Memorandum

To: *South Carolina Department of Natural Resources (DNR)*
South Carolina Department of Health and Environmental Control (DHEC)

From: *CDM Smith*

Date: *February 16, 2016*

Subject: *Santee River Basin SWAM Model Framework*

This memorandum presents the Simplified Water Allocation Model (SWAM) framework for the Santee River Basin. Several tables and figures are provided to help understand how the tributaries, water users, and discharges are being represented in the SWAM modeling environment. The tables and figures include:

Table 1 **Permitted and registered water users included in the Santee River Basin model framework.**

Table 2 **NPDES discharges included in the Santee Basin model framework.**

Table 3 **Interbasin transfers in the Santee Basin.**

Figure 1 **Overview Map**
This map consolidates and presents all active permitted and registered water users; significant discharge locations; USGS stream gage locations; and tributaries (the "higher order tributaries" are not represented explicitly in the model, but their contributions to flow are included in the flows of larger, modeled tributaries). Significant discharge locations generally include NPDES discharges that average over 3 million gallons per month (Mg/m).

Figure 2 **Model Tributaries and USGS Gages**
This map presents the Santee River Basin hydrography. Also represented are major branches, primary tributaries and several secondary tributaries. The contributions of many of the secondary and higher order tributaries are accounted for in the aggregate flow in the larger tributaries that are modeled explicitly. Both active and inactive USGS streamflow gages are displayed as are tidally and non-tidally influenced gages. Not all streams which have a former USGS streamflow gage will be explicitly included in the model due to the influence of tides on the gage records.

Figure 3 Surface Water Users
This map presents the location of permitted surface water users.

Figure 4 Registered Agricultural Users
This map presents the location of registered agricultural surface water users.

Figure 5 Dischargers
This map presents the location of all significant NPDES discharge locations, including one discharge that originates from a withdrawal inside the basin, but is discharged in the Edisto Basin (Town of Bowman). Significant discharge locations generally include NPDES discharges that average over 3 Mg/m; however, certain discharges that average less than 3 Mg/m, but with some months greater than 3 Mg/m are also included. Significant discharges to coastal streams other than the Cooper River or Santee River are not included.

Figure 6 Santee Basin SWAM Model Framework
This figure represents the SWAM model schematic, including tributaries, water users, and dischargers. Note that water and wastewater discharges can be simulated two ways in SWAM. First, they can be associated with a water user object, each of which may specify five points of discharge anywhere in the river network. These discharges are not represented with visual model objects, but are identified within the dialogue box for the associated water user object. An example in the Santee Basin is the City of Charleston, which is represented by a water user object (WS: Charleston) but not a separate discharge object. The discharge is represented within the water user object. Alternatively, discharges can be specified as a discharge object. In the Santee, some dischargers that do not have associated surface water withdrawals are represented in this manner (e.g., SC Genco). Several dischargers have a groundwater withdrawal, and have been represented using a water user object, even though they do not withdraw from surface water (e.g., WS: Williamsburg Co). Representing them as water user objects provides more flexibility in conducting future management and planning because their discharge can be directly related to changing water demand.

Portions of the Santee River Basin are tidally influenced. This includes much of the Ashley River, the Cooper River up to at least the confluence with the Back River, and the Santee River up to at least Jamestown (near Durart Creek). The approximated tidally influenced areas, based on USGS gaging station information, are noted on Figure 6. Model calibration/validation in these areas will not be possible since streamflow data is generally unavailable. At two stations (Santee River near Jamestown 02171700 and Foster Creek at Goose Creek 021720612), tidal effects have been removed (filtered) and estimated flows are available; however, the data quality is generally classified as “fair” to “poor” by the USGS, and the period of record

is ten years or less. At two other stations (Santee River near Pineville 02171500 and Lake Moultrie Tailrace Canal 02172002), daily discharge is estimated from 1-D unsteady flow simulations for a portion of the period of record, and the records are classified as "poor".

Even though the model cannot be calibrated in the tidally-influenced portions, the majority of flow within the Cooper and Santee rivers is a result of runoff and discharges in the Catawba-Wateree and Saluda basins. Below Lake Marion, there is relatively little contribution to flow. The model can still provide a reasonable representation of flow, even in the tidally influenced areas where gage information is not available to support calibration. As such, significant withdrawals and discharges in the tidally-influenced areas will be included. Area ratios using the best available reference gages will used to estimate contribution of flow in the tidal portions of the Cooper and Santee rivers.

Note that the Bushy Park Reservoir is not explicitly included in the model. It receives flow from the Back River, which is fed by the Cooper River, and releases back to the Cooper River. However, the withdrawals which occur from the reservoir are still included, and are assigned to the Cooper River.

The Goose Creek Reservoir, which is fed by Goose Creek and an interbasin transfer from the Edisto River, is included explicitly in the model.

The Ashley River will not be included in the model because limited flow records are available, it is tidally influenced for the majority of the river, and there are no significant withdrawals.

Similar to the other basins already in development, the guiding principles in determining what elements of the Santee River Basin to simulate explicitly were:

1. Begin with a simple representation, with the understanding that it is easier to add additional details in the future than to remove unnecessary detail to make the model more efficient.

2. Most tributaries with current uses (permitted or registered withdrawals or significant discharge) will be represented explicitly. In the Santee Basin, most of the significant withdrawals are on Lake Marion, Lake Moultrie, the Cooper River, and the Santee River.

