FERRY

PEE DEE RIVER
BELOW LYNCHES

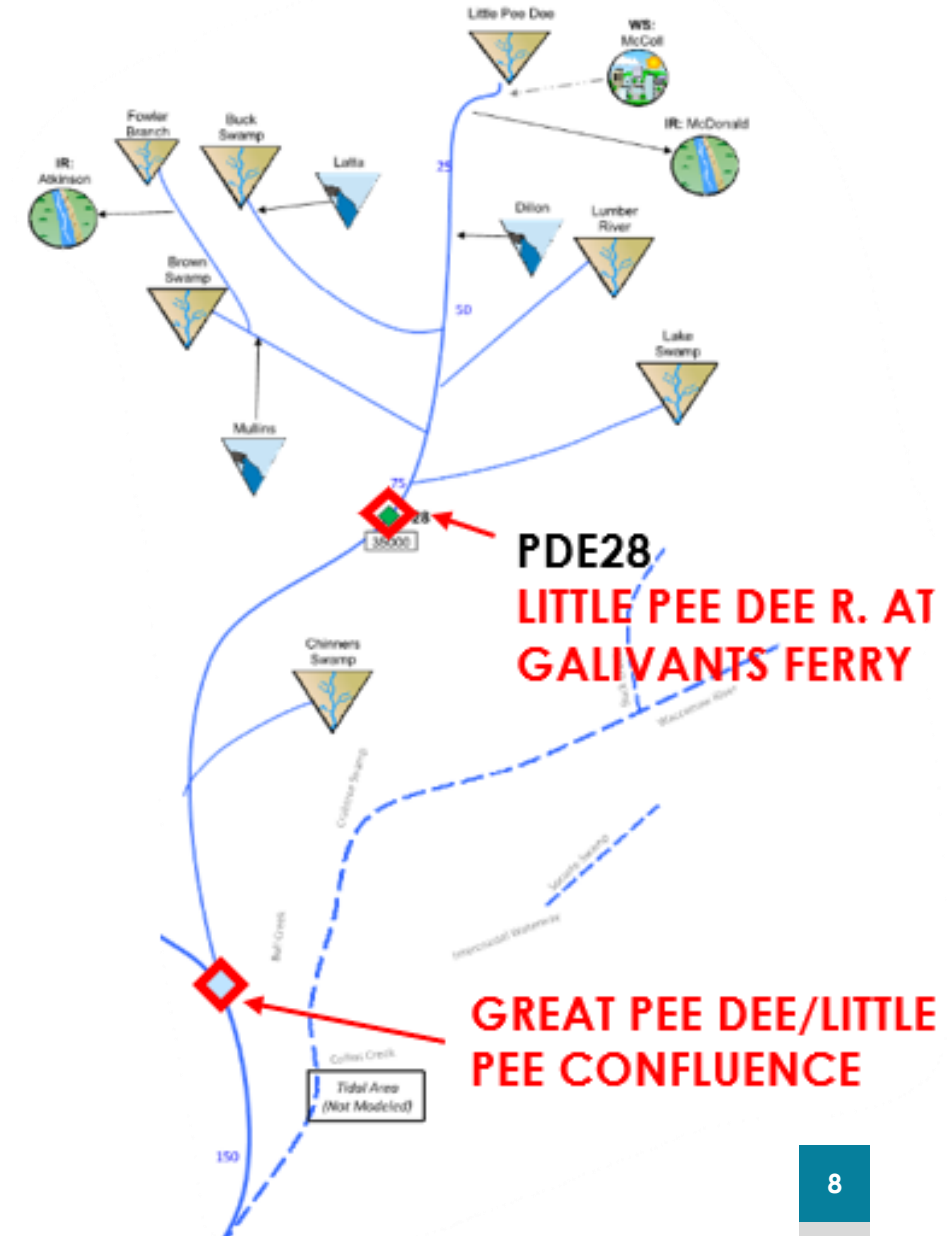
GREAT PEE DEE/LITTLE
PEE CONFLUENCE



Simulated Flows (Performance Measures) at Select Strategic Nodes

Performance Measure	Great Pee Dee River below Little Pee Dee Confluence (flow in cfs)		PDE28 Little Pee River at Galivants Ferry (flow in cfs)	
	Original	Updated*	Original	Updated*
2070 Moderate Demand Scenario				
mean flow	14,628	14,661	2,917	2,941
median flow	11,389	11,435	2,190	2,206
25th percentile flow	6,913	6,935	1,223	1,242
10th percentile flow	4,472	4,491	745	759
5th percentile flow	3,618	3,639	599	619
minimum flow	1,658	1,674	190	197
2070 High Demand Scenario				
mean flow	14,418	14,450	2,918	2,941
median flow	11,191	11,215	2,190	2,206
25th percentile flow	6,694	6,710	1,223	1,242
10th percentile flow	4,244	4,264	745	759
5th percentile flow	3,443	3,464	599	619
minimum flow	1,538	1,547	190	198

* Updated flows reflect projected North Carolina inflows on the Little Pee Dee and Lumber Rivers, assuming 2070 demand projections. Only one projection was prepared, which is considered a Moderate demand projection. It was applied to both scenarios.



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7Q10 Definition

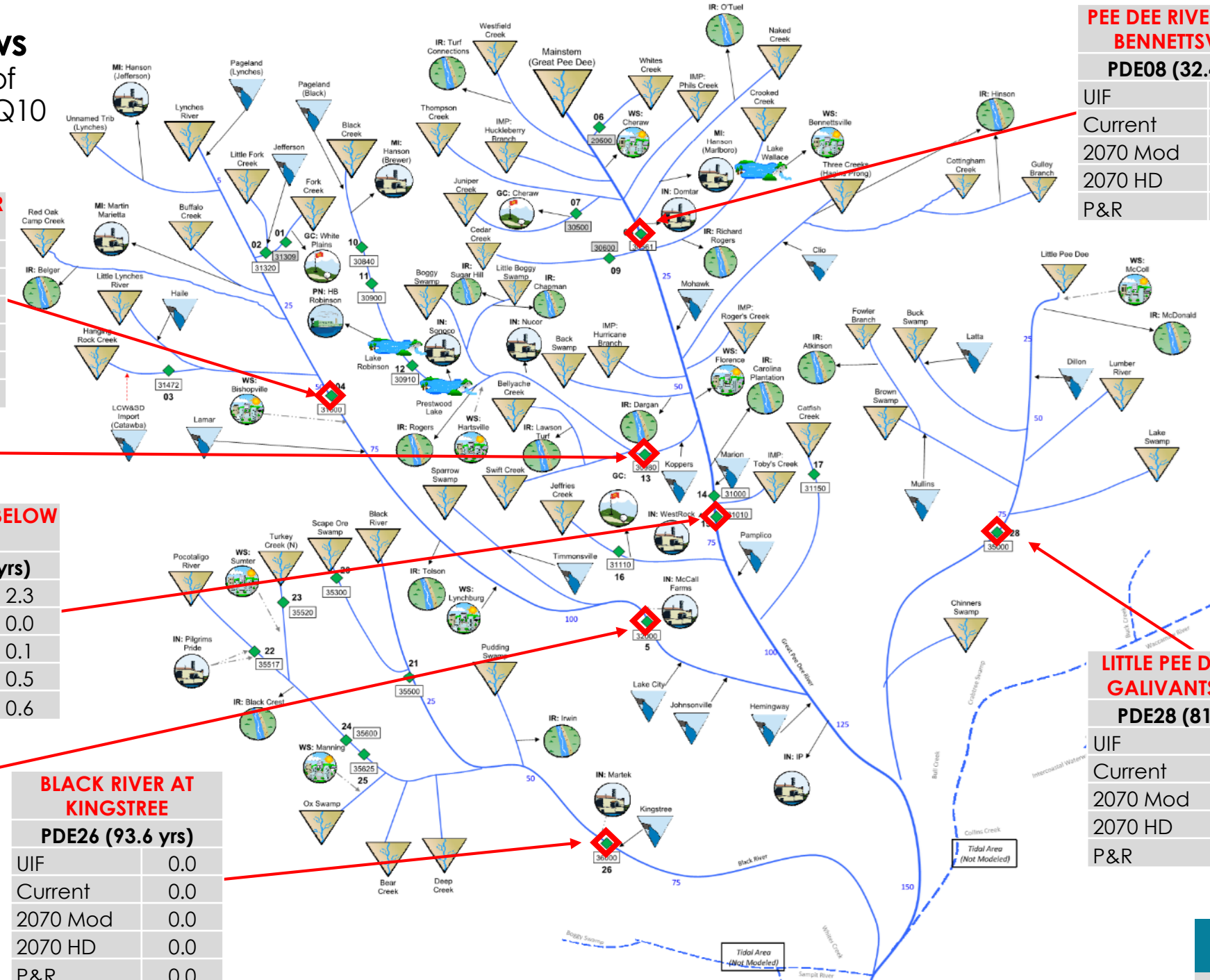
- The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years.
- There is a 1/10 or 10-percent probability that the annual minimum 7-day average flow in any 1 year will be less than the estimated 7Q10 value.

Considerations

- For this analysis 7Q10 was calculated based on actual gage data.
 - There is a different period of record for each gage.
 - The 7Q10 period of record doesn't always match the period of record for which we have simulated flows.
 - Comparisons to 7Q10 on the Pee Dee River don't provide useful information because of changing upstream reservoir release requirements and highly variable daily inflows from the NC modeling effort.

Comparison to 7Q10 Flows

Tables show the frequency (%) of daily flows that are below the 7Q10 flow (32,599 days in simulation)



PEE DEE RIVER NEAR BENNETTSVILLE	
PDE08 (32.4 yrs)	
UIF	3.5
Current	0.0
2070 Mod	0.0
2070 HD	0.0
P&R	0.0

LYNCHEs RIVER NEAR BISHOPVILLE	
PDE04 (50.2 yrs)	
UIF	2.9
Current	2.8
2070 Mod	2.9
2070 HD	3.0
P&R	3.1

BLACK CREEK NEAR QUINBY	
PDE13 (21.5 yrs)	
UIF	0.6
Current	1.1
2070 Mod	0.8
2070 HD	0.6
P&R	44.9

PEE DEE RIVER BELOW PEE DEE	
PDE15 (26.5 yrs)	
UIF	2.3
Current	0.0
2070 Mod	0.1
2070 HD	0.5
P&R	0.6

LYNCHEs RIVER AT EFFINGHAM	
PDE05 (93.6 yrs)	
UIF	1.8
Current	1.5
2070 Mod	1.6
2070 HD	1.6
P&R	1.6

BLACK RIVER AT KINGSTREE	
PDE26 (93.6 yrs)	
UIF	0.0
Current	0.0
2070 Mod	0.0
2070 HD	0.0
P&R	0.0

LITTLE PEE DEE R. AT GALIVANTS FERRY	
PDE28 (81.3 yrs)	
UIF	0.5
Current	0.6
2070 Mod	0.4
2070 HD	0.4
P&R	0.6

