Memorandum

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

From: *CDM Smith*

Date: *July 2015*

Subject: *Broad River Basin SWAM Model Framework*

This memorandum presents the Simplified Water Allocation Model (SWAM) framework for the Broad 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 Broad River Basin model framework.**

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

Table 3 **Interbasin transfers included in the Broad Basin model framework.**

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 Broad 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. All streams which have a current or former USGS streamflow gage are explicitly included in the model.

Figure 3 Surface Water Users
This map presents the location of permitted surface water users, except for golf courses.

Figure 4 Registered Agricultural Users and Golf Courses
This map presents the location of registered agriculture surface water users and golf courses with surface water withdrawal permits.

Figure 5 Dischargers
This map presents the location of all significant NPDES discharge locations, including those outside of the Broad basin which represent the export of water withdrawn from the Broad basin. Significant discharge locations generally include NPDES discharges that average over 3 Mg/m; however, discharges that average less than 3 Mg/m, but with some months greater than 3 Mg/m are also included.

Figure 6 Broad Basin SWAM Model Framework
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 Broad basin is the City of Union, which is represented by a water user object 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 Broad, some dischargers that do not have associated surface water withdrawals are represented in this manner. One discharger (IN: GE/Gas) has a groundwater withdrawal, and has been represented using a water user object, even though it does not withdraw from surface water. Representing it as water user objects provides more flexibility in conducting future management and planning because its' discharge can be directly related to changing water demand.

Similar to the Saluda and Edisto basins, the guiding principles in determining what elements of the Broad 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. This includes most primary tributaries to the Broad and its major branches, and some secondary tributaries.

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 unimpaired flows (UIFs) are developed throughout the Broad, 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). In the Broad, there are a number of tributaries that are explicitly included but have no significant withdrawals or discharges. This is because there are current or former USGS streamflow gages located on these tributaries.

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 Broad 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 Broad River Basin, and feedback will be used to refine the framework as appropriate.

Table 1. Permitted, registered, and other surface water users included in the Broad Basin model framework.

ID	Type	Facility Name	Withdrawal River, Tributary or Lake	Model Object ID
11IN002S01	IN	MILLIKEN - MAGNOLIA PLANT	Broad River	IN: Milliken
11PH001S01	PH	DUKE ENERGY GASTON SHOALS PEAKING HYDRO	Gaston Shoals Lake (Broad River)	PH: Gaston Shoals
11PH002S01	PH	DUKE ENERGY NINETY-NINE ISLANDS PEAKING HYDRO	Ninety-Nine Islands Res. (Broad River)	PH: 99 Islands
11WS001S01	WS	GAFFNEY WTP	Lake Welchel (Cherokee Creek)	WS: Gaffney
11WS001S02	WS	GAFFNEY WTP	Gaston Shoals Lake (Broad River)	WS: Gaffney
12IN002S01	IN	CHEMTRADE	Broad River	IN: Chemtrade
12IN002S02	IN	CHEMTRADE	Broad River	IN: Chemtrade
20PH001S01	PH	SCE&G FAIRFIELD PUMP STORAGE	Parr Shoals Reservoir (Broad River)	PH: Fairfield
20PH002S01	PH	SCE&G PARR	Parr Shoals Reservoir (Broad River)	PH: Parr
20PN001S01	PN	SCE&G - V.C. SUMMER NUCLEAR STATION	Monticello Reservoir	PN: V.C. Summer
20PN001S02	PN	SCE&G - V.C. SUMMER NUCLEAR STATION	Monticello Reservoir	PN: V.C. Summer
20WS001S01	WS	TOWN OF WINNSBORO WTP	Sand Creek	WS: Winnsboro
20WS001S03	WS	TOWN OF WINNSBORO WTP	Mill Creek	WS: Winnsboro
20WS001S05*	WS	TOWN OF WINNSBORO WTP	Broad River	WS: Winnsboro
23GC003S01	GC	FOX RUN COUNTRY CLUB	Durbin Creek	GC: Fox Run CC
23GC009S01	GC	HOLLY TREE COUNTY CLUB	Gilder Creek	GC: Holly Tree CC
23GC011S01	GC	PEBBLE CREEK GOLF CLUB	Mountain Creek	GC: Pebble Creek
23GC011S02	GC	PEBBLE CREEK GOLF CLUB	Mountain Creek	GC: Pebble Creek
23GC011S03	GC	PEBBLE CREEK GOLF CLUB	Mountain Creek	GC: Pebble Creek
23IR002S01	IR	FISHER BROTHERS FARMS	Middle Tyger River	IR: Fisher Bros
23IR007S01	IR	HYDER AUSTIN FARMS INC	South Pacolet River	IR: Hyder Austin
23IR007S02	IR	HYDER AUSTIN FARMS INC	Middle Tyger River	IR: Hyder Austin
23IR007S03	IR	HYDER AUSTIN FARMS INC	South Pacolet River	IR: Hyder Austin
23IR007S04	IR	HYDER AUSTIN FARMS INC	Middle Tyger River	IR: Hyder Austin
23IR008S01	IR	FISHERS ORCHARD	Enoree River	IR: Fishers Orchard
23WS004S01	WS	GREER CPW - WATER TREATMENT PLANT	Lake Cunningham (S. Tyger River)	WS: Greer
30GC003S02	GC	MUSGROVE MILL GOLF CLUB	Enoree River	GC: Musgrove Mill
30WS001S01	WS	CITY OF CLINTON WTP	Enoree River	WS: Clinton
30WS001S02	WS	CITY OF CLINTON WTP	Duncan Creek	WS: Clinton
36GC050S01	GC	MID CAROLINA GOLF CLUB	Crimms Creek	GC: Mid Carolina
36IR010S01	IR	LEWIS NURSERY & FARM	Tyger River	IR: Lewis Nursery
36WS003S01	WS	TOWN OF WHITMIRE WTP	Enoree River	WS: Whitmire
36WS003S02	WS	TOWN OF WHITMIRE WTP	Duncan Creek	WS: Whitmire
40WS054S01	WS	CITY OF COLUMBIA - CANAL WATER PLANT	Broad River	WS: Columbia
42GC005S01	GC	THE COUNTRY CLUB OF SPARTANBURG	Lawsons Fork Creek	GC: CC of Spartanburg
42GC010S01	GC	CAROLINA COUNTRY CLUB	Fairforest Creek	GC: Carolina CC
42GC013S01	GC	WILLOW CREEK GOLF CLUB	Enoree River	GC: Willow Creek
42GC015S01	GC	LINKS O'TRYON	South Pacolet River	GC: Links O'Tryon
42IN075S01	IN	REFLECTIVE RECYCLING LLC	Pacolet River	IN: Reflective Recycling
42IR026S01	IR	GILBERTS NURSERY INC	North Pacolet River	IR: Gilberts
42IR026S02	IR	GILBERTS NURSERY INC	North Pacolet River	IR: Gilberts
42IR026S03	IR	GILBERTS NURSERY INC	North Pacolet River	IR: Gilberts
42IR026S04	IR	GILBERTS NURSERY INC	North Pacolet River	IR: Gilberts
42IR026S05	IR	GILBERTS NURSERY INC	North Pacolet River	IR: Gilberts
42MI001S01	MI	VULCAN CONSTRUCTION MATERIALS	Pacolet River	MI: Vulcan
42MI001S02	MI	VULCAN CONSTRUCTION MATERIALS	Pacolet River	MI: Vulcan
42PH001S01	PH	SIMMS HYDRO	Lake Bowen (Pacolet River)	PH: Simms
42PH002S01	PH	LOCKHART POWER CO PACOLET HYDRO (LOWER)	Pacolet River	PH: Lower Pacolet
42PH002S02	PH	LOCKHART POWER CO PACOLET HYDRO (UPPER)	Pacolet River	PH: Upper Pacolet