3. Generally, tributaries that are unused are not included explicitly, but the hydrologic contributions from these tributaries is embedded in the unimpaired flows (or reach gains) in downstream locations. As UIFs are developed throughout the Santee, some additional tributaries may be added explicitly if warranted as candidates to support future use (or these can be easily added at any time in the future as permit applications are received).

The proposed framework is submitted with the understanding that it is malleable – that is, we may find that additional tributaries are warranted as explicit model objects (to support simulation of future withdrawals or discharges) rather than implicit flow additions, or that further simplifications are possible without compromising model utility.

The proposed model framework is a starting point based on discussions with DNR and DHEC, and on CDM Smith's initial estimate of an appropriate framework for planning and permitting in South Carolina. Feedback from water users, environmental organizations, and other stakeholders within the Santee River Basin will be important in refining the representation of the river system. The framework will be presented at the first planned stakeholder meeting for the Santee River Basin, and feedback will be used to refine the framework as appropriate.

Table 1. Permitted and registered surface water users included in the Santee Basin model framework.

ID	Type	Facility Name	Withdrawal Tributary	Model Object ID
08IN001S01	IN	Chargeurs Wool USA Inc	Santee River	IN: Cargeurs
08IN003S01	IN	DAK Americas Cooper River Facility	Durham Creek*	IN: DAK
08IN006S01	IN	BP Amoco - Cooper River Plant	Bushy Park Reservoir/Back River*	IN: BP Amoco
08IN008S01	IN	Bushy Park Site (CRP LLC)	Back River*	IN: Bushy Park Site
08IR001S01	IR	ZZ Real Estate LLC	West Branch Cooper River	IR: ZZ Real Estate
08PH001S01	PH	Jeffries Hydro	Lake Moultrie/West Branch Cooper River	*NA*
08PH002S01	PH	Santee Spillway Hydro	Lake Marion/Santee River	*NA*
No ID	PH	St. Stephen Hydro	Rediversion Canal	*NA*
08PT001S01	PT	SCE&G Williams Station	Bushy Park Reservoir/Back River*	PT: Williams Station
08PT001S02	PT	SCE&G Williams Station	Bushy Park Reservoir/Back River*	PT: Williams Station
08PT002S01	PT	Santee Cooper Jefferies Generating Station[1]	Cooper River/Tailrace Canal	PT: Jeffries Station
08PT002S02	PT	Santee Cooper Jefferies Generating Station[1]	Cooper River/Tailrace Canal	PT: Jeffries Station
08PT003S01	PT	Santee Cooper Cross Generating Station	Lake Marion/Diversion Canal	PT: Cross Station
08PT003S02	PT	Santee Cooper Cross Generating Station	Lake Marion/Diversion Canal	PT: Cross Station
08WS007S01	WS	Santee Cooper Lake Moultrie RWS	Lake Moultrie/West Branch Cooper River	WS: Santee Cooper RWS
08WS007S02	WS	Santee Cooper Lake Moultrie RWS	Lake Moultrie/West Branch Cooper River	WS: Santee Cooper RWS
09IR032S01	IR	Lyons Brothers Farm	Halfway Swamp Creek	IR: Lyons Bros
10IN003S02	IN	Kapstone Charleston Kraft LLC	Goose Creek Reservoir/Goose Creek	IN: Kaptsone
10WS004S01	WS	Charleston CPW - Hanahan WTP	Bushy Park Reservoir/Back River*	WS: Charleston
10WS004S02	WS	Charleston CPW - Hanahan WTP	Goose Creek Reservoir/Goose Creek	WS: Charleston
22IR034S01	IR	Parsons Nursery	North Santee River	IR: Parsons
22IR034S02	IR	Parsons Nursery	North Santee River	IR: Parsons
22IR034S04	IR	Parsons Nursery	North Santee River	IR: Parsons
22MI001S01	MI	Martin Marietta Materials - Georgetown Quarry	Dutart Creek	IN: Martin Marietta
22PT001S01	PT	Santee Cooper Winyah Generating Station	North Santee River	PT: Winyah Station
22PT001S03	PT	Santee Cooper Winyah Generating Station	Wadmacon Creek/Santee River	PT: Winyah Station
38GC006S01	GC	Santee-Cooper Resort Inc	Lake Marion/Santee River	GC: Santee Cooper Resort
38IR024S01	IR	St Julian Plantation	Lake Marion/Santee River	IR: St Julian
38IR024S02	IR	St Julian Plantation	Lake Marion/Santee River	IR: St Julian
38WS052S01	WS	Santee Cooper - Lake Marion RWS	Lake Marion/Santee River	WS: Lake Marion RWS

Blue and gray shading identifies water users with multiple permitted withdrawal locations. These are represented by one model object.

** Indicates permitted withdrawal source which will be Cooper River in the model*

1- Ceased coal-fired operations in 2012, and oil-fired operations in 2015. Industrial use may occur in the future.

NA = Not appplicable (no model object necessary)

Table 2. NPDES discharges included in the Santee Basin model framework.

