Assessing Biological Impacts to Streams Due to Small Impoundments in North Carolina to Support 401 Certification Policies

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Table of Contents

TABLES

FIGURES

APPENDICES

Executive Summary

North Carolina (NC) currently has difficulty fully assessing the risks to streams when considering 401 Certification applications for small (surface area of 10-100 acres) impoundments of headwater (≤3rd Strahler order) streams. Results from a Tennessee study (Arnwine 2006), NC monitoring data, and the existing literature suggested that this type of authorized activity can have negative effects on water quality and aquatic life uses in impounded streams. This raised concerns at NC Division of Water Resources (NC DWR) regarding possible environmental risks with such projects in NC. However, available data collected on small headwater impoundments specifically in NC were sparse. In cases where 401 Certifications were being sought to build these types of small impoundments, the NC DWQ 401 Certification Unit was uncertain how to assess the effects on water quality of these projects. The US EPA Region IV Wetland Program Development Grant program (CD 94571111) funded a study to determine effects on water quality and aquatic life use associated with these impoundments and their immediate downstream reaches. The results of that grant led to this grant which was awarded to make informed regulatory decisions regarding the extent and scale of the downstream impacts of these types of projects.

The metrics that were examined as part of this grant were: Temperature, Chlorophyll-a, Biotic Index, EPT Taxa Richness, Bioclassification and the behavior of the shredder, grazer and filter feeding portions of the invertebrate community. Temperature increased below the impoundment an average of 4.3°C for large streams and 8°c for small streams. Half of that spike was dissipated within 0.5-1 mi^2 downstream, however this left the streams 2-5°c warmer than above the impoundment. Chlorophyll-*a* in mountian streams and small piedmont streams went from <2μg/l upstream to a mean of 4μg/l below the dam then quickly falling back to upstream levels. Large Piedmont streams showed bloom levels of chl-a below the impoundment, which required 1-5 mi^2 downstream to dissipate.

Biotic Index (BI) rose (got worse) by 1.5 units for piedmont streams and 3 units for mountain streams. Piedmont streams required 3-10mi^2 to recover to upstream conditions, while mountain streams recovered half of the impairment within the first 0.25mi^2, but made no further recovery. Streams behaved without much consistency in terms of EPT Taxa Richness (EPTS). Of 12 streams studied, seven showed delines of 60-75%, three declined by 85%, while two only declined 33%. Five streams recovered within 1mi^2, three recovered at 3.5, 4 and 9.5mi^2 and four never recovered. Bioclassification, upon which Use Support decisions are based, is made up BI and EPTS, so behaved similarly. Seven of 12 streams dropped two bioclasses below the dam, three dropped one bioclass, one stream dropped 3 bioclasses and one dropped four (Excellent to Poor). Six streams recovered in <1mi^2, two between 1-5mi^2, and 4 >9mi^2.

Functional feeding groups are open to more interpretation than previous metrics, yet some interesting patterns could still be detected. The impoundment did appear to act as a break in the river continuum, depriving reached downstream of the pool of leaves for shredders. Shredder populations droped from 13-20% of the population upstream to 5% below the dam with a relatively rapid recovery to 8-10%, but never a complete recovery to upstream levels. Grazers responded less to the dam than to reach scale differences in canopy and resulting light attenuation. Filter feeders, like Chl-*a*, had two distinct patterns. In mountain streams and small piedmont streams, there was a spike in filter feeders, from 17% to 28-38% immediately below the impoundment, presumably grazing on the phytoplankton being discharged from the impoundment which

quickly dropped back to the 20-25% range, where it stayed. Large piedmont streams, were problematic. Additional sampling showed that large piedmont streams behaved more like streams with impoundments in urbanized watersheds in that below impoundment impairment of water quality limited the size of the generally intolerant filter feeding community even in the presence of an abundance (bloom levels) of Chl-*a*.

Based on the results of this grant, as well as previous work, there can be no doubt that imoundments cause impairment to the ecology of flowing water (lotic) systems, both within the pool and for a varying distance downstream of the impoundment. Many impairments have largely dissipated within a relatively short distance (0.25-1mi^2), however there are some streams that never fully recover. Based on this, it is recommended that permits for instream impoundments should be limited to projects that have a clear public purpose such as water supply or flood control and that one way to discourage amenity impoundments would be to require some level of mitigation for the impairment of funtions both the length of the pool, but also for some distance, perhaps 0.5-1mi^2 downstream of the dam as well.

I. Introduction

North Carolina (NC) currently has difficulty fully assessing the effects on water quality when considering 401 Certification applications for small (surface area of 10-100 acres) impoundments of headwater (≤3rd Strahler order) streams. Results from a Tennessee study (Arnwine 2006) suggested that this type of authorized activity can have negative effects on water quality and aquatic life uses in impounded streams. This has raised concerns at NC Division of Water Quality (NC DWQ) regarding possible environmental risks with similar projects in NC, such as loss of uses within the impounded section of the stream or below the impounded reach. However, available data collected on small headwater (first- to third-order stream) impoundments specifically in NC were sparse. In cases where 401 Certifications were being sought to build these types of small impoundments, the DWQ 401 Certification Unit was uncertain how to assess the effects on water quality associated with these projects. Funding was obtained from the US EPA Region IV Wetland Program Development Grant program to fund this study in order to determine water quality and aquatic life use impacts associated with these impoundments and their downstream reaches in order to make informed regulatory decisions regarding these types of projects.

Background

North Carolina has few natural lakes and those that exist are located in the coastal area of the state. A large number of artificial impoundments exist throughout the state to serve a wide range of purposes, including public water supplies, fire suppression, recreation, aesthetics, irrigation, hydroelectric power, and flood control. These lentic (impounded) systems can also provide ecosystem services that are different than those provided by lotic (flowing stream) systems, such as sediment removal and habitat for wildfowl, reptiles, amphibians, and sport fish. Impoundments can also provide economic benefits, such as those associated with recreational use and increases in the property tax base. However, the literature suggests that impounding flowing streams may have some negative effects on water quality, both within the impounded reach and downstream (see Baxter 1977 for an overview). One concern is nutrient enrichment, which can increase primary productivity by algae and plants, which in turn can lead to decreased oxygen, increased pH, increased chlorophyll-*a* concentrations, impacts on fish communities, effects on aesthetics/recreational use, and taste and odor problems for water supplies. And while impoundments may provide suitable habitat for wildfowl and sportfish, it may be at the detriment of native species. For example, loss of habitat and isolation of populations due to dams are considered the most serious impacts to the endangered Cape Fear shiner (*Notropis mekistocholas*) (USFWS 2004), which is endemic to the Piedmont region of NC. Changes to instream conditions below dams, such as decreases in dissolved oxygen and alterations of temperature and flow regimes, have been shown to have deleterious impacts on a variety of instream biota (Poff 1997).

Probabilistic monitoring of streams below small impoundments in Tennessee

The Tennessee Department of Environment and Conservation published results of a large, probabilistic-design project to determine instream effects below artificial impoundments of small, headwater systems across Tennessee (Arnwine, 2006). A total of 75 sites were selected from across the state in proportions equivalent to impoundment frequency within each level 4 ecoregion. The monitoring effort addressed chemical, physical, aquatic life, and habitat assessments below impoundments. Results were compared to state water quality standards and state-specific screening values derived from regional, first-order stream reference sites. Major findings were:

- The great majority of sites failed to meet reference guidelines for aquatic insects in the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT; generally the most intolerant taxa) for both number of taxa (96%) and abundance (86%). When examining all taxa, 87% of sites did not meet taxa richness guidelines and showed a general shift towards more tolerant communities.
- Insufficient flow was present to support aquatic life below approximately 39% of monitored impoundments. During site reconnaissance, lack of flow below dams was the most common reason (32%) given for disqualification of candidate study sites.
- Approximately 50% of monitored streams showed signs of active bank instability.
- Instream habitat was degraded, primarily due to sediment deposition, at 80% of sites.
- Nutrients were elevated and dissolved oxygen concentrations were lower as compared to reference condition.
- Violation of temperature water quality standard criteria was relatively rare (8 of 75 sites), though 69% of sites were above the 90th percentile of reference values.
- Total suspended solids (TSS) were elevated above reference values at approximately half of the study sites.
- Nutrients exceeded regional reference standards for ammonia (~80% of sites), total phosphorus (~75%), TKN (~65%), and nitrite+nitrate (~40%).
- Periphyton density was greater than reference levels at approximately half of sites.
- Stressors may persist for as far as 1/4-mile downstream of dams.

Each of these effects was found within multiple ecoregions in Tennessee. The authors concluded that these small, headwater impoundments have deleterious effects on downstream reaches throughout the state.

First NC impoundments monitoring

In 2010 the EPA awarded North Caroina a grant to examine the metrics identified by the Tennessee study with the objective of confirming or refuting the Tennessee observations in North Carolina waters. Twelve small impoundments in the Mountains and Piedmont of North Carolina were identified and sampled in four locations each – upstream of the pool (A), middle of the impoundment (B), near the dam (C) and below the dam (D) - for a suite of water quality metrics. Sampling occurred in 2011. Temperature was collected with data loggers every 15 minues for a year. Water chemistry was collected three times in the growing season for Dissolved Oxygen, pH, Specific Concuctance, Total Kjeldahl Nitrogen, Nitrate-Nitrite (NOx), Total Nitrogen, Total Phosphorus, Chlorophyll-a, and Total Suspended Solids. Periphyton biomass, habitat assessment and benthic macroinvertebrates were collected once.

- While Table 1 is a summary of the findings of the study, several individual results are worthy of notice.
- Summertime temperature increases below the dam ranged from 0-9^{o}C compared to upstream. Maximum allowable temperature for Trout Waters (20^{o}C) was regularly violated.
- Lakes became more eutrophic closer to the dam than near the inlet. Periphyton levels were much higher in the lake than above and that eutrophication continued immediately below the dam.
- The downstream benthic community was much more tolerant than the upstream community (mean 5.8 out of 10 compared to 3.6), however the benthic community in the lake was much more tolerant than either (mean 9 of 10).

- While not statistically significant, there was a trend toward an increase in filter feeders and a decline in the grazer and shredder components of the benthic community below the dam compared to upstream.

Table 1 Summary of significant (p<0.05) differences found in matched pair analyses. A, B, C, and D are monitoring stations. Red indicates the change is in an unfavorable direction; green indicates a change in a favorable direction; black indicates the direction is neither favorable nor unfavorable. Blank cells indicate no significant change. "-" indicates that comparisons were not made for that matched pair and parameter.

	BLUE RIDGE						PIEDMONT					
	B-A	C-A	C-B	D-A	D-B	D-C	B-A	C-A	C-B	D-A	D-B	D-C
DO % saturation				↓	↓	↓					↓	↓
DO concentration	↓	↓		↓			↑	↑			↓	↓
pH						↓						
SC					↑	↑	↓	↓			↑	↑
Temperature	↑	↑		↑	↓	↓	↑	↑	↑	↑	↓	↓
NOx	↓	↓		↓	↑	↑	↓	↓		↓	↑	
TKN							↑	↑		↑		
TN	↓	↓	↑	↓	↑					↑		
TP	↓										↑	
TN:TP				↓			↑	↑				
Chlorophyll	↑	↑	↑	↑	↓	↓	↑	↑	↑	↑		
Secchi	-	-	↑	-	-	-	-	-		-	-	-
NCTSI	-	-	↑	-	-	-	-	-	↑	-	-	-
TSS							↓	↓			↑	
Benthic taxa richness (all sites)	↓	-	-	↓	↑	-	↓	-	-	↓	↑	-
BI (all sites)	↑	-	-	↑	↓	-	↑	-	-	↑	↓	-
Periphyton (all sites)	↑	-	-	↑		-	↑	-	-	↑		-

Extent of impoundments in NC

In NC, natural lakes are limited to the coastal plain region of the state. Artificial impoundments, however, are extremely common in NC and primarily located in the Piedmont and Blue Ridge ecoregions (Griffith 2002) (Figure 1). According to the US Army Corps of Engineers' National Inventory of Dams (USACE, Accessed October 2012), there are 3,382 dams in NC. Over half of these are small (dam height <25 feet, n=1,796), and the great majority are privately owned (n=3,074) with earthen dams (n=3,154), and a stated primary purpose of recreation (n=2,426). Construction dates have been identified for slightly over half (n=1,834), with the great majority having been built since 1950. However, the NC Division of Energy, Mineral, and Land Resources' Dam Safety Program database shows 5,612 dams statewide (NC DEMLR, accessed October 2012). The disparity is likely due to the criteria for dams tracked by each program; for example, the USACE inventory generally only includes dams that are high hazard (likely to cause loss of human life or property damage in the case of failure), dams ≥25 feet in height and >15 acre-feet of storage, or dams >6 feet in height and ≥50 acre-feet of storage (http://geo.usace.army.mil/pgis/f?p=397:1:0, accessed January 21, 2013).

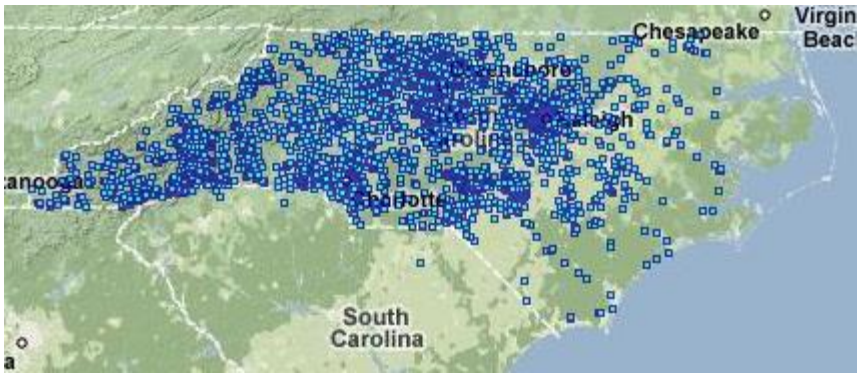

Figure 1 Location of NC dams from the USACE National Inventory of Dams. Image adapted from USACE, http://geo.usace.army.mil/pgis/f?p=397:3:837413223002001::NO::P3_STATES:NC

II. Methods

Overall Approach

The study design was based on biological monitoring upstream and downstream of impoundments within the Blue Ridge and Piedmont ecoregions within NC then further sampling at three locations at varying distances downstream below the dam. These ecoregions were chosen because artificial impoundments are predominantly located in these areas of the state. Also, the previous grant looking at impoundment effects looked at these areas because NC DWQ 401 Certification staff from the Blue Ridge and Piedmont had voiced concern and requested additional guidance when reviewing these types of permitted projects.

