Effectiveness of Demand-side Surface Water Management Strategies and Selection of Strategies for Feasibility Evaluation

Agenda Item #5

Review of November Meeting

- **Identified Issues from Surface Water availability modeling:**

  a. **Surface water shortages** for Aiken and CWS in the 2070 High Demand Scenario(with no surface water conditions)

  b. **Low Flows during drought** – For all Scenarios, flow at Givhans Ferry and other locations drops below Minimum Instream Flow (20%, 30% and 40% of Mean Daily Flow)

Review of November Meeting

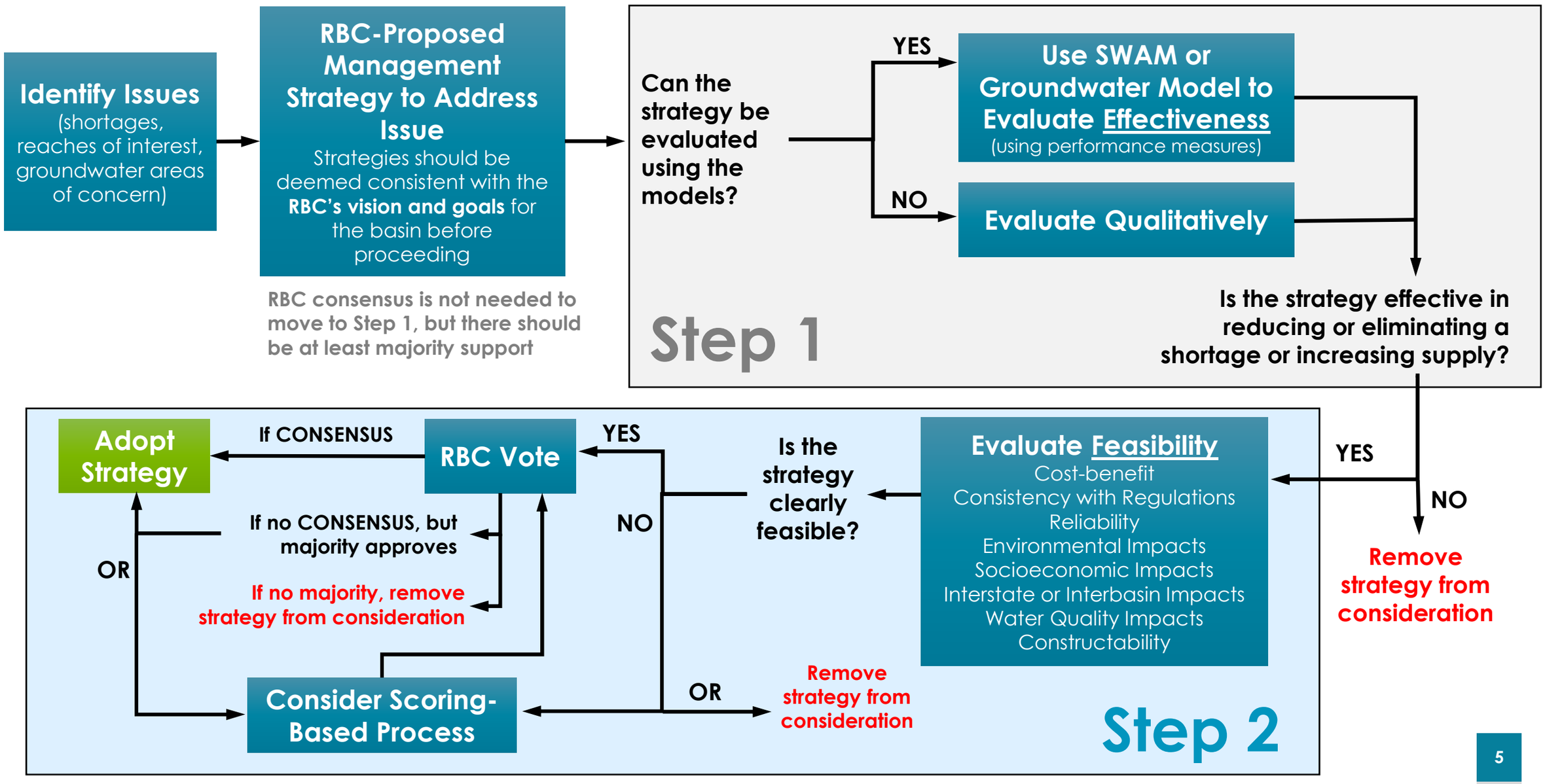
- **Guiding Principle #4**: River Basin Plans should utilize effective supply and demand strategies
- Demand strategies include:
    a. Water loss control programs
    b. Low flow fixtures and appliances
    c. Reclaimed water programs
    d. Conservation-based pricing structures
    e. Ag water audits and irrigation efficiency measures
    f. Soil moisture sensor/smart irrigation

Review of November Meeting

Our Plan was to:

- Investigate the effectiveness in-place and demand-side strategies using the SWAM model
- Subsequently, supply-side strategies may be identified by the RBC, and those, along with a proposed Low Flow Strategy, may be evaluated using the model.

Decision-Making Process for Selecting Water Management Strategies



SUMMARY - Demand Side Scenarios

- **Scenario 1** – Existing **Drought Management Plan** actions

- **Scenario 2** – Scenario 1 strategies, plus **agriculture water efficiency strategies**

- **Scenario 3** – Scenario 1 and 2 strategies, plus **municipal water conservation strategies**

Scenarios 1, 2 and 3 were run using **2070 water demands** from the **Business-as-Usual** and **High Demand Scenarios**

Scenario 1
Existing Municipal Drought Management Plan Triggers and Actions

Drought Phase:	Moderate	Severe	Extreme
Water use reduction goals (Actions):	15%	20%	25%
Charleston Water System Triggers	**When the Edisto River at the CWS intake is 312 cfs, the CWS withdrawal should not exceed 80 mgd (72% reduction of permitted capacity)**	**When the Edisto River at the CWS intake is 260 cfs, the CWS withdrawal should not exceed 60 mgd (79% reduction of permitted capacity)**	**When the Edisto River at the CWS intake is 174 cfs, the CWS withdrawal should not exceed 40 mgd (86% reduction of permitted capacity). If the Edisto River at the CWS intake drops to 87 cfs, the CWS withdrawal should not exceed 25 mgd (91% reduction of permitted capacity)**
Orangeburg Triggers	1. North Fork Edisto River Elevation less than 151.6 ft. M.S.L. (as measured at the Water Plant) **2. Stream-flow less than 125 cfs (use Orangeburg gage)** 3. Determination by the Manager of DPU	1. North Fork Edisto River Elevation less than 151.4 ft. M.S.L. (as measured at the Water Plant) **2. Stream-flow less than 110 cfs (use Orangeburg gage)** 3. Determination by the Manager of DPU	1. North Fork Edisto River Elevation less than 151.3 ft. M.S.L. (as measured at the Water Plant) **2. Stream-flow less than 100 cfs (use Orangeburg gage)** 3. Determination by the Manager of DPU
Aiken Triggers	1. Aquifer levels falling 5 feet below historic static level. 2. Average daily use greater than 15.5 mgd for five consecutive days. **[For modeling: when flow in Shaw Creek at intake is less than 14 cfs]**	1. Reservoir Valve 1 discharge required to maintain flow in Shaws Creek. **[For modeling: when flow in Shaw Creek at intake is less than 11 cfs]** 2. Aquifer levels falling 10 feet below historic static level. 3. Average daily use greater than 16.5 mgd for five consecutive days.	1. Reservoir Valve 2 discharge required to maintain flow in Shaws Creek. **[For modeling: when flow in Shaw Creek at intake is less than 8 cfs]** 2. Aquifer levels falling 12 feet below historic static level. 3. Average daily use greater than 17.5 mgd for five consecutive days.
Batesburg-Leesville Triggers	1. Town Pond Reservoir 4/5 full **2. Brodie (Lightwood Knot) Creek flow below 5.0 cfs.** 3. Sixty days of raw water supply available 4. Average daily use greater than 1.3 mgd for 45 consecutive days 5. Local average rainfall less than 6 inches for sixty days.	1. Town Pond Reservoir 3/5 full **2. Brodie (Lightwood Knot) Creek flow below 3.0 cfs** 3. Forty-five days of raw water supply available 4. Average daily use greater than 1.5 mgd for 30 consecutive days 5. Local average rainfall less than 2 inches for ninety days.	1. Town Pond Reservoir 1/2 full **2. Brodie (Lightwood Knot) Creek flow below 1.5 cfs** 3. Twenty-one days of raw water supply available 4. Average daily use greater than 1.5 mgd for 30 consecutive days 5. Local average rainfall less than 1 inch for one hundred twenty days.

Triggers listed in green were incorporated into the SWAM model

Scenario 1
Other Water User's Triggers and Actions

- **Dominion Energy Cope Plant**
  - **Trigger** – S. Fork Edisto Flow is 192 cfs or less
  - Action – Switch to 100% groundwater
- **Walther Farms**
  - **Trigger –** Edisto River flow at Givhans is 312 cfs or less
  - **Action –** Switch to meeting 20% of demand from groundwater (reduce surface water withdrawal by 20%
  - Note – This trigger and action is **NOT** part of a drought plan

Do Voluntary Reductions Work?

California Example

- The Governor requested voluntary conservation following California's second driest year on record, with a goal of **15% reduction in water use.**
- **Total water usage is down just 6% since July** compared to the same period in 2020.
- Collectively, in October 2021, Californians reduced their water use by **13.2%** compared to October 2020.
- Northern California had the greatest reduction compared to October 2020, dropping by as much as **22%**, while the southern region that includes Los Angeles and San Diego dropped by about **12%** in October compared to 2020.

Source: https://www.islandpacket.com/news/business/article256416331.html#storylink=cpy

Scenario 1 - Results

When are drought actions triggered in the model with Business as Usual 2070 demands?

Drought Phase:	Moderate	Severe	Extreme
Water use reduction goals (Actions):	15%	20%	25%
Charleston Water System	7 months	14 months	6 months
Orangeburg	Never (lowest monthly flow at Orangeburg is 168 cfs vs. the trigger flow of 125 cfs)	Never	Never
Aiken	2 months	Never	Never
Batesburg-Leesville	Never (lowest monthly flow at intake in Lightwood Knot Creek is 6 cfs vs. the trigger flow of 5 cfs)	Never	Never

Total number of modeled months is 1,049

Scenario 1 - Results

When are drought actions triggered in the model with Business as Usual 2070 demands?

- **Dominion Energy Cope Plant**
  - 16 months
  - 1956 (2 months); 1986; 1990, 2002 (3 months); 2007 (2 months); 2008 (2 months); 2011 (3 months); 2012 (2 months)
- **Walther Farms**
  - Same as CWS (27 months)
  - Note – This trigger (and action) is **NOT** part of a drought plan

Total number of modeled months is 1,049

Scenario 1 - Results

When are drought actions triggered in the model with High Demand 2070 demands?