NPDES Pipe ID	Facility Name	Discharge Tributary	Associated Surface Water Permit	Associated Groundwater Withdrawal ID	Model Object ID
SC0000990-001	CHARGEURS WOOL (USA) INC	Santee River	08IN001	08IN001G	IN: Cargeurs
SC0028584-001	BP AMOCO CHEMICALS COOPER RIVER	Cooper River	08IN006	08IN006G	IN: BP Amoco
SC0003441-001	SUN CHEMICAL CORP/BUSHY PARK	Cooper River	08IN008	None	IN: Bushy Park Site
SC0003441-002	SUN CHEMICAL CORP/BUSHY PARK	Cooper River	08IN008	None	IN: Bushy Park Site
SC0003883-002	SCGENCO/A M WILLIAMS STATION	Cooper River	08PT001	None	PT: Williams Station
SC0003883-005	SCGENCO/A M WILLIAMS STATION	Cooper River	08PT001	None	PT: Williams Station
SC0003883-006	SCGENCO/A M WILLIAMS STATION	Cooper River	08PT001	None	PT: Williams Station
SC0001091-001	SCPSA/JEFFERIES GEN STATION[1]	West Branch Cooper River	08PT002	08PT002G	PT: Jeffries Station
SC0001091-003	SCPSA/JEFFERIES GEN STATION[1]	West Branch Cooper River	08PT002	08PT002G	PT: Jeffries Station
SC0001091-004	SCPSA/JEFFERIES GEN STATION[1]	West Branch Cooper River	08PT002	08PT002G	PT: Jeffries Station
SC0001091-006	SCPSA/JEFFERIES GEN STATION[1]	West Branch Cooper River	08PT002	08PT002G	PT: Jeffries Station
SC0037401-001	SCPSA/CROSS GENERATING STATION	Diversion Canal	08PT003	08PT003G	PT: Cross Station
SC0037401-002	SCPSA/CROSS GENERATING STATION	Diversion Canal	08PT003	08PT003G	PT: Cross Station
SC0037401-004	SCPSA/CROSS GENERATING STATION	Diversion Canal	08PT003	08PT003G	PT: Cross Station
SC0026506-001	DAK AMERICAS LLC/COOPER RIVER PLANT	Cooper River	08WS007	08IN003G	IN: DAK
SC0021598-001	MONCKS CORNER WWTF	West Branch Cooper River	08WS007	08WS003G	WS: Santee Cooper RWS
SC0037541-001	SUMMERVILLE WWTF	Ashley River*	08WS007	18WS001G	NA
SCG641011-001	SCPSA/MONCKS CORNER WTP	West Branch Cooper River	08WS007	None	WS: Santee Cooper RWS
SC0001759-001	KAPSTONE CHARLESTON KRAFT LLC	Cooper River	10IN003	10IN003G	IN: Kaptsone
SC0001759-004	KAPSTONE CHARLESTON KRAFT LLC	Cooper River	10IN003	10IN003G	IN: Kaptsone
SC0022471-002	SCPSA/WINYAH STEAM STATION	North Santee River	22PT001	None	PT: Winyah Station
SCG646061-001	LAKE MARION REGIONAL WTP	Lake Marion/Santee River	38WS052	None	WS: Lake Marion RWS
SC0039764-001	BCW&SA/CENTRAL BERKELEY WWTP	West Branch Cooper River	None	08WS004G	WS: Santee Cooper RWS
SC0025259-001	BCW&SA/ST STEPHEN WWTP	Santee River	None	08WS005G	WS: Santee Cooper RWS
SC0035190-001	C R BARD INC	West Branch Cooper River	None	08IN007G	WS: CR BARD
SC0047392-001	NUCOR STEEL/BERKELEY PLANT	Cooper River	None	08IN011G/ 08WS058G	WS: Nucor
SC0047392-002	NUCOR STEEL/BERKELEY PLANT	Cooper River	None	08IN011G/ 08WS058G	WS: Nucor
SC0028801-001	ST MATTHEWS/SOUTH PLANT	Halfway Swamp Creek	None	09WS001G	WS: St Mathews
SC0048186-001	KIAWAH RESORT/CASSIQUE GOLF CO	Coast*	None	10GC021G	*NA*
SC0043273-001	MT PLEASANT/WTR #2	Cooper River	None	10WS006G	WS: Mt. Pleasant #2
SC0025283-001	ISLE OF PALMS/FOREST TRAIL SD	Coast*	None	10WS010G	*NA*
SC0025283-002	ISLE OF PALMS/FOREST TRAIL SD	Coast*	None	10WS010G	*NA*
1- Ceased coal-fi	ISLE OF PALMS W&S R/O	Coast*	None	10WS010G	*NA*
SC0048097-001	WILLIAMSBURG CO/SANTEE RV WWTF	Santee River	unknown	unknown	WS: Williamsburg Co
SC0042170-001	PINEWOOD SITE CUSTODIAL TRUST	Lake Marion/Santee River	None	42IN010G	Pinewood Site
SC0042170-002	PINEWOOD SITE CUSTODIAL TRUST	Lake Marion/Santee River	None	42IN010G	Pinewood Site
SC0042170-02A	PINEWOOD SITE CUSTODIAL TRUST	Lake Marion/Santee River	None	42IN010G	Pinewood Site
SC0047937-001	US ARMY/ST STEPHEN POWER PLANT	Rediversion Canal	None	08WS056G[2]	St. Stephen Power
SC0047937-01A	US ARMY/ST STEPHEN POWER PLANT	Rediversion Canal	None	08WS056G[2]	St. Stephen Power
SC0001350-001	KINDER MORGAN-SHIPYARD RIVER TERMINAL	Cooper River	None	None	Agg Discharge 1
SC0001350-002	KINDER MORGAN-SHIPYARD RIVER TERMINAL	Cooper River	None	None	Agg Discharge 1
SC0002852-001	HESS/CHARLESTON NORTH TERMINAL	Cooper River	None	None	Agg Discharge 1
SC0003026-004	DELFIN GROUP USA LLC	Cooper River	None	None	Agg Discharge 1
SC0020052-001	SULLIVANS ISLAND WWTF	Coast*	None	None	*NA*
SC0043206-001	NAVAL NUCLEAR POWER TRAINING UNIT	Cooper River	None	None	Navy
SC0043206-002	USN/NUCLEAR POWER TNG UNIT	Cooper River	None	None	Navy
SC0043206-003	NAVAL NUCLEAR POWER TRAINING UNIT	Cooper River	None	None	Navy
SC0046175-001	SCGENCO/WILLIAMS ASH DISP HW52	West Branch Cooper River	None	None	SC Genco
SC0039535-001	SCGENCO/WILLIAMS ASH DISP H17A	West Branch Cooper River	None	None	SC Genco
SC0047261-001	PETROLIANCE LLC/CHARLESTON	Cooper River	None	None	Agg Discharge 1
SC0047562-001	DETYENS SHIPYARD/MAIN YARD	Cooper River	None	None	Agg Discharge 1
SC0047562-01A	DETYENS SHIPYARD/MAIN YARD	Cooper River	None	None	Agg Discharge 1
SC0047562-01B	DETYENS SHIPYARD/MAIN YARD	Cooper River	None	None	Agg Discharge 1
SCG731087-1BC	LAUREL OAKS PLT/LAUREL OAKS MINE	Coast*	None	None	*NA*