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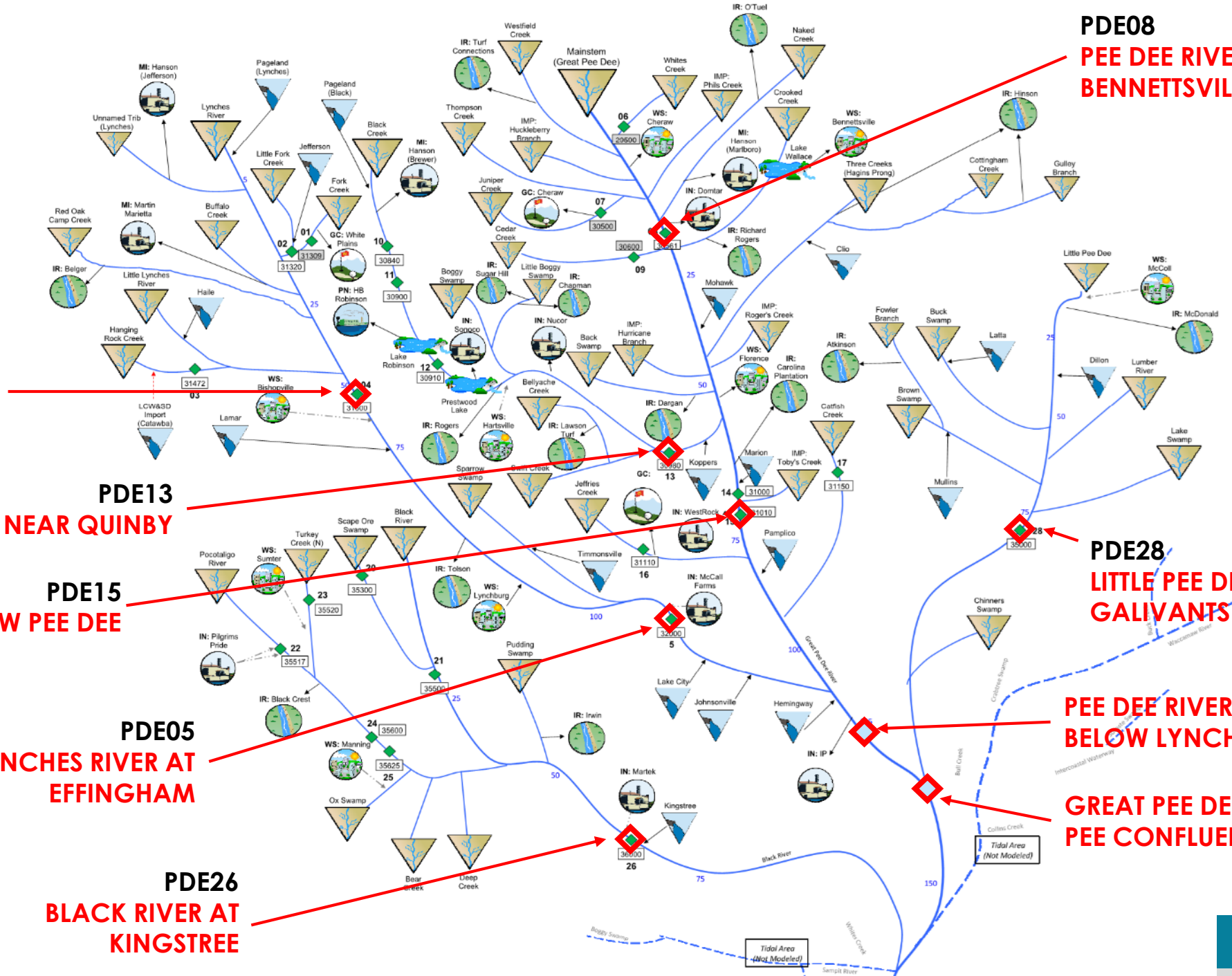
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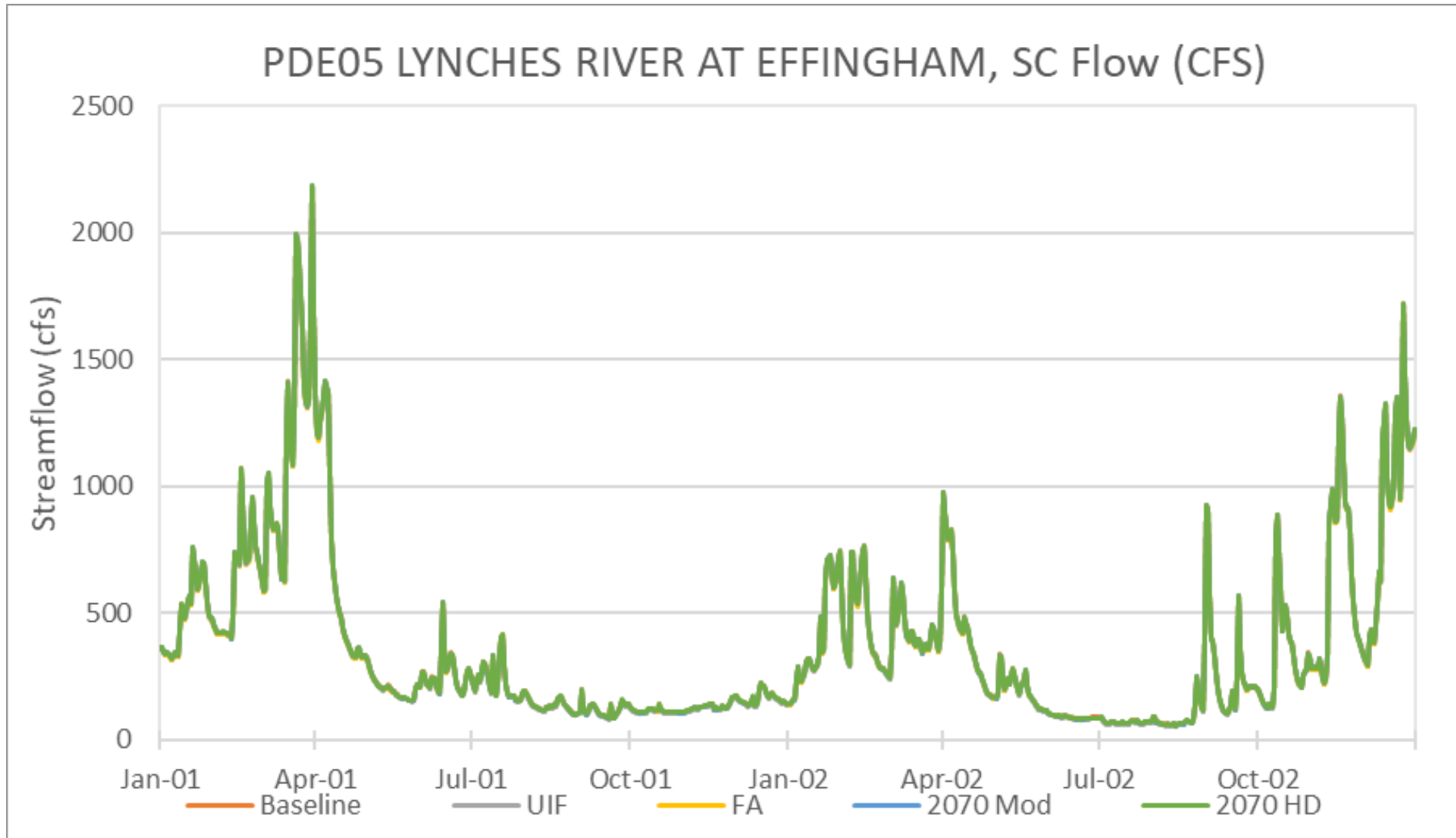
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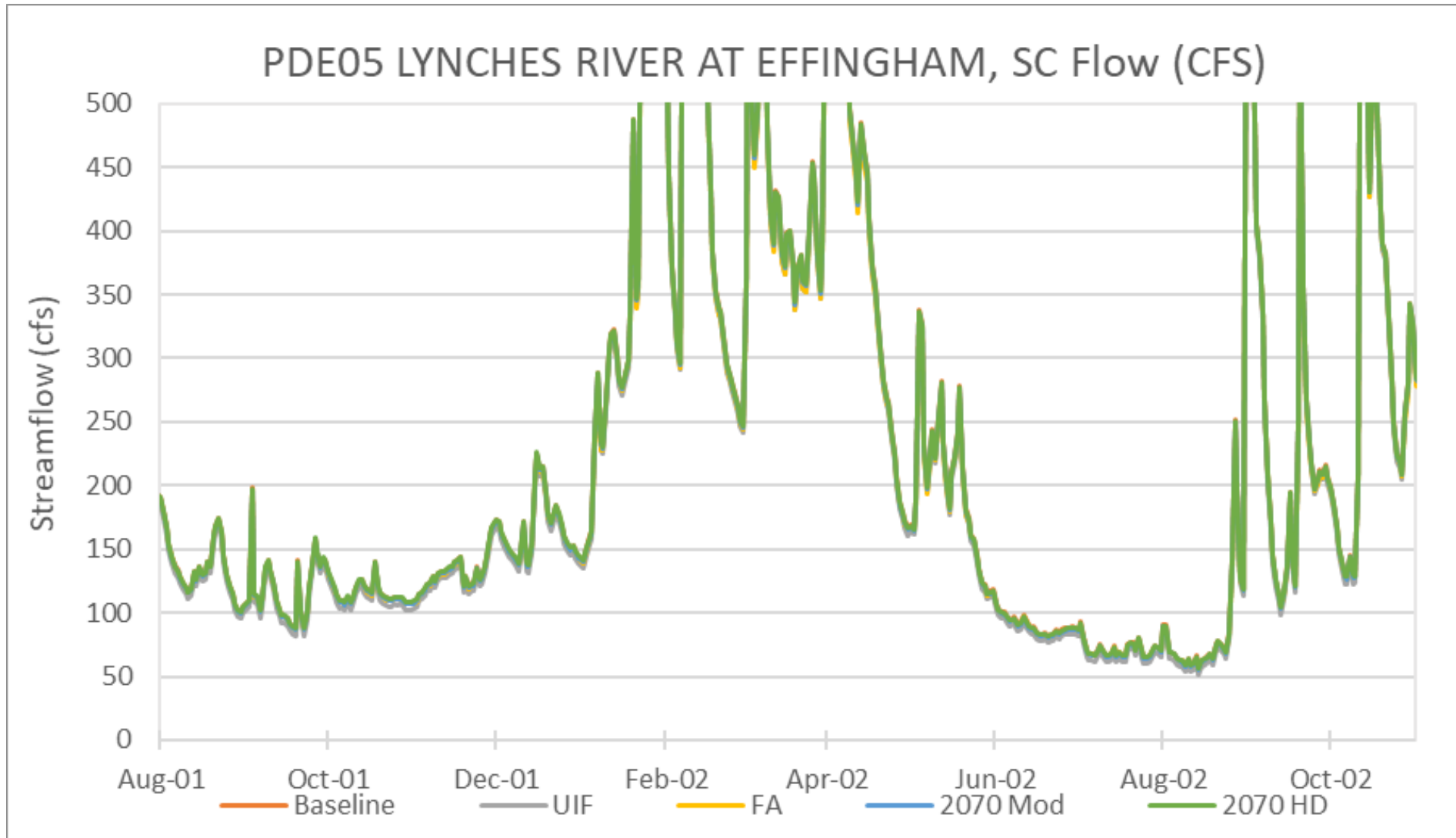