Drought Phase:	Moderate	Severe	Extreme
Water use reduction goals (Actions):	15%	20%	25%
Charleston Water System	18 months	17 months	17 months
Orangeburg	Never (lowest monthly flow at Orangeburg is 159 cfs vs. the trigger flow of 125 cfs)	Never	Never
Aiken	2 months	Never	Never
Batesburg-Leesville	Never (lowest monthly flow at intake in Lightwood Knot Creek is 6 cfs vs. the trigger flow of 5 cfs)	Never	Never

Total number of modeled months is 1,049

Scenario 1 - Results

When are drought actions triggered in the model with High Demand 2070 demands?

- **Dominion Energy Cope Plant**
  - 30 months
- **Walther Farms**
  - Same as CWS (52 months)
  - Note – This trigger (and action) is **NOT** part of a drought plan

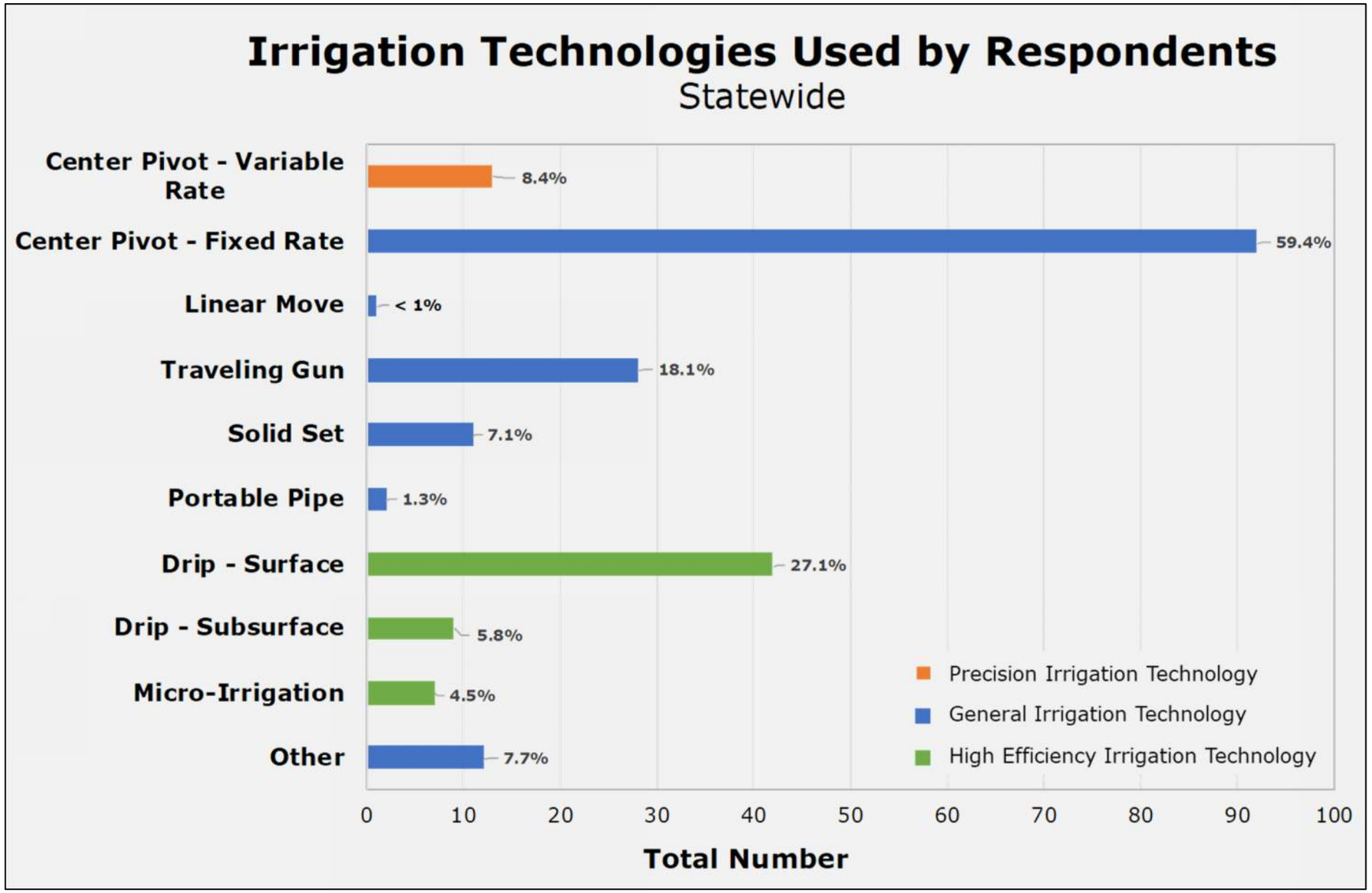
Total number of modeled months is 1,049

Scenario 2 – Scenario 1 strategies plus **agriculture water efficiency strategies**

Conditions and Assumptions

- 70% of existing and future irrigators achieve **15% reduction in projected demand** via water audits followed by nozzle retrofits and/or other measures, such as deployment of smart irrigation technologies, use of cover crops, and crop selection.
- The "70% of existing irrigators" were assumed to be those with the highest demand, excluding Walther Farms, which has performed a water audit and already employs water efficient practices.
- Combined average water savings of 1.6 mgd for **Business as Usual 2070** demands.

Basis for the "70% of Irrigators" Assumption



Source:

Calvin B. Sawyer, PhD (and others)

Clemson Cooperation Extension, 2018

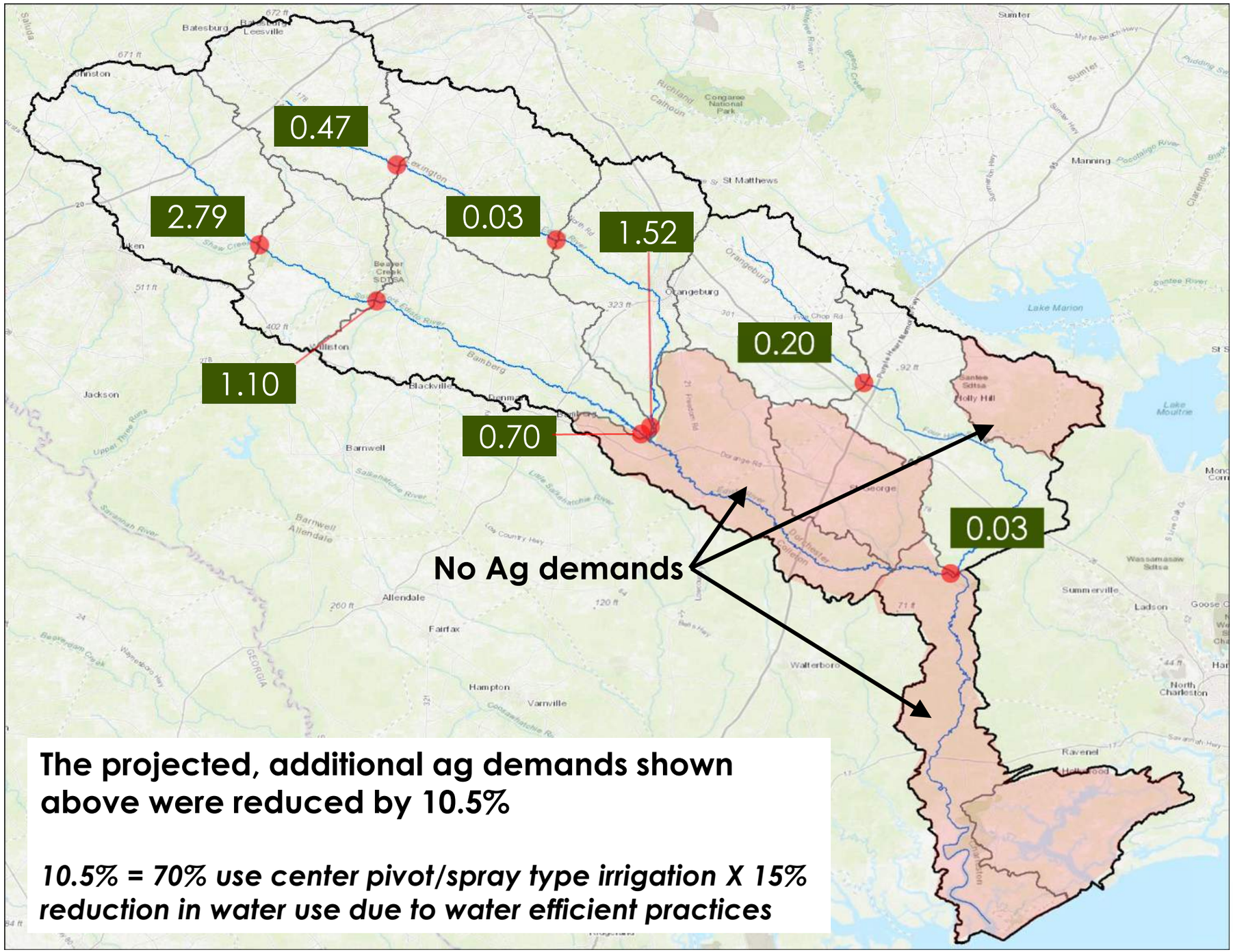
Agricultural Water Use in South Carolina: Preliminary Results of the South Carolina Agricultural Water Use and Irrigation Survey