Table 1. Permitted, registered, and other surface water users included in the Broad Basin model framework.

ID	Type	Facility Name	Withdrawal River, Tributary or Lake	Model Object ID
42WS001S01	WS	INMAN CAMPOBELLO N SPARTANBURG PROJECT #1	North Pacolet River	WS: ICWD
42WS004S01	WS	SPARTANBURG CPW	Lake Blalock (Pacolet River)	WS: Spartanburg
42WS005S01	WS	WOODRUFF-ROEBUCK WTP	North Tyger River	WS: Woodruff-Roebuck
42WS005S02	WS	WOODRUFF-ROEBUCK WTP	South Tyger River	WS: Woodruff-Roebuck
42WS008S01	WS	CITY OF LANDRUM (SPARTANBURG CPW)	Vaughn Creek	WS: Landrum
42WS008S02	WS	CITY OF LANDRUM (SPARTANBURG CPW)	Vaughn Creek	WS: Landrum
42WS012S01	WS	SJWD MIDDLE TYGER WTP	Middle Tyger River	WS: SJWD
42WS012S02	WS	SJWD MIDDLE TYGER WTP	North Tyger River	WS: SJWD
42WS012S03	WS	SJWD MIDDLE TYGER WTP	Lake Cooley (Jordan Creek)	WS: SJWD
42WS014S01	WS	SPARTANBURG CPW	Lake Bowen/Reservoir #1 (South Pacolet River)	WS: Spartanburg
44IN003S01	IN	CARLISLE FINISHING LLC	Broad River	IN: Carlisle Finishing
44PH001S01	PH	SCE&G NEAL SHOALS HYDRO	Neal Shoals Res. (Broad River)	PH: Neal Shoals
44PH002S01	PH	LOCKHART POWER CO LOCKHART HYDRO	Broad River	PH: Lockhart
44PH002S02	PH	LOCKHART POWER CO (MINIMUM FLOW UNIT)	Broad River	PH: Lockhart
44WS001S01	WS	CITY OF UNION WTP	Broad River	WS: Union
46WS002S01	WS	CITY OF YORK WTP	Turkey Creek	WS: York

