



Memorandum

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

From: CDM Smith

Date: October 2015

Subject: Catawba-Wateree River Basin SWAM Model Framework

This memorandum presents the Simplified Water Allocation Model (SWAM) framework for the Catawba-Wateree 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 Catawba-Wateree River Basin model framework.

Table 2 NPDES discharges included in the Catawba-Wateree River Basin model framework.

Table 3 Interbasin transfers included in the Catawba-Wateree River Basin model framework.

Figure 1 Overview Map

This map consolidates and presents all active permitted and registered water users, which are those greater than 3 million gallons in any month (Mg/m); significant discharge locations; USGS stream gage locations; the “main stem” consisting of the Catawba and Wateree rivers; major reservoirs; and major 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 Mg/m. In some instances, discharges which average less than 3 mg/m are included because they are directly associated with a permitted withdrawal. Note that the withdrawal and discharge threshold of 3 Mg/m is similar to the 0.1 million gallon per day (mgd) threshold that the Catawba-Wateree Water Management Group (CWWMG) has been using in their river basin modeling and water supply planning work.

Figure 2 Model Tributaries and USGS Gages

This map presents the Catawba-Wateree 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. In the Catawba-Wateree River Basin, it is anticipated that several unused/ungaged tributaries in the middle and lower portion of the basin will be represented implicitly, as shown in Figure 2. Implicit tributaries serve as point inflows to a larger, explicitly simulated reach (to represent smaller, incremental flow inputs). Flows from these tributaries, delivered to downstream reaches are important to the overall basin water balance and thus are included as point sources in the models.

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.

Figure 4 Registered Agricultural Users

This map presents the location of registered agriculture 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 outside of the Catawba-Wateree River Basin (City of York). Additionally, there are two water users that discharge outside the basin: Chester Sewer District (CSD) and Lancaster County Water and Sewer District (LCW&SD). 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 typically included, as are those directly associated with a permitted withdrawal.

Figure 6 Catawba-Wateree River 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 Catawba-Wateree River Basin is the City of Rock Hill, 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 Catawba-Wateree River Basin, some dischargers that do not have associated surface water withdrawals are represented in this manner. 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., Clariant). 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.

Operating rules (minimum releases, monthly or seasonal rule curves, etc.) associated with the seven hydropower facilities that occur along the Catawba River and Wateree River will be represented by the associated Reservoir object. Operating rules, as detailed in existing CWWMG technical reports and/or provided by Duke Power, will be reviewed and included during model development. These will include both historical rules, for the calibration model, and current rules, for the baseline model. Within SWAM, both simple and complex operating rules can be included within Reservoir objects.

The SWAM model's upstream boundary is represented by Lake Wylie. Lake Wylie resides in both North Carolina and South Carolina, and has surface water withdrawals from portions of the lake in both states. North Carolina withdrawals (and discharges) in Lake Wylie from Duke's Allen Steam Station and the City of Belmont will be included in the model; however, these are not subject to regulation by South Carolina. Note that other withdrawals/dischargers in North Carolina from/to the Lake and its drainage basin may be accounted for in the inflow data series (if impaired flows are used) or as a separate, aggregated water user object (if unimpaired flows are used).

Similar to the other basins already in development, the guiding principles in determining what elements of the Catawba-Wateree 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 Catawba and Wateree Rivers.
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 previously noted, several tributaries will be represented implicitly, as point inflows to a larger, explicitly simulated reach.

Note that the mainstem (Catawba River and Wateree River) unimpaired flows (UIFs) have already been developed by DTA (now HDR, Inc.) under contract to Duke Energy Carolinas, LLC, as reported in the Operations/Verification Report for the Catawba-Wateree CHEOPS Model, 2006. The UIFs were recently updated by HDR, Inc. to include daily inflows through December 2010. CDM Smith will enhance the existing UIF dataset by adding UIF points and calculating UIFs along significant tributaries to the mainstem and on the mainstem itself, between Lake Wylie and Fishing Creek Reservoir. CDM Smith will also develop tributary UIFs and geographically extend the UIFs below Lake Wateree. Further discussion of this approach will be presented in the UIF methodology memorandum.

As tributary UIFs are developed throughout the basin (within South Carolina), 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 basin, there are a several tributaries that are explicitly included but have no significant withdrawals or discharges (e.g., Rocky Creek and Sugar Creek). 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, the CWWMG and other stakeholders within the Catawba-Wateree 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 Catawba-Wateree River Basin, and feedback will be used to refine the framework as appropriate.

Table 1. Permitted and registered surface water users included in the Catawba-Wateree River Basin model framework.