Comparison of Drought of Record Flows



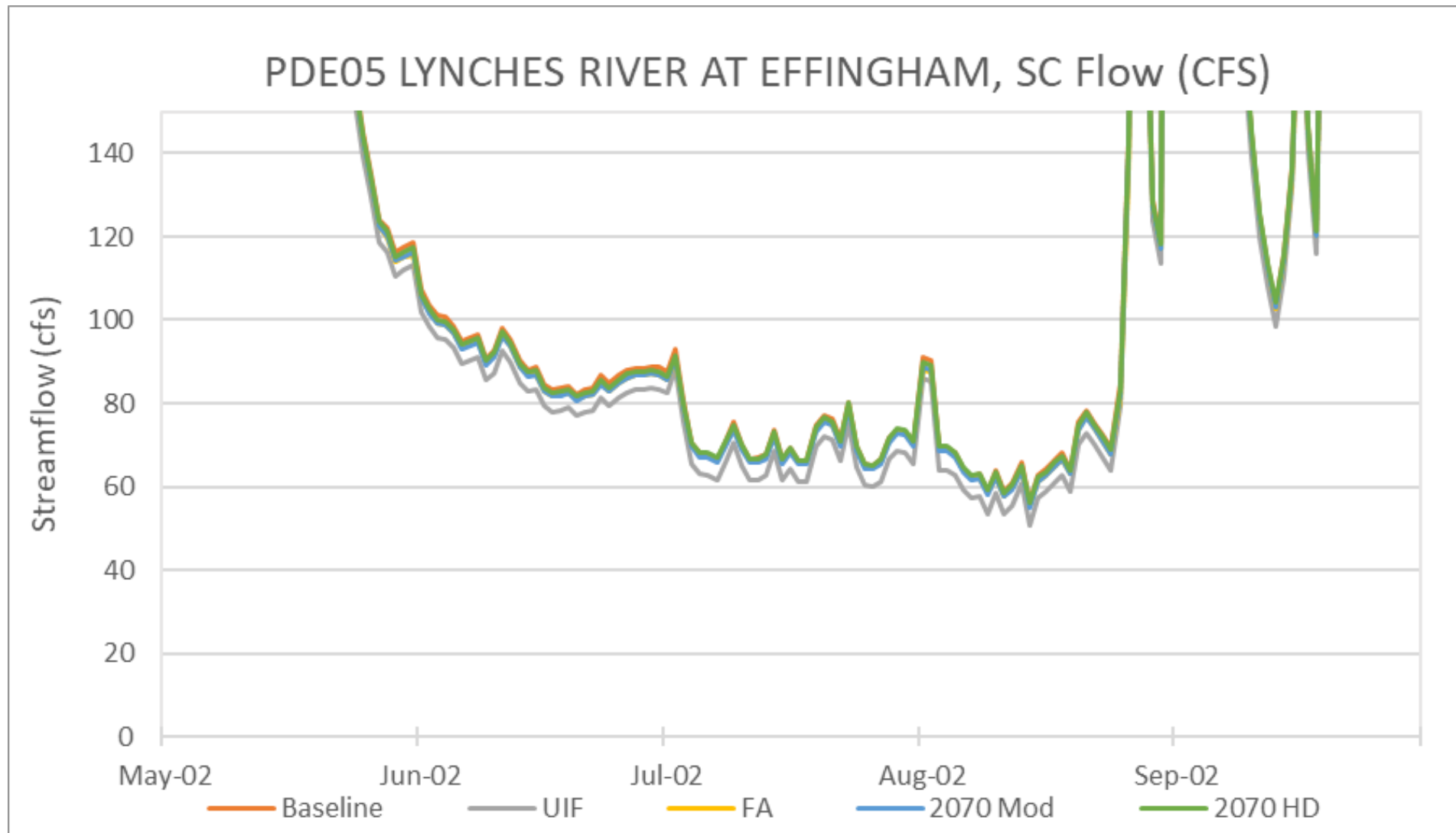
Flows during 2001 and 2002

Comparison of Drought of Record Flows



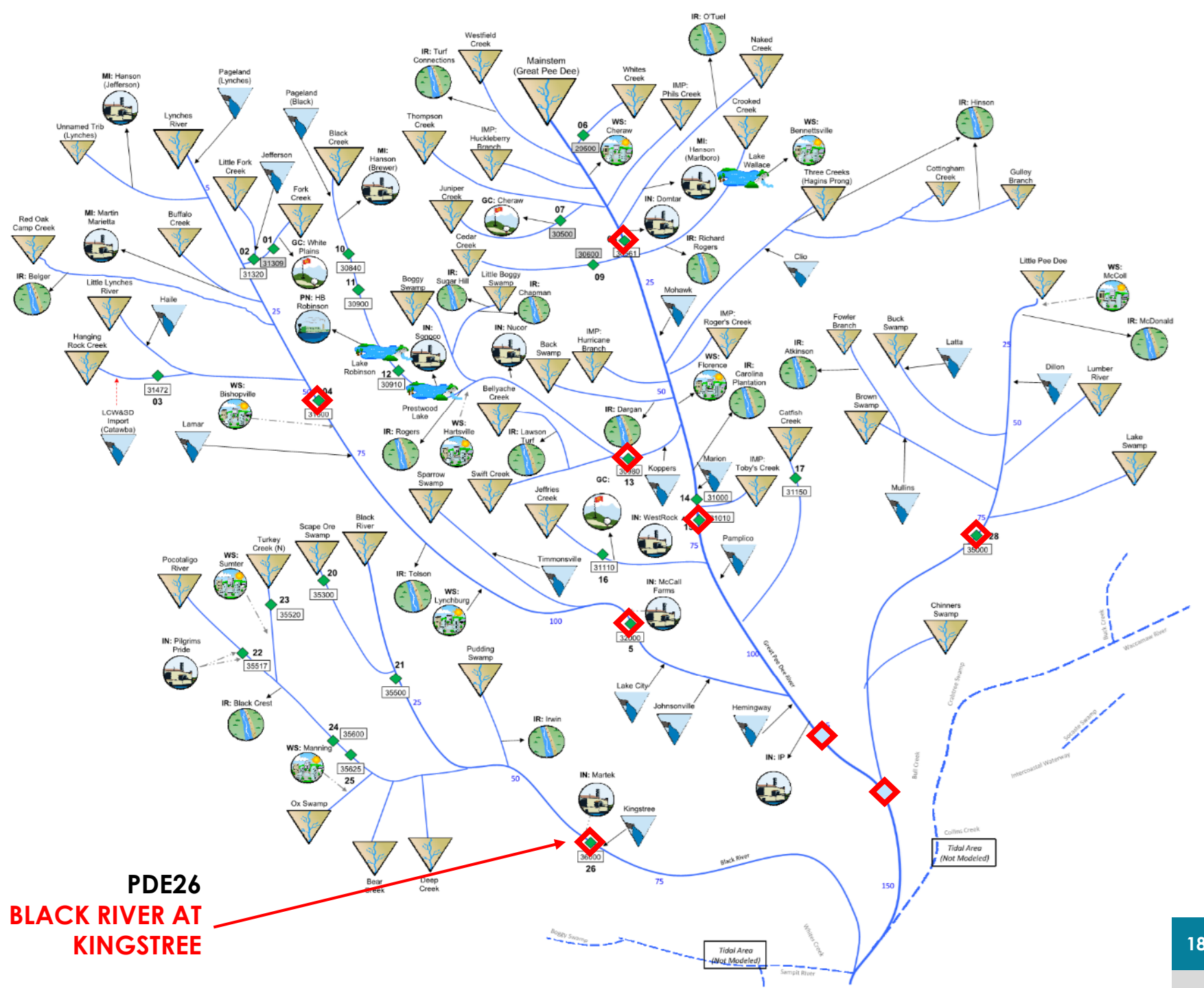
Flows below 500 cfs between Aug 2001 and Nov 2002

Comparison of Drought of Record Flows



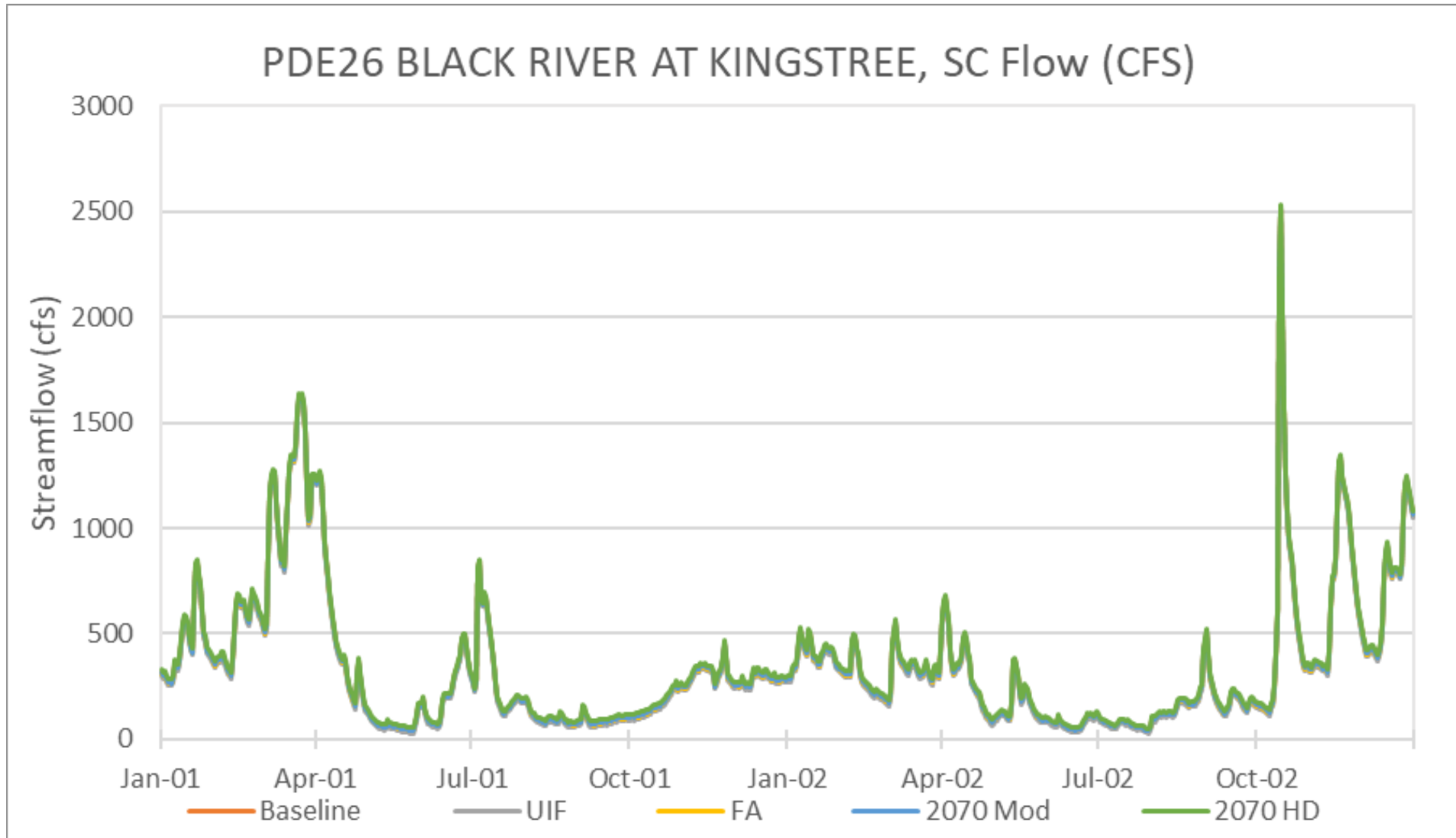
Flows below 150 cfs between May 2002 and Oct 2002