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

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

NPDES Pipe ID	Facility Name	Discharge Tributary	Associated Surface Water Permit	Model Object ID
SC0047244-001	UNION/TOSCH'S CREEK WWTP	Fairforest Creek	44WS001	WS: Union
SCG646042	CITY OF UNION WTP	Broad River	44WS001	WS: Union
SC0001368-001	CONE MILLS CORP/CARLISLE PLANT	Broad River	44IN003	IN: Carlisle Finishing
SC0042668-001	SSSD/CLIFTON WWTP	Pacolet River	42WS014/ 42WS004	WS: Spartanburg
SC0045624-001	SSSD/COWPENS-PACOLET RIVER	Pacolet River	42WS014/ 42WS004	WS: Spartanburg
SC0044717-001	SSSD/PACOLET MILLS WWTP	Pacolet River	42WS014/ 42WS004	WS: Spartanburg
SC0020435-001	SSSD/FAIRFOREST PLANT	Fairforest Creek	42WS014	WS: Spartanburg
SC0020435-002	SSSD/FAIRFOREST PLANT	Pacolet River	42WS014	WS: Spartanburg
SC0048143-001	SSSD/LOWER N TYGER RIVER WWTP	North Tyger River	42WS014/ 42WS012	WS: Spartanburg/ WS: SJWD
SCG646049	SIMMS WTP	Pacolet River	42WS014	WS: Spartanburg
SC0026875-001	SSSD/PAGE CREEK WWTP	North Pacolet River	42WS008	WS: Landrum
SCG64500	SWS LANDRUM WTP	Vaughn Creek	42WS008	WS: Landrum
SC0045802-001	WOODRUFF/ENOREE RIVER	Enoree River	42WS005	WS: Woodruff-Roebuck
SC0002798-002	AURIGA POLYMERS INC./SPARTANBURG	Pacolet River	42WS004	WS: Spartanburg
SC0021601-001	INMAN, CITY OF	Lawsons Fork Creek	42WS001	WS: ICWD
SC0003581-001	MILLIKEN/DEWEY PLANT	Lawsons Fork Creek	42WS001	WS: ICWD
SCG730293	VULCAN MATERIALS - PACOLET Quarry	Pacolet River	42MI001	MI: Vulcan
SC0049174-002	REFLECTIVE RECYCLING OF SC LLC	Pacolet River	42IN075	IN: Reflective Recycling
SC0022390-001	WHITMIRE, TOWN OF	Duncan Creek	36WS003	WS: Whitmire
SC0046345-001	GREER/MAPLE CREEK PLANT	South Tyger River	23WS004/ 42WS012	WS: Greer/ WS: SJWD
SC0026565-001	UNITED UTILS/N GREENVILLE COLL	South Tyger River	23WS004	WS: Greer
SC0033804-001	WCRSA/PELHAM WWTF	Enoree River	23WS004	WS: Greer
SC0030856-001	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: SCE&G
SC0030856-003	SCE&G/V C SUMMER NUCLEAR STAT	Parr Shoals Reservoir (Broad River)	20PN001	PN: V.C. Summer
SC0030856-004	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0030856-005	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0030856-007	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0030856-008	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0030856-012	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0030856-013	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0030856-014	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0030856-06A	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0030856-06B	SCE&G/V C SUMMER NUCLEAR STAT	Monticello Reservoir	20PN001	PN: V.C. Summer
SC0022756-001	CHEMTRADE PERF CHEMICALS/LEEDS	Broad River	12IN002	IN: Chemtrade
SC0047457-001	BLACKSBURG/CANOE CREEK (NEW)	Broad River	11WS001	WS: Gaffney
SC0031551-001	GAFFNEY/CLARY WWTF	Thicketty Creek	11WS001	WS: Gaffney
SC0047091-001	GAFFNEY/PEOPLES CRK-BROAD RVR	Ninety-Nine Islands Res. (Broad River)	11WS001	WS: Gaffney
SC0021300-001	LYMAN, CITY OF	Middle Tyger River	42WS012	WS: SJWD
SC0020125-001	WINNSBORO/JACKSON CREEK PLANT	Jackson Creek	20WS001	WS: Winnsboro
SC0022900-001	RIDGEWAY, TOWN OF	Trib to Cedar Creek	20WS001	WS: Winnsboro
SC0025763-001	CHESNEE WWTF	Buck Creek	*none*	none[1]
SC0003484-001	GE/GAS TURBINE MFG OPERATION	Enoree River	23IN058G	IN: GE/Gas
SC0024988-001	JONESVILLE, TOWN OF	Pacolet River	44WS001	WS: Union
SC0003051-001	LOCKHART TREATMENT FACILITY	Broad River	*none*	none[2]
SC0036145-001	MIDLAND CAPITAL LLC/MOORE PLANT	South Tyger River	*none*	Midland
SC0047732-001	SSSD/S. TYGER RV REGIONAL WWTP	South Tyger River	42WS012	WS: SJWD
SCG646023	SJWD WTP	Middle Tyger River	42WS012	WS: SJWD

- No shading identifies dischargers that have a surface water withdrawal permit and are represented by a Water User object.