Projected, Additional Agricultural Demands

2070 Business as Usual Scenario

Year	Added Ag Demand (mgd)
2070	1.10

HUC 10 Outlet ●



The projected, additional ag demands shown above were reduced by 10.5%

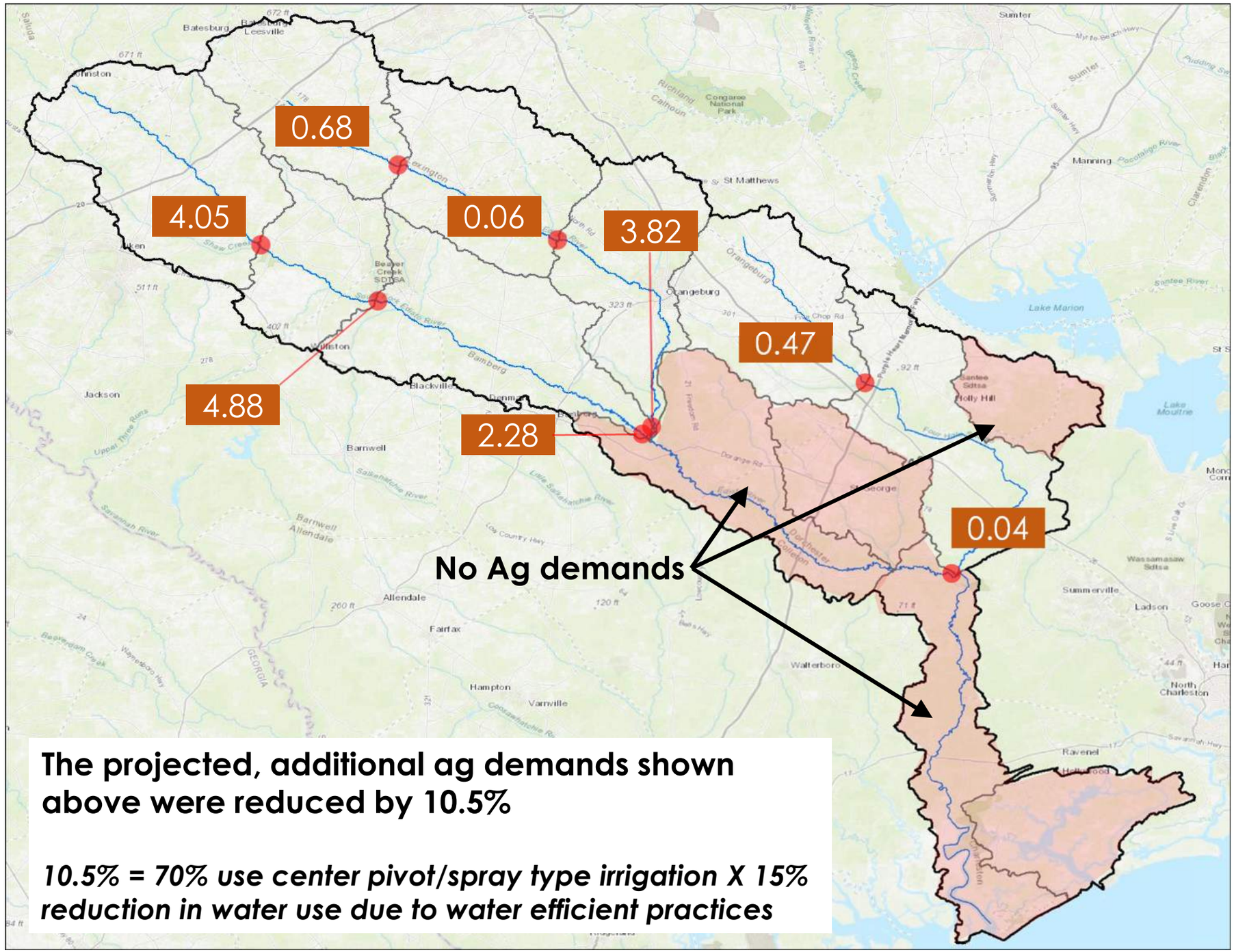
10.5% = 70% use center pivot/spray type irrigation X 15% reduction in water use due to water efficient practices

Projected, Additional Agricultural Demands

2070 High Demand Scenario

Year	Added Ag Demand (mgd)
2070	4.88

HUC 10 Outlet



The projected, additional ag demands shown above were reduced by 10.5%

10.5% = 70% use center pivot/spray type irrigation X 15% reduction in water use due to water efficient practices

Scenario 2
Scenario 1 strategies, plus **agriculture water efficiency strategies**

Conditions and Assumptions

- Existing **Ag water users** assumed to have center pivot/spray type irrigation and were assigned a **15% reduction** in 2070 project demand:

IR: Millwood
IR: Shady Grove
IR: Thomas C. Fink
IR: Walter P. Rawl & Sons
IR: Rob Bates
IR: Haigler
IR: Williams & Sons
IR: RRR Farms
IR: Backman IR: Inabinet Farms
IR: Shivers Trading
IR: Phil Sandifer & Sons
IR: Norway
IR: Cotton Lane
IR: Gray

Scenario 3 – Scenario 1 and 2 strategies plus **municipal water conservation strategies**

Conditions and Assumptions

- **Municipal water users** achieve a **15% reduction in demand** by implementing a portfolio of **water conservation and water efficiency/loss strategies**, such as:
  - Low flow and water smart appliances and fixtures
  - Conservation-based pricing structures
  - Landscape irrigation ordinances
  - Residential water audits
  - Public education
  - Reclaimed water
  - Utility water efficiency and water loss programs

Water Conservation Strategies

Town of Cary, NC (pop. 175,000)

- **Since 1999, the Town has implemented:**
  - Three-tiered water rate structure
  - Landscape and irrigation codes
  - Toilet flapper rebates
  - Residential water audits
  - Points program for new construction with water efficient measures
  - Monthly water budgets for large irrigators
  - Public education
  - Reclaimed water program
- Conservation strategies reduced per capita water demand from **114 gpcd in 2001** to **81 gpcd in 2016 (29% reduction in per capita demand)**

Water Conservation Strategies

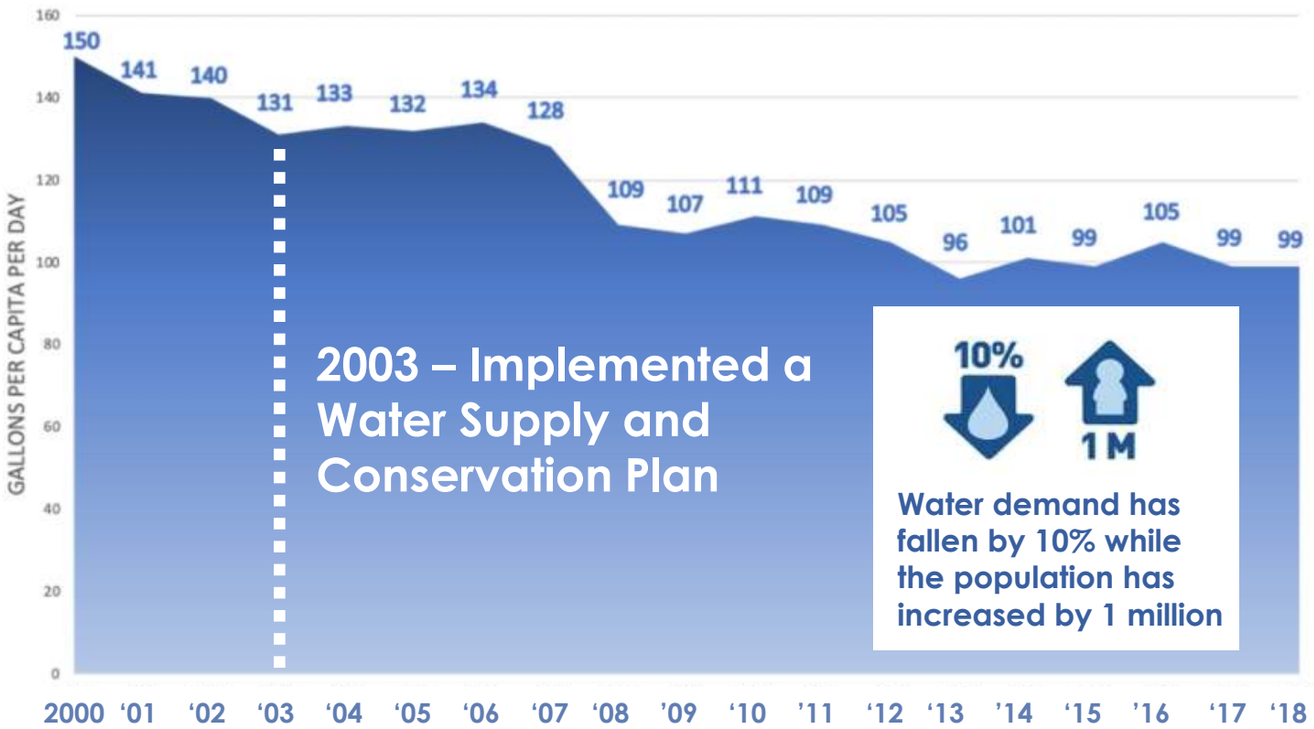
Metro North Georgia Water Planning District

Example Water Conservation & Efficiency measures implemented:

- Conservation pricing structures
- Toilet rebate program
- Landscape irrigation program
- Leak detection and water loss control programs
- Car wash recycling ordinances
- Public education

Conservation strategies reduced per capita water demand from 131 gpcd in 2003 to 99 gpcd in 2018 **(24% reduction in per capita demand)**

Annual Per Capita Water Use



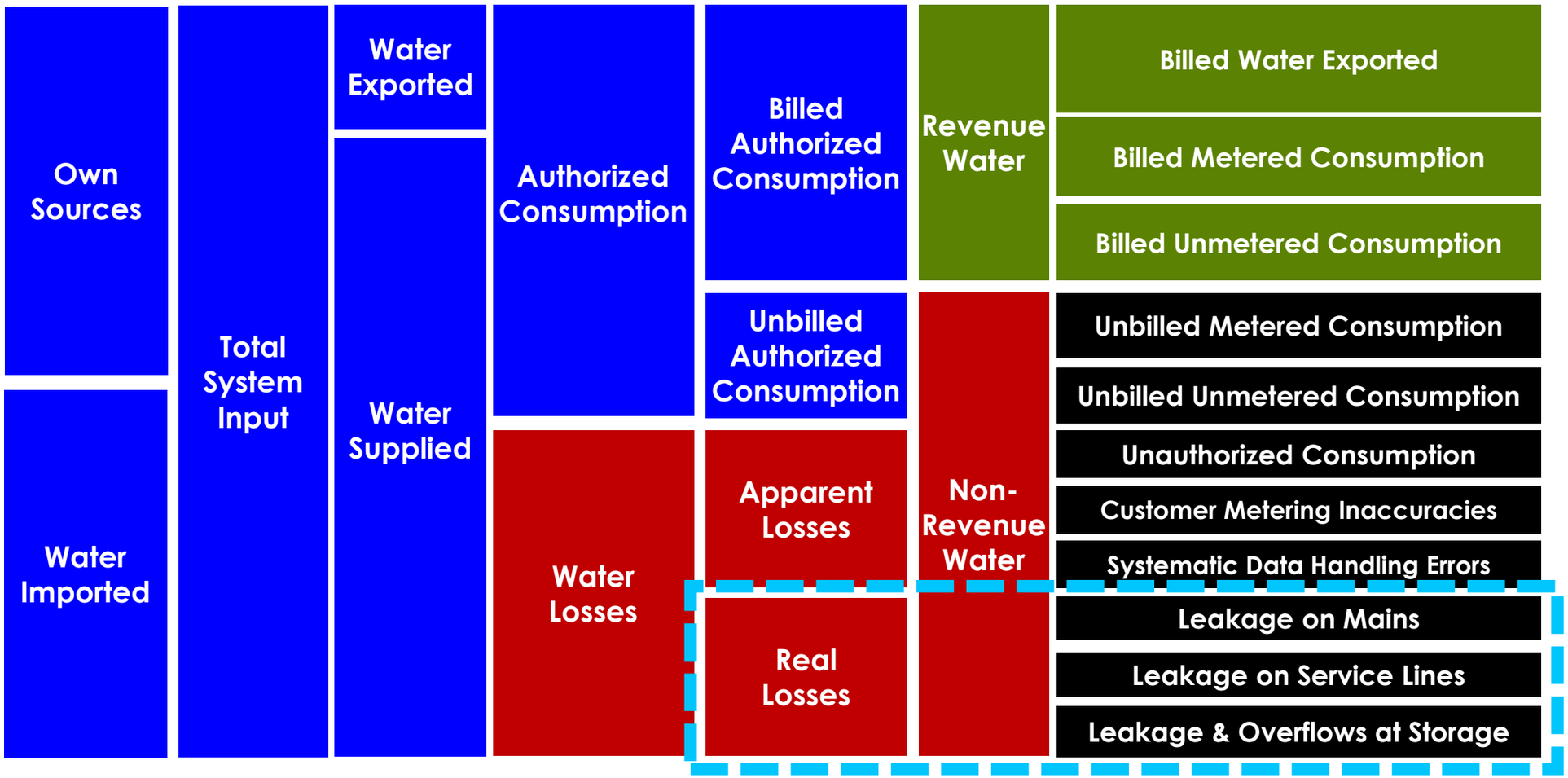
Sources: Metropolitan North Georgia Water Resource Management Plan, June 2017 and https://northgeorgiawater.org/current-water-stats/water-withdrawals-per-capita-remain-steady/