Strategic Nodes



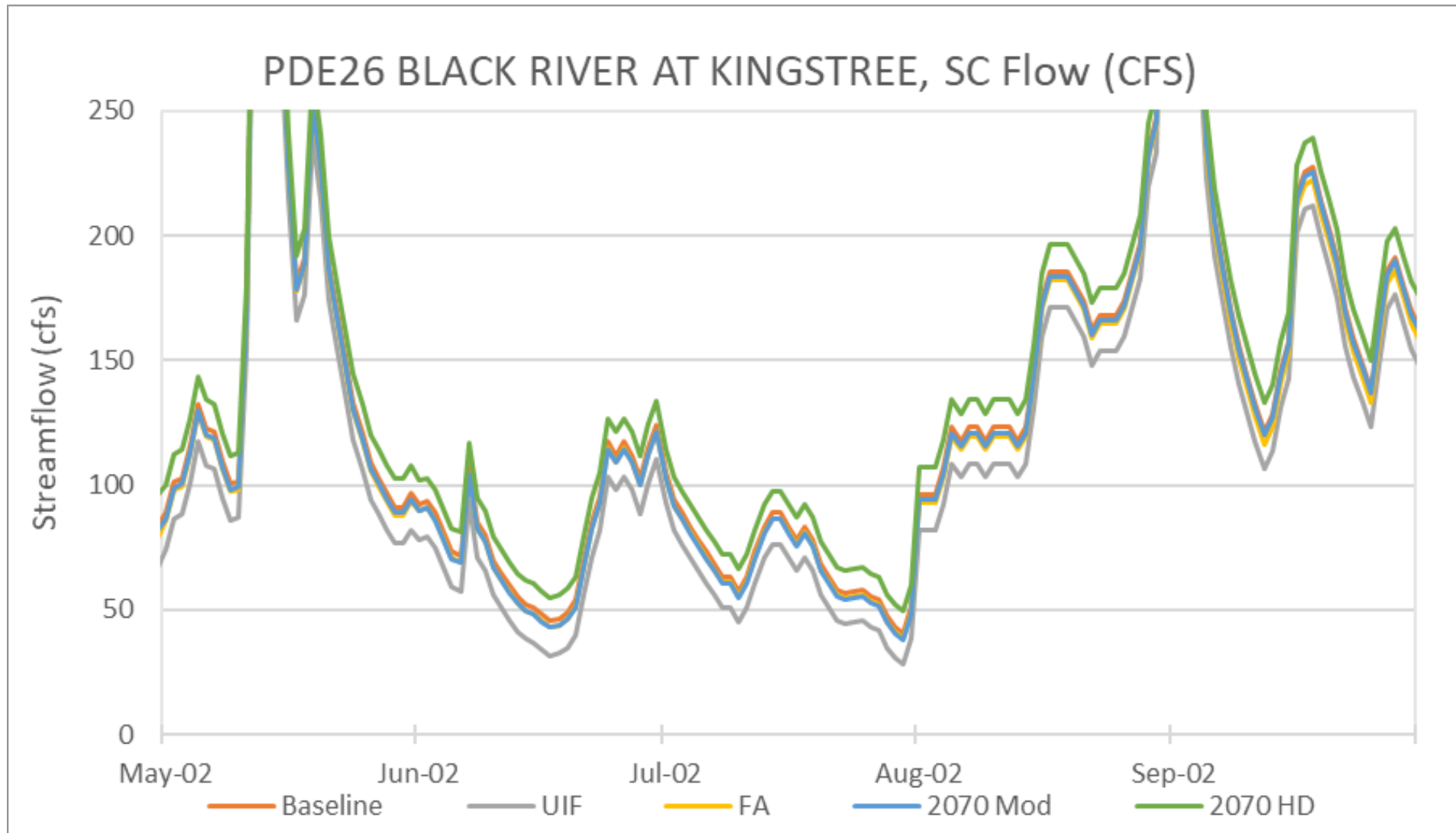
**PDE26
BLACK RIVER AT
KINGSTREE**

Comparison of Drought of Record Flows



Flows during 2001 and 2002

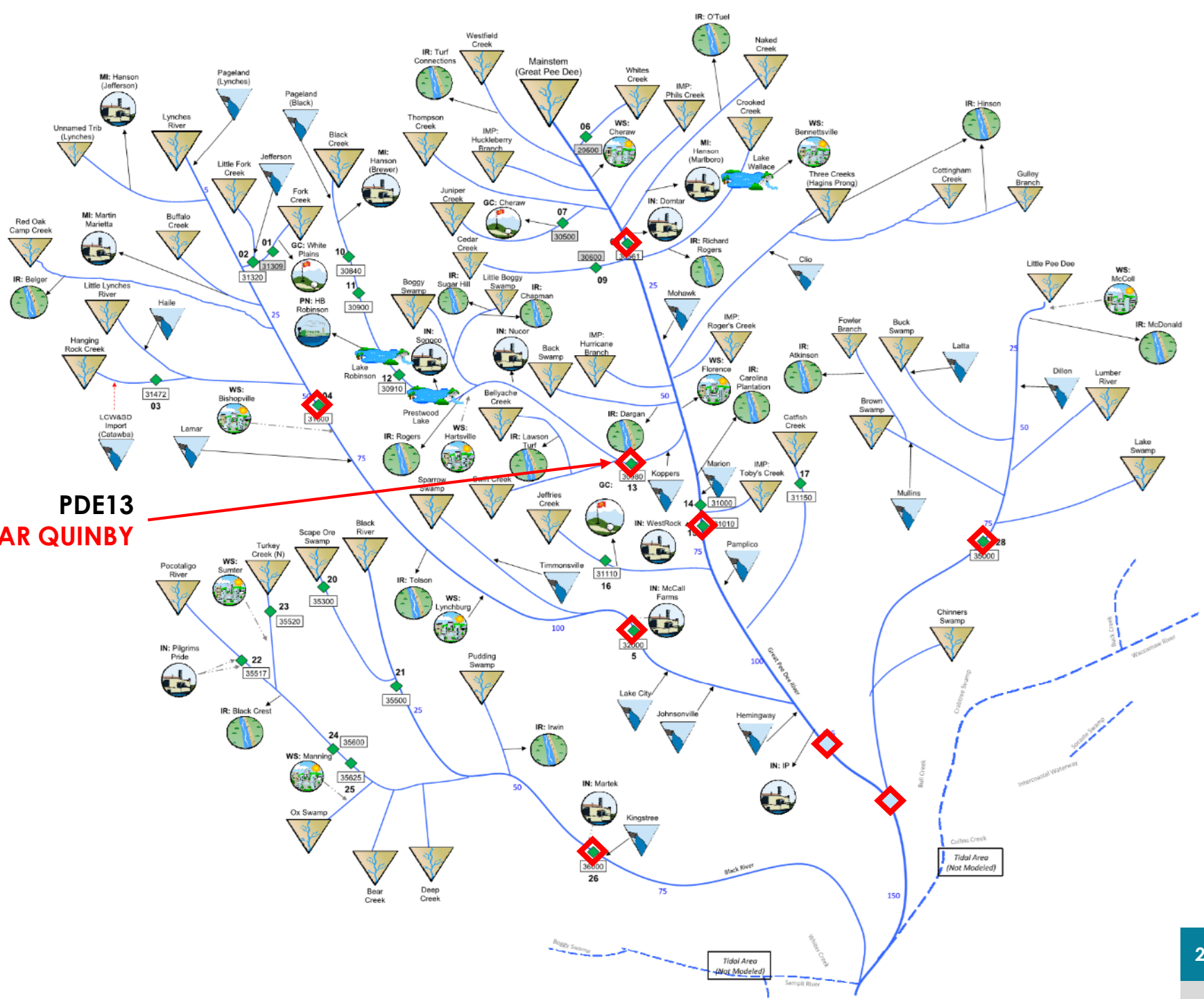
Comparison of Drought of Record Flows



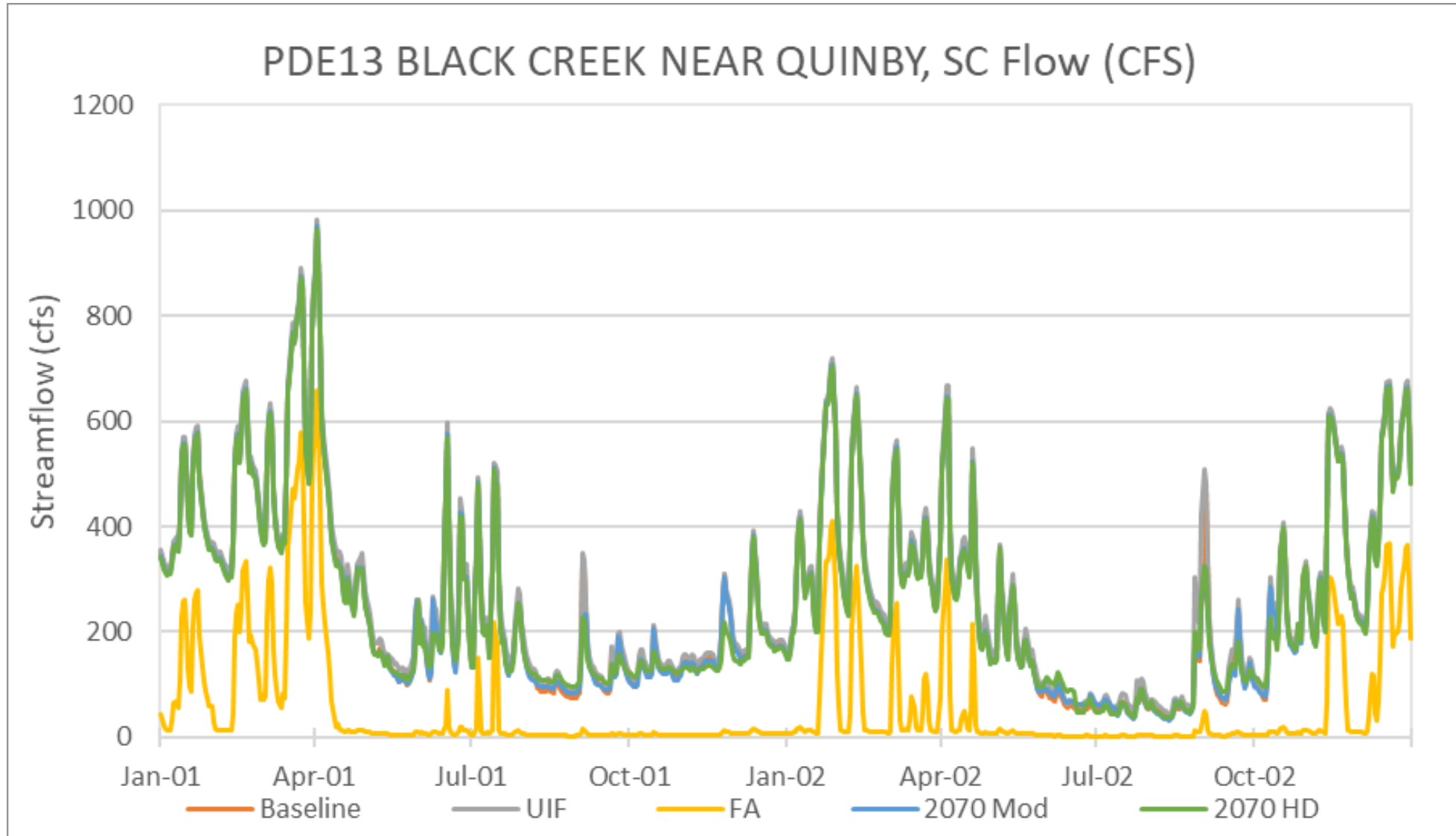
Flows below 250 cfs between May 2002 and Oct 2002