ID	Type	Facility Name	Withdrawal Tributary	Model Object ID
12PH001S01	PH	Dearborn Hydro	Catawba River	Great Falls Lake
12PH002S01	PH	Fishing Creek Hydro	Fishing Creek Reservoir/ Catawba River	Fishing Creek Reservoir
12PH003S01	PH	Great Falls Hydro	Great Falls Lake/ Catawba River	Great Falls Lake
12WS002S01	WS	Chester Metropolitan District	Catawba River	WS: Chester
20PH003S01	PH	Rocky Creek Hydro	Rockey Creek Lake/Catawba River	Rocky Creek Lake
28GC006S01	GC	The Members Club At Woodcreek And Wildewood	Spears Creek	GC: The Members
28IR011S01	IR	Belger Farms	Swift Creek	IR: Belger
28IR011S02	IR	Belger Farms	Big Pine Tree Creek	IR: Belger
28MI002S01	MI	Unimin Corp	Gillies Creek	MI: Unimin
28MI002S02	MI	Unimin Corp	Gillies Creek	MI: Unimin
28PH001S01	PH	Wateree Hydro	Lake Wateree/Wateree River	Lake Wateree
28WS001S01	WS	City of Camden	Lake Wateree/Wateree River	WS: Camden
28WS004S01	WS	Lugoff-Elgin Water Authority	Lake Wateree/Wateree River	WS: Lugoff-Elgin
28WS006S01	WS	Invista Sarl*	Wateree River	WS: Invista
29IN004S01	IN	Springs Global Us Inc	Catawba River	IN: Springs Global
29PH001S01	PH	Cedar Creek Hydro	Catawba River	Rocky Creek Lake
29WS005S01	WS	Lancaster County Water & Sewer District	Catawba River	WS: LCW&SD
40GC001S01	GC	Columbia Country Club	Rice Creek	GC: Columbia CC
40IN002S01	IN	International Paper Company Eastover Mill	Wateree River	IN: International Paper
40PT001S01	PT	SCE&G-Wateree Station	Wateree River	PT: SCE&G Wateree
43IR011S01	IR	Triple J Farms	Beech Creek	IR: Triple J
43IR054S01	IR	SC Dept of Corr Wateree Riv Co	Swift Creek	IR: SC Dept of Corr
43IR054S02	IR	SC Dept of Corr Wateree Riv Co	Swift Creek	IR: SC Dept of Corr
43IR054S03	IR	SC Dept of Corr Wateree Riv Co	Wateree River	IR: SC Dept of Corr
43IR054S04	IR	SC Dept of Corr Wateree Riv Co	Wateree River	IR: SC Dept of Corr
43IR054S05	IR	SC Dept of Corr Wateree Riv Co	Swift Creek	IR: SC Dept of Corr
43IR054S06	IR	SC Dept of Corr Wateree Riv Co	Swift Creek	IR: SC Dept of Corr
43IR054S07	IR	SC Dept of Corr Wateree Riv Co	Swift Creek	IR: SC Dept of Corr
43IR054S08	IR	SC Dept of Corr Wateree Riv Co	Wateree River	IR: SC Dept of Corr
43IR054S09	IR	SC Dept of Corr Wateree Riv Co	Wateree River	IR: SC Dept of Corr
43IR054S10	IR	SC Dept of Corr Wateree Riv Co	Swift Creek	IR: SC Dept of Corr
43IR054S11	IR	SC Dept of Corr Wateree Riv Co	Wateree River	IR: SC Dept of Corr
46GC002S01	GC	City of Tega Cay	Lake Wylie/Catawba River	GC: Tega Cay
46GC004S01	GC	River Hills Country Club	Lake Wylie/Catawba River	GC: River Hills CC
46IN002S01	IN	Nation Ford Chemical Co	Catawba River	IN: Nation Ford
46IN006S01	IN	Resolute FP US Inc	Catawba River	IN: Resolute
46IR028S01	IR	The Peach Tree	Allison Creek	IR: Peach Tree
46PH001S01	PH	Wylie Hydro	Lake Wylie/Catawba River	Lake Wylie
46PN001S01	PN	Duke Energy Carolinas LLC	Lake Wylie/Catawba River	PN: Duke Catawba Station
46PN001S02	PN	Duke Energy Carolinas LLC	Lake Wylie/Catawba River	PN: Duke Catawba Station
46PN001S03	PN	Duke Energy Carolinas LLC	Lake Wylie/Catawba River	PN: Duke Catawba Station
46WS003S01	WS	City of Rock Hill	Catawba River	WS: Rock Hill
46WS003S02	WS	City of Rock Hill	Lake Wylie/Catawba River	WS: Rock Hill
no permit**	GC	Windmere Golf Club	Rice Creek	GC: Windmere

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

* Withdrawal for both industrial use and public water supply

** Windmere does not have a surface water withdrawal permit, but has been included based on their historical water use

Table 2. NPDES discharges included in the Catawba-Waterree River Basin model framework.