Results from the upstream, flowing reach at each site served as a reference to which downstream data were compared. This design allowed the upstream site to provide a control for water quality, land use, drainage areas, and other conditions within each watershed. Any differences seen downstream could then be more definitively tied to the presence of that particular impoundment in that particular location in that particular stream. A range of indicators were selected for monitoring:

- *Field measurements, including dissolved oxygen (DO), water temperature, pH, and specific conductance (SC)*: Except for SC, these parameters have associated numerical water quality standards.
- *Chlorophyll-a*: Chlorophyll-*a* is the only parameter with an associated numerical water quality standard. Collections were made in accordance with NCDWR Sample Submission Guidelines https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/sample-submission#Submission
- *Benthic macroinvertebrates*: Taxa were collected and identified and assigned biocriteria in accordance with the DWR SOP. https://ncdenr.s3.amazonaws.com/s3fs-public/Water%20Quality/Environmental%20Sciences/BAU/NCDWRMacroinvertebrate-SOP-February%202016_final.pdf
- *Habitat assessments*: A standard habitat assessment was used at all sites to determine if instream conditions such as substrate composition, embeddedness, bed stability, and instream structure showed significant changes below the impoundments. This information was also helpful for interpretation of benthic macroinvertebrate data.

- *GIS data*: Land use and elevation data were obtained for delineation of the drainage area for each sampling station and to determine the percent contribution of major land use types (e.g., forest, development, agriculture).

Each stream/impoundment had five sampling locations: upstream (station 1), immediately below the dam (station 2), a short distance downstream, yet above tributaries (station 3), about 3 mi2 downstream (station 4), and a final station located downstream several additional square miles (station 5). All stations were sampled for physical field parameters and Chlorophyll-*a* when benthic macroinvertebrates were sampled. Habitat assessments were performed concurrent with benthic macroinvertebrate sampling.

Field sites

Study sites were, to the greatest extent practical, sites that had been sampled in the earlier impoundments study (CD 95471111). These were within the Piedmont and Blue Ridge ecoregions, as these are the areas of the state where impoundments are most common. Selection criteria for included: <100 acres in size; location in or near the headwaters of a stream network; presence of a perennial, wadeable, flowing stream above and below the impounded area; and reasonable access for sampling activities (preferably on public lands or where permission could be obtained from private landowners). Primary sources for prospective sites included impoundments previously monitored in the first Impoundments grant (CD 95471111). Additional impoundments were added to replace impoundments that lacked adequate access to downstream areas using the NC Division of Energy, Mineral, and Land Resources Dam Inventory (NC DEMLR 2012); public lands (e.g., state and local parks); and visual inspection of USGS topographic maps and aerial photography. Landowners of the prospective sites were contacted to obtain permission for access. Sites were visited to ground-truth that the sites met the stated criteria and were accessible. Twelve streams were initially identified with three more added later.

Site locations are shown in Figure 2 and described in Table 2. Most were clearly located in the Piedmont or Blue Ridge ecoregion but two sites (DEV, and SOUT) lay on the boundary between the two ecoregions and CAM was in the Sand Hills. For these sites, onsite conditions were used to definitively assign them to an ecoregion for the study based on the predominant stream characteristics and features seen. The final twelve sites were split between the Piedmont and Blue Ridge ecoregions. Information about the year built, surface area, and discharge/release type (top, bottom, or combined) were obtained from the NC DEMLR Dam Inventory. Release types were verified on-site where possible.

Benthic macroinvertebrate sampling

NC DWQ has standard methods for stream assessment using benthic macroinvertebrate community sampling (NC DWQ 2010c). The methods used in this study were the Qual 4 method for streams whose watershed at the upstream most site was < 3 mi2 (small streams) and Full Scale methods were for streams where all sites had watersheds > 3 mi2 (large streams). To index period that would allow assignment of bioclassifications to these sites was March – June for the Qual 4 samples and July – September for Full Scale samples. Biocriteria were assigned using a combination of Intolerant Taxa Richness (EPTS) and Biotic Index (BI), a calculation of the intolerance to pollution of all the taxa collected at a site and weighted by their abundance.

Stream habitat assessments

A standard NC DWQ Habitat Assessment protocol (NC DWQ 2010c) was used. The Mountain/Piedmont version of the form was used at all sites. The method assesses channel modification, instream habitat types and quality, bottom substrate composition, embeddedness, pool and riffle frequency and quality, bank vegetation and stability, and vegetated riparian zone width and quality. It provides a numerical score ranging from 1 to 100, with higher values associated with better instream and near-stream conditions.

Chlorophyll-a assessments

Water for Chlorophyll-*a* samples was collected in brown bottles, filtered in the field then stored frozen in a portable freezer until delivery to the NCDWR Chemistry Laboratory for analysis.

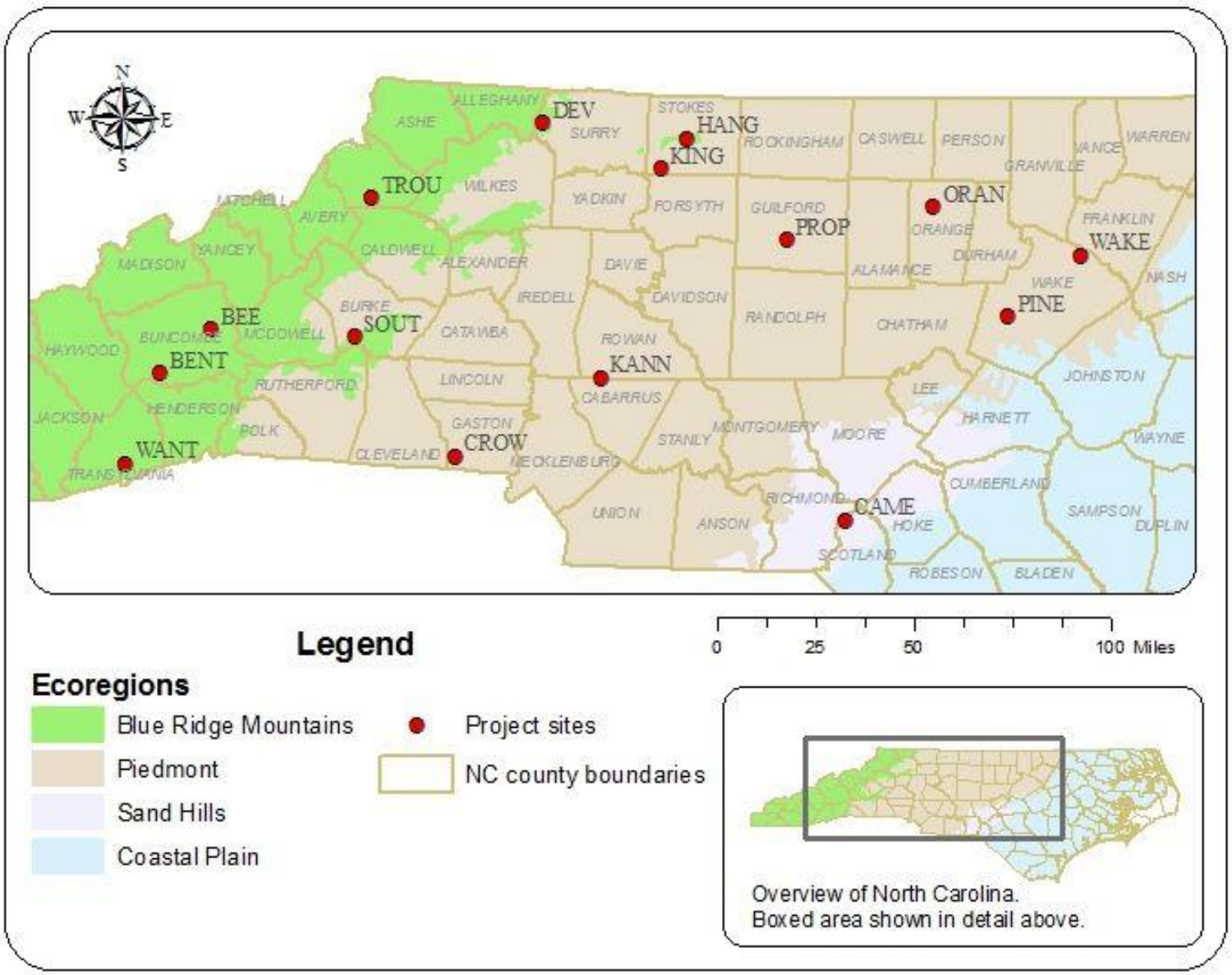

Figure 2. Map of Study Streams.

Table 2. Project site descriptions. Dam ID, year built, and surface area obtained from the NC DEMLR dam database unless otherwise noted. Age indicates age at the time of data collections.

Project ecoregion	Site Code	Site Name	EPA Ecoregion Level 4 [1]	Dam ID	Year Built	Age (years)	Surface Area (acres)	Release Type [3]	Stream classification(s) [4]
Blue Ridge	BEE	Bee Tree Reservoir	66d	BUNCO-006	1927	88	41	T	WS-I HQW; C
	BENT	Bent Creek	45e [2]	BUNCO-050	1950	66	7	B	B;Tr
	DEV	Devotion	66d [2]	SURRY-031	1936	79	54	T	B Tr ORW
	HANG	Hanging Rock	66m	STOKE-016	1938	77	12	T	B ORW; B
	SOUT	South Mountain State Park	66l [2]	BURKE-003	1950	65	13	T	C HQW
	WANT	Lake Wanteska	66d	TRANS-010	1972	43	46	B	C;Tr,HQW
	TROU	Trout Lake	66g	WATAU-005	1971	44	14	T	WS-II B Tr HQW
Piedmont	CROW	Crowders Mountain State Park	45i	GASTO-003	1961	54	12	B	C
	WAKE	Wake Forest Reservoir	45f	WAKE-176	1960	55	50	B	C; NSW
	ORAN	Orange Lake	45c	ORANG-005	1969	46	140	B	C
	KING	King Lake	45e	STOKE-098	1981	40	27	T	C
	CAMR	Cameron Lake	65c	SCOTL-012	1935	80	30	T	C
Impaired	PINE	Pine Lake	45f	WAKE-067	1968	48	10	T	WS-III; NSW
	PROP	Property Lake	45b	GUILF-082	1959	56	6	T	WS-V; NSW
	KANA	Kanapolis Lake	45b	ROWAN-007	1940	75	267	T	C

[1] Key to ecoregions (Griffith 2002): 45b: Southern Outer Piedmont, 45c: Carolina Slate Belt, 45i: Kings Mountain, 45e: Northern Inner Piedmont, 45f: Northern Outer Piedmont,65c: Sand Hills, 66d: Southern Crystalline Ridges and Mountains, 66l: Eastern Blue Ridge Foothills ,66m: Sauratown Mountains, 66g: Southern Metasedimentary Mountains

[2] These sites and their watersheds were on or near the boundary between the Blue Ridge and Piedmont ecoregions. Site conditions were used to determine most appropriate category for this study.

[3] T = top-only release; B = bottom-only release; T,B = combined top and bottom releases

[4] Stream classifications are assigned by NC DWQ and designate the protected uses. All waters of the state are protected for basic uses (e.g., aquatic life, secondary recreation). Streams protected for only these basic uses carry a C classification. B waters are additionally protected for primary/organized recreation. WS-I and WS-II are additionally protected for use as water supplies. The supplemental classification Tr indicates an additional protected use for trout survival and reproduction. HQW and ORW indicate waters of high or outstanding quality. NSW indicates designated nutrient-sensitive waters.

III. Results and Discussion

The following information are summaries of the data collected. Maps of the streams and raw data are found in Appendices 1 and 2, respectively.

Temperature, the first metric found to be a problem below impoundments in previous studies, remains a problem in this study. On average, large streams (>3mi^2 watershed) had temperature elevated 4.5^{o}C from above to below the impoundment (Figure 3). Small streams showed an even greater increase – 8^{o}C. Both large and small streams required an increase of approximately one mi^2 to return to an equilibrium of 21-22^{o}C, a 3-5^{o}C increase from upstream conditions. Orange Lake, a bottom release dam, was the only stream in the study that did not violate the 2.8^{o}C increase NC Water Quality Standard and returned to upstream temperature.

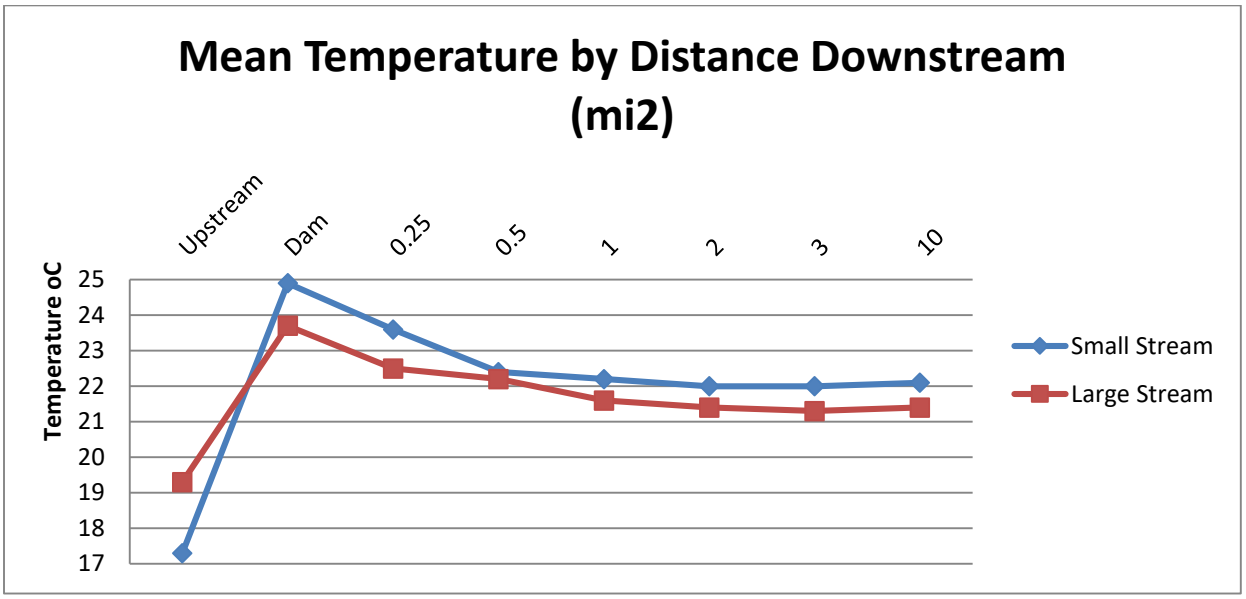

Figure 3. Mean stream temperature of Large (>3mi^2) and Small (< 3 mi^2) streams by distance downstream.