- Blue shading identifies dischargers that have a public water supply permit or registration to withdrawal groundwater , but no surface water permit, and are represented by a Water User object.

- Gray shading identifies dischargers that do not have a permit or registration to withdrawal groundwater or surface water and are represented by a discharge object.

- Red shading identifies dischargers that that purchase surface water from another from a permitted water user, and discharge it at their own facility. The discharge is represented in the appropriate water supply user object.

[1] *Chesnee WWTF treats water that is withdrawn by Spartanburg CPW. The discharge is represented in the WS: Spartanburg water user object.*

[2] *Lockart WWTF treats water that is withdrawn by Union County. The discharge is represented in the WS: Union water user object.*

Table 3. Interbasin transfers included in the Broad Basin model framework.

NPDES Pipe ID	NPDES Facility Name	Associated Water Permit	Associated Water Permit Facility	Intake Basin	Discharge Basin	Location of Discharge in Broad Basin	Model Object ID
SC0036081-001	CHESTER/SANDY RIVER WWTF	12WS002	Robert W. Hemphill Filtration Plant	Catawba	Broad	Sandy River	Chester Import
SC0040002-001	ReWa/DURBIN CREEK	23W007	Witty Adkins WTP	Savannah	Broad	Durbin Creek	Greenville Import (Durbin)
SC0040525-001	ReWa/GILDER CREEK	23W007	Witty Adkins WTP	Savannah	Broad	Enoree River	Greenville Import (Gilder)
SC0033804-001	ReWa/PELHAM WWTF	23W007	Witty Adkins WTP	Savannah	Broad	Enoree River	Greenville Import (Pelham)
SC0046621-001	RICHLAND CO/BROAD RIVER WWTF	40WS002	City of Columbia - Lake Murray Water Plant	Saluda	Broad	Broad River	Columbia Import (Richland)
SC0040631-001	CHAPIN, TOWN OF	40WS002	City of Columbia - Lake Murray Water Plant	Saluda	Broad	Broad River	Columbia Import (Chapin)
SC0033804-001	ReWa/PELHAM WWTF	23WS002	Greenville Water L.B. Stovall Plant	Saluda	Broad	Enoree River	Greenville Import (Pelham)
SC0040002-001	ReWa/DURBIN CREEK	23WS002	Greenville Water L.B. Stovall Plant	Saluda	Broad	Durbin Creek	Greenville Import (Durbin)
SC0040525-001	ReWa/GILDER CREEK	23WS002	Greenville Water L.B. Stovall Plant	Saluda	Broad	Enoree River	Greenville Import (Gilder)
SC0048313-001	NCW&SA/CANNONS CREEK WWTP	36WS002	NCWSA - Lake Murray WTP	Saluda	Broad	Cannons Creek	NCWSA Import
SC0037974-001	LAURENS CO W&S/CLINTON-JOANNA	30WS001	City of Clinton Water Treatment Plant	Broad	Saluda	-	WS: Clinton
SC0020940-001	COLUMBIA/METRO PLANT	40WS054	Columbia Canal Water Treatment Plant	Broad	Saluda	-	WS: Columbia
SC0038865-001	EAST RICH CO PSD/GILLS CREEK	40WS054	Columbia Canal Water Treatment Plant	Broad	Saluda	-	WS: Columbia
SC0038156-001	YORK/FISHING CREEK WWTF	46WS002	City of York	Broad	Catawba	-	WS: York
See note 1	*See note 1*	20WS001	Winnsboro Water Treatment Facility	Broad	Catawba	-	WS: Winnsboro

[1] *Some water associated with the Town of Winnsoboro's withdrawal is discharged in the Catawba River Basin via septic systems, and possibly surface water discharges. The significance of the surface water discharges, in terms of the model, is still being investigated.*

Spartanburg Municipal Reservoir #1
Lake H. Taylor Blalock
Gaston Shoals Lake
Lake Welchel
Lake William C. Bowen
Lake John A. Robinson
Ninety-Nine Islands Lake
Lyman Lake
Lake Cunningham
Pacolet River
Lake Cooley
Neal Shoal Reservoir
Broad River
Enoree River
Monticello Recreation Lake
Little River
Tyger River
Parr Shoals
Monticello Reservoir

N

Legend

- Broad USGS Gages
- Registered Agriculture
- Dischargers

Surface Water Permits

- Golf Course
- Industrial
- Mining
- Nuclear
- Drinking Water
- Hydroelectric
- Higher Order Tribs