Water Efficiency and Water Loss Programs

Georgia Water Stewardship Act of 2010

- The Act set water loss control requirements that include:
  - Completion of an Annual Water Loss Audit using AWWA M36 Methodology
  - Development and implementation of a Water Loss Control Program
  - Development of individual goals to set measures of water supply efficiency
  - Demonstration of progress toward improving water supply efficiency
- Requirements apply to public water systems serving populations over 3,300 (about 250 utilities)

Water Efficiency and Water Loss Programs



Source: *AWWA M36 Methodology from Demonstrating Progress Toward Improving Water Supply Efficiency (presentation slides), GA EPD, T. Cash, B. Frechette, J. Smith, and W. Zeng, May 2019*

Water Efficiency and Water Loss Programs

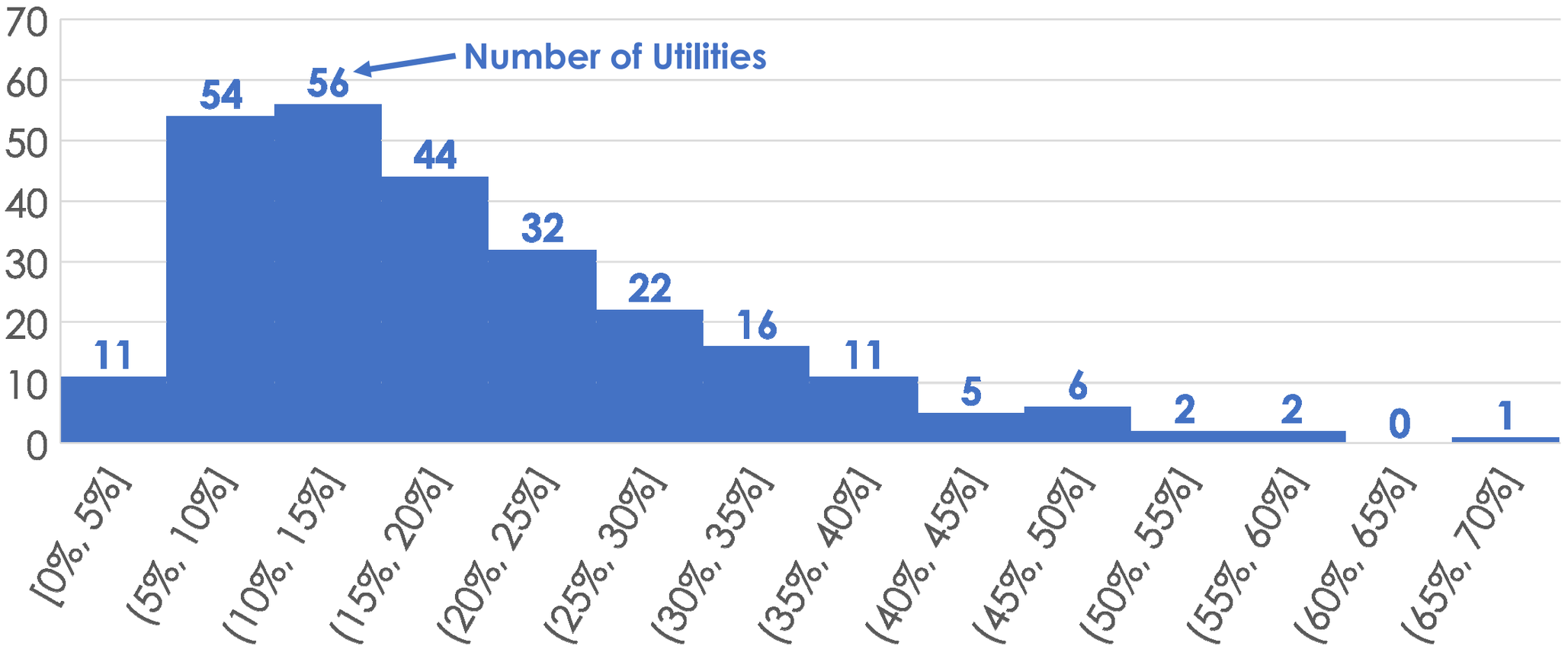
Real Losses

- Also called ***Physical* Losses – Water that enters the distribution system, but never reaches a user**
- **Examples Include:**
  - Leakage on transmission and distribution mains
  - Storage tank overflows
  - Service Line leakage up to customer meter
- **Reducing real losses *extends* the water resource**

Source: *Demonstrating Progress Toward Improving Water Supply Efficiency (presentation slides), GA EPD, T. Cash, B. Frechette, J. Smith, and W. Zeng, May 2019*

Water Efficiency and Water Loss Programs

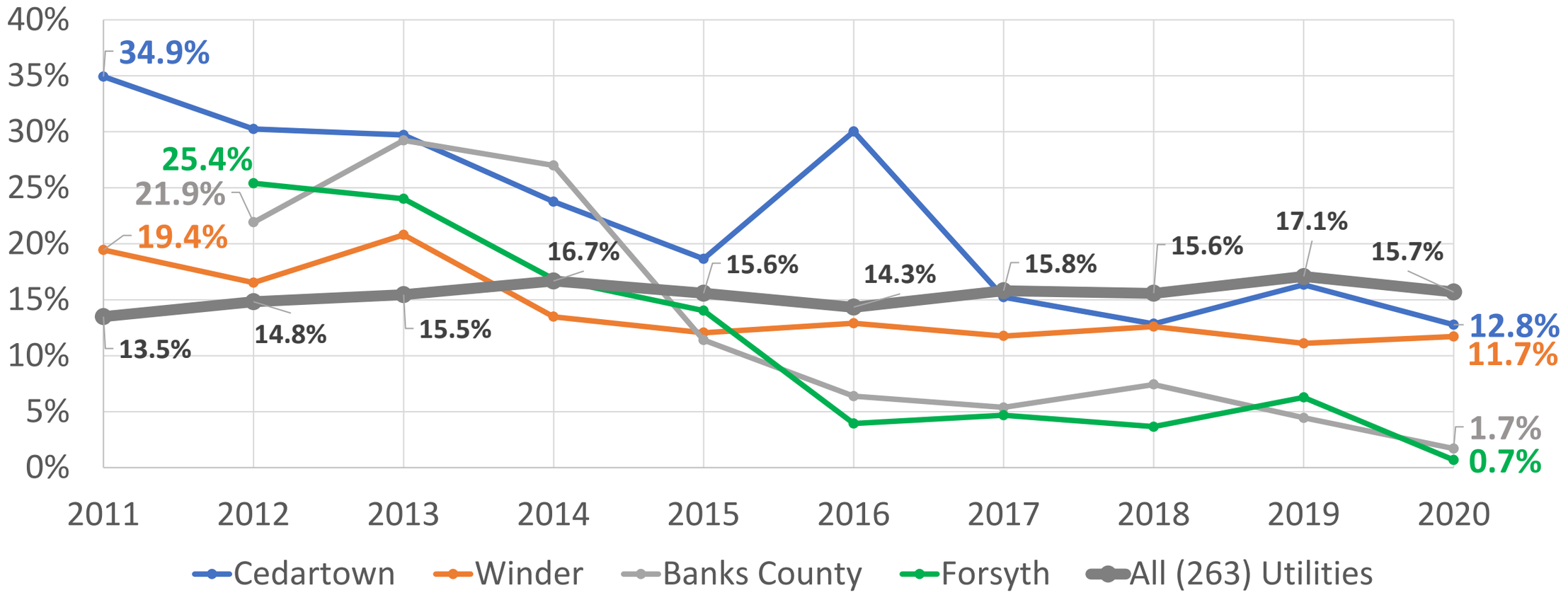
Histogram of Real Losses as a Percent of Total Water Supplied
10 Year Average for 263 Georgia Utilities



Source: *GA EPD Validated Water Audits, 2011 through 2020 (https://epd.georgia.gov/watershed-protection-branch/water-efficiency-and-water-loss-audits)*

Water Efficiency and Water Loss Programs

Annual Real Losses as a Percent of Total Water Supplied
High Performers and Average for All Utilities



Source: *GA EPD Validated Water Audits, 2011 through 2020 (https://epd.georgia.gov/watershed-protection-branch/water-efficiency-and-water-loss-audits)*

Demand Management Strategies Results

- **Business as Usual 2070 Scenarios 1, 2 and 3**

Results for Business as Usual 2070 Scenarios Comparison to Minimum Instream Flows

Percentage of Months below 20/30/40 threshold (Mean)

Strategic Node	Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EDO05	**Business as Usual (2070)**	**0**	**0**	**0**	**1**	**2**	**7**	**1**	**1**	**0**	**0**	**0**	**0**
	BAU 2070 - Scenario 1	0	0	0	1	2	7	1	1	0	0	0	0
	BAU 2070 - Scenario 2	0	0	0	1	2	7	1	1	0	0	0	0
	BAU 2070 - Scenario 3	0	0	0	1	2	6	1	1	0	0	0	0
Outlet of Shaw Creek	**Business as Usual (2070)**	**0**	**0**	**0**	**1**	**2**	**7**	**1**	**1**	**0**	**0**	**0**	**0**
	BAU 2070 - Scenario 1	0	0	0	1	2	7	1	1	0	0	0	0
	BAU 2070 - Scenario 2	0	0	0	1	2	7	1	1	0	0	0	0
	BAU 2070 - Scenario 3	0	0	0	1	1	5	0	1	0	0	0	0
EDO13	**Business as Usual (2070)**	6	2	1	7	22	29	21	20	19	11	3	5
	BAU 2070 - Scenario 1	6	2	1	7	22	29	21	20	19	11	3	5
	BAU 2070 - Scenario 2	6	2	1	7	22	29	21	20	18	11	3	5
	BAU 2070 - Scenario 3	6	2	1	7	21	25	18	18	18	9	3	5