The maximum temperature for waters designated Trout (Tr) in North Carolina is 20^{o}C. Of the four streams designated Tr in this study, one stream, Bent Creek, stayed within this limit while three others violated this limit for 0.4 mi^2 (Lower Creek), 1 mi^2 (Flannery Fk) and one, Mitchell River, never cooled down to 20^{o}C.

Chlorophyll -*a*, which behaved fairly consistently in the previous grant, behaved very differently in this study (Figure 4). Mountain streams and small streams in the piedmont showed a slight elevation (1-2 μg/l) in Chl-a level immediately below the dam and a quick return to low upstream levels. Large piedmont streams, on the other hand, showed a huge increase in Chl-*a* (mean 46 μg/l – NC criteria for a bloom is 40 μg/l). This spike in Chl-*a* dissipated in 2-5 mi^2 downstream. One possible reason for this will be discussed in the feeding guild section of this report.

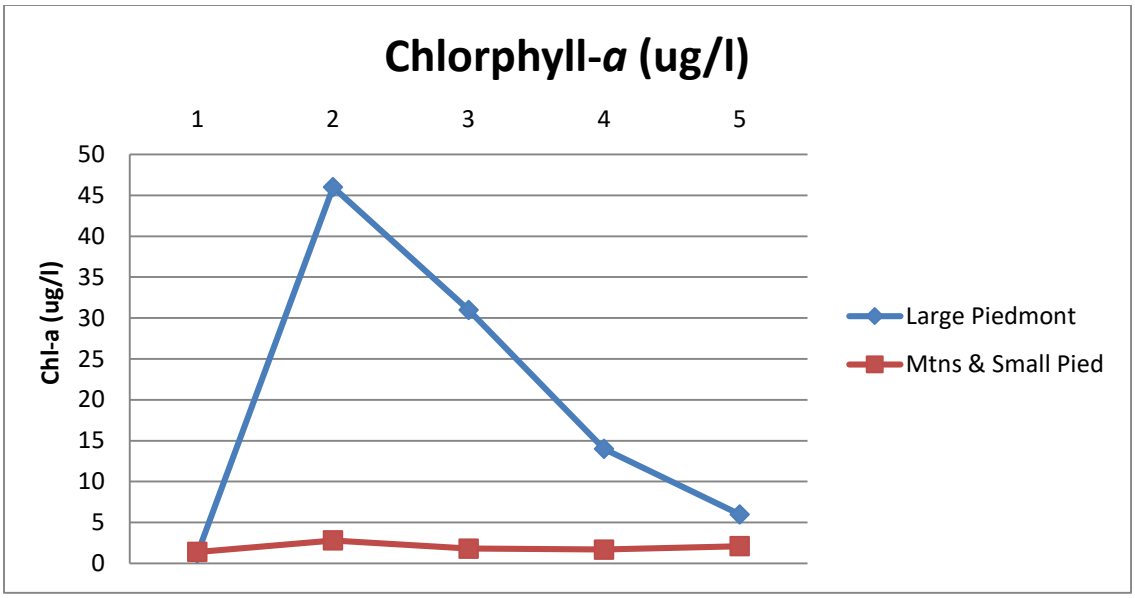

Figure 4. Chlorophyll-*a* by site for Mountain streams, Small Piedmont and Large Piedmont streams.

The final two metrics that were demonstrated to show negative shifts in the previous impoundments study were Taxa Richness and Biotic Index. While there are no State standards for these metrics, a combination of Biotic Index and EPT Taxa Richness make up the biocriteria North Carolina uses to determine impacts in aquatic communitities (NC DWR 2016). Table 3 is a summary of EPT Taxa Richness changes, Figure 5 shows recovery of Biotic Index below impoundments and Table 4 is a summary of changes in bioclassification documenting the distance downstream required for recovery.

EPT Taxa Richness (EPTS) below the impoundment declined to an average of 32.4% of the EPTS found above the impoundment (median 28%, range 12-76%). EPT Taxa recovery was uneven. Five sites recovered to upstream levels within 1 mi^2 (mean 0.46mi2), two streams recovered in between one and five miles (mean 3.77 mi^2), one stream had recovered by 9.5 mi^2 and four streams had not recovered by the furthest downstream station sampled. While many factors can influence the number of intolerant mayflies, stoneflies and caddisflies (EPTS), it appears that impoundment size may have some impact. Of the five streams that recovered to upstream levels within the 1mi^2 downstream, three of the impoundments, Trout Lake, Lake Powhatan and Hanging Rock Lake were among the impoundments with the smallest surface area in the study. There is likely to be a better correlation with residence time, rather than surface area, however efforts to model residence time on these lakes were unsuccessful.

Table 3. EPT Taxa Richness changes below impoundment.

Project ecoregion	Site Code	Upstream EPTS	% upstream EPTS be dam	Distance Downstream to recover to ups EPTS	Maximum Downstream EPTS (% of upstream)
Blue Ridge	BEE	41	39	4+	88
	BENT	38	76	0.24	102
	DEV	49	16	16.9+	86
	HANG	25	28	0.76	108
	SOUT	34	26	11+	68
	WANT	24	25	0.29	142
	TROU	26	23	0.2	135
Piedmont	CROW	13	38	4.03	138
	WAKE	15	60	9.5	107
	ORAN	17	13	17.7+	66
	KING	15	33	3.5	120
	CAMR	8	12	0.81	262

Biotic Index, an average of the tolerance values of all taxa collected at a site weighted by their abundance, has proven to be another consistent metric by which to measure stresses in the macroinvertebrate community. Unlike Taxa Richness, an increasing Biotic Index means that the community is becoming more tolerant to pollution and other stressors. When assigning a bioclassification, a change in Biotic Index of a unit or more will change the bioclassification one level. In the piedmont, Biotic Index rises (gets worse) an average of 1.5 units below an impoundment compared to above it. About half of this increase is lost within the first 0.25 mi^2 while most of the rest of the increase dissipates by 3 mi^2 below the impoundment. Biotic Index in mountain streams see greater impacts. BI rises an average of three units below the impoundment compared to above and while half of that increase disapates after the first 0.25 mi^2, there doesn't seem to be further recovery

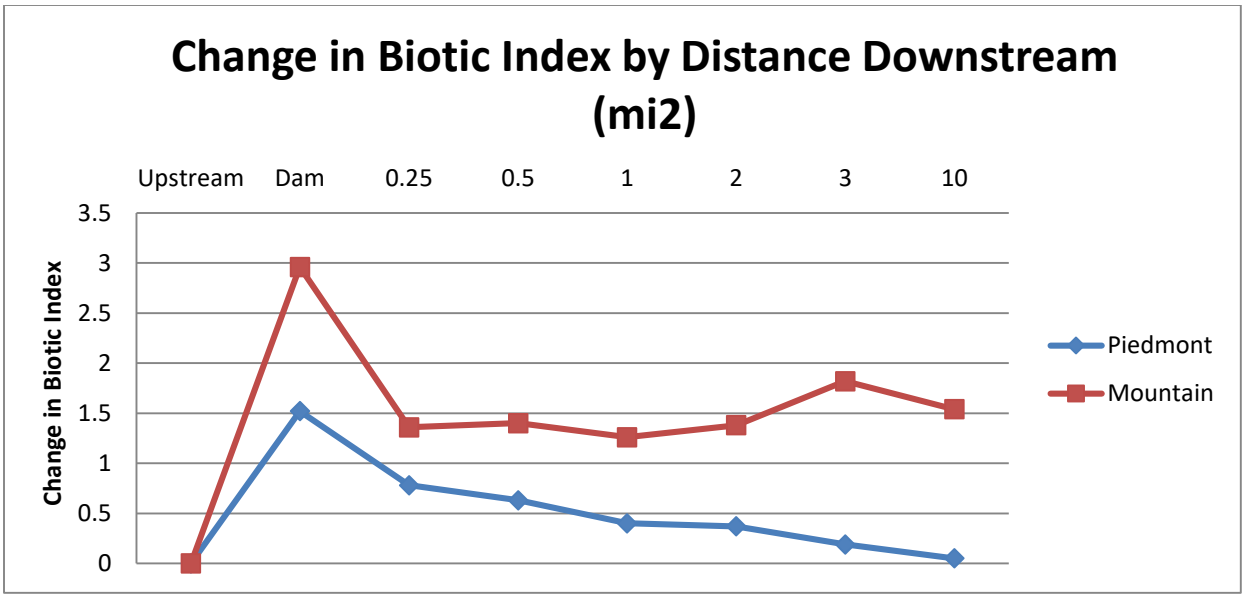

Figure 5. Change in Biotic Index by Distance Downstream

Combining these two sets of observations into a metric with regulatory implications helps to quantify the size and extent of impacts. North Carolina has five bioclassifications for assignment of water quality ratings: Excellent, Good, Good-Fair, Fair and Poor. In terms of Use Support, Excellent and Good correlate with Supporting Aquatic Life Uses while Fair and Poor represent cases where streams are Not Supporting their uses. Good-Fair usually also represent Supporting Uses, though sometimes it can represent that a stream is Partially Supporting or be Support Threatened.

All streams in this study were Supporting their aquatic life uses upstream of their impoundment and all streams declined in water quality (median 2 bioclassifications, range 1 to 4) below it. Seven of the streams declined to the point that the stream immediately below the dam was Not Supporting its aquatic life uses (rated Fair or Poor). The majority of these were in the piedmont. Like EPTS, half of the streams recovered in less than 1 mi^2 (mean 0.45 mi^2). This observation is in general agreement with the Tennessee observations (Arnwine et. al. 2006) where they found most streams had recovered by 0.5 miles downstream. Like EPTS, two additional streams recovered to their upstream bioclassifications in 1-5 mi^2 downstream (mean 3.2). Of the remaining four streams, two recovered within nine mi^2 and two never fully recovered, however this was likely due to increasing agriculture or development in the downstream watershed. Once again many of the streams with the shortest recovery time had the smallest impoundments above them.

Table 4. Summary of Bioclassification Recovery Changes

Project ecoregion	Site Code	# Bioclasses declined be dam	Distance Downstream to recover to ups Bioclass (mi^2)	Initial/Final Bioclasses
Blue Ridge	BEE	2	4+	Ex/Good
	BENT	1	0.24	Good/Good
	DEV	4	11	Ex/Ex
	HANG	3	0.76	Ex/Ex
	SOUT	2	11+	Ex/Good
	WANT	2	0.29	Ex/Ex
	TROU	2	0.2	Ex/Ex
Piedmont	CROW	2	0.55	Good/Good
	WAKE	2	9.5	G-F/G-F
	ORAN	1	2.3	G-F/G-F
	KING	1	0.63	G-F/Ex
	CAMR	2	9.4	Good/Good

Functional Feeding Groups

While discussions of functional feeding groups can be very helpful in understanding an ecosystem, agreement on functional categories and assignment of individual taxa in to just one group can become problematic. North Carolina recognizes categories of both scraper and herbivore, however if a mayfly is scraping alage off of a rock, which category should it be placed in? Voshell (date) also presents ecological conundrums. Many small stoneflies will shred leaves when they are small, then move into predation as they grow large enough to catch prey. Baetid mayflies prefer to scrape algae from rocks, however when conditions become unfavorable they have been seen eating detritus from between sand grains. One stonefly, *Isoperla*, was believed to be a predator based on the shape of its jaws, but when someone did a gut analysis on them, most of what was found was algae and detritus. All this is to say that the following results should be viewed with some caution. Functional feeding groups have been assigned based on best professional judgement of NC DWR biologists. Not all NC biologists agree with all classifications and there are certainly differences between these classifications and those of other groups (e.g. USGS). Using alternative classification schemes are likely to produce different results. As a reminder of the imprecision of these data, results have not been translated from site numbers to distance downstream. Site 1 is upstream of the impoundment, 2 is immediately below it and 3,4 and 5 are increasing distances from the dam.

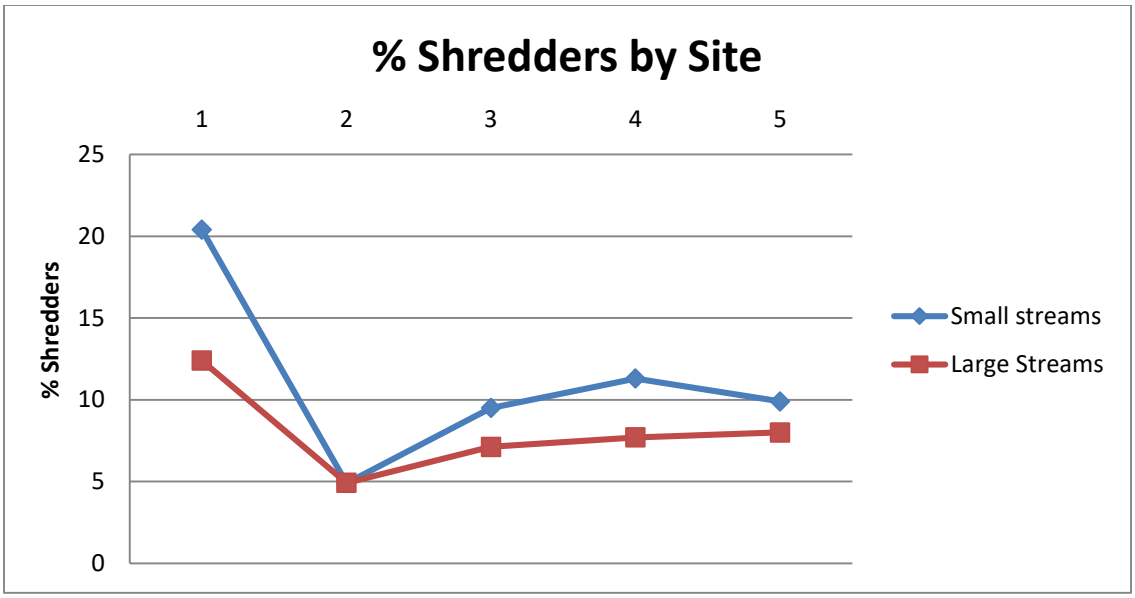

Figure 6. *Percent Shredders by Site*

Shredders are animals that derive their nutrition from eating the fungus and bacteria that are on decomposing leaves that have fallen into the stream. In the process to extracting the bacteria, the animal shreds the leaf into small pieces that are more easily digestible to other animals downstream. The River Continuum concept (Vannote et al. 1980) predicts that small streams have more shredders than larger streams because decaying leaves is the primary source of production in small streams whereas in larger streams the largest source of primary production is periphyton growing on rocks. These results appear to confirm this prediction. Small streams had an average of 21% of the invertebrate community comprised of shredders, while in larger streams only 13% of the community was shredders. Below the impoundment, however, shredders dropped to only 5% of the community for both large and small streams. While the shredder community recovered somewhat of the next 0.5-2 mi2, there appears to be a new maximum number of shredders in the range of 8-10% of the community.