No shading identifies dischargers that have a surface water withdrawal permit (or purchase water) and are represented by a Water User object.
Blue shading identifies dischargers that have a public water supply permit or registration to withdraw groundwater, but no surface water permit, and are represented by a Water User object.
Gray shading identifies dischargers that do not have a public water supply permit or active registration to withdrawal groundwater, and are represented by a Discharge model object.
** Will not be included in the model due to discharge location near the coast or on the Ashley River.*
NA = Not appplicable (no model object necessary) *[2] - No longer active* *[1] - Ceased operations in 2012*

Table 3. Interbasin transfers in the Santee Basin.

NPDES Pipe ID	NPDES Facility Name	Associated Water Permit	Associated Water Permit Facility	Intake Basin	Discharge Basin	Location of Discharge in Santee Basin	Model Object ID
SC0040037-001	TOWN OF BOWMAN	38WS052	SANTEE COOPER LAKE MARION REGIONAL WATER SYSTEM	Santee	Edisto	-	WS: Lake Marion RWS
SC0021229-001	CHARLESTON CPW/PLUM ISLAND	10WS004	CHARLESTON CPW	Edisto	Santee	Ashley River/Coast	WS: Charleston
SC0024783-001	NCSD/FELIX C DAVIS WWTP	10WS004	CHARLESTON CPW	Edisto	Santee	Cooper River	WS: Charleston
SC0040771-001	MT PLEASANT/CENTER ST & RR RD.	10WS004	CHARLESTON CPW	Edisto	Santee	Coast	NA[1]
SC0040771-002	MT PLEASANT/CENTER ST & RR RD.	10WS004	CHARLESTON CPW	Edisto	Santee	Coast	NA[1]
SC0040771-003	MT PLEASANT/CENTER ST & RR RD.	10WS004	CHARLESTON CPW	Edisto	Santee	Coast	NA[1]
SC0040771-004	MT PLEASANT/CENTER ST & RR RD.	10WS004	CHARLESTON CPW	Edisto	Santee	Coast	NA[1]
SC0040771-005	MT PLEASANT/CENTER ST & RR RD.	10WS004	CHARLESTON CPW	Edisto	Santee	Coast	NA[1]
SC0046060-001	BCW&SA/LOWER BERKELEY WWTF	10WS004	CHARLESTON CPW	Edisto	Santee	Cooper River	WS: Charleston
SC0038822-001	DORCHESTER CO/LOWER DORCHESTER	10WS004	CHARLESTON CPW	Edisto	Santee	Ashley River	WS: Charleston

[1] *- Since these are coastal discharges, they are not represented by a model object*