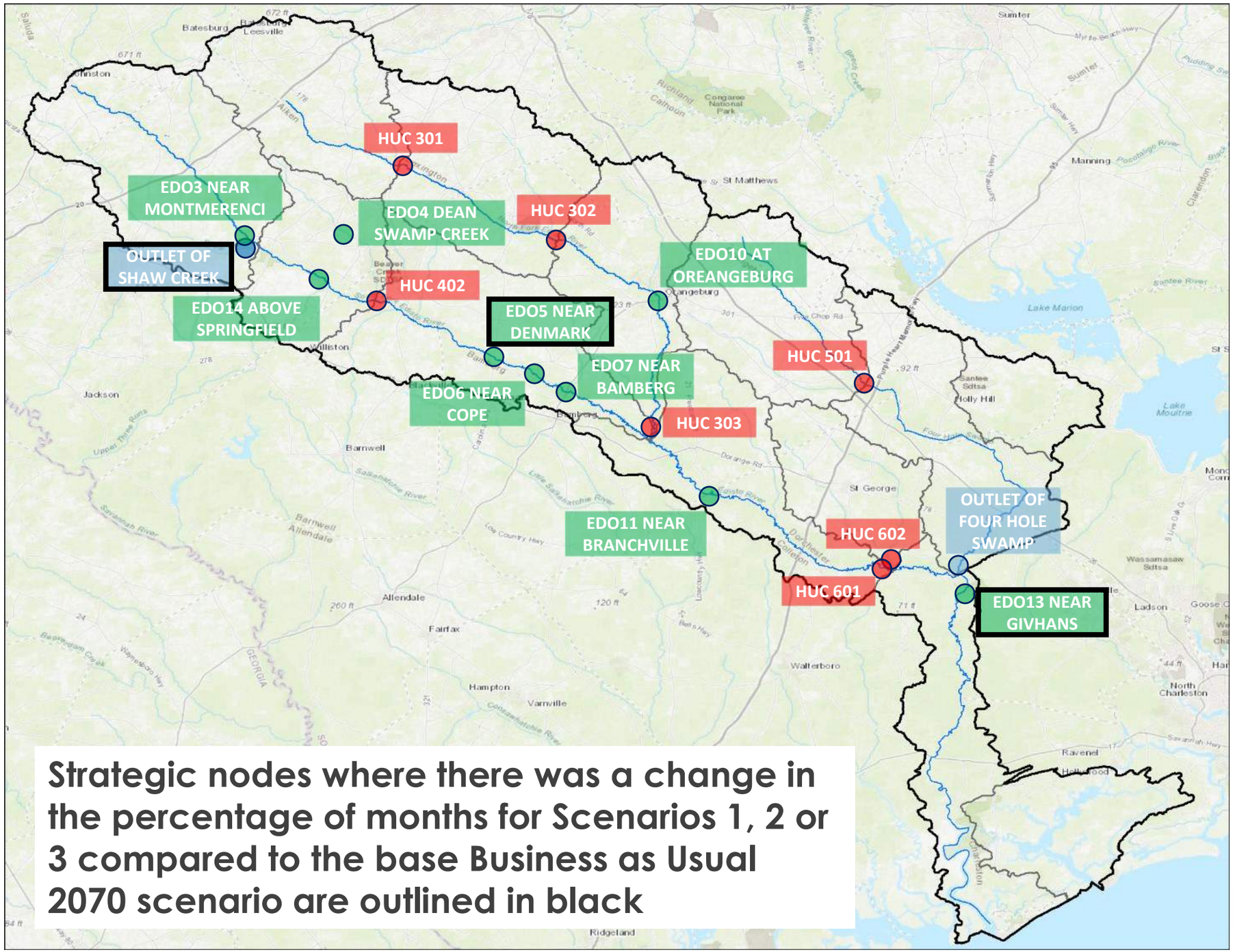
Only the strategic nodes where there was a change in the percentage of months for Scenarios 1, 2 or 3 compared to the base Business as Usual 2070 scenario are listed.

Strategic Nodes

HUC 10 Outlet

USGS Gage

Other Strategic Nodes



Results for Business as Usual 2070 Scenarios Comparison of 5th percentile Flows

5th percentile flows (cfs)	EDO14 SOUTH FORK EDISTO RIVER ABOVE SPRINGFIELD	HUC402 OUTLET	EDO05 SOUTH FORK EDISTO RIVER NEAR DENMARK	EDO06 SOUTH FORK EDISTO RIVER NEAR COPE	EDO07 SOUTH FORK EDISTO RIVER NEAR BAMBERG	EDO11 EDISTO RIVER NEAR BRANCHVILLE	HUC601 OUTLET	EDO13 EDISTO RIVER NR GIVHANS	SHAW CREEK OUTLET	HUC302 OUTLET	EDO10 NORTH FORK EDISTO RIVER AT ORANGEBURG	HUC303 OUTLET
Business as Usual 2070	132	151	236	240	245	586	493	393	44	195	305	316
BAU 2070 - Scenario 1	132	151	236	240	245	585	492	392	44	195	305	316
BAU 2070 - Scenario 2	132	152	237	241	246	587	496	395	44	195	305	317
BAU 2070 - Scenario 3	135	154	240	244	249	591	499	422	46	196	307	318

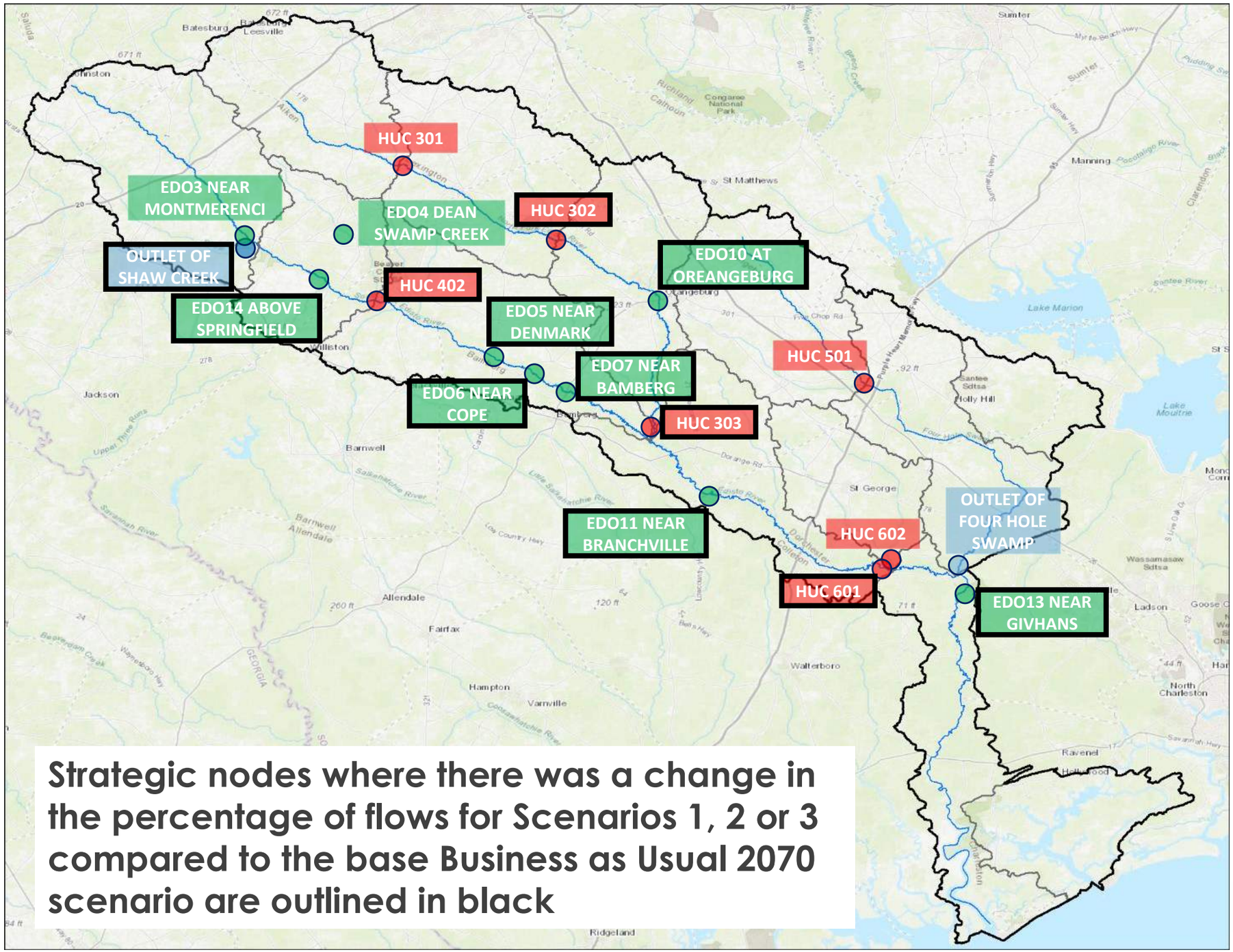
Only the strategic nodes where there was a change in the percentage of flows for Scenarios 1, 2 or 3 compared to the base Business as Usual 2070 scenario are listed.