In the first impoundments study, there was a suggestion that grazers, animals who eat algae off of rocks, logs or plants, declined in abundance from above to below and impoundment. This work could not confirm this observation. In fact, it appears that grazer abundance appears to be much more influenced by the amount of available sunlight at a given site than by any distance from an impoundment.

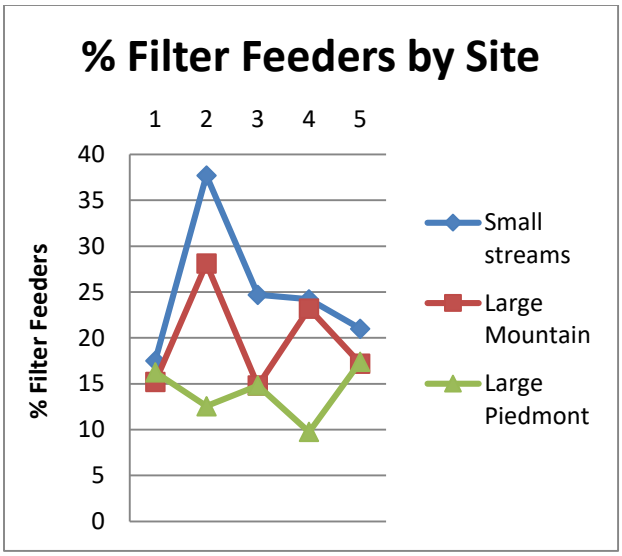

Figure 7. *Percent Filter Feeders by Site*

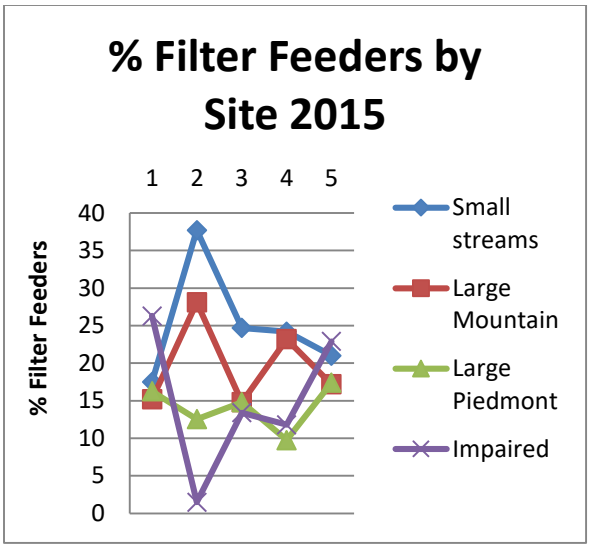

Figure 8. *Percent Filter Feeders plus an Impaired stream*

Figure 7 is an attempt to describe changes in the filter feeding community. Filter feeders are animals that possess adaptations that allow them to filter food out of the current as it floats downstream (e.g. phytoplankton). This is a fairly small and specialized group requiring not only adaptations (hairs, combs, nets etc) to catch food, but also flow in the stream to bring food to it.

The first imoundments grant suggested that filter feeders increased below impoundments, probably due to the increased phytoplankton quantities flushing out of the impoundment. What this study found was a little more complicated. All streams started with approximately 16% of the upstream communities populated by filter feeders. All small streams, as well as large mountain streams, had much higher percentage of the community as filter feeders below the impoundment than above it, with 50-100% of that peak being lost less than 0.5mi2 downstream and coming back to equalitbrium in the 17-21% range. Large piedmont streams had a very different, slightly negative, response to the impoundment. Initially, the reasons for this were unclear and suspected to be a spurious result due to low number of observations (n=2). Figure 8, the same graph plus an additional impaired stream from an urban catchment, that had not been part of the study up to this point, shows a more exaggerated pattern as large piedmont streams. To try to resolve this anomaly, one more impaired stream in an urban catchment and two more large piedmont streams were sampled during the 2016 sampling season. Figure 9 incorporates these additional data points.

The additional impaired stream and large piedmont data served to smooth both lines to the point that they appear to be behaving in the same way, dropping from 16% of the community above the impoundment to 10% below then rapidly returning to upstream levels, thus making it unlikely that these results are anomalous due to small sample size. It appears that there are two things going on here. Comparing Figure 9 with the Chlorophyll-a graph of Figure 4 helps explain this. The first impoundments grant found large amounts of phytoplankton, food for filter feeders entering the stream below the dam. In this study, for small streams and mountain streams, filter feeders spike below the dam grazing down the phytoplankton population and keeping chlorophyll-a levels low. This a classic example of Top-down ecosystem controls (References). In the impaired

and large piedmont streams, the filter feeders are not responding, so bloom level of chlorophyll-a are impairing the system, with levels

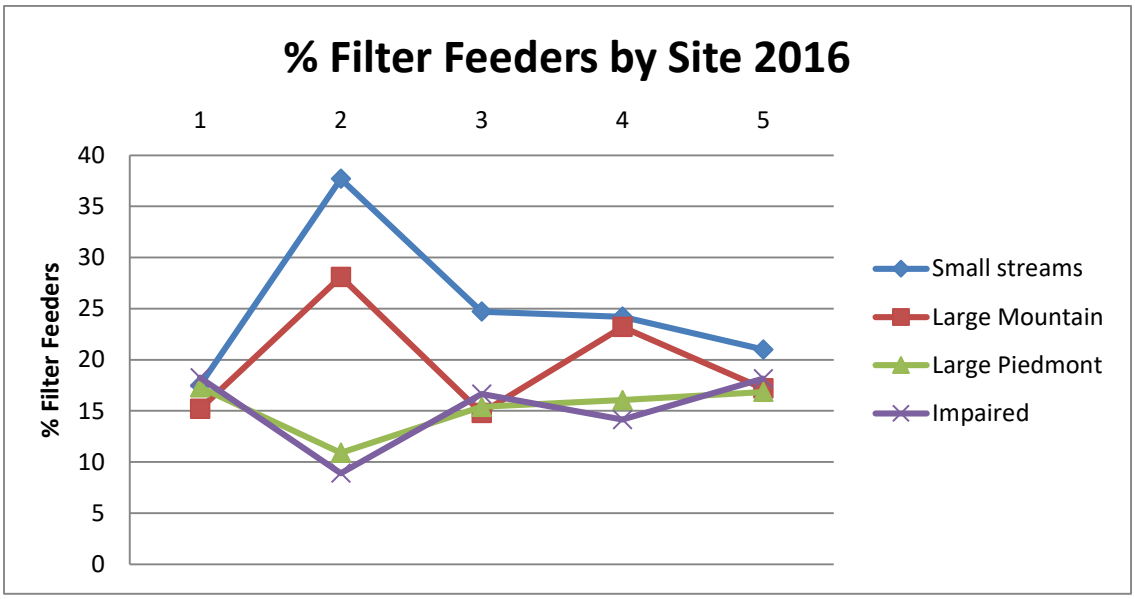

Figure 9. *Percent Filter Feeders by site w/ 2016 data*

dropping further downstream. The question is, what is it about the impaired and large piedmont streams that is preventing the filter feeders from responding? The answer may be water quality. All large piedmont streams were rated Good-Fair above their impoundments and water quality declined to Fair or Poor (Not Supporting) downstream, just like the impaired stream were Not Supporting their aquatic life uses along their entire length. Of the 33 taxa NCDWR call filter feeders, most are considered to be intolerant to moderately intolerant (Tolerance Values 0-5). The mean of all filter feeders is 3.91. Only a few are considered tolerant (6.5-10). Only five filter feeding taxa were collected below the dam at all impaired stream and large piedmont sites, with tolerance values ranging from 4.9 (*Simulium*) to 7.9 (*Hydropsyche betteni*). There may not be enough filter feeding taxa tolerant enough to survive in the Fair and Poor water quality found below these impoundments to eat bloom levels of phytoplankton. As water quality improves downstream, the filter feeders begin to return and the phytoplankton are removed from the stream. Further exploration of this phenomenon is not in the purview of this grant.

IV. Summary and Recommendations

Summary

In the previous study, four metrics were found to be elevated in ponds located both in the mountains and piedmont: Temperature, Chlorophyll-*a*, EPT Taxa Richness and Biotic Index. This study looked at those metrics to determine how far downstream each of the metrics had elevated values. Temperature increased an average of five degrees (19-24°C) in large streams and eight degrees (17-25 °C) in small streams from above to below the dam. In both large and small streams, temperature declined to 21-22°C within the first mi^2 below the dam and never got any cooler.

Chlorophyll-*a* levels were found to be low and relatively stable (< 5 μg/l) in mountain streams and small piedmont streams. Large Piedmont streams and small streams in urban catchments showed near bloom levels of Chl-*a* immediately below the dam, then rapidly falling to mountain stream levels within a few square miles.

EPT Taxa Richness fell to 32% of upstream levels immediately below the dam (range 12-76%). Five of the twelve streams recovered within the first square mile (mean 0.46 mi^2), however four streams never returned to upstream levels. Shifts in Biotic Index were very different between Piedmont and Mountain streams.

Biotic Indices in Piedmont streams went up by 1.5 (out of 10) then dropped to half that within the first 0.25 mi^2 and back down to around upstream levels by three mi^2 downstream. Mountain streams saw Biotic Index jumps of twice that (3.0) then quickly, within the first 0.25 mi^2, dropped to 1.4 over upstream and did not recover further.

Since EPTS and Biotic Index make up the metrics of NC DWR biocriteria, these impoundment-related community shifts were looked at in terms of water quality criteria. All sites showed a decline in water quality from above the impoundment to immediately below. Seven streams dropped of 2 bioclassifications, three dropped one and one dropped 4 (Excellent to Poor). Six streams recovered within the first square mile downstream (mean 0.46 mi^2), two streams between 1-5 mi^2 (mean 3.2 mi^2), more recovered between 5-10 mi^2 (mean 9.5 mi^2) and two never recovered. Four of the five streams with the quickest recovery were among the six smallest lakes in the study.

The initial grant also noted a decline in the shredder functional feeding group, from 20% to 10% of the community, and an increase in filter feeders, from 10% above to 20% immediately below impoundments, however these trends were not significantly different in that study. This study mostly mirrored those observations. Impoundments did appear to be a sink for leaves. Small streams above impoundments averaged 21% of the community as shredders and large streams 13%. Below dams, shredders dropped to 5% of the community. Recovery was usually within the first mi^2, at 8-10%, below upstream levels.

Filter feeders were somewhat more complicated, though all streams started with about 16% of the upstream community being filter feeders. Mountain and Piedmont small streams behaved most similarly, peaking immediately below the dam, at 37% filter feeders and large mountain streams peaked at just over half that (27%). Both quickly (< 0.5 mi^2) dropped back to about 20% of the community being filter feeders. Large piedmont streams showed no downstream spike in filter feeders, rather an indication of a slight decline downstream. Additional sampling of large piedmont streams and small streams in impaired watersheds, showed similar signals of filter feeders declining from 16% above to 10% below the dam then rapid recovery to upstream levels. In comparing the Chlorophyll-a values in this study with the behavior of the filter feeders, it appears that in small streams and large mountain streams, which had generally higher water quality, that filter feeder populations increased in response to elevated levels of phytoplankton from the impoundment and were able to graze down the plankton to consistently low levels. Large piedmont streams and impaired streams all had below-impoundment bioclassifications of Fair or Poor (Not Supporting Aquatic Life Uses) which limited the response of the moderately intolerant filter feeders (mean Tolerance Value 3.91) to only the most tolerant five taxa of the group (TV range 4.9-7.9). This limited community did not seem to be able to immediately (< 5mi^2) consume the bloom levels of plankton.

Based on this work, as well as the previous study, it is clear that damming a flowing water system has myriad negative effects on the stream ecosystem and thus approving their construction should be limited to projects with a defined public good (e.g. drinking water, flood control). One way to discourage the construction of amenity ponds would be to require mitigation for the impairment of the lotic ecosystem of the impoundment as well as for the documented impairments downstream. While much of the stream impairment from an impoundment dissipates very quickly, others do not recover for many miles downstream. It may be reasonable to use the area 0.5-1.0 mi^2 below the dam as an average impaired area when determining mitigation for downstream impacts.

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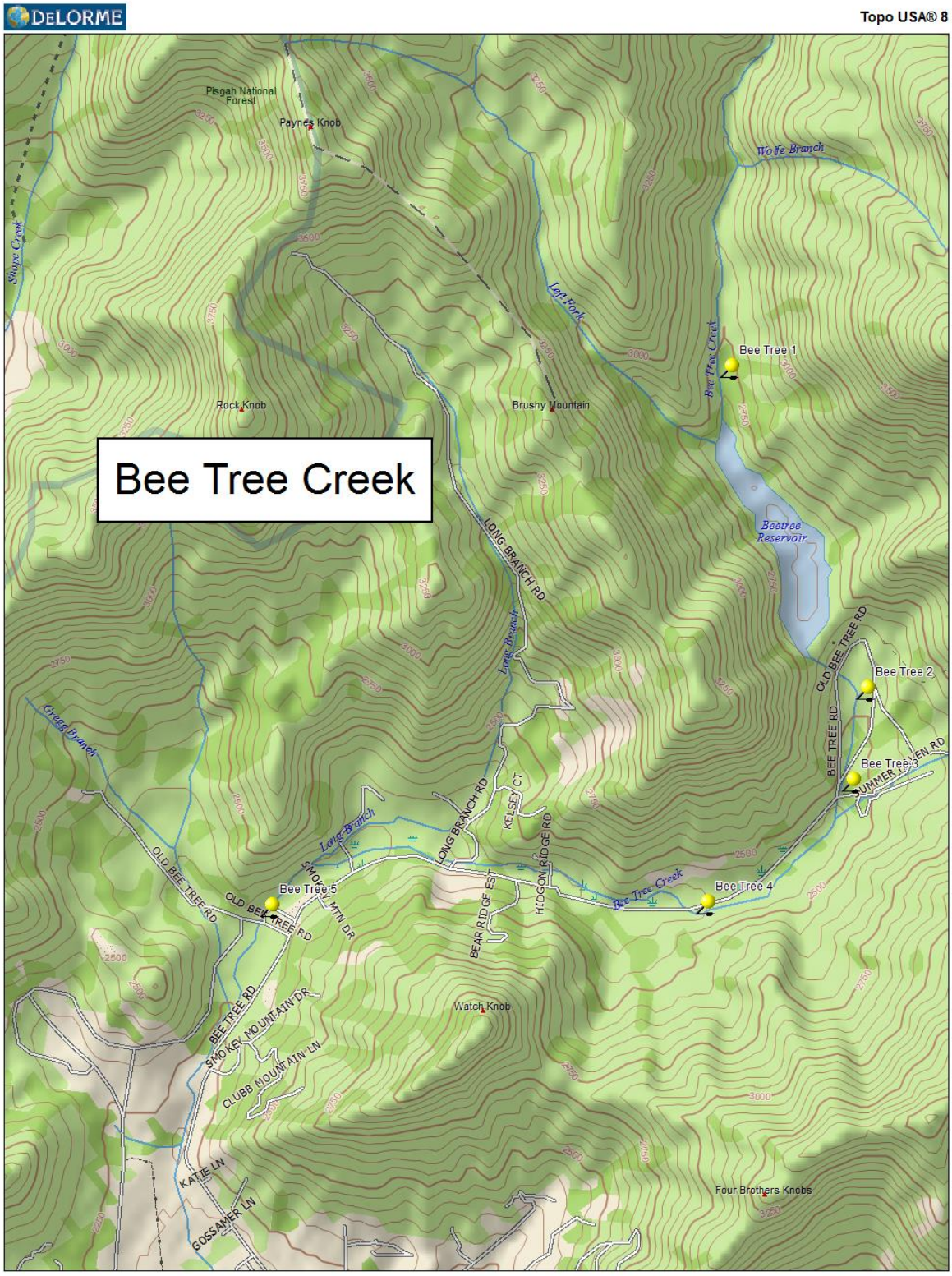
Appendix 1: Station Information