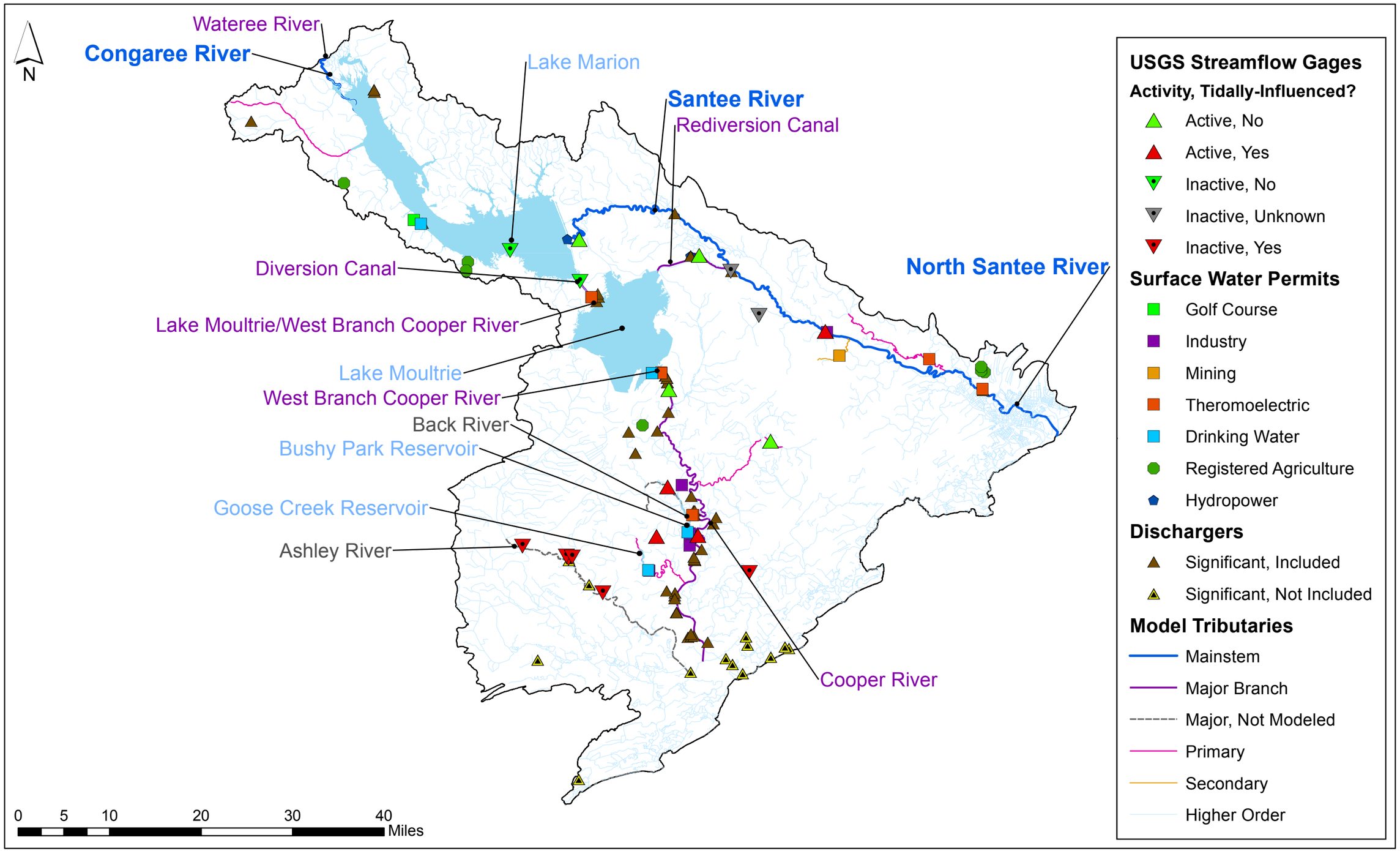

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Figure 1: Overview Map

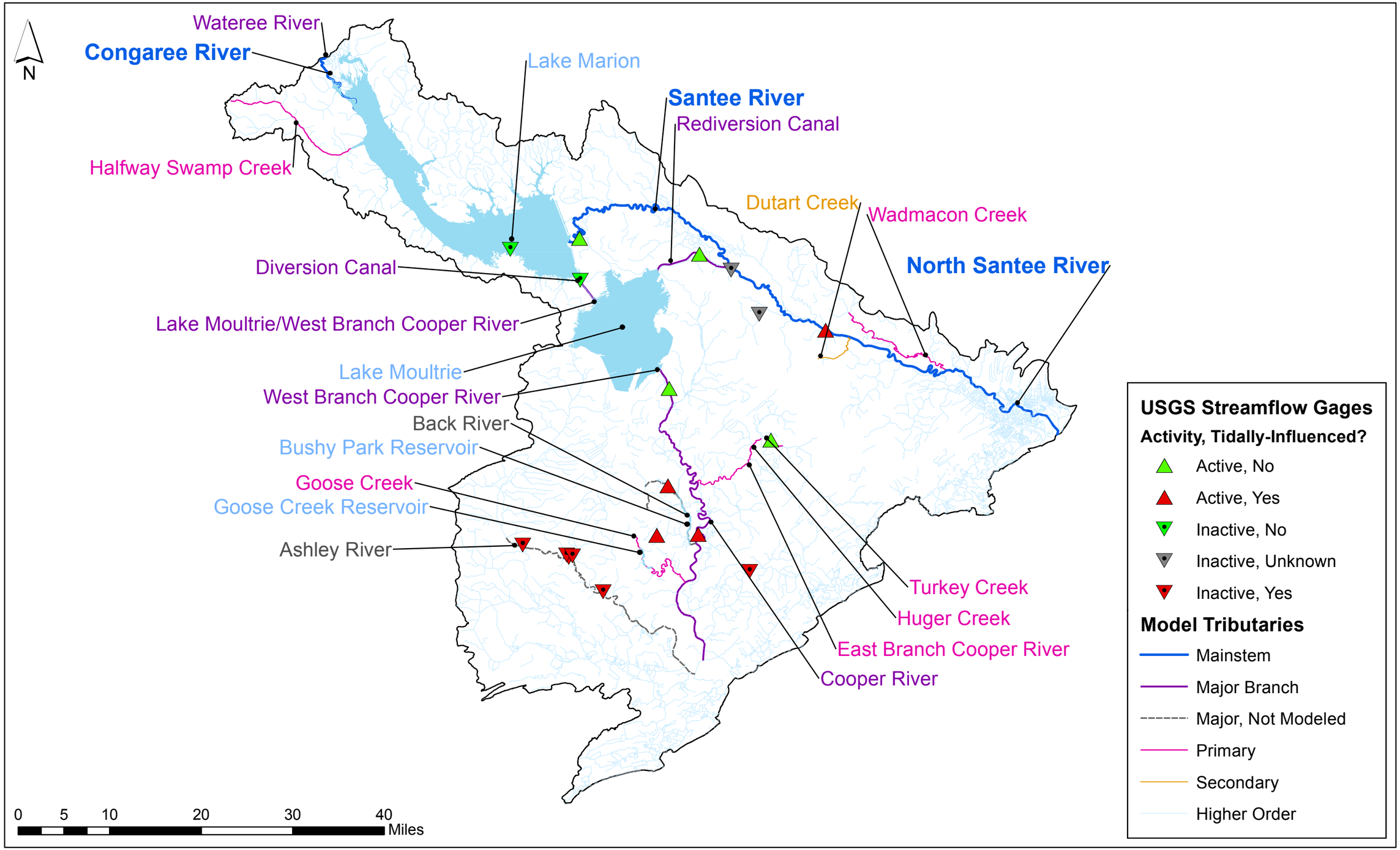

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Figure 2: Model Tributaries and USGS Streamflow Gages