Strategic Nodes

PDE13
BLACK CREEK NEAR QUINBY

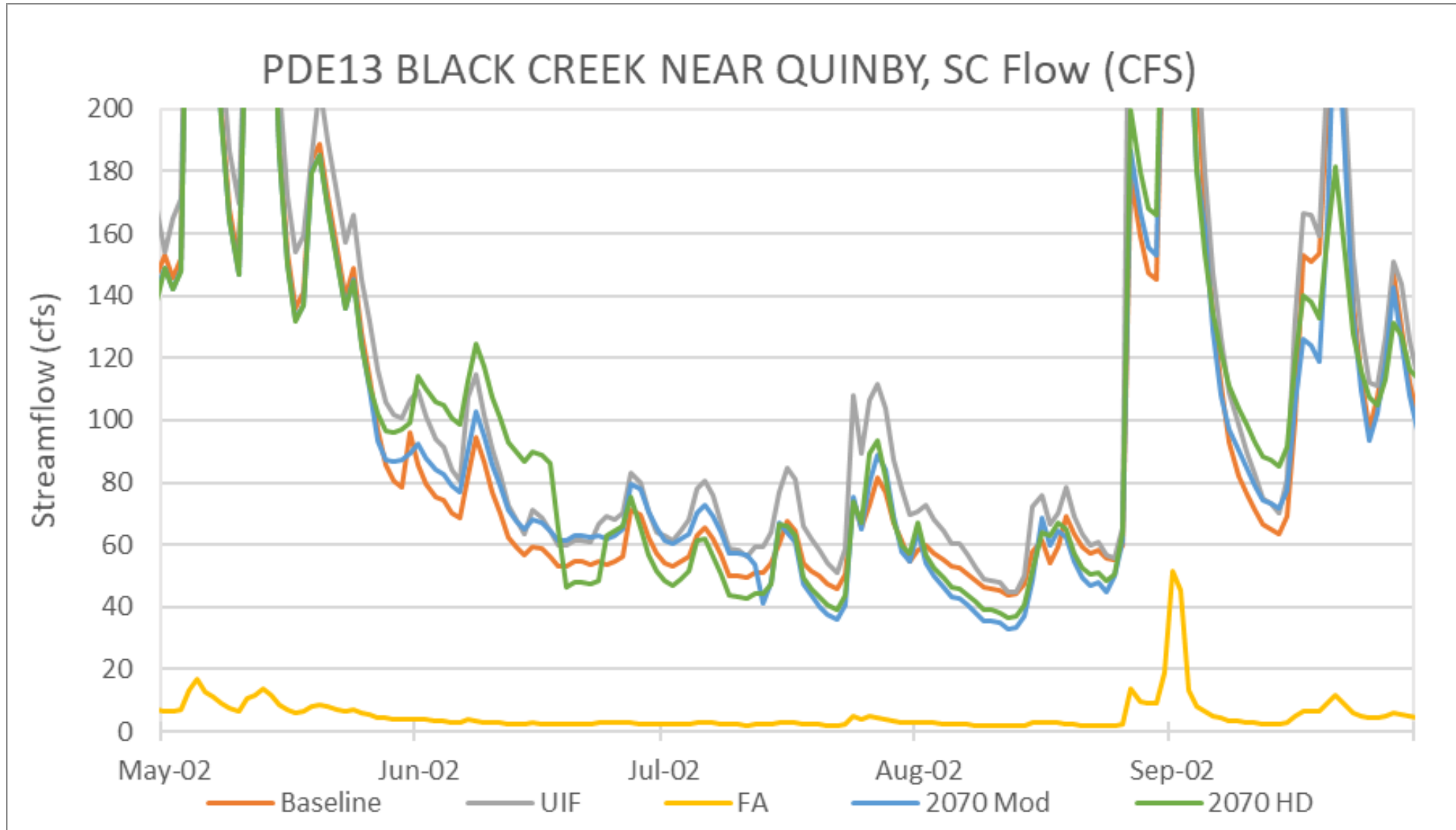


Comparison of Drought of Record Flows



Flows during 2001 and 2002

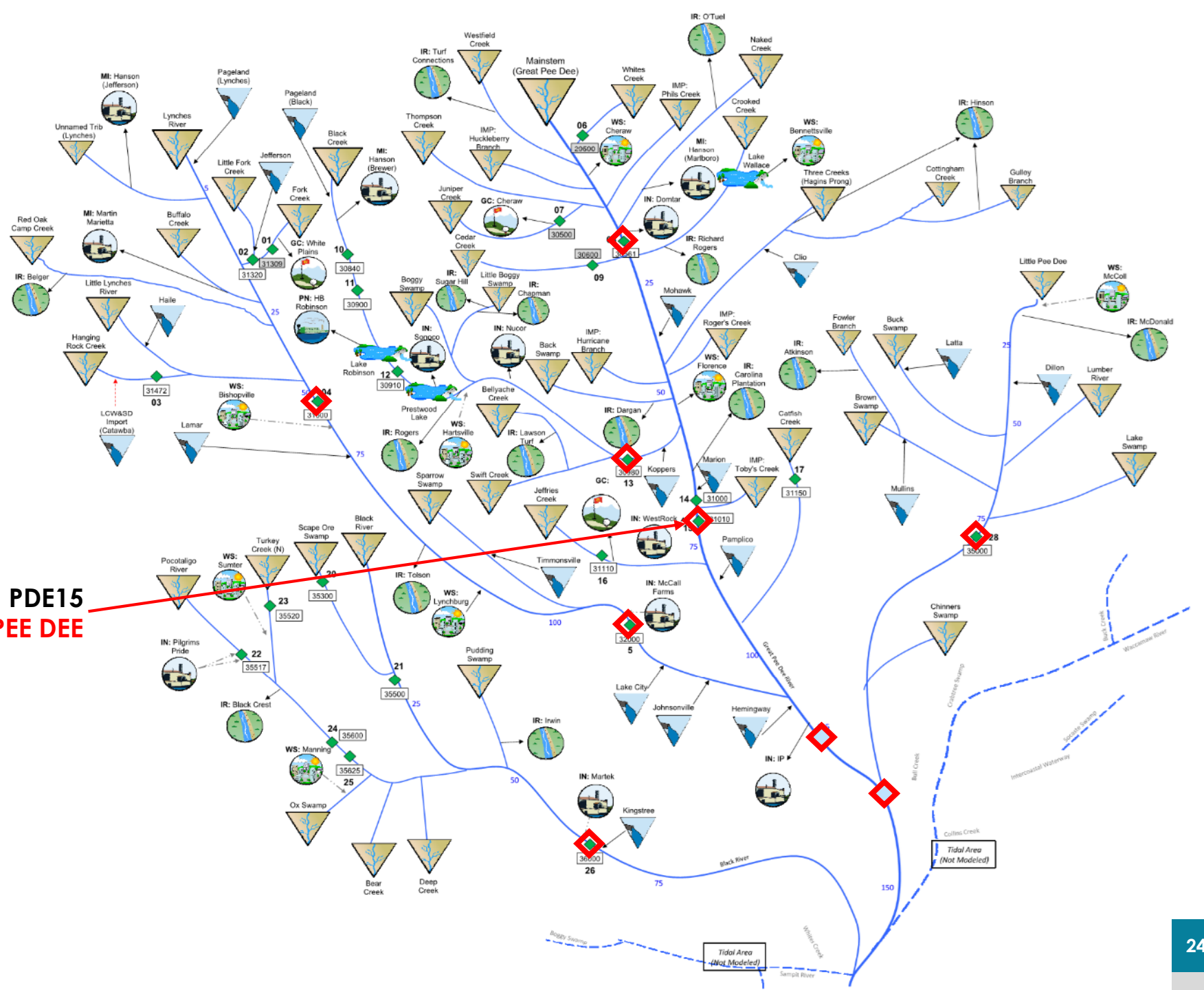
Comparison of Drought of Record Flows



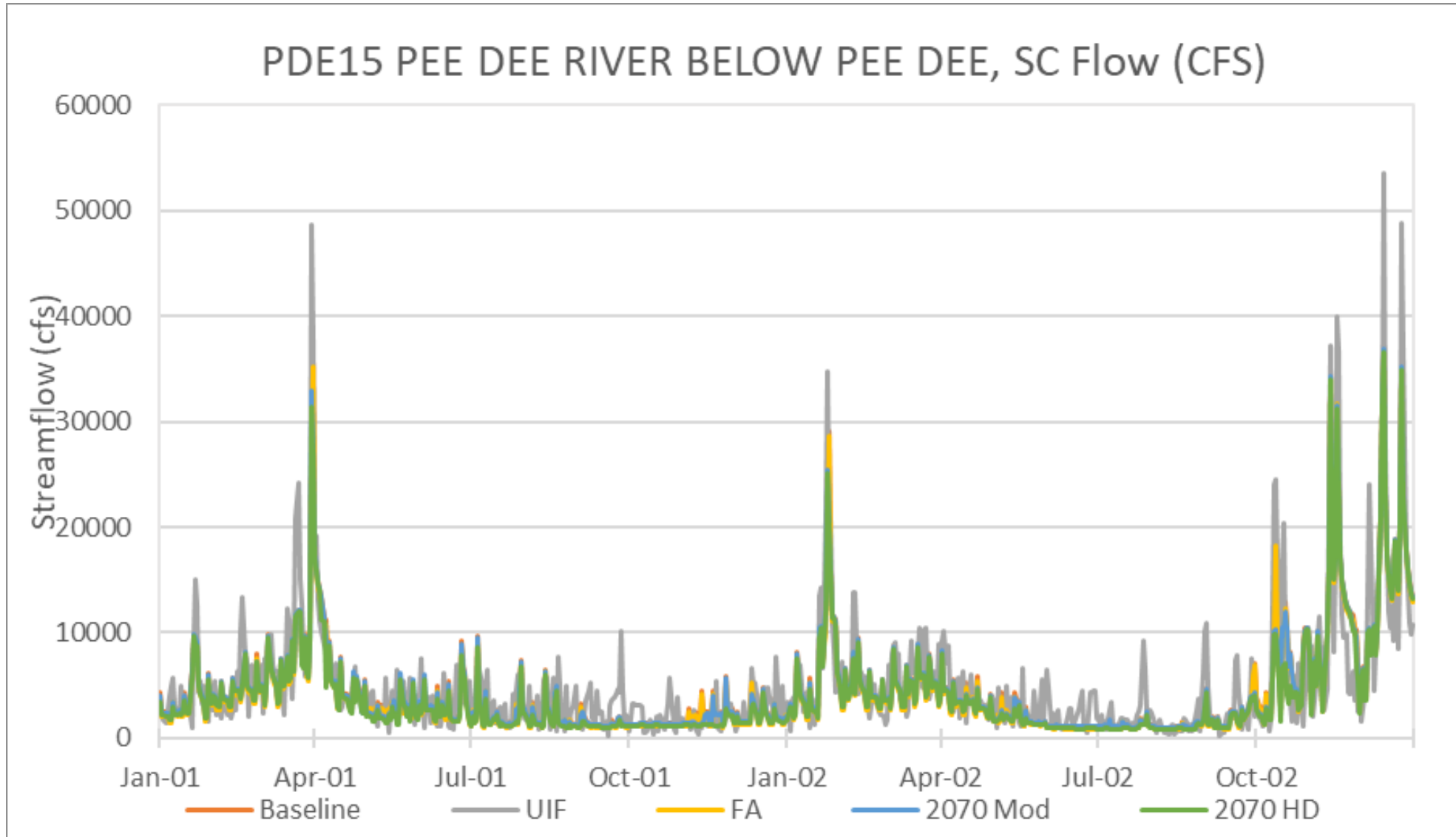
Flows below 200 cfs between May 2002 and October 2002