Model Tributary Objects

- Broad
- Major Branch
- Primary
- Secondary

0 5 10 20 Miles

CDM Smith

Figure 1: Overview Map

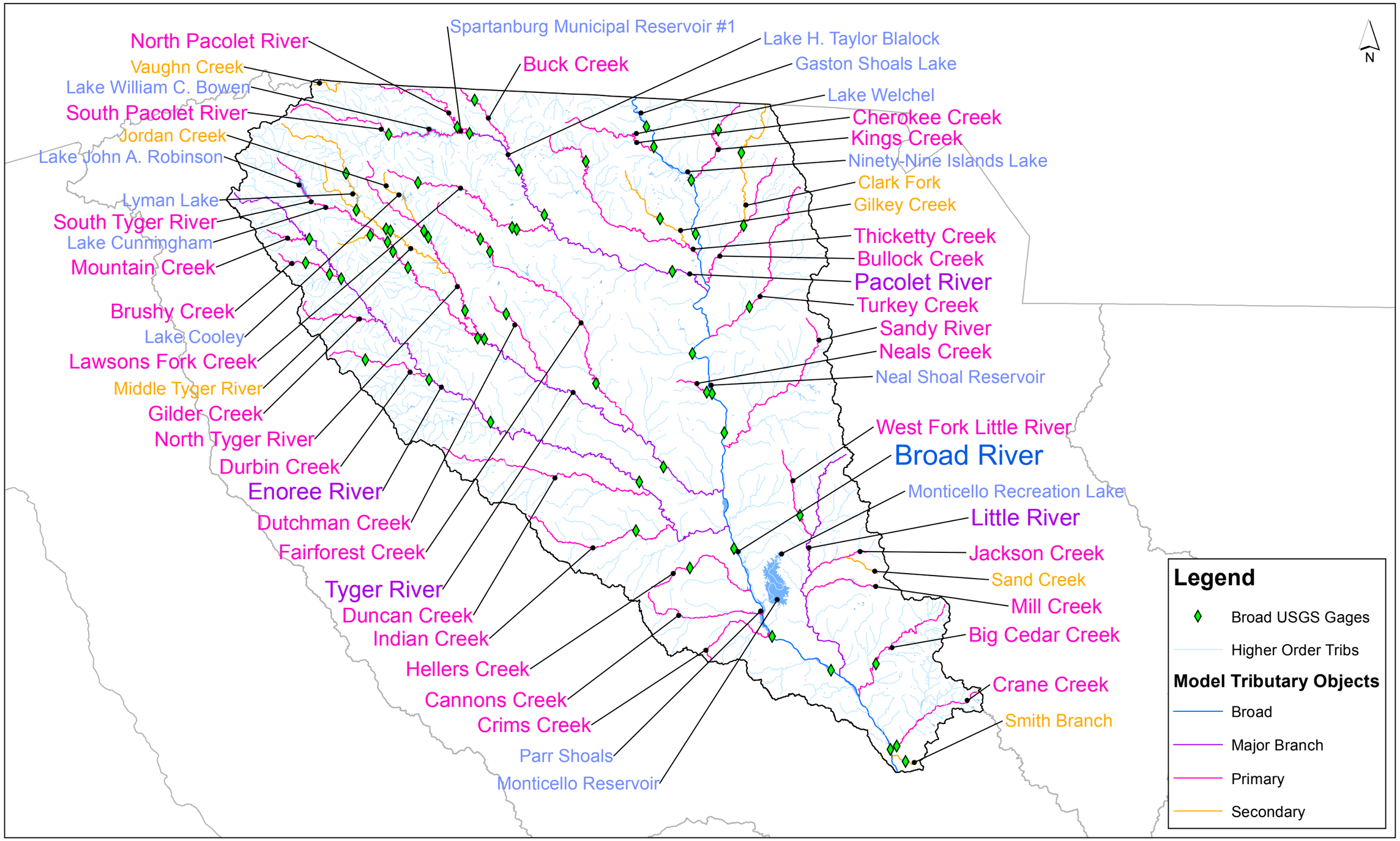

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Figure 2: Model Tributaries and USGS Streamflow Gages