Lake/Stream	Site #	Date	Ecoreg	Tot Taxa	EPT Taxa	BI	Sample type	Bioclass	Habitat Sc	Drainage (mi2)	Conduct	Temp	Chl-a
Pine Lake	1	5/1/2014	P	26	1	6.73	Qual 4	Fair	61	1.33	81	18.6	4.2
Pine Lake	2	5/1/2014	P	27	1	8.29	Qual 4	Poor	52	2.21	95	23.7	8.7
Pine Lake	3	5/1/2014	P	29	2	7.59	Qual 4	Poor	64	2.3	96	23.3	9.5
Pine Lake	4	5/6/2014	P	22	2	8.26	Qual 4	Poor	63	2.71	dead meter	19.4	20
Pine Lake	5	5/6/2014	P	47	2	7.76	Qual 4	Poor	36	4.75	113	19	4.1
Pine Lake	6	5/6/2014	P	32	3	7.72	Qual 4	Fair	46	5.01	115	19.1	5.2
Cameron Lake	1	5/7/2014	P	26	8	4.64	Qual 4	Good	77	0.68	3	17.9	< 1.0
Cameron Lake	2	5/7/2014	P	32	1	6.94	Qual 4	Fair	52	2.38	15	22.3	3
Cameron Lake	3	5/7/2014	P	39	8	6.13	Qual 4	Fair	74	3.19	12	25.2	2.1
Cameron Lake	4	5/10/2014	P	44	15	5.48	Qual 4	GF	74	6.7	11	28.1	6.4
Cameron Lake	5	5/10/2014	P	53	21	4.73	Qual 4	Good	81	11.8	14	24.3	2.25
Clear Cr	1	5/29/2014	Mt	61	34	2.67	Qual 4	Ex	91	1.79	26	16.2	< 1.0
Clear Cr	2	5/29/2014	Mt	27	9	5.44	Qual 4	GF	78	2.41	30	25.7	2.5
Clear Cr	3	5/29/2014	Mt	51	18	5.08	Qual 4	GF	74	3.61	45	23.3	4
Clear Cr	4	5/28/2014	Mt	42	19	3.92	Qual 4	Good	80	9.04	56	22.1	1.7
Clear Cr	5	5/28/2014	Mt	52	23	4.6	Qual 4	Good	47	13.41	46	22.6	1.4
Crowders Cr	1	5/27/2014	P	31	13	4.83	Qual 4	Good	78	0.19	46	18	< 1.0
Crowders Cr	2	5/27/2014	P	16	5	6.33	Qual 4	Fair	66	0.87	57	26	2.9
Crowders Cr	3	5/27/2014	P	27	10	4.52	Qual 4	Good	76	1.42	61	22.7	< 1.0
Crowders Cr	4	5/28/2014	P	62	18	5.29	Qual 4	GF	76	4.9	39	19.2	1
Crowders Cr	5	5/28/2014	P	52	16	4.94	Qual 4	Good	75	10	54	19.3	< 1.0
King Lake	1	6/11/2014	P	37	15	5.51	Qual 4	Good-Fair	78	1.5	78	18.5	4.8
King Lake	2	6/11/2014	P	32	5	6.71	Qual 4	Fair	48	2.7	81	25.2	5.3

King Lake	3	6/11/2014	P	43	11	5.45	Qual 4	Good-Fair	40	3.33	42	24.3	1.6
King Lake	4	6/11/2014	P	38	18	4.54	Qual 4	Good	62	6.2	92	22.4	1.1
King Lake	5	6/11/2014	P	55	26	3.96	Qual 4	Excellent	79	8.2	92	22.8	4.1
Lake Wanteska	1	6/17/2014	Mt	40	24	1.95	Qual 4	Excellent	68	0.13	15	15.8	< 1.0
Lake Wanteska	2	6/17/2014	Mt	23	6	5.77	Qual 4	Good-Fair	62	0.51	24	24.1	3.4
Lake Wanteska	3	6/17/2014	Mt	33	10	5.11	Qual 4	Good	69	0.57	30	24	2.6
Lake Wanteska	4	6/18/2014	Mt	68	34	3.15	Qual 4	Excellent	89	0.8	36	21.1	1.5
Lake Wanteska	5	6/18/2014	Mt	68	35	2.48	Qual 4	Excellent	83	1.06	33	18.8	1.15
Trout Lake	1	6/24/2014	Mt	41	26	1.84	Qual 4	Excellent	93	0.18	28	15.2	< 1.0
Trout Lake	2	6/24/2014	Mt	26	6	5.53	Qual 4	Good-Fair	77	0.53	22	23.8	4.9
Trout Lake	3	6/24/2014	Mt	52	27	2.68	Qual 4	Excellent	91	0.73	28	20.4	2.5
Trout Lake	4	6/24/2014	Mt	52	31	2.46	Qual 4	Excellent	87	2.04	27	18.8	< 1.0
Trout Lake	5	6/24/2014	Mt	59	35	2.55	Qual 4	Excellent	85	2.83	32	18	1.8
Cascade Cr	1	6/26/2014	Mt	47	25	2.96	Qual 4	Excellent	87	0.51	10	17.9	< 1.0
Cascade Cr	2	6/26/2014	Mt	22	7	5.87	Qual 4	Fair	79	0.71	14	27.2	2.4
Cascade Cr	3	6/26/2014	Mt	45	25	2.24	Qual 4	Excellent	84	1.47	12	20.9	< 1.0
Cascade Cr	4	6/26/2014	Mt	41	24	2.86	Qual 4	Excellent	82	1.69	12	21.1	< 1.0
Cascade Cr	5	6/26/2014	Mt	49	27	3.89	Qual 4	Good	61	2.8	12	22.7	< 1.0
Wake Forest Reservoir	1	7/1/2014	P	56	15	5.53	Full	Good-Fair	62	2.41	82	20.5	< 1
Wake Forest Reservoir	2	7/1/2014	P	44	9	7.77	Full	Poor	52	3.2	38	29.1	28
Wake Forest Reservoir	3	7/1/2014	P	57	10	6.51	Full	Fair	70	3.48	82	28	10
Wake Forest Reservoir	4	7/2/2014	P	56	10	5.94	Full	Fair	68	8.62	78	22.9	2.7
Wake Forest Reservoir	5	7/2/2014	P	63	16	6.21	Full	Good-Fair	57	12.7	82	24.5	1.9

Orange Lake	1	7/7/2014	P	81	17	6.01	Full	Good-Fair	61	3.19	102	21.8	1.5
Orange Lake	2	7/9/2014	P	40	4	6.41	Full	Fair	84	9.09	74	20.3	64
Orange Lake	3	7/10/2014	P	72	11	6.13	Full	Fair	36	9.43	82	21.3	52
Orange Lake	4	7/10/2014	P	70	17	5.58	Full	Good-Fair	74	11.4	95	21.7	< 1.0
Orange Lake	5	7/7/2014	P	74	17	6.09	Full	Good-Fair	78	26.79	85	22.1	1.65
Bee Tree	1	7/15/2014	Mt	78	41	2.51	Full	Excellent	94	5.47	17	17.7	<1
Bee Tree	2	7/15/2014	Mt	50	16	4.75	Full	Good-Fair	64	7.59	22	25.9	1.1
Bee Tree	3	7/16/2014	Mt	62	33	3.53	Full	Good	69	8.45	33	20.1	<1
Bee Tree	4	7/16/2014	Mt	68	32	3.83	Full	Good	81	9.2	38	18.9	<1
Bee Tree	5	7/16/2014	Mt	75	36	3.45	Full	Good	74	11.59	43	19.9	<1
Devotion Mill Cr	1	7/24/2014	Mt	85	49	2.23	Full	Excellent	90	2.02	19	19	<1
Devotion Mill Cr	2	7/24/2014	Mt	30	8	5.8	Full	Poor	80	2.32	20	24	1.2
Devotion Mill Cr	3	7/24/2014	Mt	98	28	5.14	Full	Good-Fair	59	2.41	19	20.3	1.1
Devotion Mitchell R	4	7/23/2014	Mt	111	42	3.87	Full	Excellent	69	11.02	22	21	1.7
Devotion Mitchell R	5	7/23/2014	Mt	94	39	3.68	Full	Good	68	19.2	24	21.8	1.4
Bent Cr	1	8/5/2014	Mt	79	38	2.69	Full	Good	90	5.48	17	18	<1
Bent Cr	2	8/5/2014	Mt	77	29	4.54	Full	Good-Fair	86	5.83	18	19.7	1.4
Bent Cr	3	8/6/2014	Mt	80	38	3.87	Full	Good	65	6.07	17	19	<1
Bent Cr	4	8/6/2014	Mt	90	39	3.59	Full	Good	90	6.73	19	19.2	<1
Bent Cr	5	8/6/2014	Mt	92	34	3.41	Full	Good	90	8	19	20.2	<1
Property Lake	1	4/5/2016	P	34	4	7.14	Qual 4	Poor	39	1.1	309	11.7	no sample
Property Lake	2	4/5/2016	P	38	3	7.56	Qual 4	Poor	71	1.55	166	15.8	no sample

Property Lake	3	4/5/2016	P	48	4	7.03	Qual 4	Poor	64	1.66	261	15.4	no sample
Property Lake	4	4/5/2016	P	40	7	6.65	Qual 4	Fair	52	4.21	251	14.6	no sample
Property Lake	5	4/5/2016	P	42	6	7.08	Qual 4	Poor	69	5	268	18.7	no sample
Wake Forest Reservoir	1	5/31/2016	P	68	16	5.29	Full	Good-Fair	49	2.41	47	18.8	no sample
Wake Forest Reservoir	2	5/31/2016	P	61	9	7.27	Full	Fair	60	3.2	70	28.3	no sample
Wake Forest Reservoir	3	5/31/2016	P	61	11	6.7	Full	Fair	79	3.48	70	28	no sample
Wake Forest Reservoir	4	6/1/2016	P	62	15	6.29	Full	Good-Fair	57	8.62	82	21.3	no sample
Wake Forest Reservoir	5	6/1/2016	P	66	10	6.19	Full	Fair	49	12.7	96	21.9	no sample
Kanapolis Lake	1	6/2/2016	P	67	19	4.93	Full	Good	47	14.7	118	20.6	no sample
Kanapolis Lake	2	6/2/2016	P	64	5	7.57	Full	Poor	59	61.6	127	27.6	no sample
Kanapolis Lake	3	6/2/2016	P	58	6	6.53	Full	Fair	51	61.7	151	22.1	no sample
Kanapolis Lake	4	6/3/2016	P	50	12	5.94	Full	Fair	55	64.6	155	21	no sample
Kanapolis Lake	5	6/3/2016	P	62	16	5.84	Full	Good-Fair	62	75.4	148	22	no sample


DeLORME
Topo USA® 8
Pisgah National Forest
Paynes Knob
Wolfe Branch
Shope Creek
Left Fork
Bee Tree Creek
Bee Tree 1
Rock Knob
Brushy Mountain
Bee Tree Creek
Beetree Reservoir
LONG BRANCH RD
Long Branch
Craggy Branch
OLD BEE TREE RD
Bee Tree 2
BEE TREE RD
Bee Tree 3
SUMMER GLEN RD
KELSEY CT
HIDDEN RIDGE RD
BEAR RIDGE EST
Bee Tree 5
SMOKEY MTN DR
Bee Tree 4
Watch Knob
SMOKEY MOUNTAIN DR
CLUBB MOUNTAIN LN
KATIE LN
GOSSAMER LN
Four Brothers Knobs
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www.delorme.com
MN (6.5° W)
ft
0 600 1200 1800 2400 3000 3600
Data Zoom 13-2