Strategic Nodes

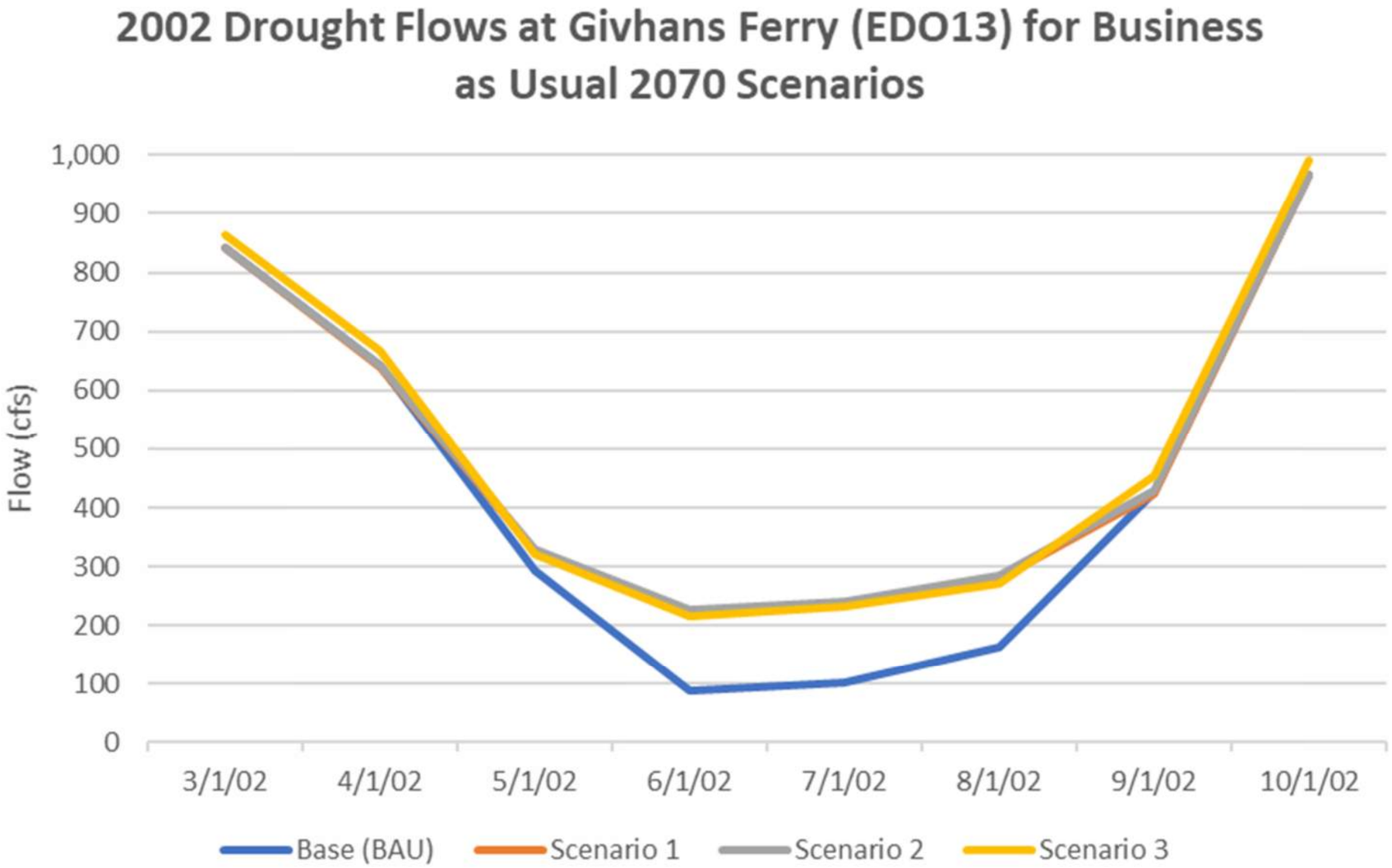
HUC 10 Outlet

USGS Gage

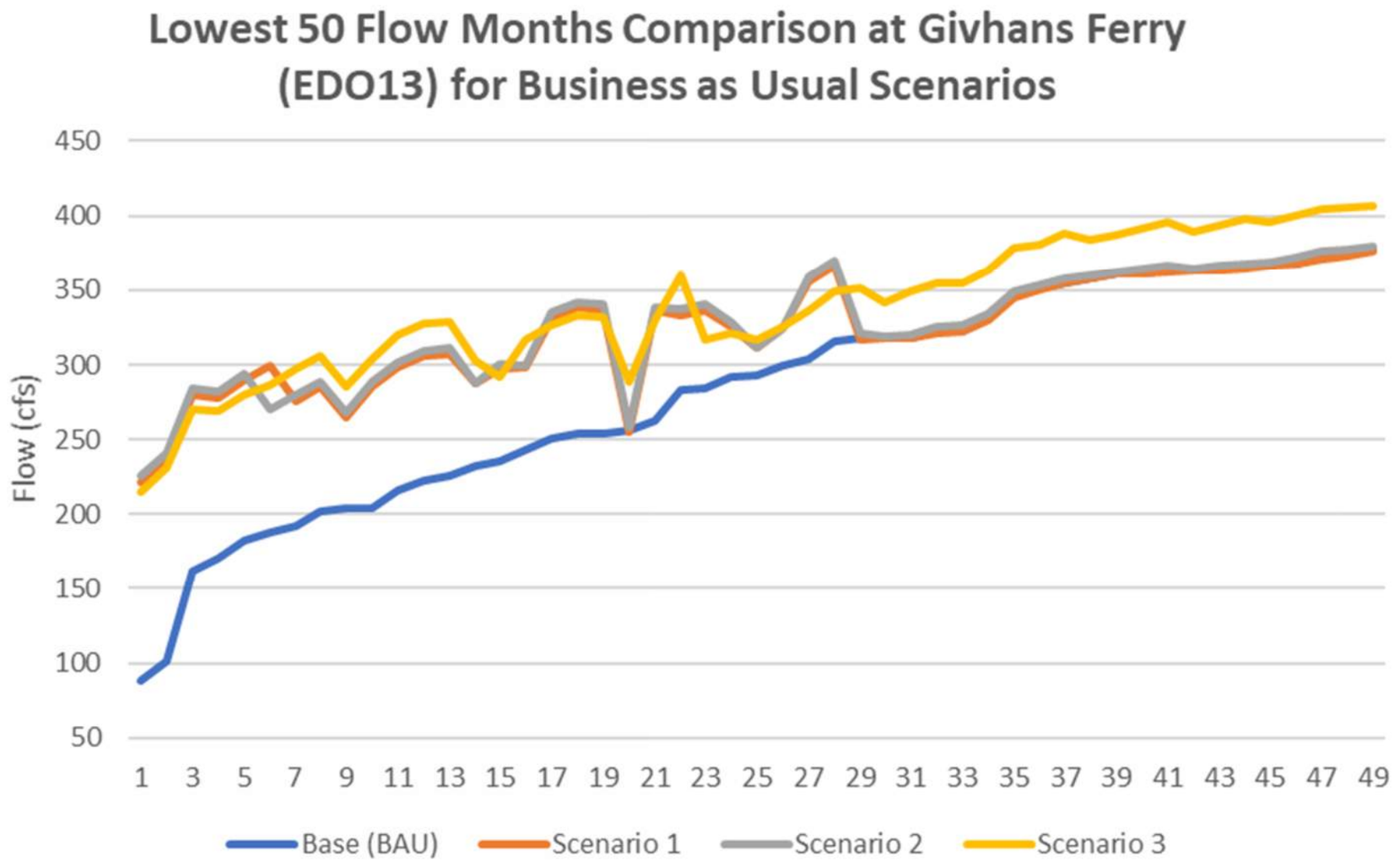
Other Strategic Nodes



Results for Business as Usual 2070 Scenarios 2002 Drought Flows at Givhans Ferry



Results for Business as Usual 2070 Scenarios Comparison of Low Flows at Givhans Ferry



This graph compares flows for each Business as Usual scenario for the 50 lowest flow months at Givhans Ferry

Demand Management Strategies Results

- **High Demand 2070 Scenarios 1, 2 and 3**

Results for High Demand 2070 Scenarios Comparison to Minimum Instream Flows

Percentage of Months below 20/30/40 threshold (Mean)

Strategic Node	Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EDO05	**High Demand (2070)**	**0**	**0**	**0**	**1**	**3**	**10**	**3**	**2**	**0**	**0**	**0**	**0**
	HD 2070 - Scenario 1	0	0	0	1	3	10	2	2	0	0	0	0
	HD 2070 - Scenario 2	0	0	0	1	3	8	2	2	0	0	0	0
	HD 2070 - Scenario 3	0	0	0	1	2	8	2	1	0	0	0	0
Outlet of Shaw Creek	**High Demand (2070)**	**0**	**0**	**0**	**1**	**6**	**11**	**6**	**2**	**1**	**1**	**0**	**0**
	HD 2070 - Scenario 1	0	0	0	1	6	11	6	2	1	1	0	0
	HD 2070 - Scenario 2	0	0	0	1	6	11	6	2	1	1	0	0
	HD 2070 - Scenario 3	0	0	0	1	3	7	1	1	0	0	0	0
EDO13	**High Demand (2070)**	**6**	**2**	**1**	**9**	**29**	**33**	**28**	**26**	**27**	**15**	**7**	**6**
	HD 2070 - Scenario 1	6	2	1	9	29	33	28	26	27	15	7	6
	HD 2070 - Scenario 2	6	2	1	9	29	32	26	26	27	15	7	6
	HD 2070 - Scenario 3	6	2	1	9	24	30	25	26	23	14	5	6
HUC 303	**High Demand (2070)**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**
	HD 2070 - Scenario 1	0	0	0	0	0	5	0	0	0	0	0	0
	HD 2070 - Scenario 2	0	0	0	0	0	3	0	0	0	0	0	0
	HD 2070 - Scenario 3	0	0	0	0	0	3	0	0	0	0	0	0
EDO11	**High Demand (2070)**	**0**	**0**	**0**	**1**	**0**	**6**	**1**	**1**	**0**	**0**	**0**	**0**
	HD 2070 - Scenario 1	0	0	0	1	0	6	1	1	0	0	0	0
	HD 2070 - Scenario 2	0	0	0	1	0	6	1	1	0	0	0	0
	HD 2070 - Scenario 3	0	0	0	1	0	5	1	1	0	0	0	0