NPDES Pipe ID	Facility Name	Discharge Tributary	Associated Surface Water Permit	Associated Groundwater Withdrawal ID	Model Object ID
SC0038121-001	International Paper/Eastover	Waterree River	40IN002	40IN002G	IN: International Paper
SC0035360-01A	Nation Ford Chemical Company	Catawba River	46IN002		IN: Nation Ford
SC0001015-001	Bowater Inc/Coated Paper Div	Catawba River	46IN006		IN: Resolute
SC0001015-01A	Bowater Inc/Coated Paper Div	Catawba River	46IN007		IN: Resolute
SC0003255-001	Springs Global/Grace Complex	Catawba River	29IN004		IN: Springs Global
SC0003255-01A	Springs Global/Grace Complex	Catawba River	29IN005		IN: Springs Global
SC0002585-001	Invista S.A.R.L./Camden	Waterree River	28WS006		WS: Invista
SCG730382-001	Unimin Corporation-Lugoff Facility	Gillies Creek	28MI002		MI: Unimin
SCG730382-002	Unimin Corporation-Lugoff Facility	Gillies Creek	28MI002		MI: Unimin
SC0004278-001	Duke Energy/Catawba Nuclear	Allison Creek	46PN001		PN: Duke Catawba Station
SC0004278-002	Duke Energy/Catawba Nuclear	Allison Creek	46PN001		PN: Duke Catawba Station
SC0004278-005	Duke Energy/Catawba Nuclear	Allison Creek	46PN001		PN: Duke Catawba Station
SC0004278-006	Duke Energy/Catawba Nuclear	Catawba River	46PN001		PN: Duke Energy
SC0002038-03A	SCE&G/Waterree Station	Waterree River	40PT001	40WS012G	PT: SCE&G Waterree
SC0021032-001	Camden WWTF	Waterree River	28WS001		WS: Camden
SCG646025	Camden Water Treatment Plant	Grannies Quarter Creek	28WS001		WS: Camden
SC0001741-001	Chester/Lando-Manetta Plant	Fishing Creek	12WS002		WS: Chester
SC0021211-001	Great Falls WWTF	Rocky Creek	12WS002		WS: Chester
SC0036056-001	Chester/Rocky Creek Plant	Rocky Creek	12WS002		WS: Chester
SCG646007	Robert W. Hemphill Filtration Plant	Catawba River	12WS002		WS: Chester
SC0030112-001	CWS/Lamplighter Village SD	McAlpine Creek	29WS005		WS: LCW&SD
SC0046892-001	Lancaster/Catawba River	Cane Creek	29WS005		WS: LCW&SD
SCG646000	Catawba River WTP	Catawba River	29WS005		WS: LCW&SD
SC0047864-001	Lancaster Co/Indianland WWTP	Catawba River	29WS005		WS: LCW&SD
SCG646020	Lugoff-Elgin Water Authority Water Plant	Waterree River	28WS004		WS: Lugoff-Elgin
SC0039870-001	Kershaw Co/Lugoff WWTF	Waterree River	28WS004	28WS004G	WS: Lugoff-Elgin
SC0020371-001	Fort Mill WWTF	Catawba River	46WS003		WS: Rock Hill
SC0020443-001	Rock Hill/Manchester Creek	Catawba River	46WS003		WS: Rock Hill
SC0026743-001	Tega Cay WWTP #2	Catawba River	46WS003		WS: Rock Hill
SC0026751-001	Tega Cay #3 And #4 WWTF	Catawba River	46WS003		WS: Rock Hill
SC0026751-002	Tega Cay #3 And #4 WWTF	Catawba River	46WS003		WS: Rock Hill
SC0002682-001	Clariant LSM (America) Inc	Spears Creek	none	28IN008G	IN: Clariant
SC0047384-001	New South Lumber Co/Camden Plant	Sanders Creek	none	28IN010G	New South Lumber
SC0045349-001	SC Dept Corr/Waterree River	Waterree River	none	43WS011G	WS: SC Dept Corr
SC0002518-001	Deroyal Textiles	Big Pine Tree Creek	none	none	Deroyal
SC0024970-002	USAF/Shaw Air Force Base	Beech Creek	none	none	USAF/Shaw AFB
SC0041378-003	Kennecott/Ridgeway Gold Mine	Twentyfive Mile Creek	none	none	Kennecott Mine
SC0041378-03A	Kennecott/Ridgeway Gold Mine	Twentyfive Mile Creek	none	none	Kennecott Mine
SC0047902-001	Finnchem USA Inc	Waterree River	none	none	Finnchem