DeLORME

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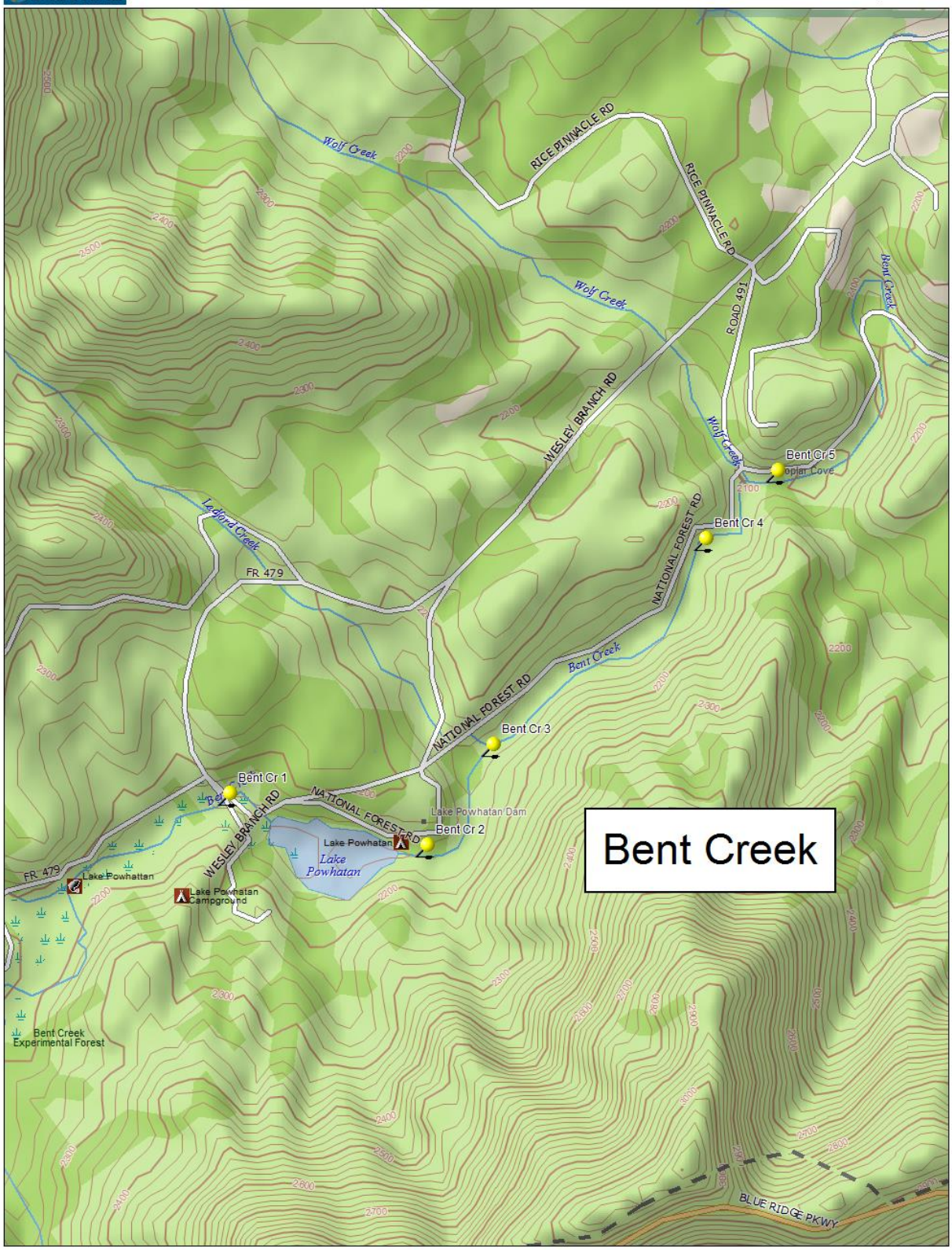

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MN (6.3° W)

0 400 800 1200 1600 2000 ft

Data Zoom 14-0

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MN (8.3° W)

0 ¼ ½ ¾ 1 1¼ mi

Data Zoom 12-1

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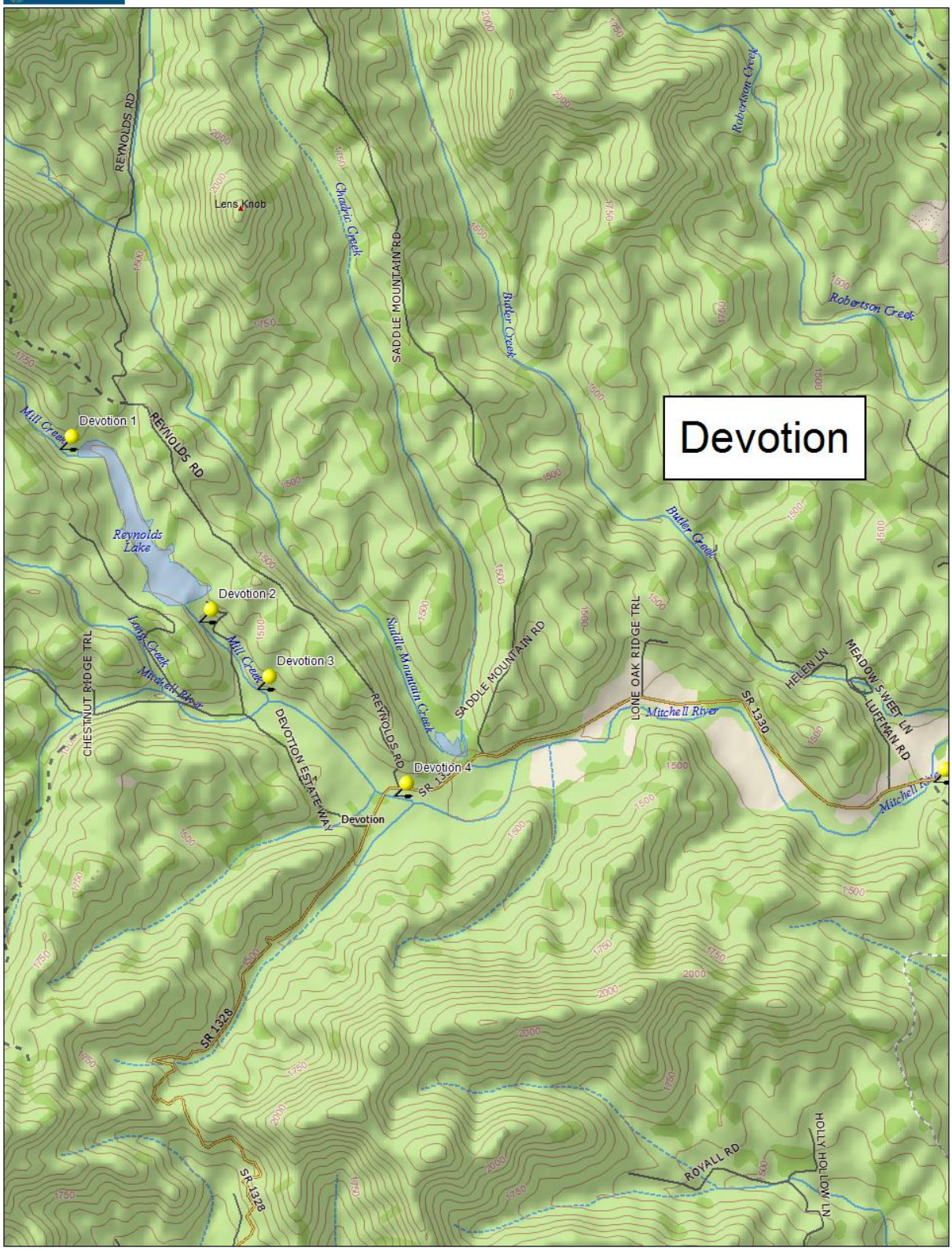

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MN (7.7° W)

0 800 1600 2400 3200 4000 ft

Data Zoom 12-7

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MN (8.1° W)

0 1000 2000 3000 4000 5000 ft

Data Zoom 12-6

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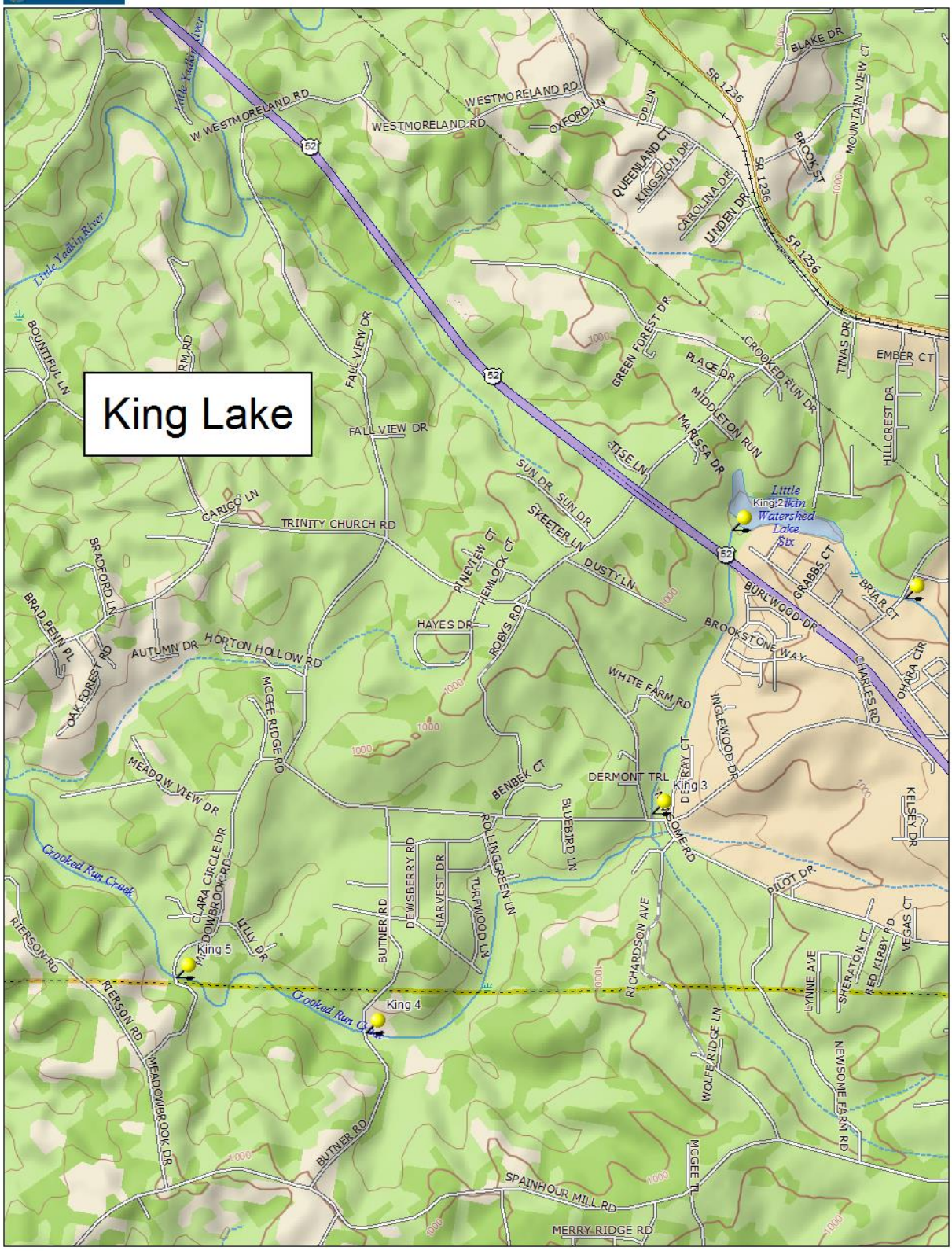

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MN (8.0° W)

0 800 1600 2400 3200 4000 ft

Data Zoom 13-0

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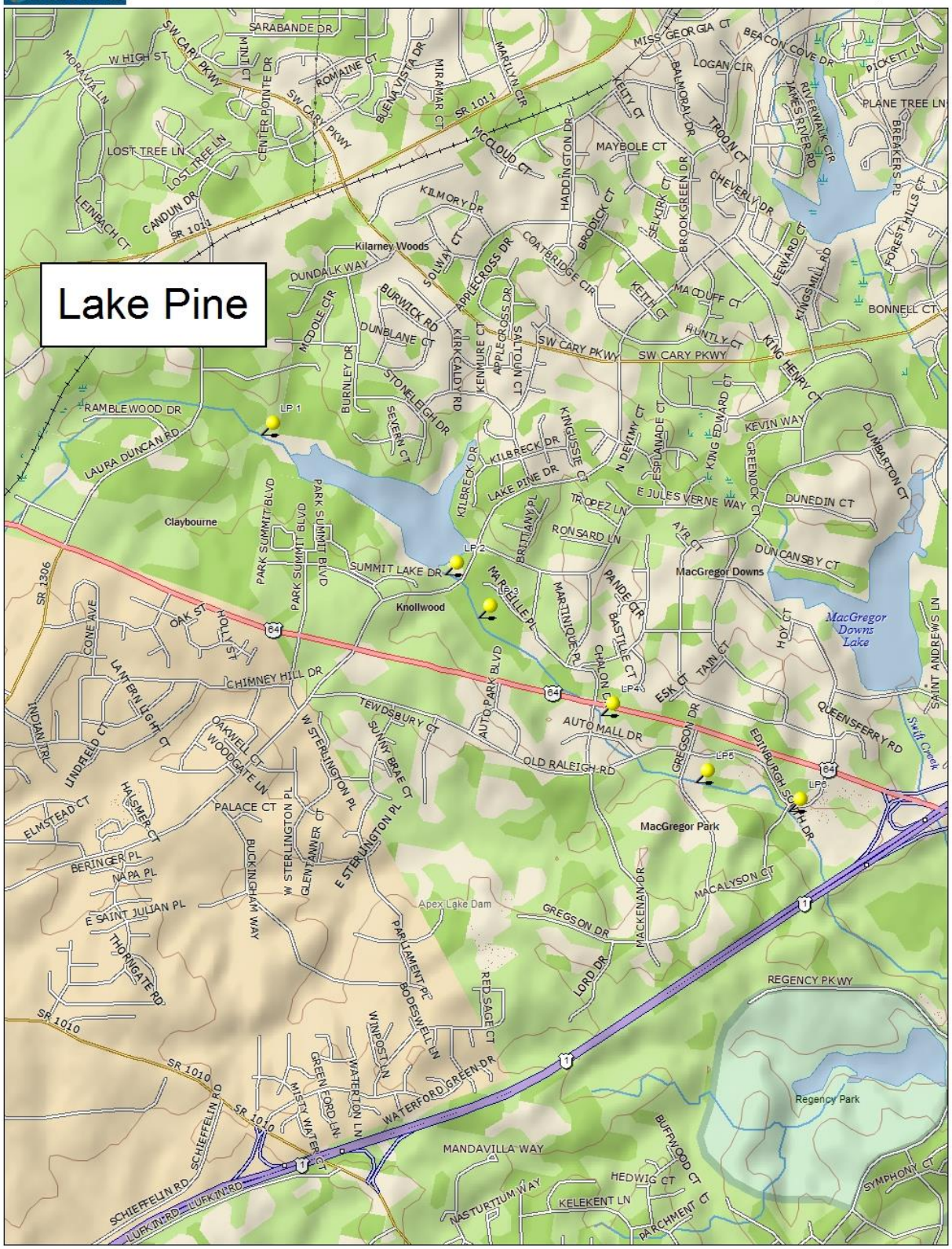

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MN (8.9° W)