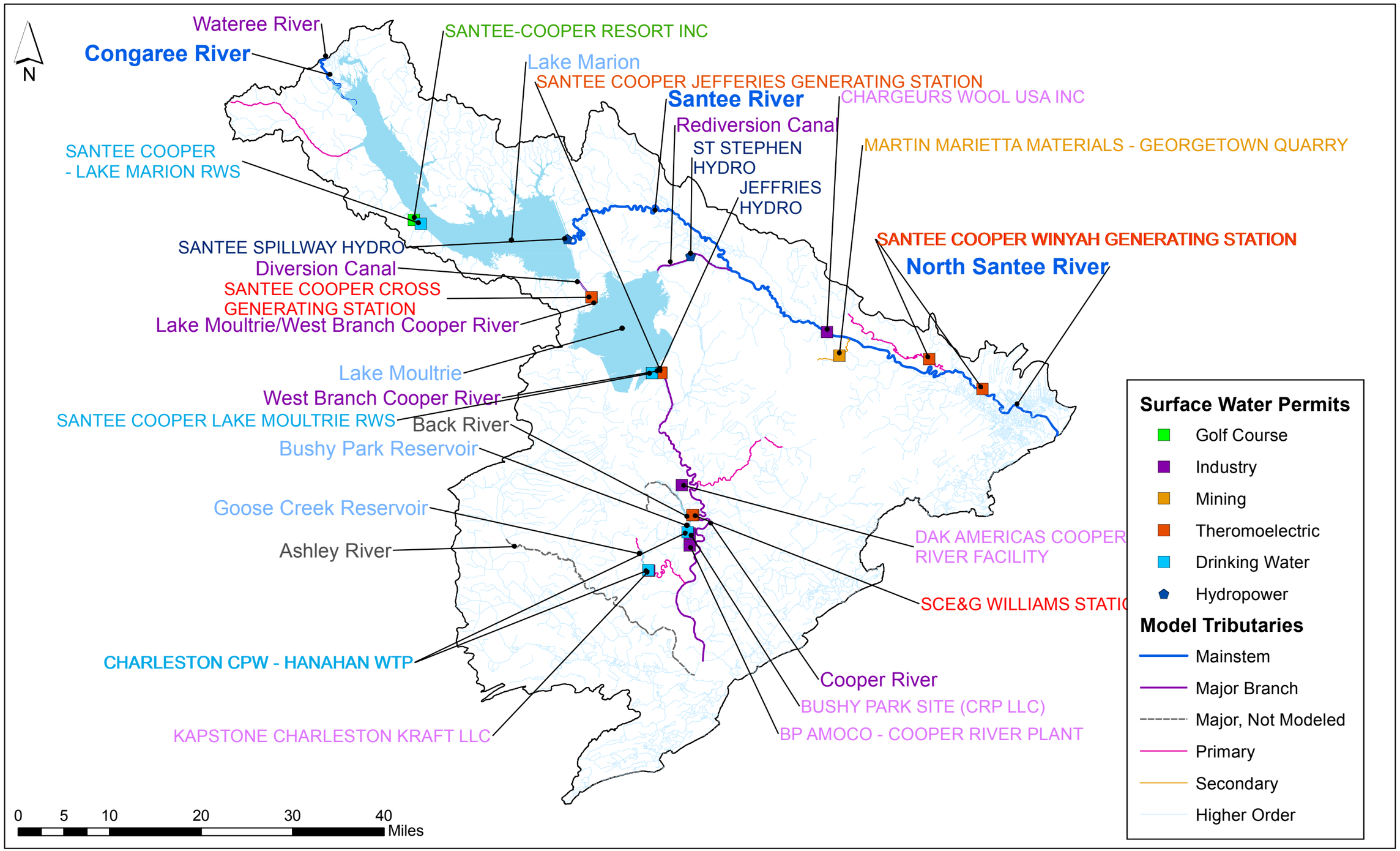

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Figure 3: Permitted Surface Water Users