Strategic Nodes

PDE15
PEE DEE RIVER BELOW PEE DEE

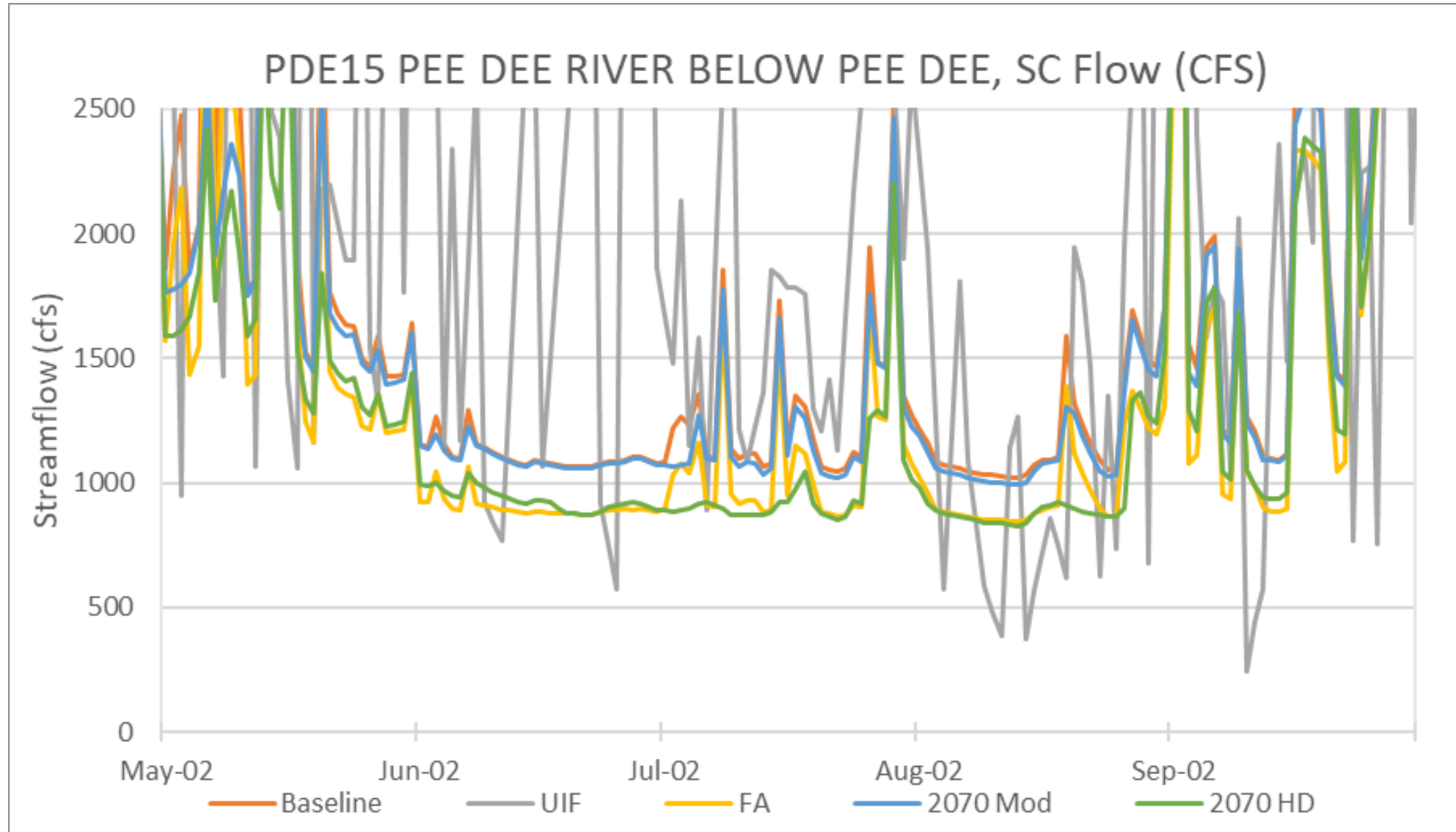


Comparison of Drought of Record Flows



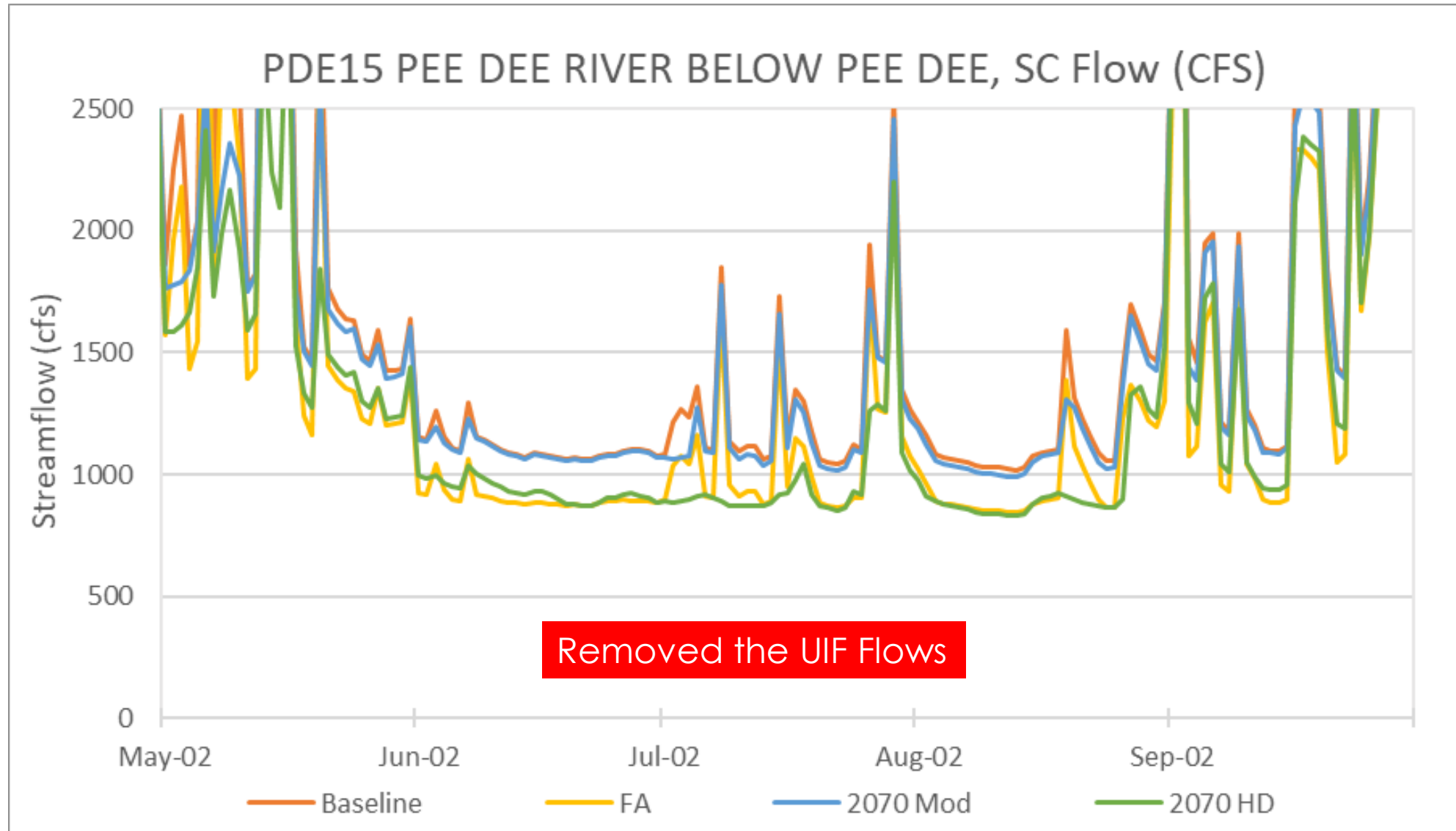
Flows during 2001 and 2002

Comparison of Drought of Record Flows



Flows below 2,500 cfs between May 2002 and Oct 2002

Comparison of Drought of Record Flows



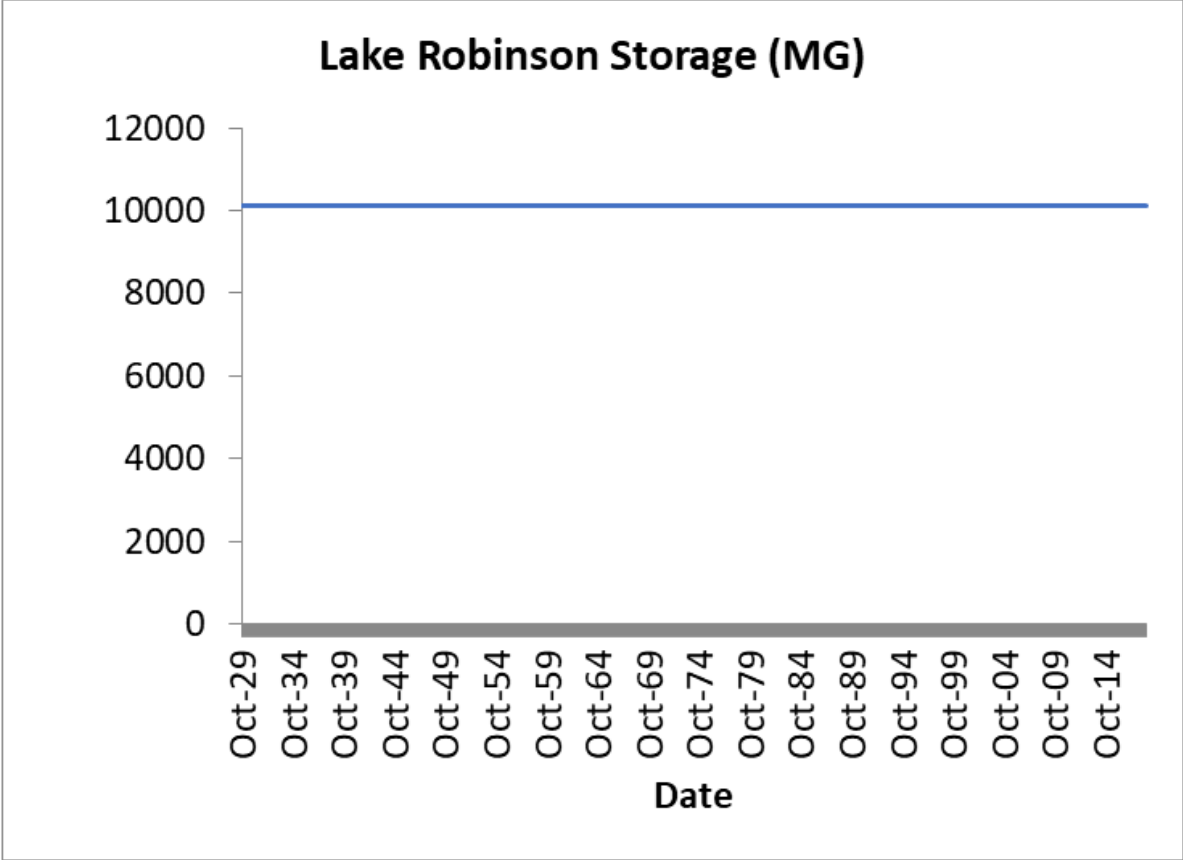
Flows below 2,500 cfs between May 2002 and Oct 2002

Additional Analyses Requested in March

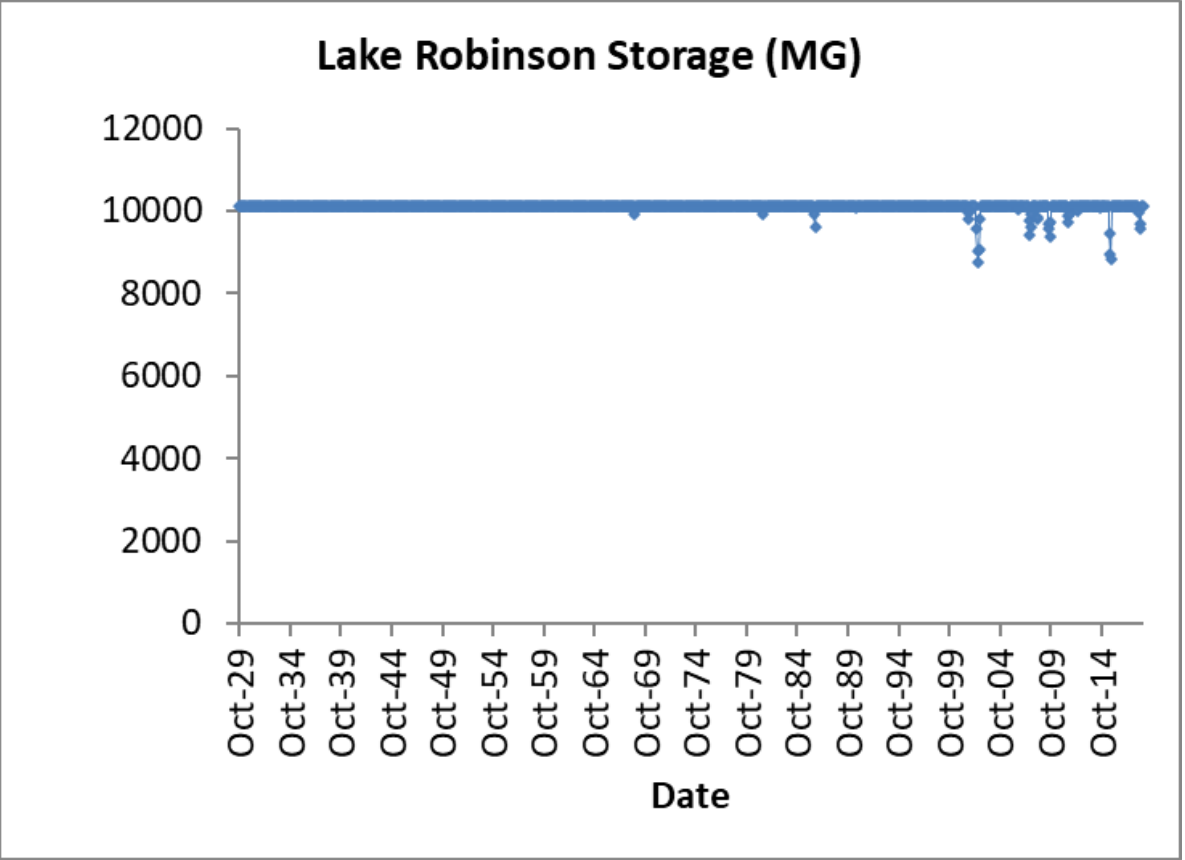
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Reservoir Storage – Lake Robinson 2070 High Demand Scenario

Original Simulation

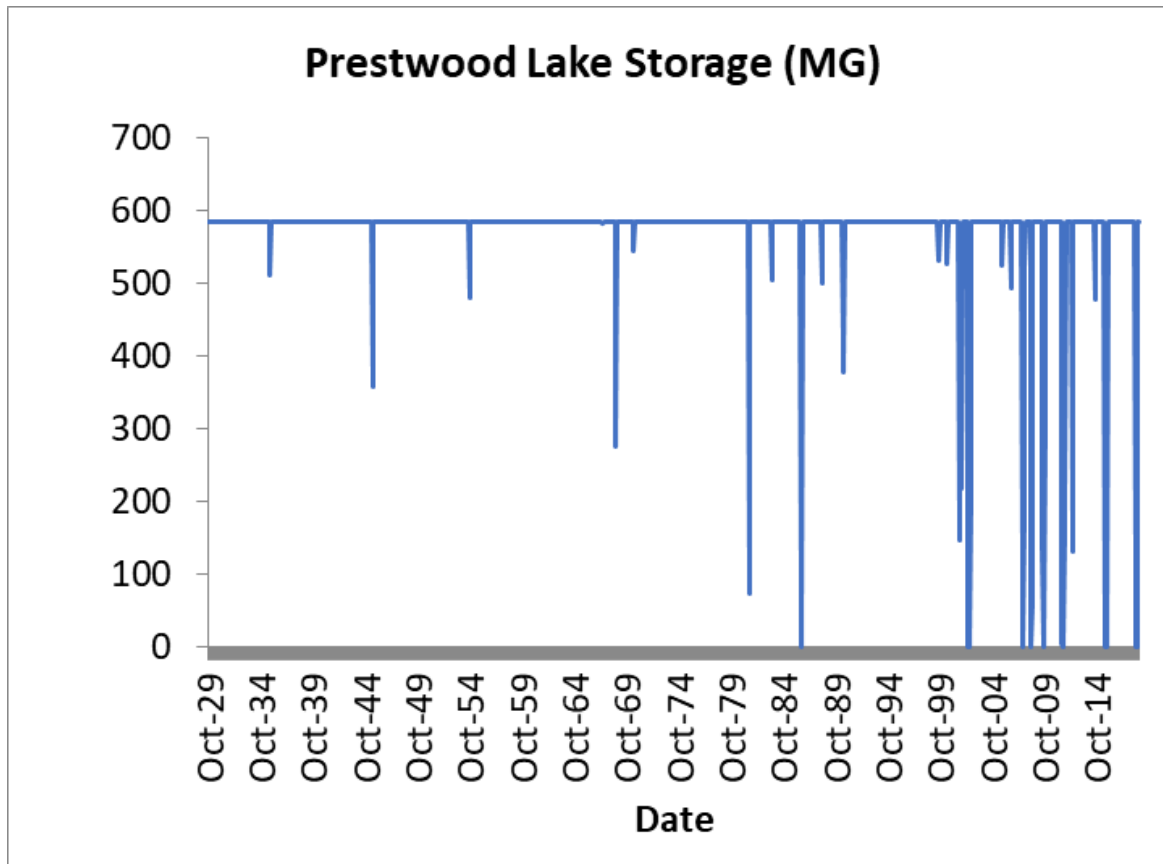


Steady Minimum Release of 35 cfs from Robinson with condition of not dropping more than 2 feet

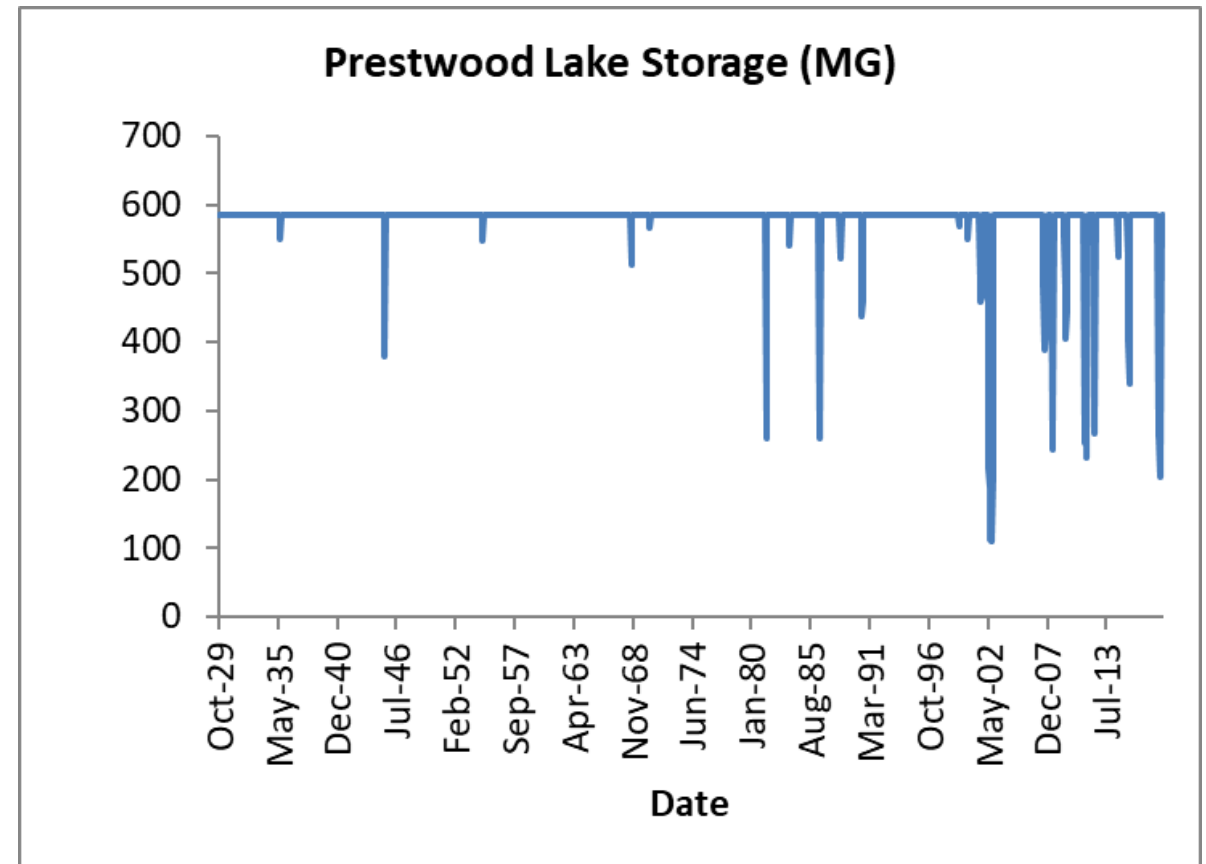


Reservoir Storage – Prestwood Lake 2070 High Demand Scenario

Original Simulation



Steady Minimum Release of 35 cfs from Robinson with condition of not dropping more than 2 feet