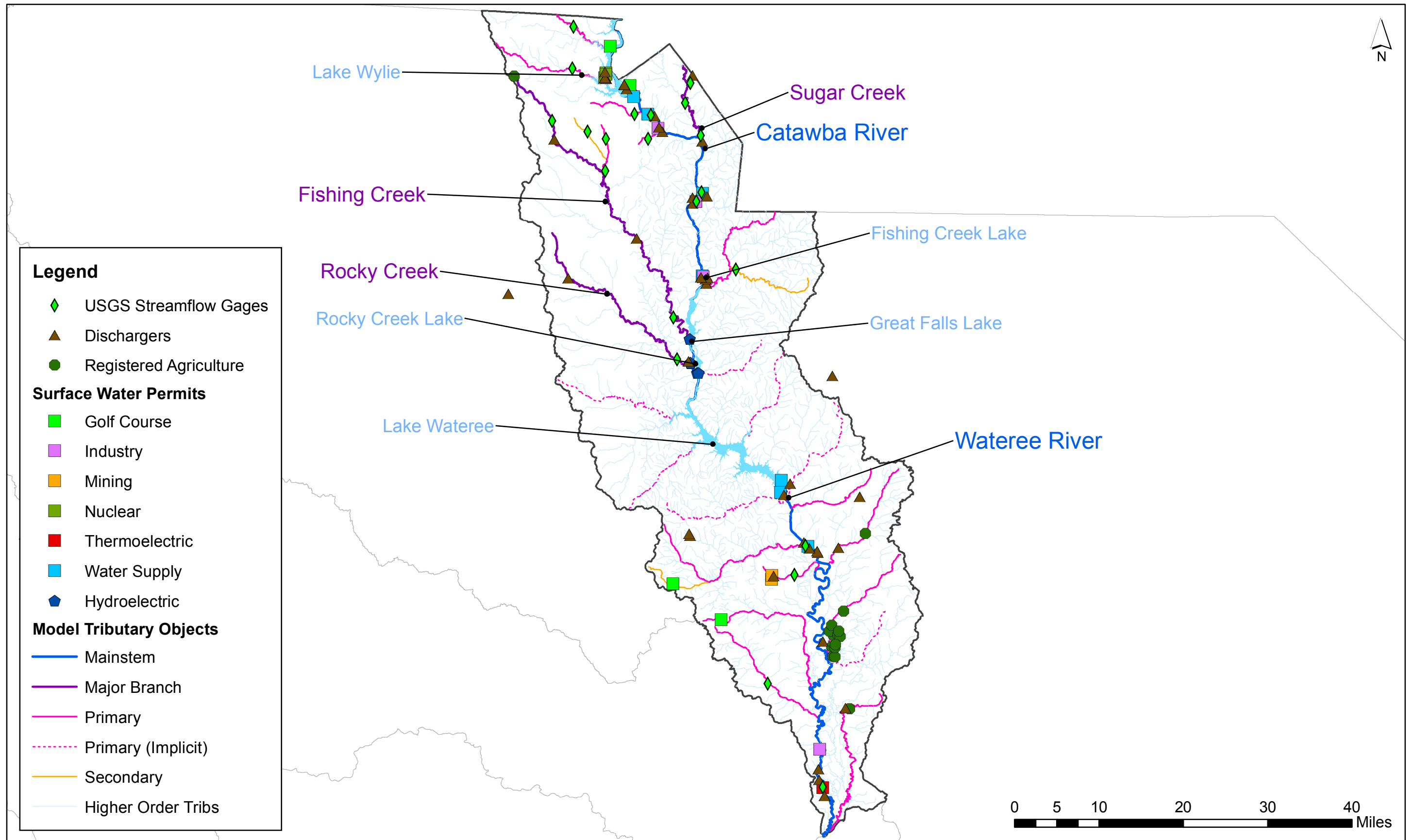
No shading identifies dischargers that have a surface water withdrawal permit and are represented by a Water User object.

Blue shading identifies dischargers that have a public water supply permit or registration to withdraw groundwater, but no surface water permit, and are Gray shading identifies dischargers that do not have a public water supply permit or registration to withdraw groundwater, and are represented by a Discharge model object.

Table 3. Interbasin transfers included in the Catawba-Wateree River Basin model framework.

NPDES Pipe ID	NPDES Facility Name	Associated Water Permit	Associated Water Permit Facility	Intake Basin	Discharge Basin	Location of Discharge in Catawba Basin	Model Object ID
SC0038156-001	York/Fishing Creek WWTF	46WS002	City of York	Broad	Catawba	Fishing Creek	York
SC0036081-001	Chester/Sandy River WWTF	12WS002	Robert W. Hemphill Filtration Plant	Catawba	Broad	-	WS: Chester
SC0025798-001	Kershaw/Hanging Rock Creek	29WS005	Lancaster County Water & Sewer District	Catawba	Pee Dee	-	WS: LCW&SD

Note: Some water associated with the Town of Winnsboro's withdrawal (20WS001) in the Broad River Basin is discharged in the Catawba River Basin via septic systems. It is not included in the model framework.