0 600 1200 1800 2400 3000 3600 ft

Data Zoom 13-2

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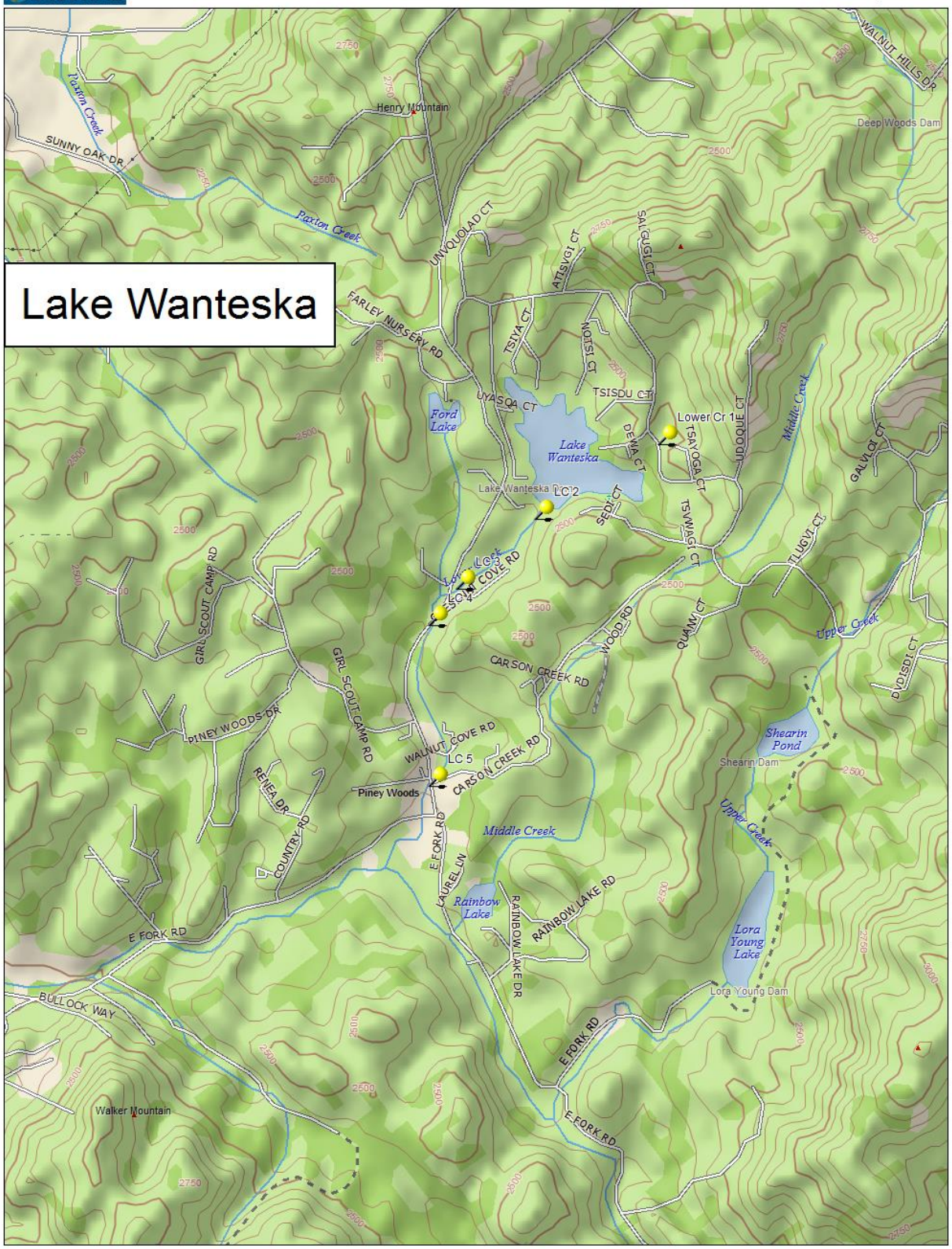

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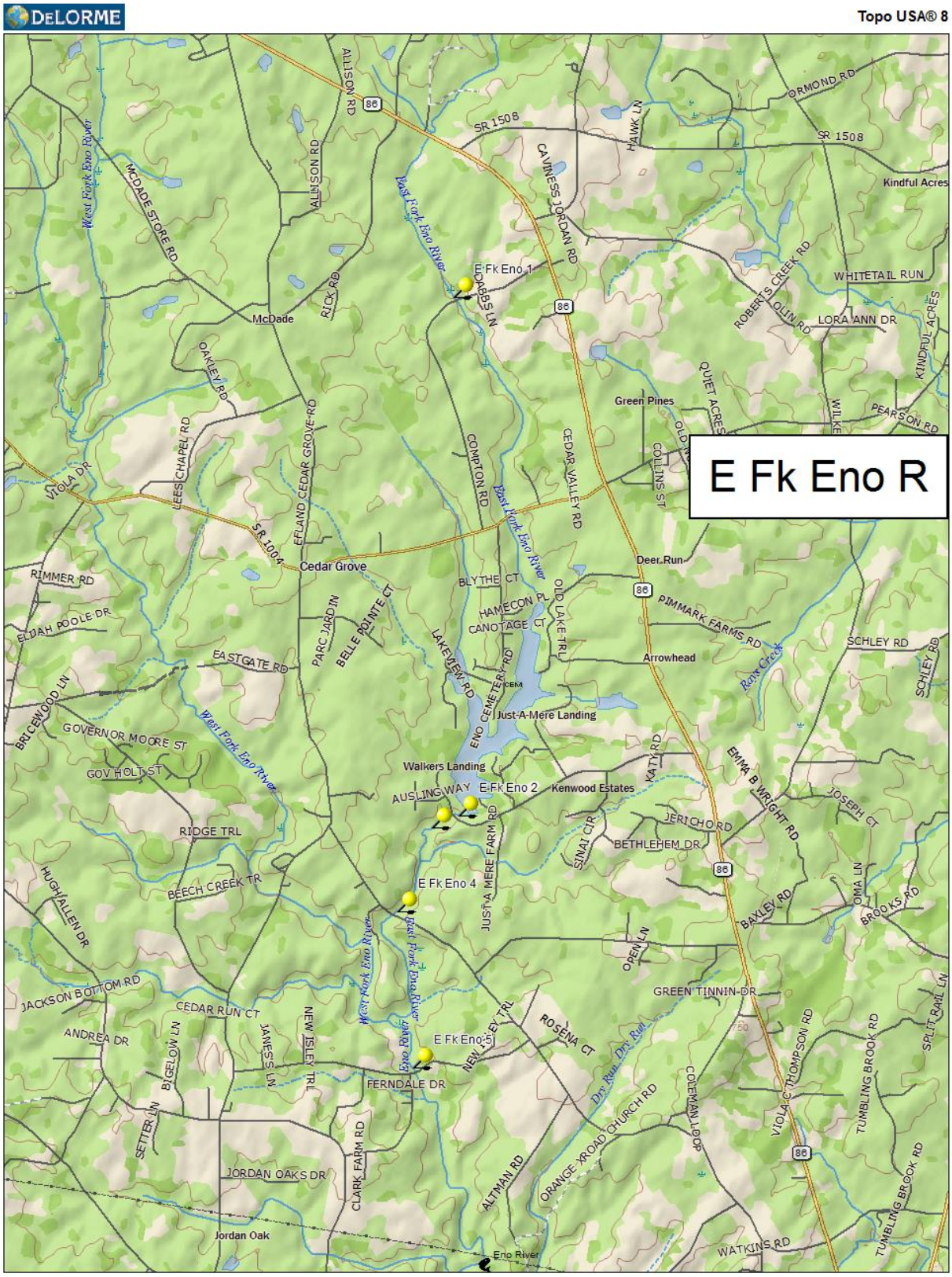
MN (6.2° W)

0 600 1200 1800 2400 3000 ft

Data Zoom 13-3


DeLORME
Topo USA® 8
E Fk Eno R
E Fk Eno 1
E Fk Eno 2
E Fk Eno 4
E Fk Eno 5
McDade
Cedar Grove
Walkers Landing
Just-A-Mere Landing
Arrowhead
Deer Run
Green Pines
Kenwood Estates
Kindful Acres
Jordan Oak
Eno River
West Fork Eno River
East Fork Eno River
Rock Creek
Dry Run
SR 1508
SR 1004
86
ALLISON RD
CAVINESS JORDAN RD
HAWK LN
ORMOND RD
WHITETAIL RUN
LORA ANN DR
ROBERTS CREEK RD
KINDFUL ACRES
PEARSON RD
QUIET ACRES
COLLINS ST
CEDAR VALLEY RD
COMPTON RD
EFLAND CEDAR GROVE RD
LEES CHAPEL RD
OAKLEY RD
MCDADE STORE RD
RICK RD
CABBS LN
VIOLA DR
RIMMER RD
ELDAH POOLE DR
EASTGATE RD
BRICEWOOD LN
GOVERNOR MOORE ST
GOV HOLT ST
RIDGE TRL
BEECH CREEK TR
HUGH ALLEN DR
JACKSON BOTTOM RD
CEDAR RUN CT
ANDREA DR
BIGELOW LN
SETTER LN
JORDAN OAKS DR
CLARK FARM RD
ALTMAN RD
ORANGE CHURCH RD
COLEMAN LOOP
VIOLA C THOMPSON RD
TUMBLING BROOK RD
WATKINS RD
SPLIT RAIL LN
GREEN TINNIN DR
ROSENA CT
NEW ISLEY TRL
JANESS LN
FERNDALE DR
OPEN LN
BAXLEY RD
OMA LN
BROOKS RD
JOSEPH CT
EMMA B WRIGHT RD
KATY RD
JERICHO RD
BETHLEHEM DR
SINAI CIR
JUST A MERE FARM RD
AUSLING WAY
LAKEVIEW RD
ENO CEMETERY RD
CEM
OLD LAKE TRL
CANOTAGE CT
HAMECON PL
BLYTHE CT
BELLE POINTE CT
PARC JARDIN
PIMMARK FARMS RD
SCHLEY RD
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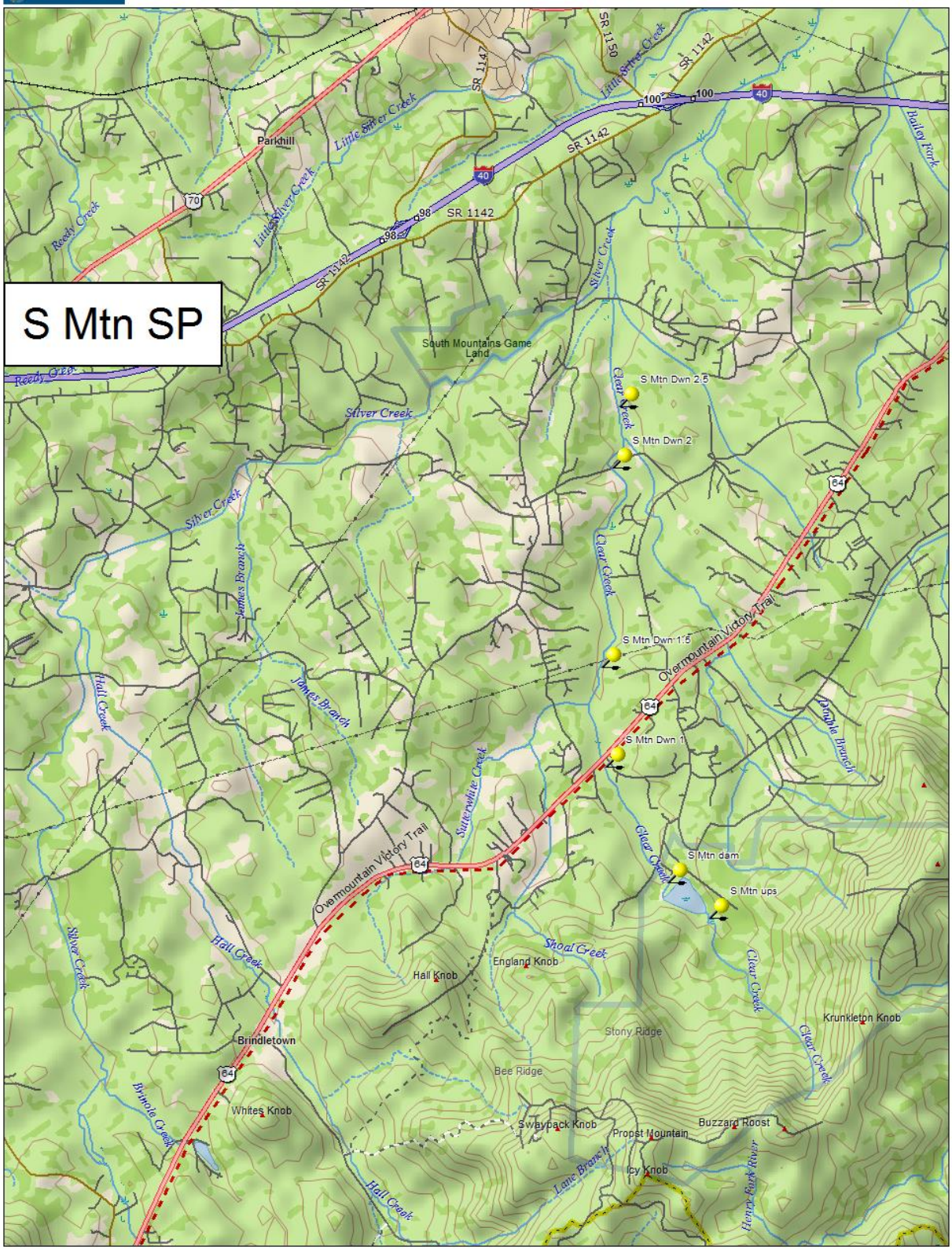
MN (8.8° W)
mi
0 ¼ ½ ¾ 1 1¼
Data Zoom 12-0

DeLORME

Topo USA® 8



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MN (6.9° W)