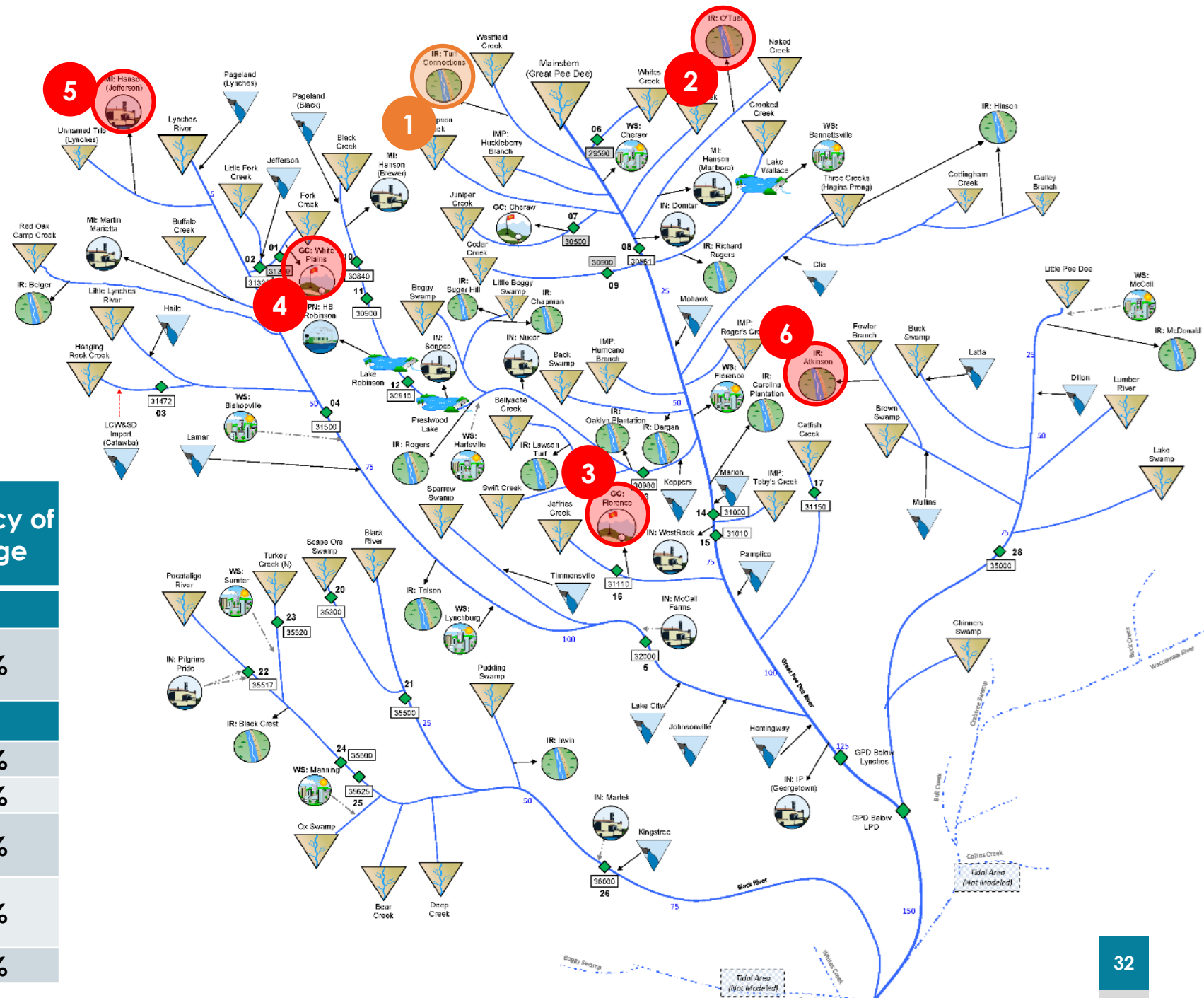


Sonoco Demand 2070 High Demand Scenario Withdrawal is 29.8 MGD

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Current Use Scenario



Surface Water Shortage Table

Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
Regulatory Shortage			
1	IR: Turf Connections	0.1	33.3%
Physical Shortages			
2	IR: O'Tuel	0.3	0.4%
3	GC: Florence	0.1	0.3%
4	GC: White Plains	0.1	7.0%
5	MI: Hanson (Jefferson)	0.05	6.1%
6	IR: Atkinson	0.05	1.2%



Considerations and Next Steps

RBC Considerations Moving Forward

- Are there additional scenarios the RBC would like to see modeled?
- Would the RBC like to see how often simulated flows under each scenario drop below the **Minimum Recommended Instream Flows (MIFs)** (even though most water users in the basin are not subject to them)?
- Is there any need to establish a **Surface Water Condition** at any location?
- Is there any need to establish one or more **Reaches of Interest**?

Extra Slides (as needed)

N. Tyger River below Wellford (15 yrs)

UIF	0.5
Current	5.5
2070 Mod	3.4
2070 HD	12.9
P&R	70.2

N. Pacolet River near Fingerville (92 yrs)

UIF	0
Current	0.3
2070 Mod	1.6
2070 HD	3.3
P&R	1.9

S. Tyger River below Duncan (21 yrs)

UIF	0.5
Current	4.9
2070 Mod	8.4
2070 HD	8.4
P&R	10.7

Middle Tyger River near Lyman (22 yrs)

UIF	1.5
Current	6.3
2070 Mod	19.8
2070 HD	40.3
P&R	47.8

Years of gage data used to calculate the MIF

Pacolet River near Saratt (10 yrs)

UIF	4.4
Current	9.9
2070 Mod	9.2
2070 HD	9.9
P&R	17.9

Percent of days below MIF for the location

Enoree River near Whitmire (49 yrs)

UIF	6.6
Current	4.5
2070 Mod	3.5
2070 HD	3.4
P&R	7.0

Tyger River near Delta (49 yrs)

UIF	5.7
Current	8.6
2070 Mod	10.5
2070 HD	12.7
P&R	17.6

Broad below Ninety-Nine Islands (22 yrs)

UIF	1.5
Current	0.7
2070 Mod	0.8
2070 HD	1.0
P&R	0.9

Broad near Carlise (84 yrs)

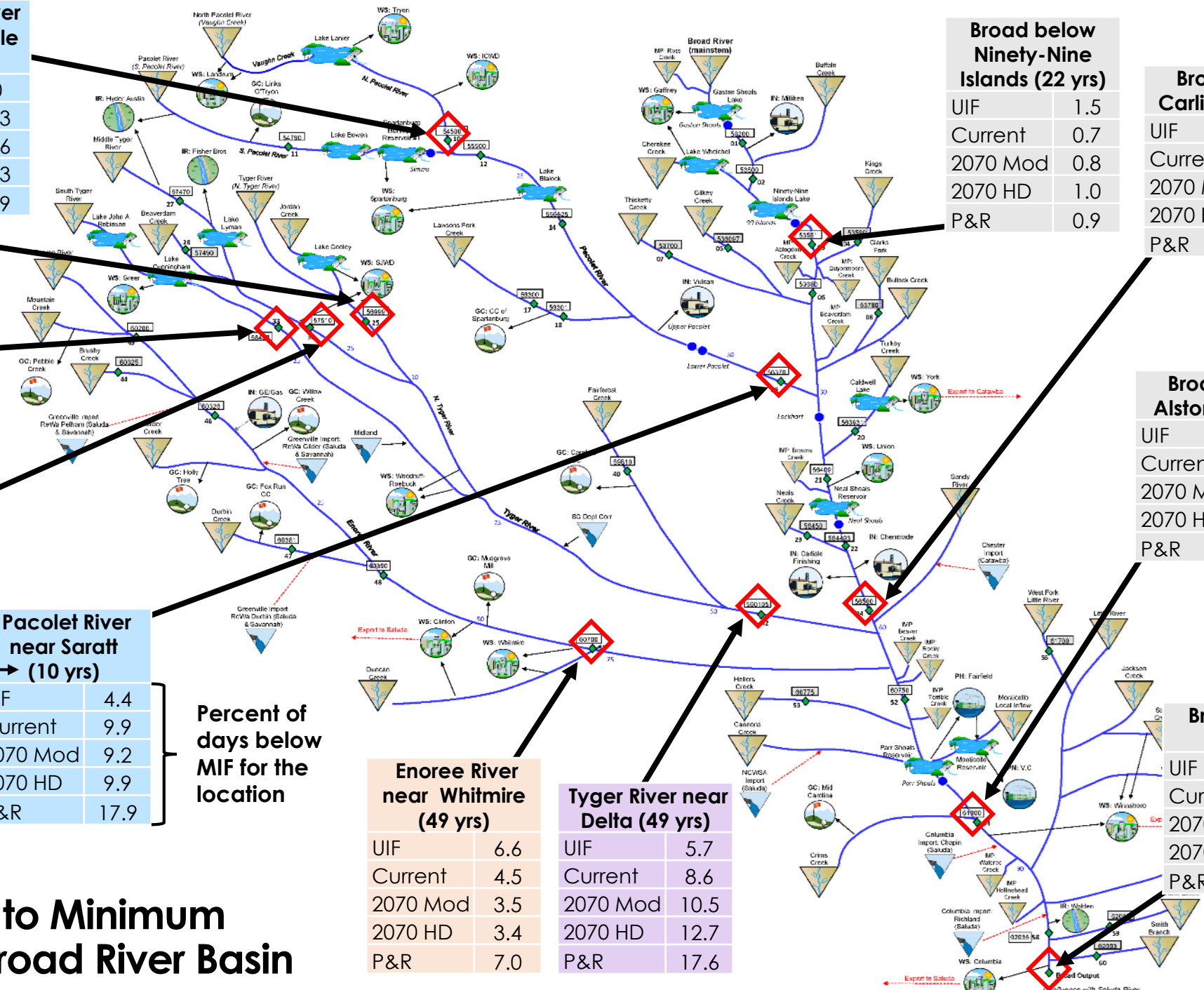
UIF	4.0
Current	6.1
2070 Mod	6.6
2070 HD	7.2
P&R	7.9

Broad near Alston (42 yrs)

UIF	3.7
Current	6.7
2070 Mod	7.1
2070 HD	7.7
P&R	9.3

Broad Outlet (11 yrs)

UIF	2.9
Current	5.8
2070 Mod	6.4
2070 HD	7.6
P&R	10.5



Example: Comparison to Minimum Instream Flows in the Broad River Basin

Definitions

- **Physically Available Surface Water Supply** – maximum amount of water occurring 100% of the time at a location on a surface water body, with no defined conditions applied on the surface water body.
- **Surface Water Condition** – a physical limitation on the amount of water that can be withdrawn from a surface water source and is independent of water demand.
- **Surface Water Supply** – maximum amount of water available for withdrawal 100% of the time at a location on a surface water body without violating any applied *Surface Water Conditions* on the surface water source and considering upstream demands.
- **Surface Water Shortage** – occurs when the water demand exceeds the *Surface Water Supply* for any water user in the basin.
- **Regulatory Shortage** – occurs when the water demand exceeds the permitted or registered amount for a water user.
- **Reaches of Interest** – specific stream reaches that may have no identified Surface Water Shortage but experience undesired impacts, environmental or otherwise, determined from current or future water-demand scenarios or proposed water management strategies.