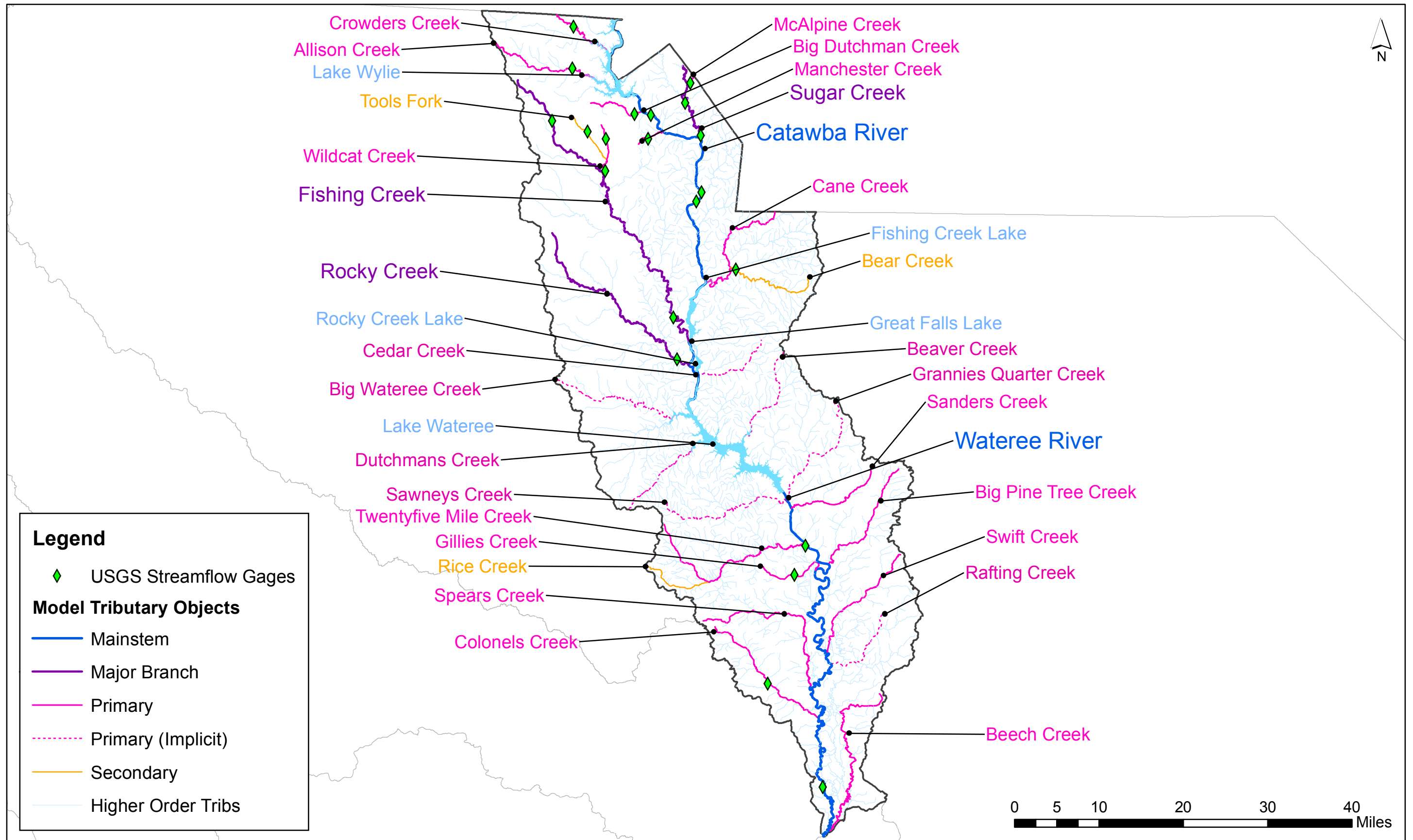


Figure 2: Model Tributaries and USGS Streamflow Gages

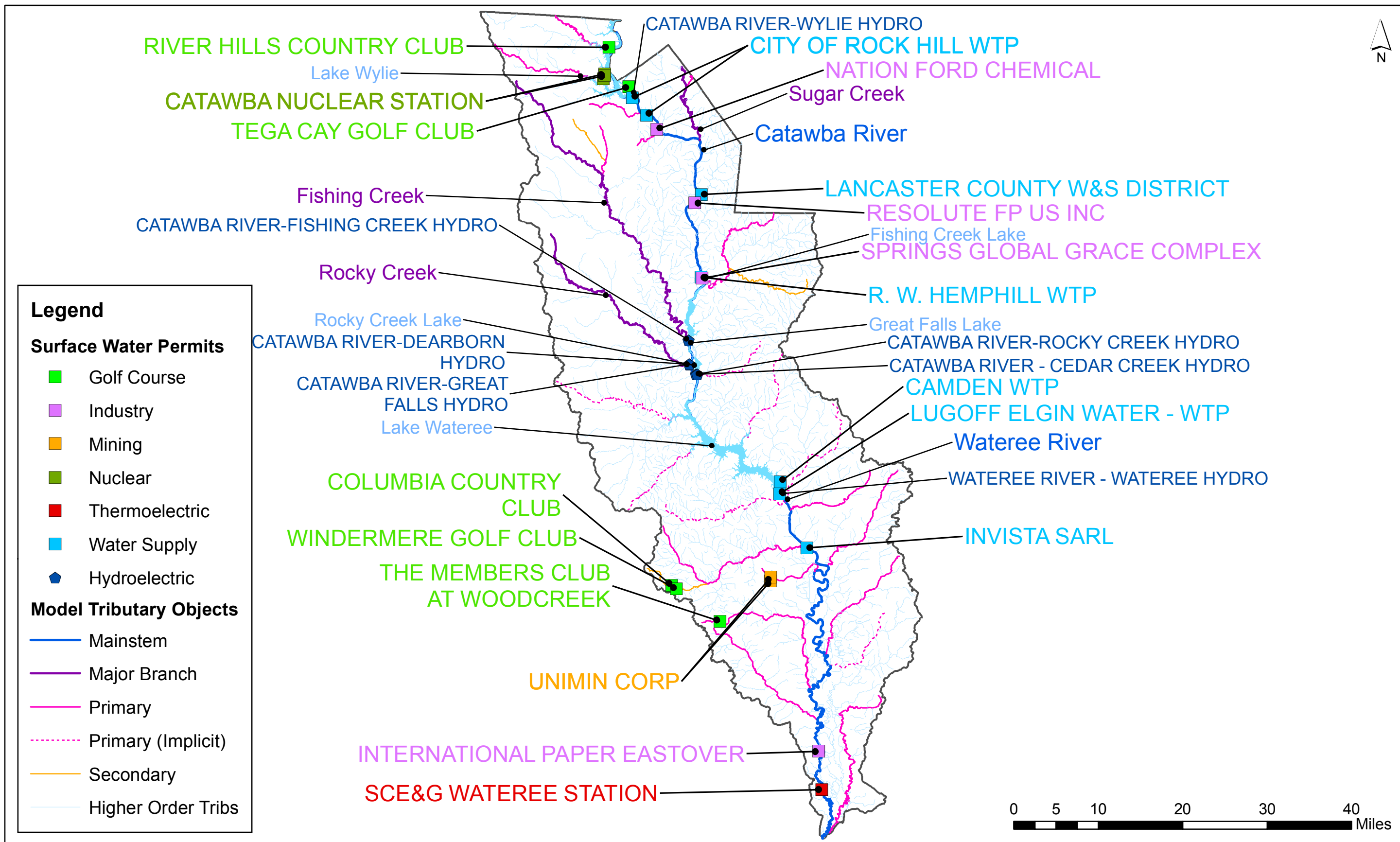