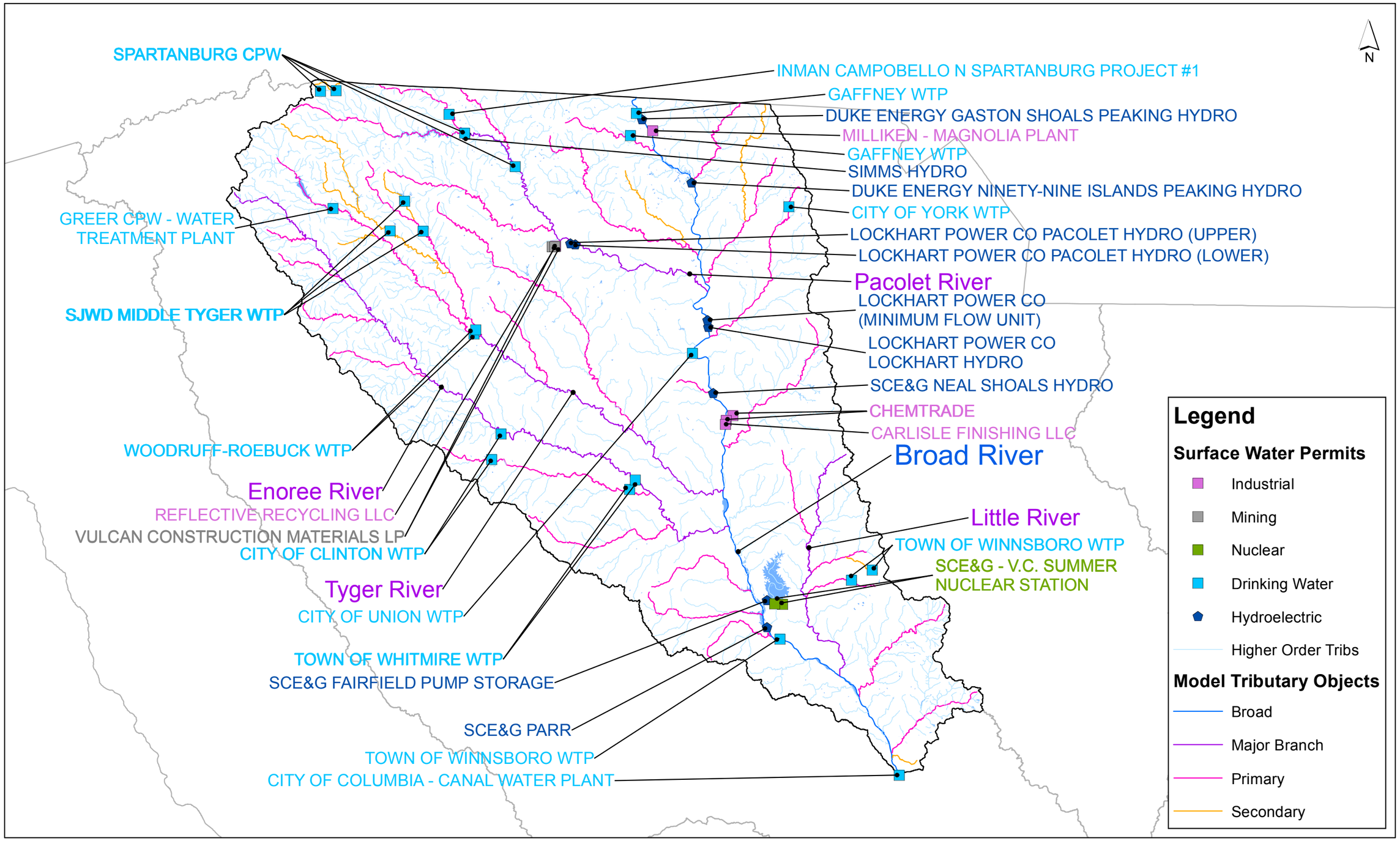

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Figure 3: Permitted Surface Water Users