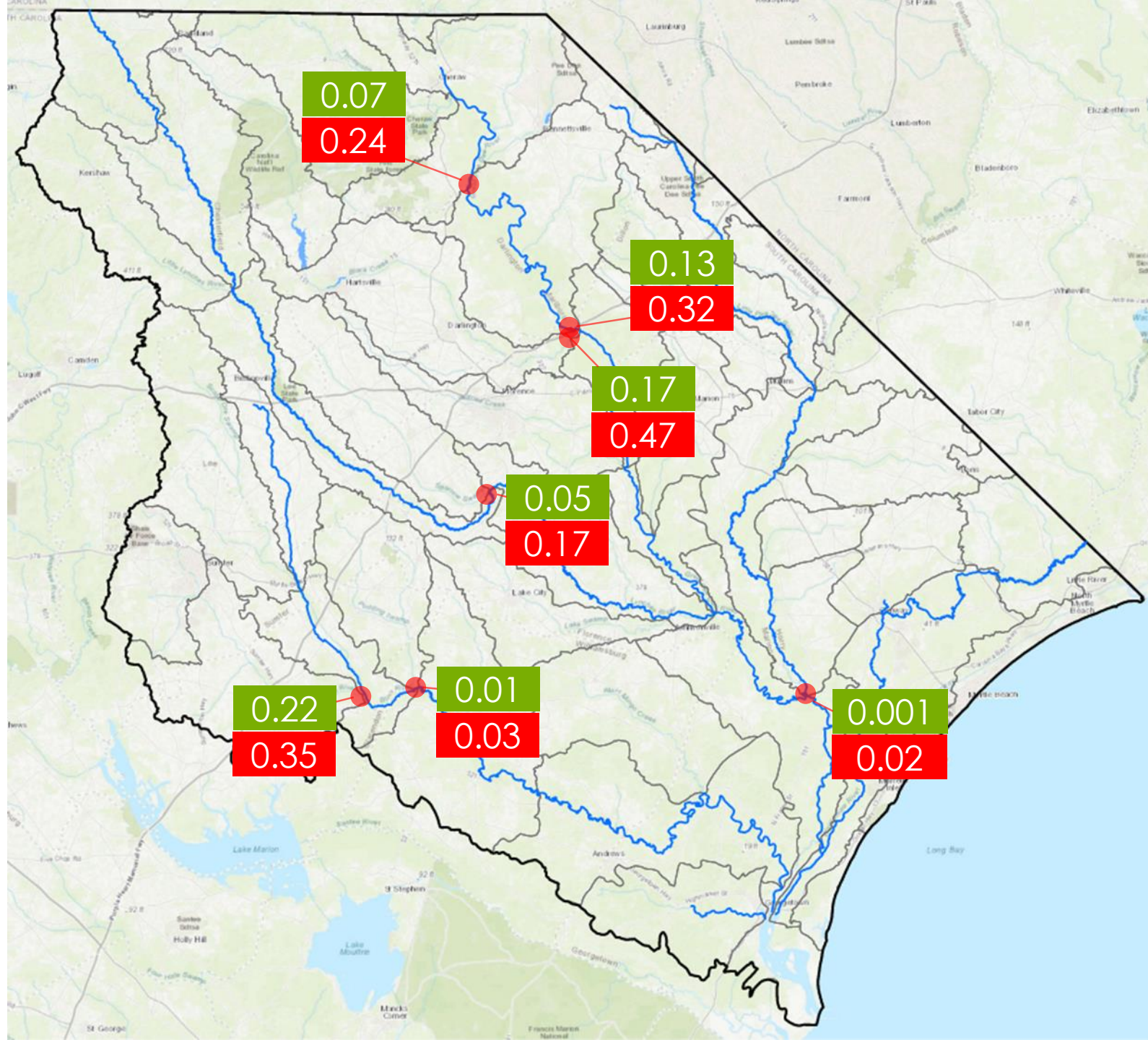
Projected Agricultural Demands

2070 Average Annual Demands, by Scenario

Scenario	Added Agriculture Demand (mgd)
Moderate	0.22
High Demand	0.35

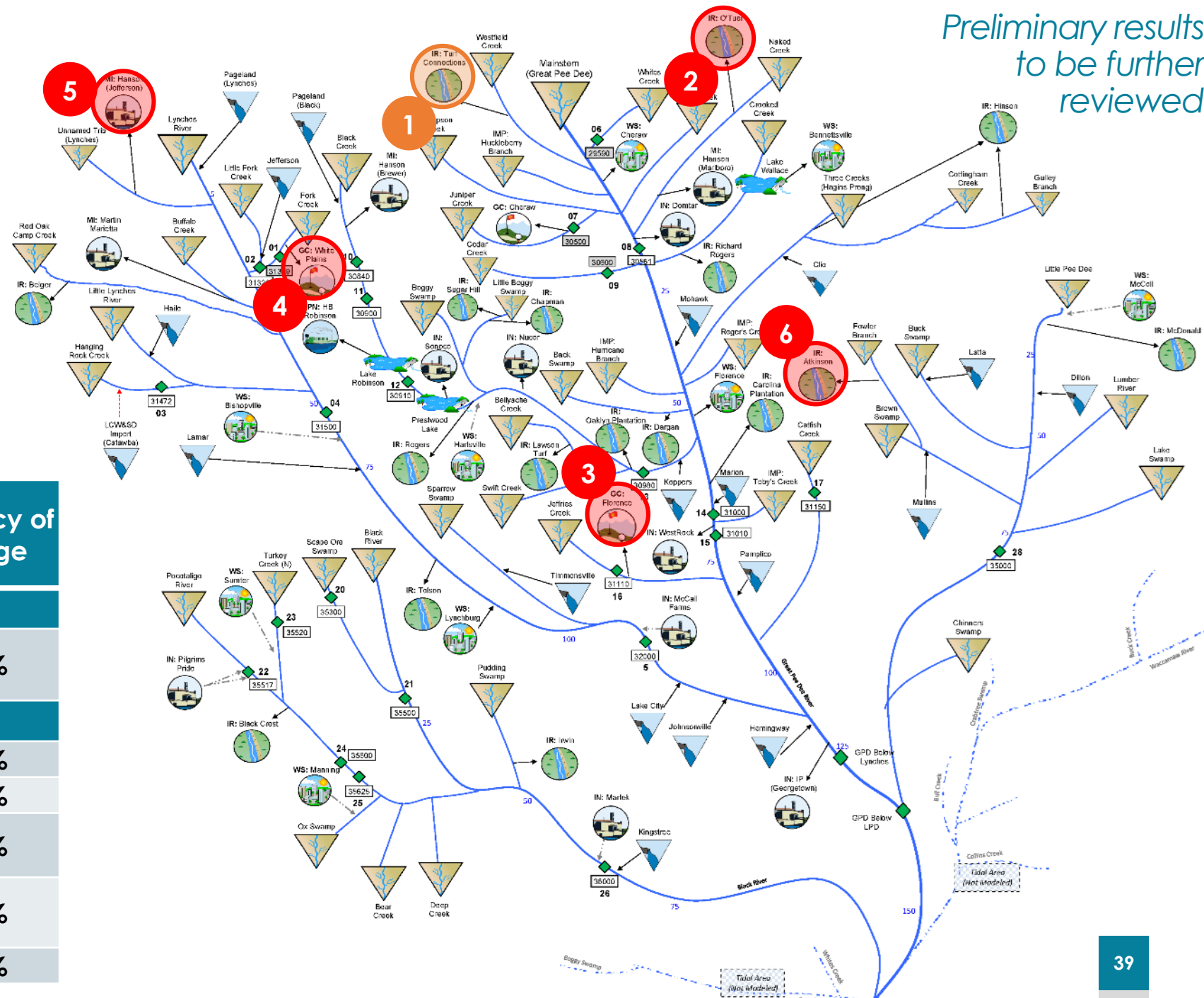
HUC 10 Outlet ●

HUC 10s without values are assumed to have no additional Ag demand



Current Use Scenario

Preliminary results to be further reviewed



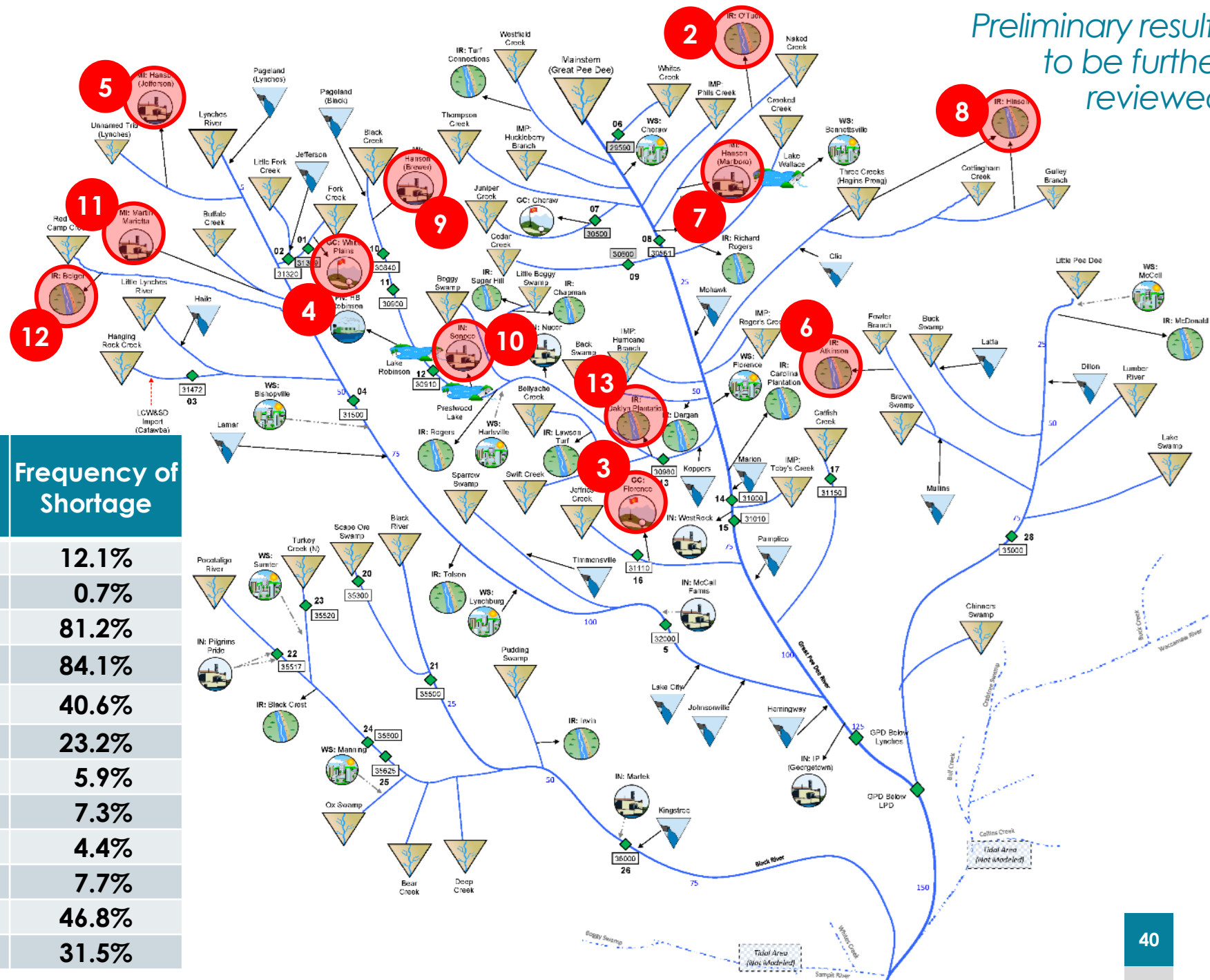
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4	GC: White Plains	0.1	7.0%
5	MI: Hanson (Jefferson)	0.05	6.1%
6	IR: Atkinson	0.05	1.2%

Permitted and Registered (P&R) Scenario

Preliminary results to be further reviewed

1 Physical Shortage



Surface Water Shortage Table

Map ID	Water User	Max Shortage (MGD)	Frequency of Shortage
2	IR: O'Tuel	1.8	12.1%
3	GC: Florence	1.6	0.7%
4	GC: White Plains	1.6	81.2%
5	MI: Hanson (Jefferson)	0.9	84.1%
6	IR: Atkinson	0.3	40.6%
7	MI: Hanson (Marlboro)	3.9	23.2%
8	IR: Hinson	0.3	5.9%
9	MI: Hanson (Brewer)	4.5	7.3%
10	IN: Sonoco	35.5	4.4%
11	MI: Martin Marietta	2.8	7.7%
12	IR: Belger	2.9	46.8%
13	IR: Oaklyn Plantation	146.3	31.5%

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	IN: Sonoco	9.2	0.3%
2	IR: O'Tuel	0.3	0.4%
3	IR: Atkinson	0.05	1.2%
4	GC: Florence	0.03	0.3%
5	GC: White Plains	0.1	6.3%
6	MI: Hanson (Jefferson)	0.04	5.0%
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