Figure 3: Permitted Surface Water Users

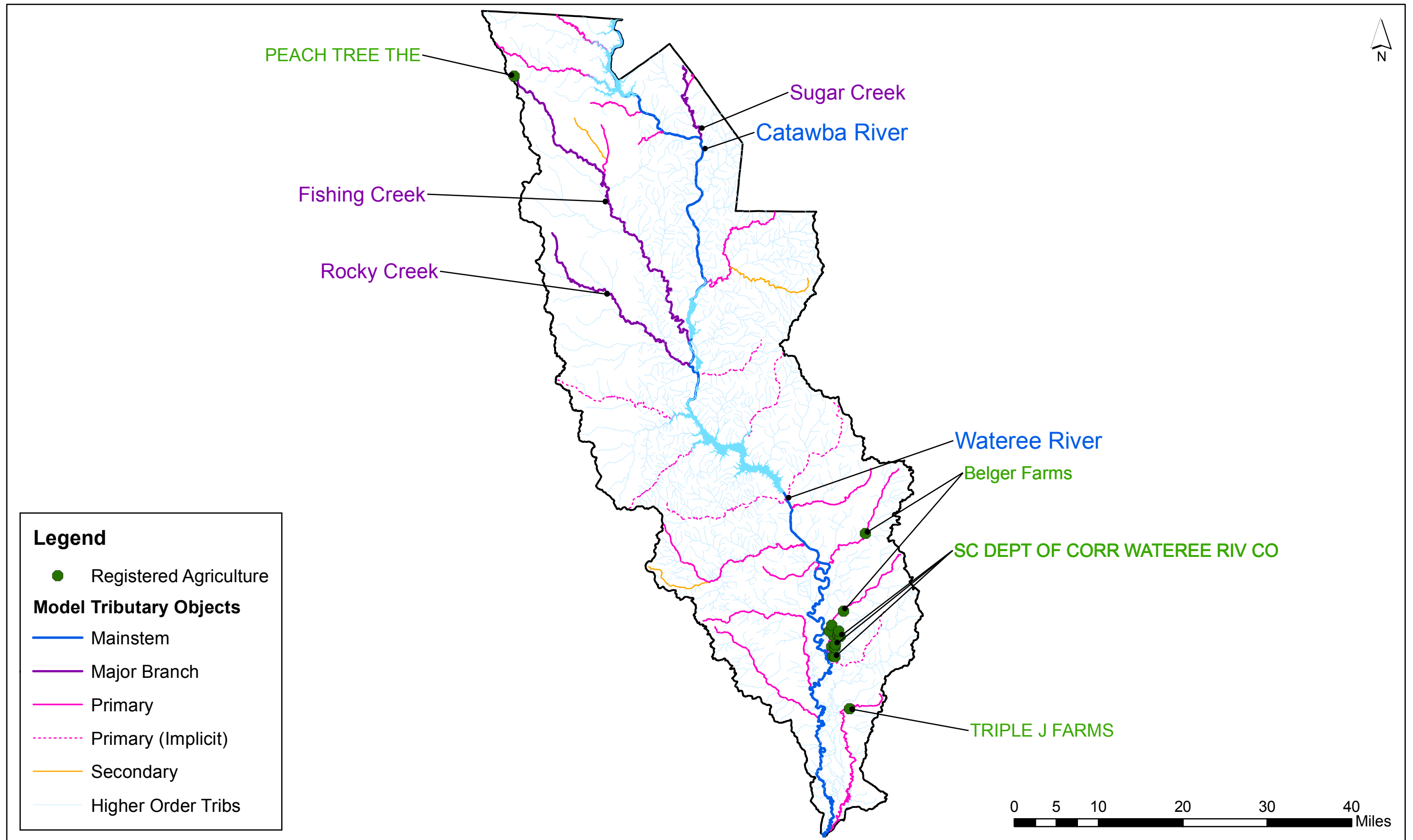


Figure 4: Registered Agricultural Users

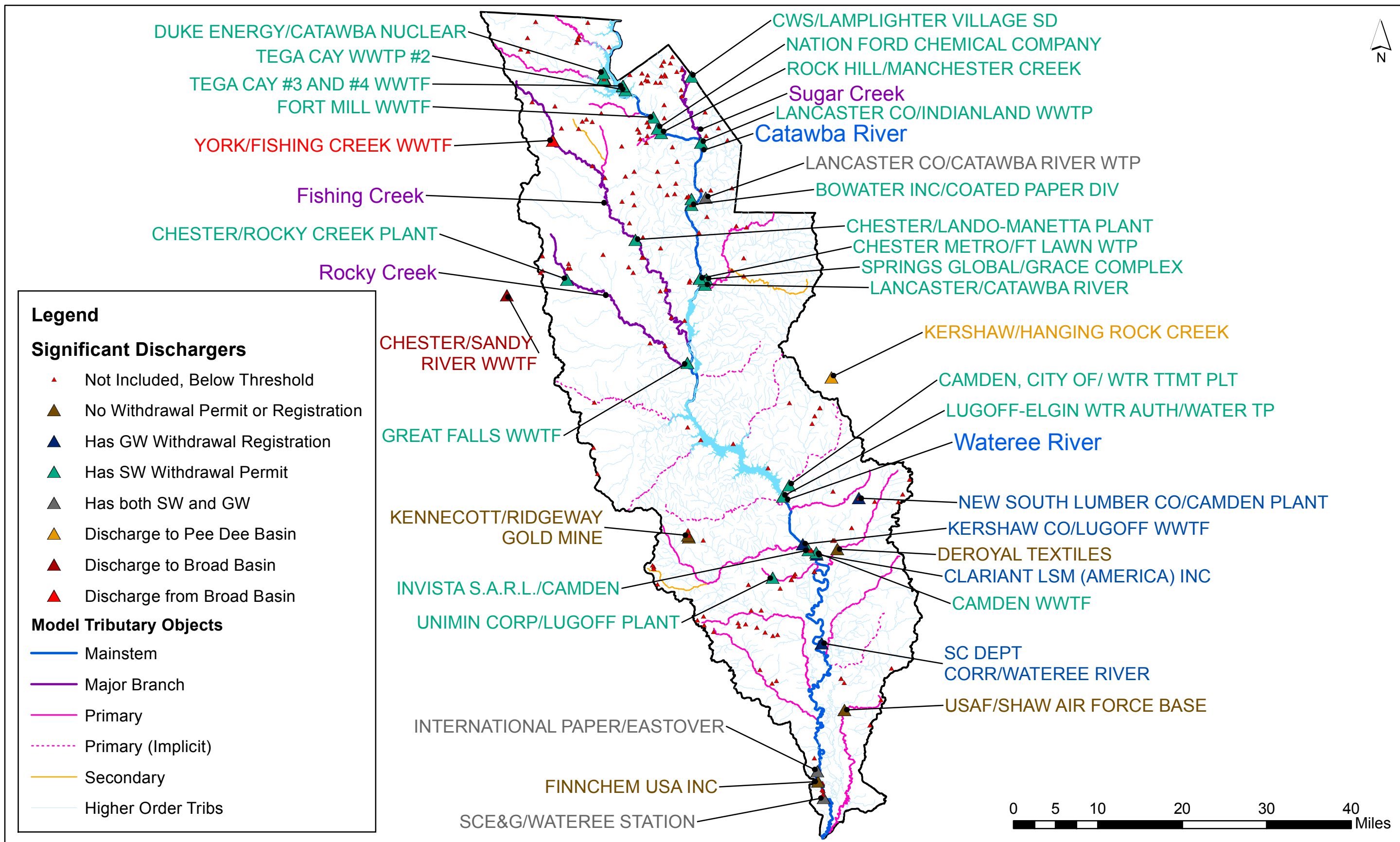