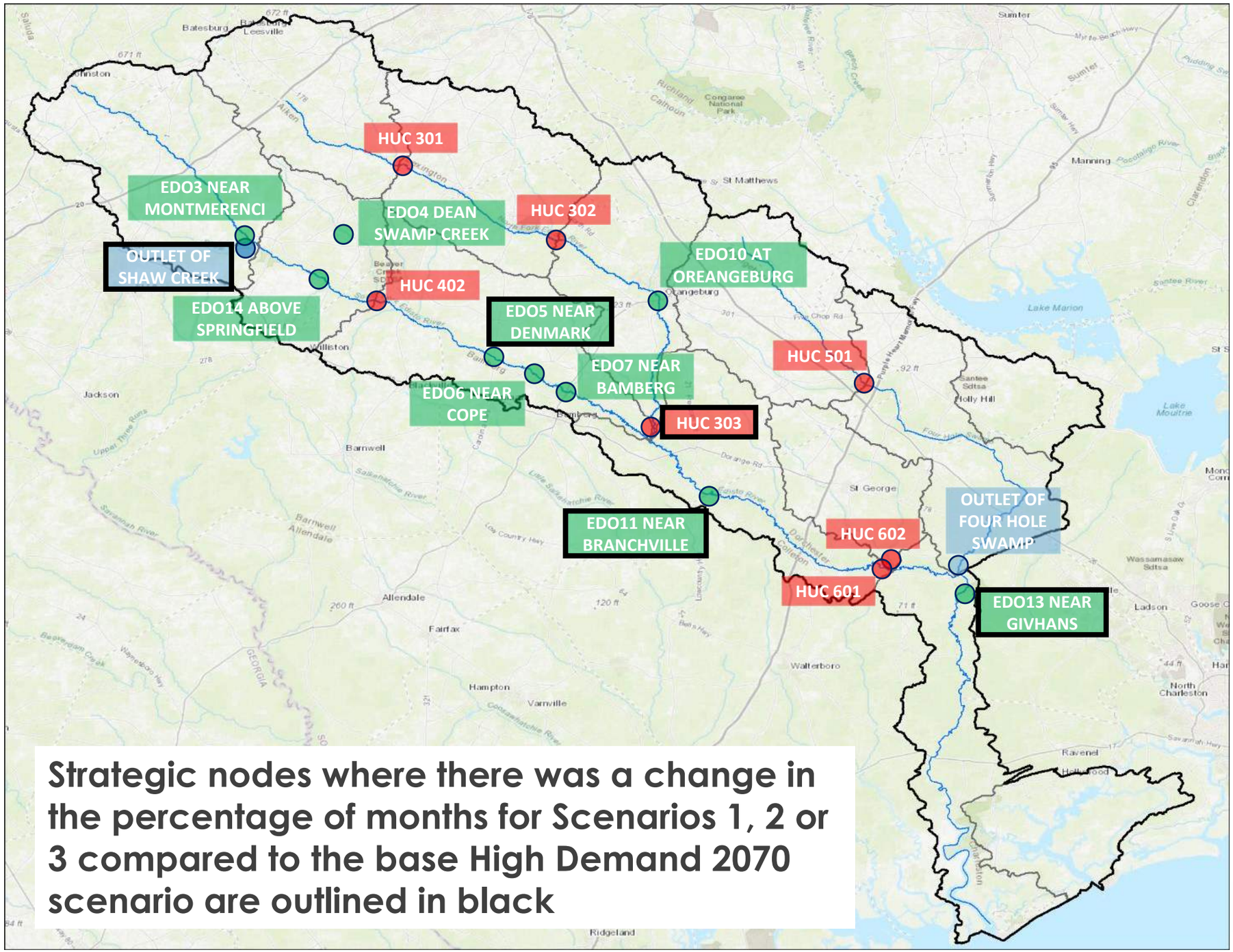
Only the strategic nodes where there was a change in the percentage of months for Scenarios 1, 2 or 3 compared to the base High Demand 2070 scenario are listed.

Strategic Nodes

HUC 10 Outlet

USGS Gage

Other Strategic Nodes



Results for High Demand 2070 Scenarios Comparison of 5th percentile Flows

5th percentile flow (cfs)	EDO14 SOUTH FORK EDISTO RIVER ABOVE SPRINGFIELD	HUC402 OUTLET	EDO05 SOUTH FORK EDISTO RIVER NEAR DENMARK	EDO06 SOUTH FORK EDISTO RIVER NEAR COPE	EDO07 SOUTH FORK EDISTO RIVER NEAR BAMBERG	EDO11 EDISTO RIVER NEAR BRANCHVILLE	HUC601 OUTLET	EDO13 EDISTO RIVER NR GIVHANS	SHAW CREEK OUTLET	HUC301 OUTLET	HUC302 OUTLET	EDO10 NORTH FORK EDISTO RIVER AT ORANGEBURG	HUC303 OUTLET
High Demand 2070	123	134	219	223	226	541	452	299	38	104	194	292	303
HD 2070 - Scenario 1	123	134	220	224	226	543	453	359	38	104	194	292	303
HD 2070 - Scenario 2	125	136	223	227	229	550	458	363	38	105	194	293	305
HD 2070 - Scenario 3	128	140	227	231	232	555	464	371	42	105	195	297	307

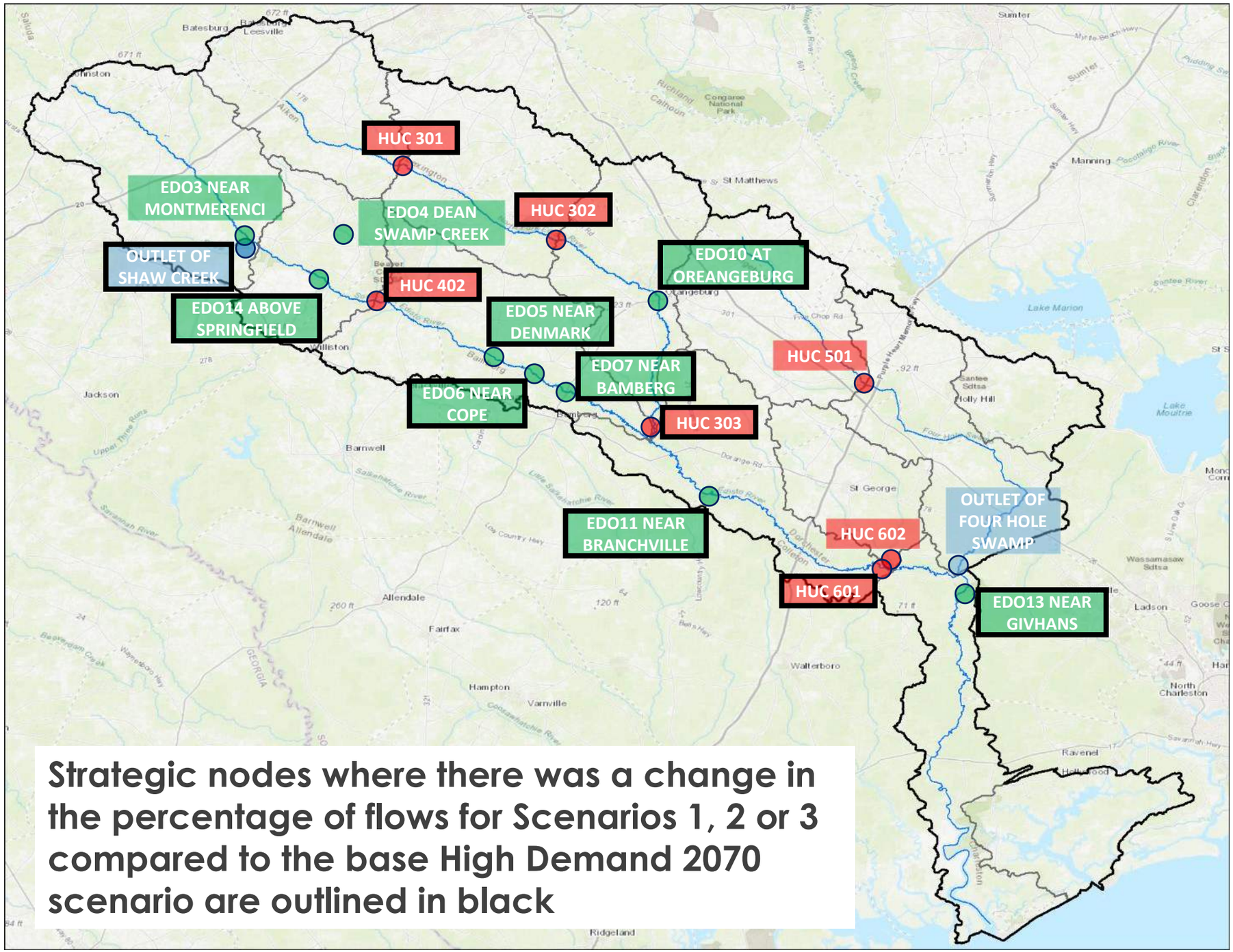
Only the strategic nodes where there was a change in the percentage of flows for Scenarios 1, 2 or 3 compared to the base High Demand 2070 scenario are listed.