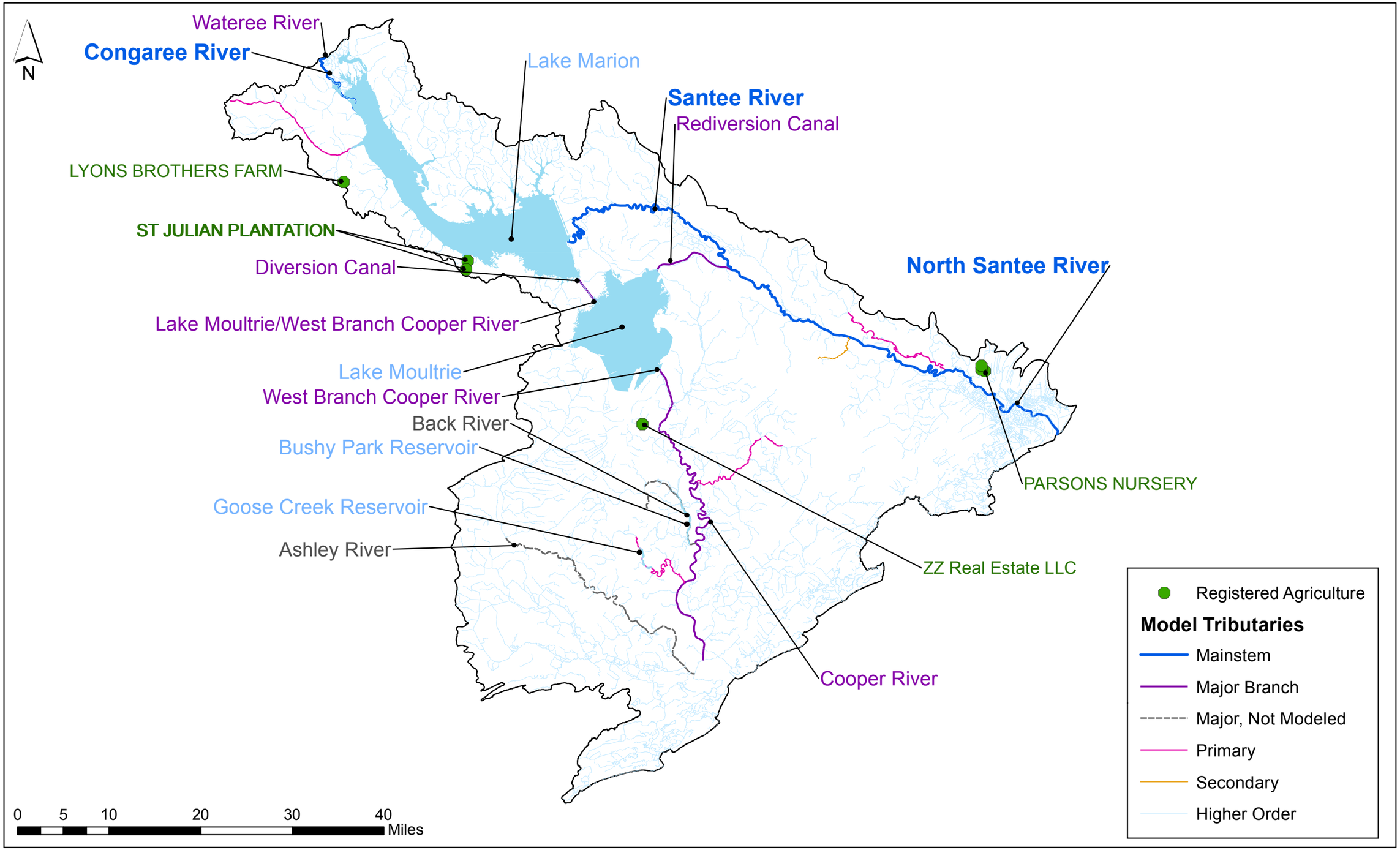

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Figure 4: Registered Agriculture