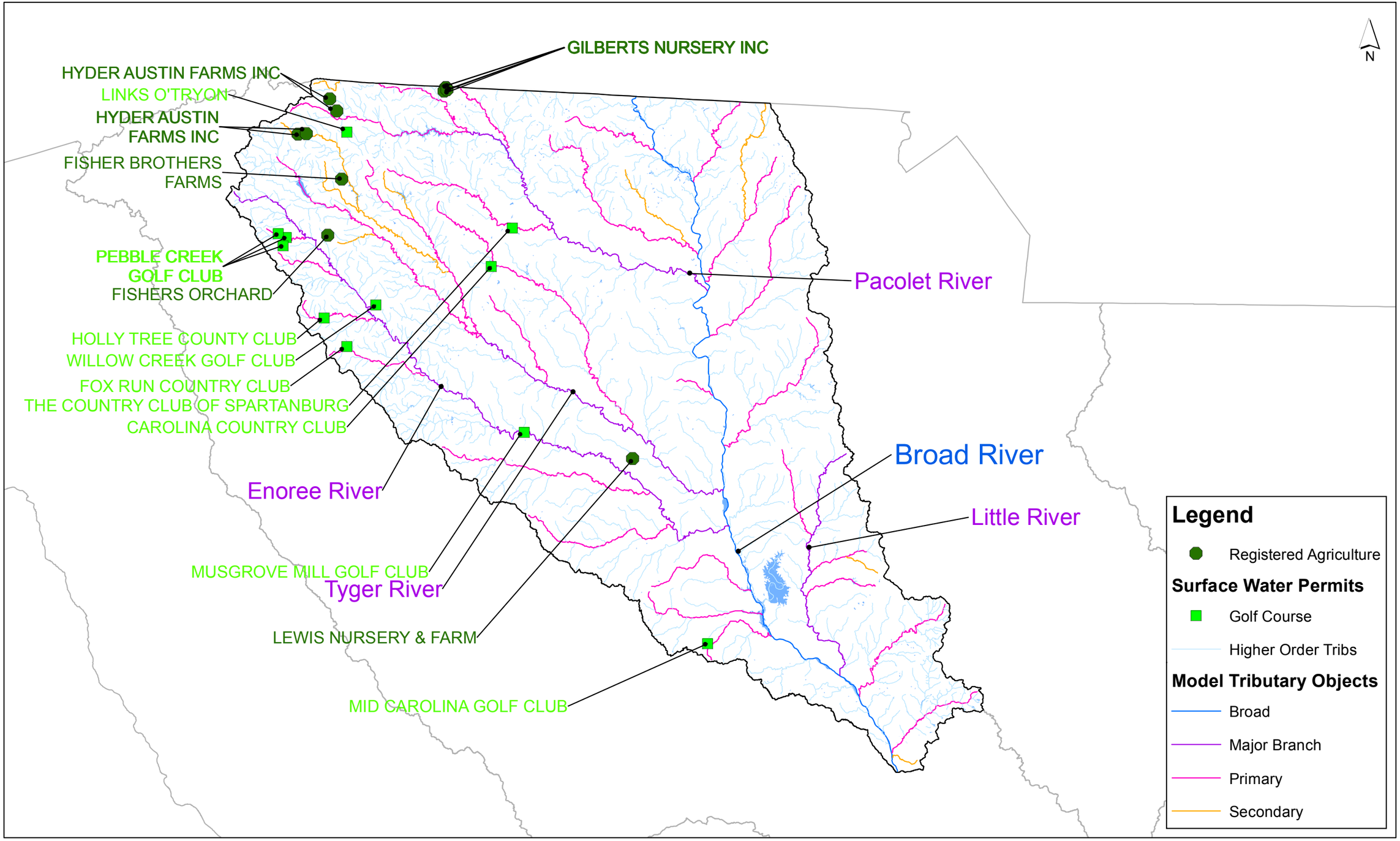

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Figure 4: Registered Agricultural Users and Golf Courses