Figure 5: Dischargers

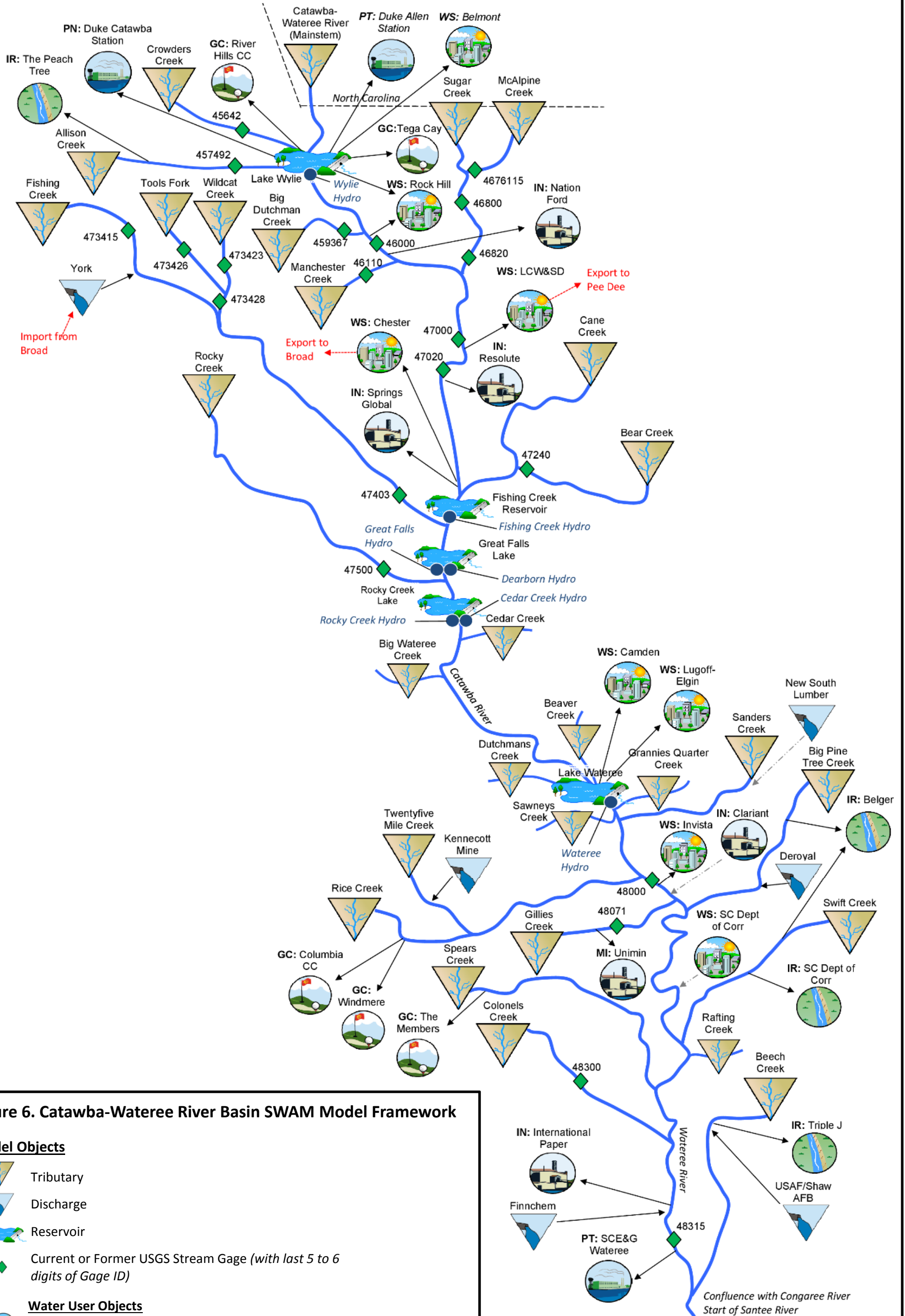









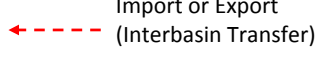
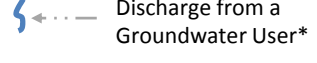


Figure 6. Catawba-Wateree River Basin SWAM Model Framework

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.