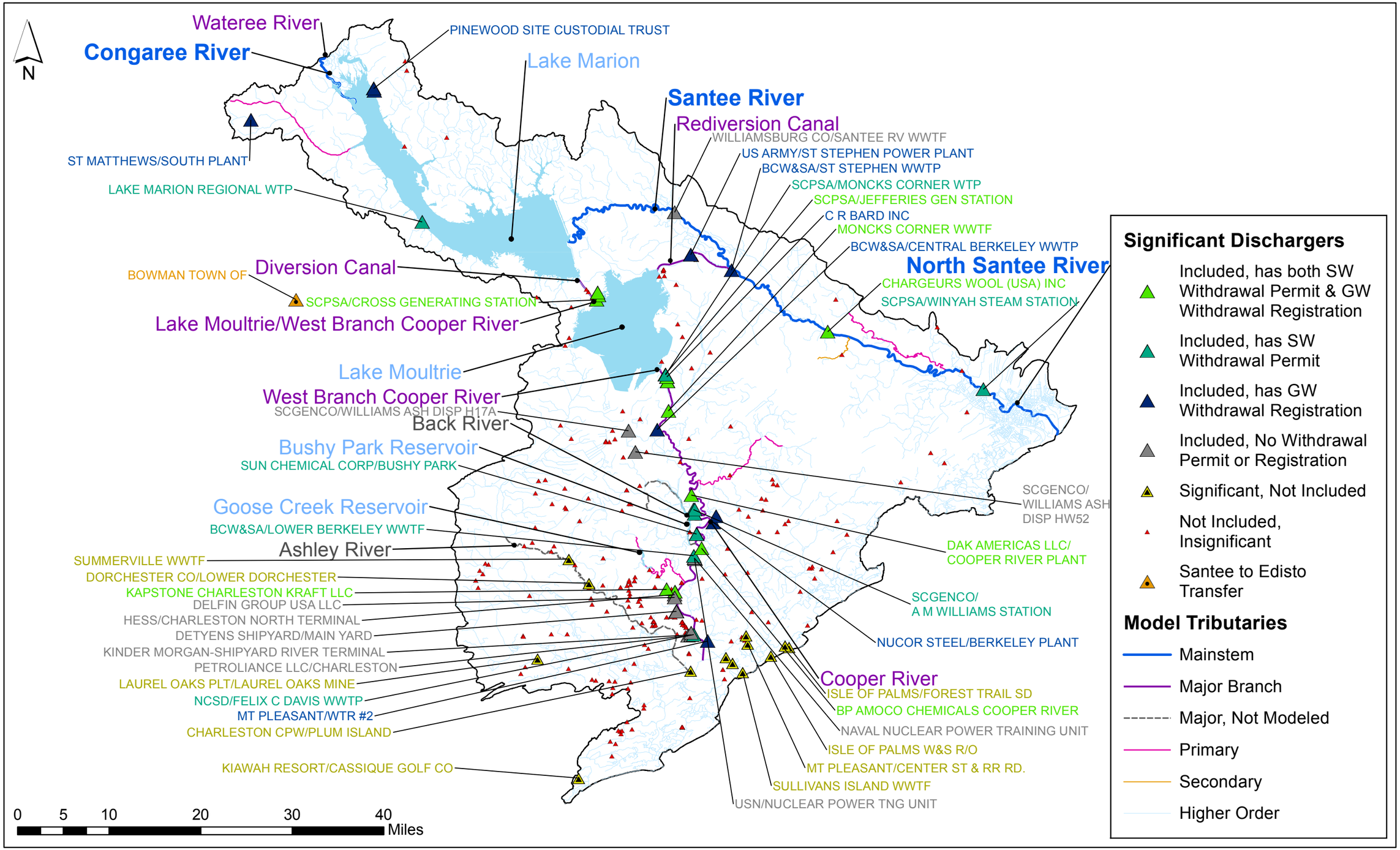

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Figure 5: Dischargers

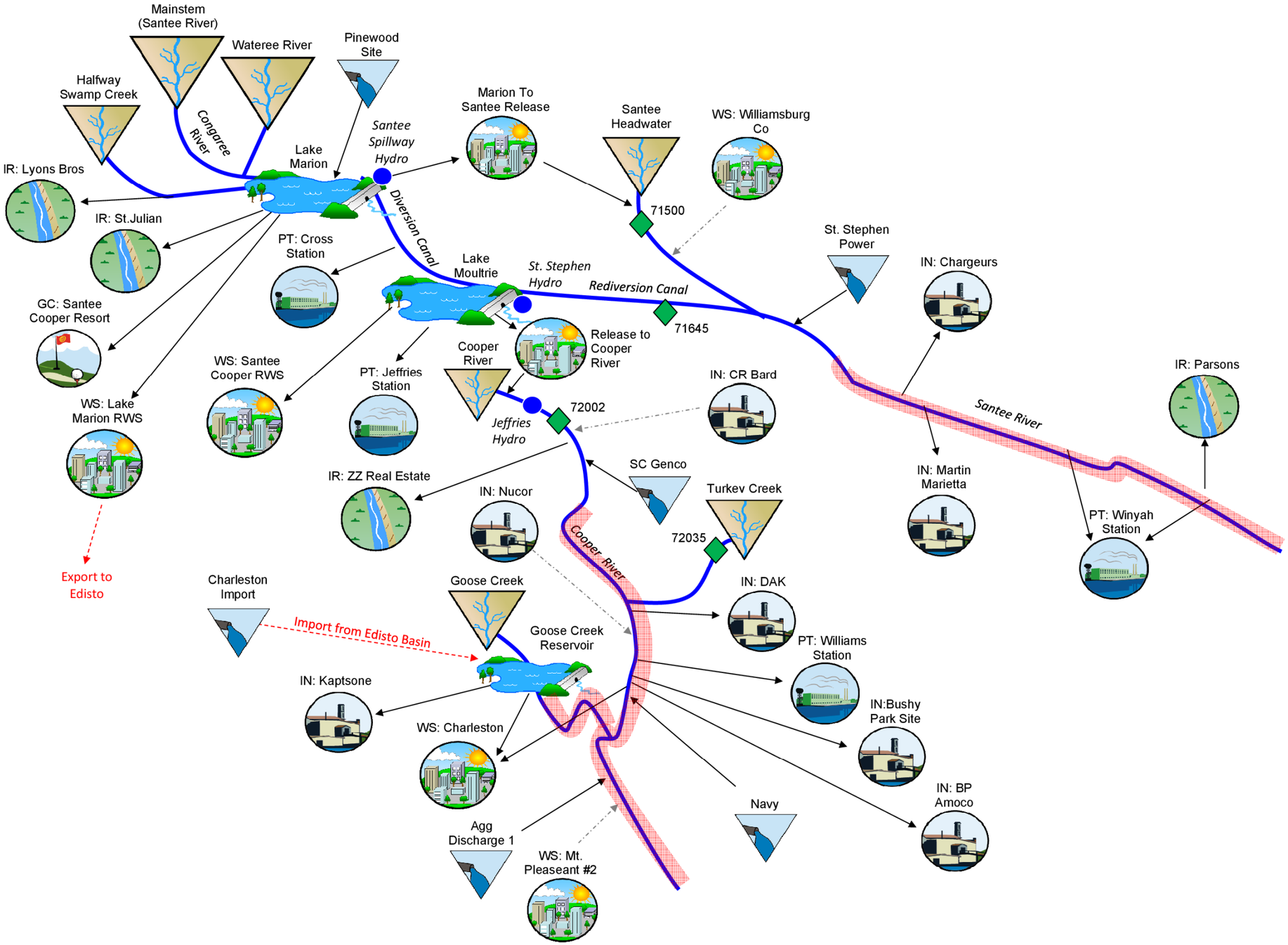

Figure 6. Santee River Basin SWAM Model Framework

Model Objects

- Tributary
- Discharge
- Current or Former USGS Stream Gage *(with last 4 digits of Gage ID)*

Water User Objects

- Municipal
- Agriculture (Irrigation)
- Thermoelectric
- Industrial
- Golf Course

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

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

- Approximate extent of tidally influenced portion

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