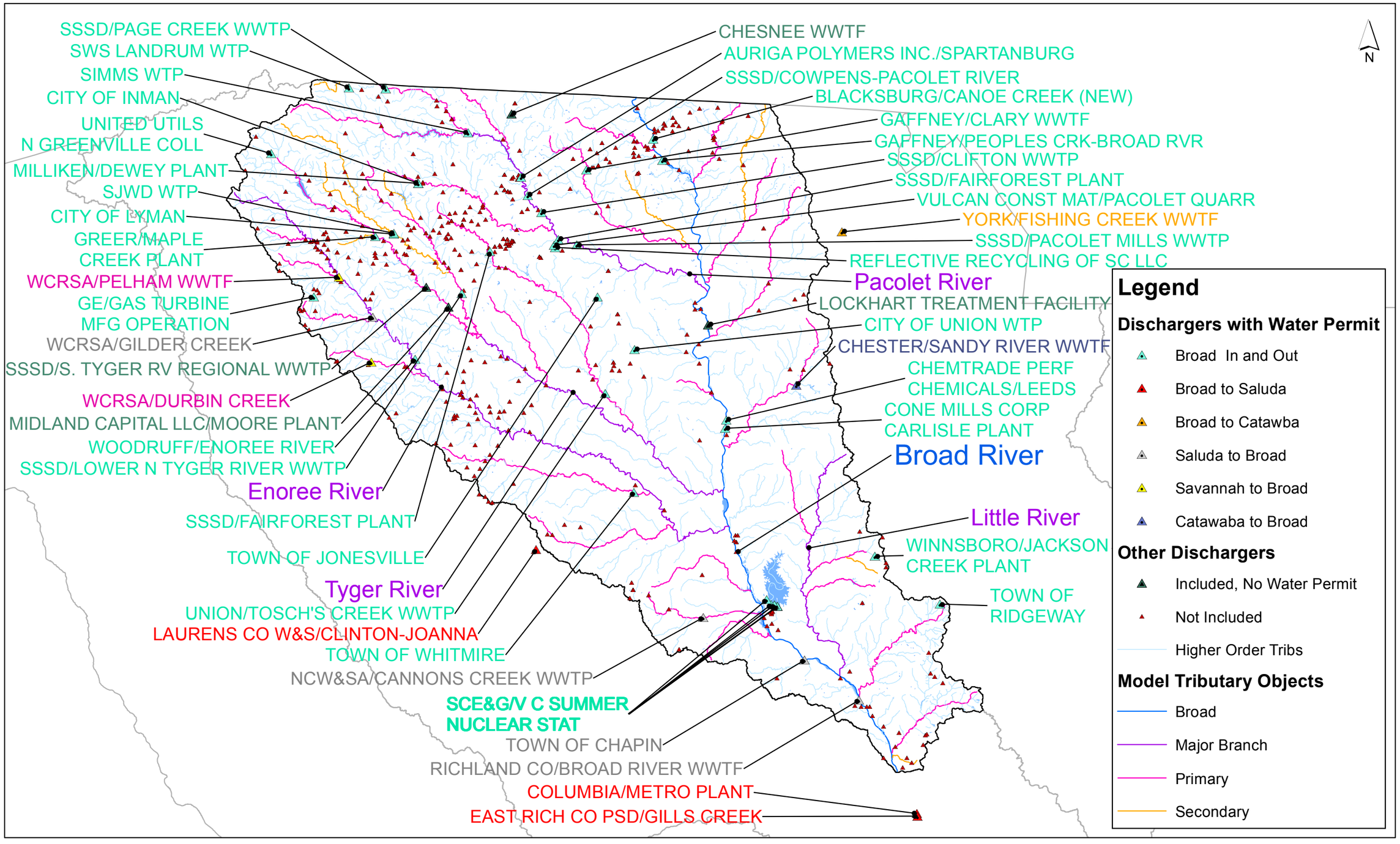
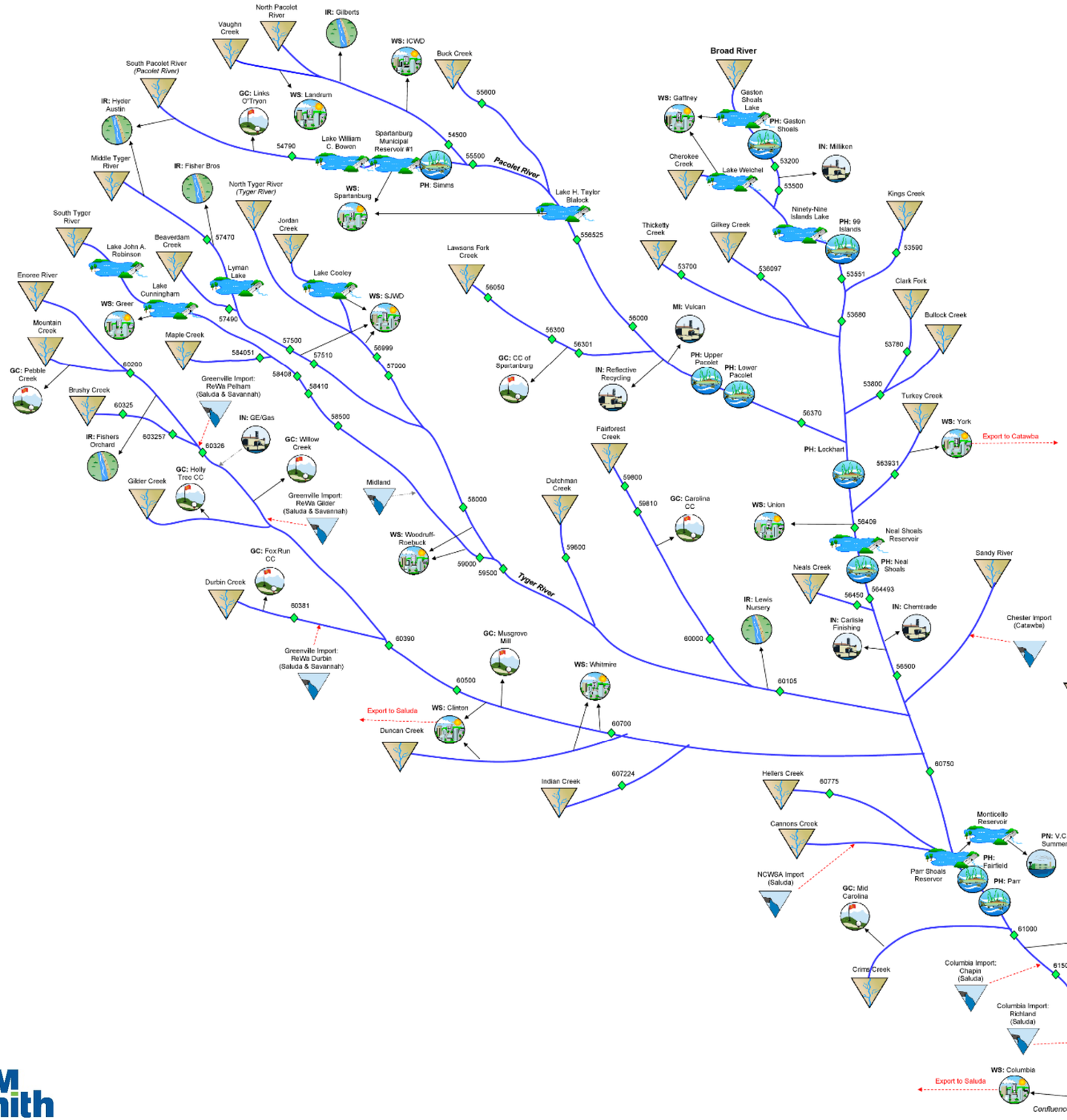


Figure 5: Dischargers

Figure 6. Broad River Basin SWAM Model Framework



Model Objects

- Tributary
- Discharge
- Instream Flow (used with Hydropower)
- Reservoir
- Current or Former USGS Stream Gage *(with last 5 to 6 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.*

CDM Smith