Strategic Nodes

HUC 10 Outlet

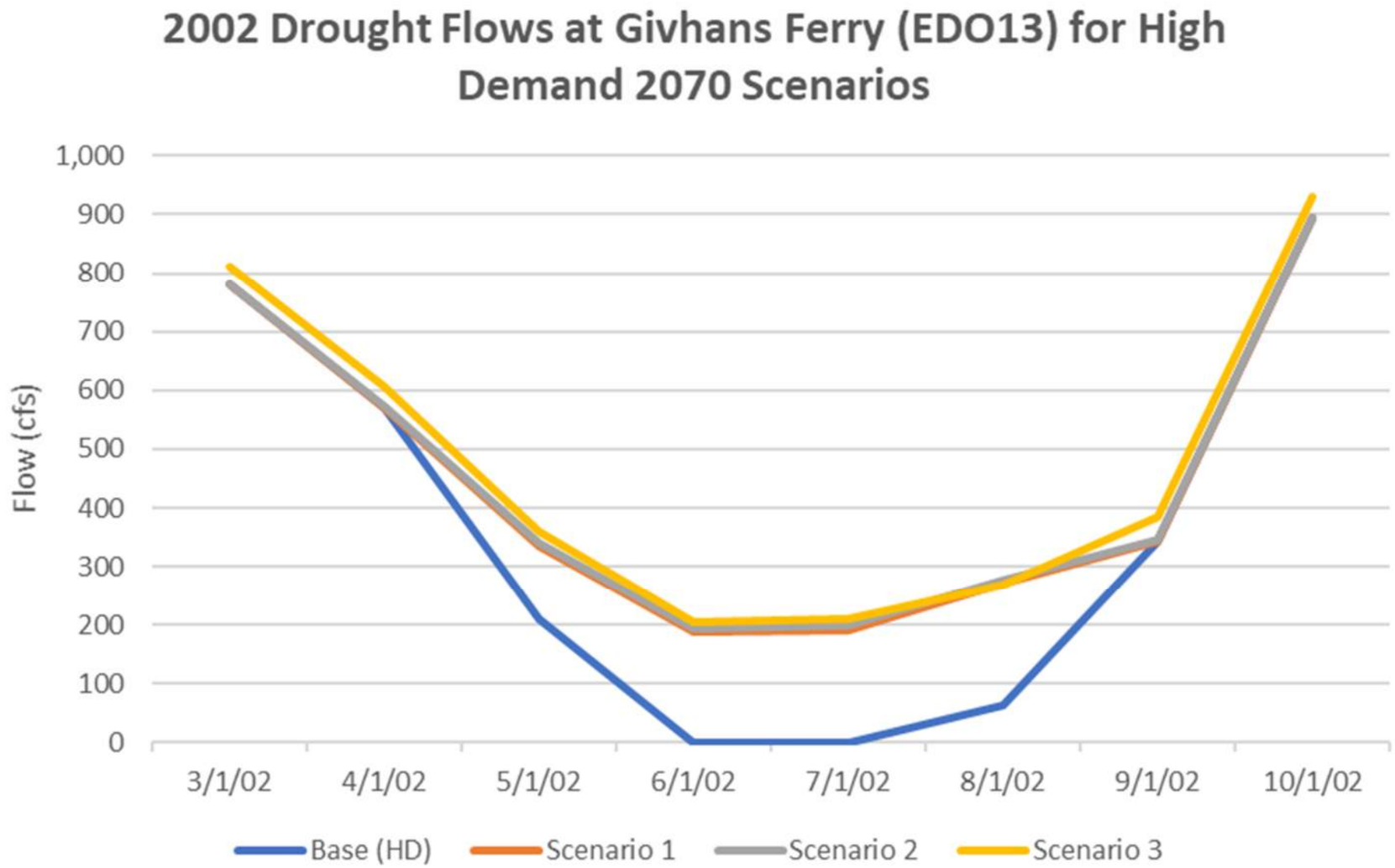
USGS Gage

Other Strategic Nodes

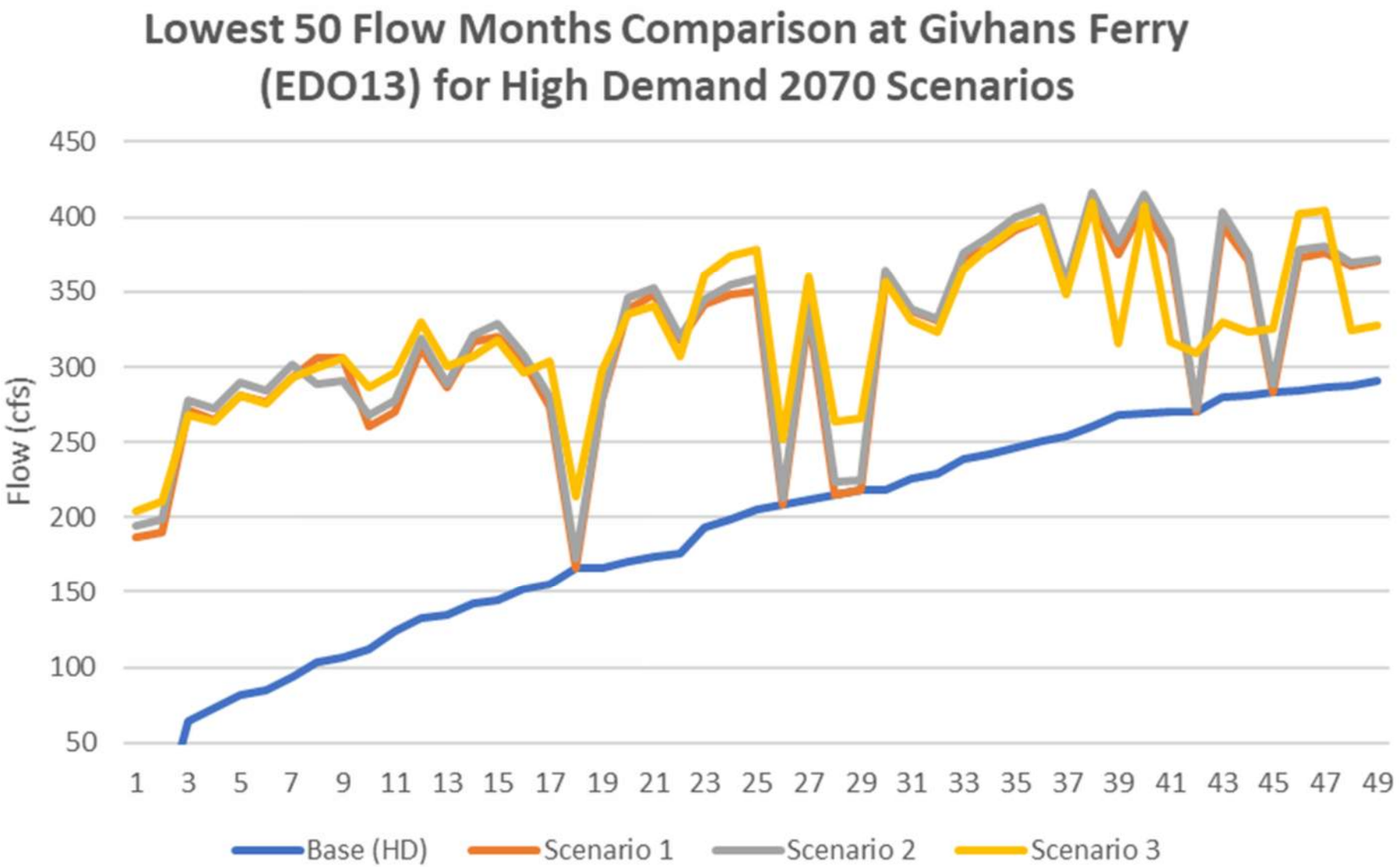


Strategic nodes where there was a change in the percentage of flows for Scenarios 1, 2 or 3 compared to the base High Demand 2070 scenario are outlined in black

Results for High Demand 2070 Scenarios 2002 Drought Flows at Givhans Ferry



Results for High Demand 2070 Scenarios
Comparison of Low Flows at Givhans Ferry



This graph compares flows for each High Demand scenario for the 50 lowest flow months at Givhans Ferry

SUMMARY - Demand Side Scenarios

- **Scenario 1** – Existing **Drought Management Plan** actions

- **Scenario 2** – Scenario 1 strategies, plus **agriculture water efficiency strategies**

- **Scenario 3** – Scenario 1 and 2 strategies, plus **municipal water conservation strategies**

Scenarios 1, 2 and 3 were run using **2070 water demands** from the **Business-as-Usual** and **High Demand Scenarios**

SUMMARY - Demand Side Scenarios

Scenario 1 – Existing **Drought Management Plan** actions

- Only Aiken's and Charleston Water System's Drought Management Plans have actions that are triggered in the **Business as Usual 2070** and **High Demand 2070** scenarios
- Charleston Water Systems triggered reduction in withdrawals from the Edisto have the greatest impact on increasing flow at Givhans Ferry, during drought
  - During the 27 months where CWS Edisto withdrawals are reduced, flows increase from an average of 226 cfs to 300 cfs

SUMMARY - Demand Side Scenarios

Scenario 2 – Scenario 1 strategies, plus **agriculture water efficiency strategies**

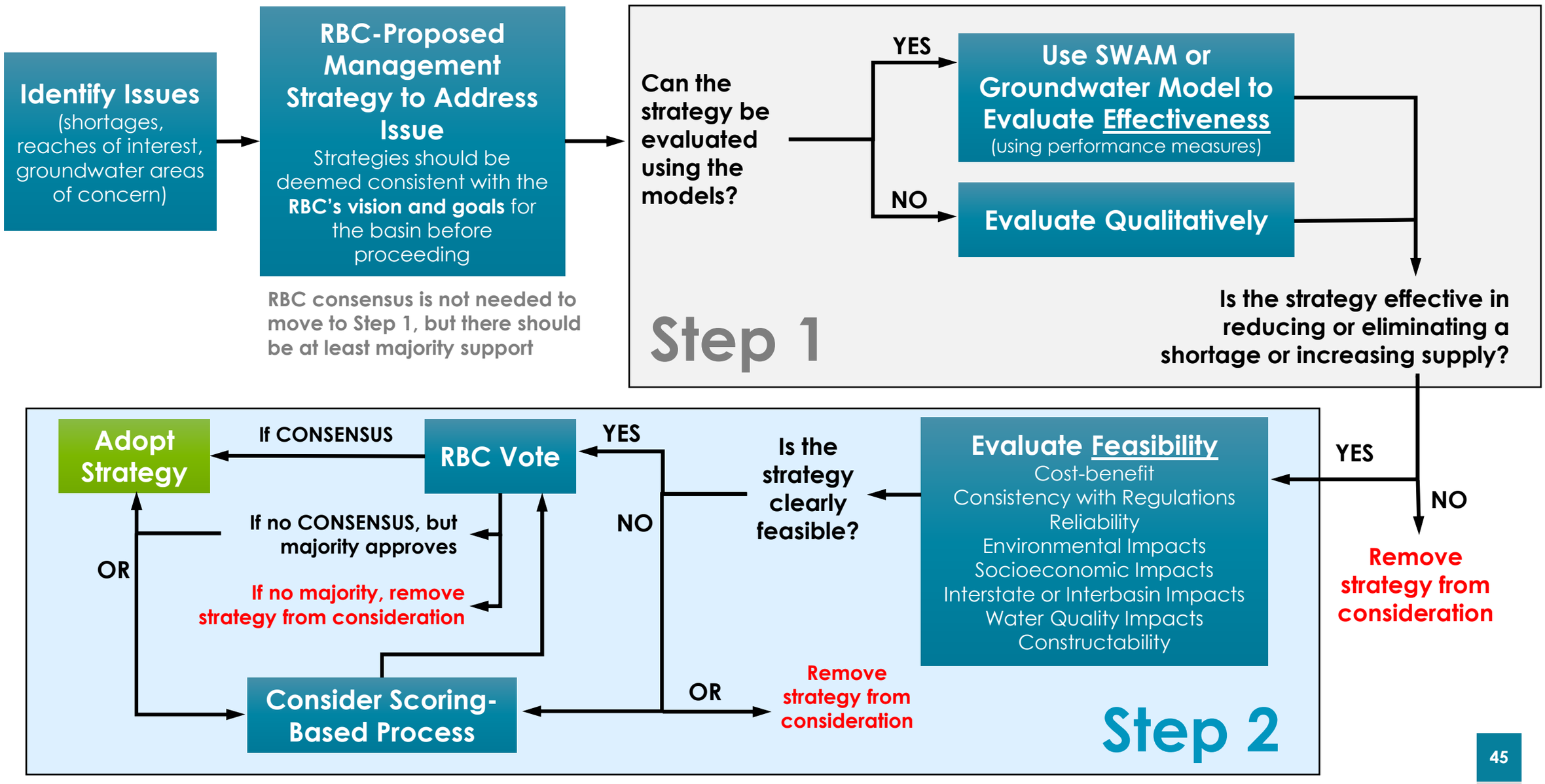
- A 15% reduction in water demand for 70% of existing and new users has limited effect on increasing North and South Fork Edisto River flows during drought.
- More impact may be observed on the small tributaries with multiple ag withdrawals

SUMMARY - Demand Side Scenarios

- **Scenario 3** – Scenario 1 and 2 strategies, plus **municipal water conservation strategies**

- A 15% reduction in water demand for municipal users has a greater effect on increasing North and South Fork Edisto River flows during drought, especially in the **High Demand** set of Scenarios.

Decision-Making Process for Selecting Water Management Strategies



Demand Side Scenarios

Questions and Decisions for the RBC:

1. **Do you want to see any addition demand-side modeling, data or analysis?**
2. **Do you want to move to Step 2 with the "portfolio" of demand-side strategies**
   a. Are there specific strategies from the portfolio that should be evaluated further?
   b. Are there specific strategies from the portfolio that should not be considered?