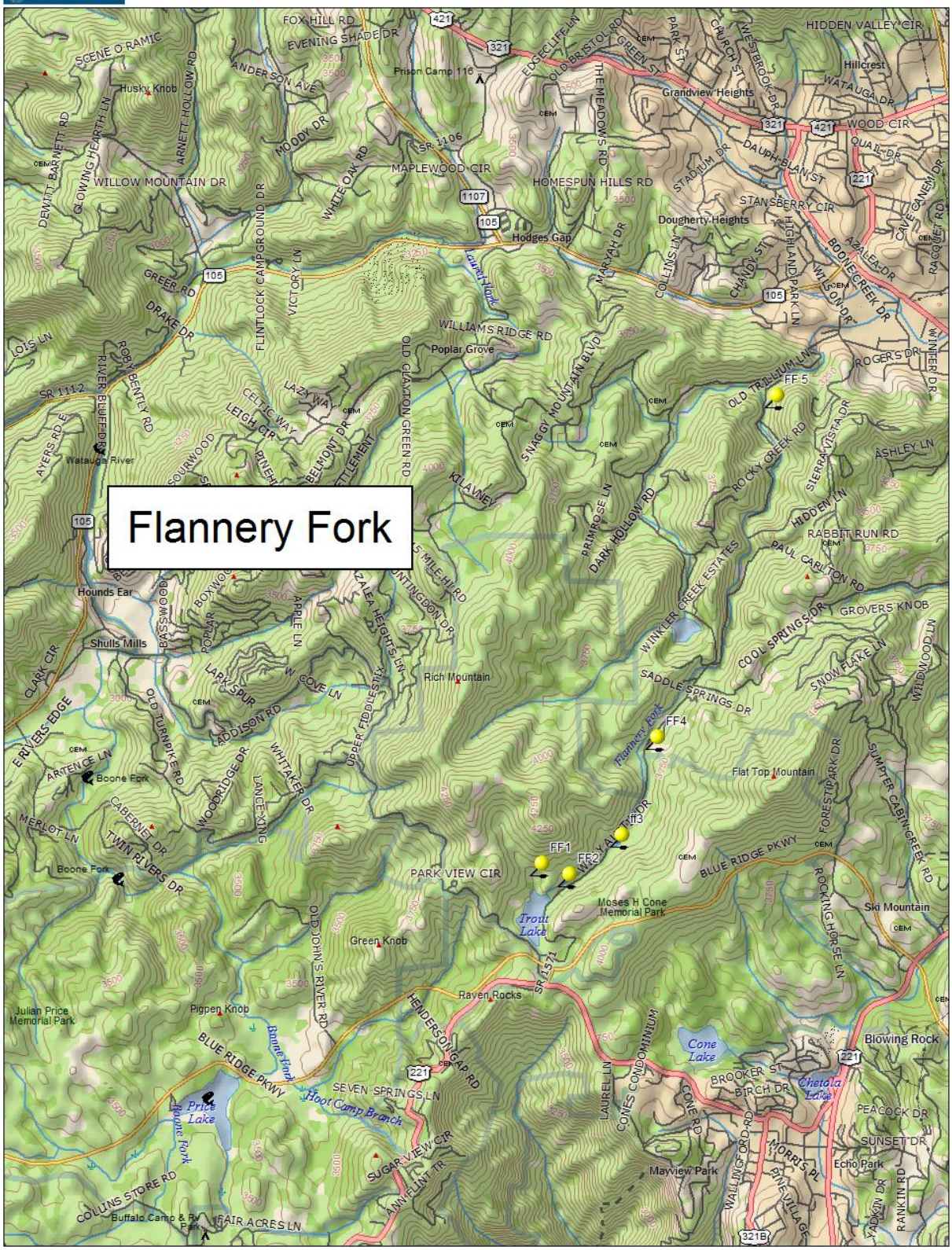
mi

0 ¼ ½ ¾ 1 1¼ 1½

Data Zoom 11-7

DeLORME

Topo USA® 8



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MN (7.1° W)

0 ¼ ½ ¾ 1 1¼ mi

Data Zoom 12-1

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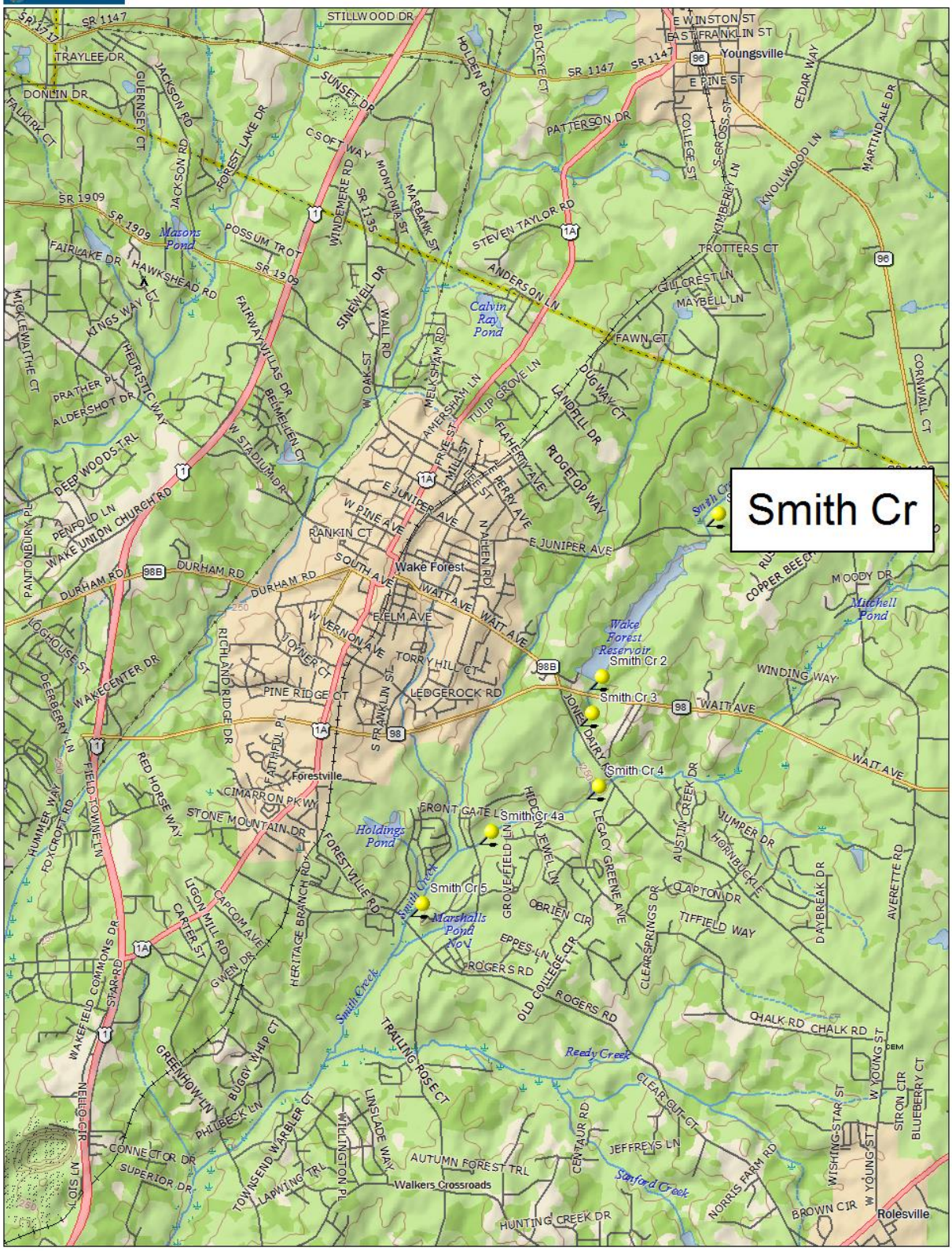

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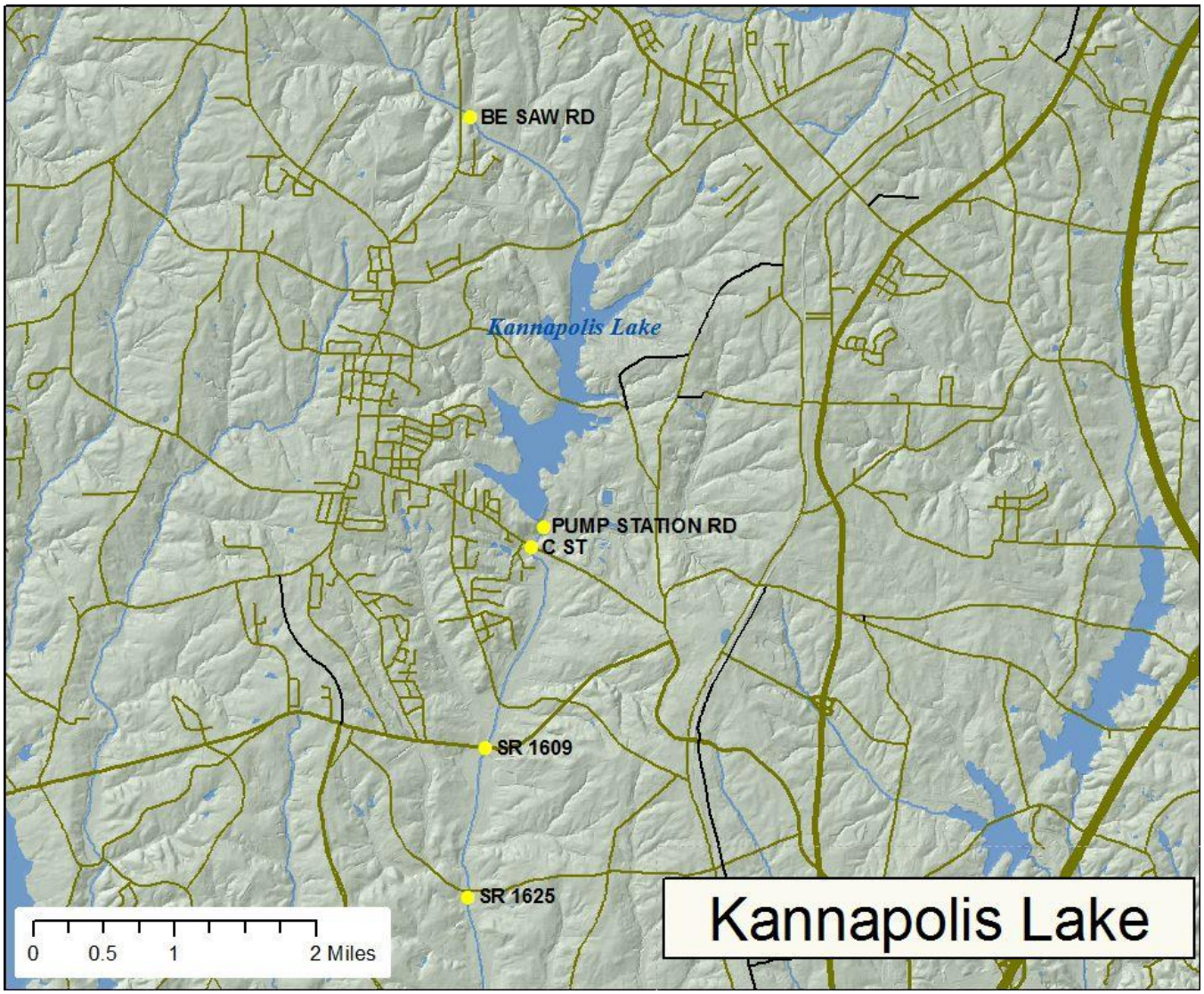
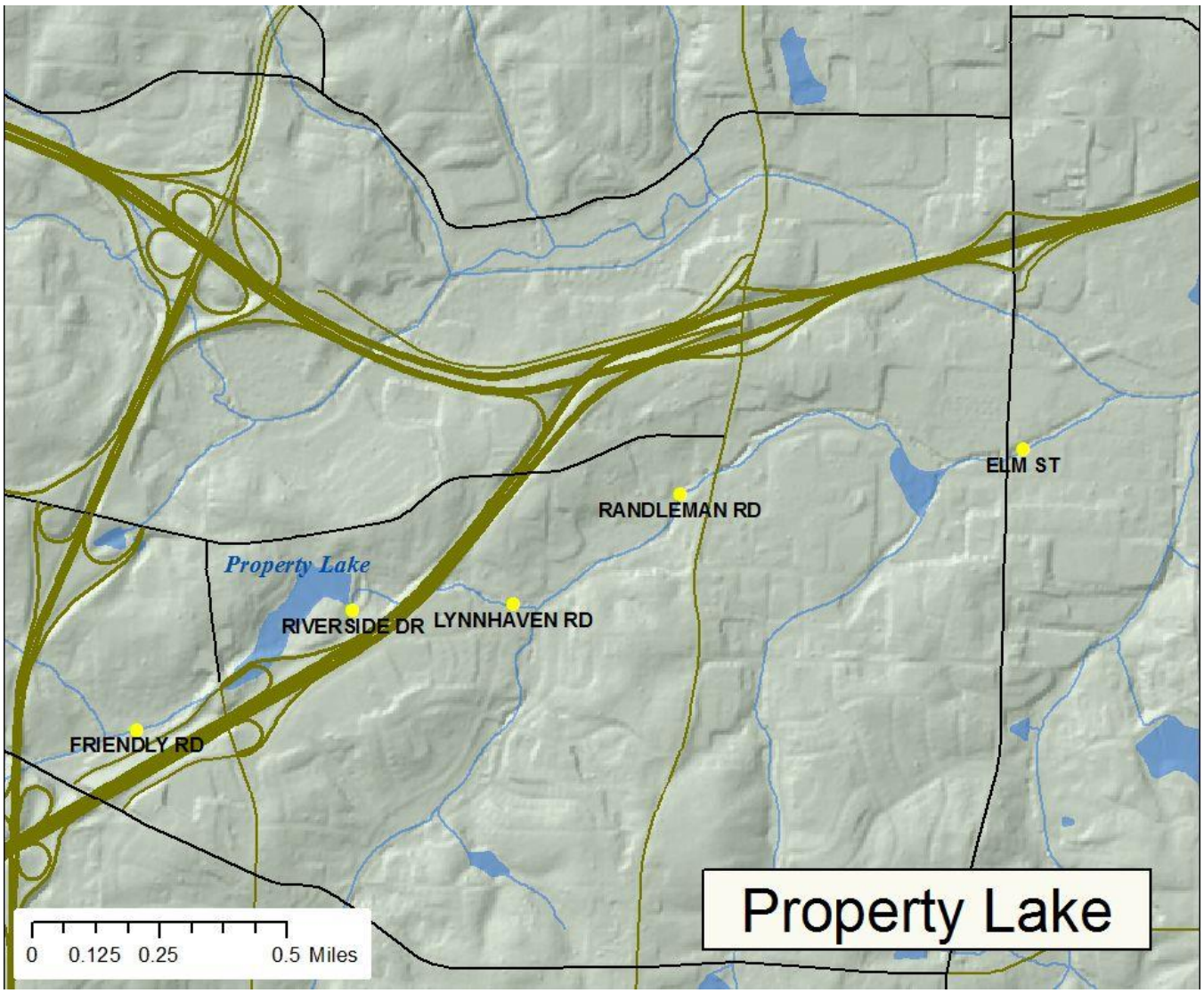
MN (9.2° W)

0 ¼ ½ ¾ 1 1¼ mi

Data Zoom 12-0


BE SAW RD
Kannapolis Lake
PUMP STATION RD
C ST
SR 1609
SR 1625
0 0.5 1 2 Miles
Kannapolis Lake


ELM ST
RANDLEMAN RD
Property Lake
RIVERSIDE DR
LYNNHAVEN RD
FRIENDLY RD
0 0.125 0.25 0.5 Miles
Property Lake

Appendix 2: Benthic Macroinvertebrate Data

		BEETREE CR SUMMER HAVEN RD Buncombe COUNTY 16 Jul 2014	BEETREE CR SR 2427 Buncombe COUNTY 15 Jul 2014	BEETREE CR BE DAM Buncombe COUNTY 15 Jul 2014	BEETREE CR LONG BRANCH RD Buncombe COUNTY 16 Jul 2014	BEETREE CR OLD BEETREE RD Buncombe COUNTY 16 Jul 2014
Ephemeroptera						
Baetidae	Acentrella nadineae					R
	Acentrella turbida gr	R				R
	Baetis flavistriga	C	C	C		
	Baetis intercalaris	C	R	A	R	A
	Baetis pluto	A		C	C	R
	Baetis tricaudatus		C			
	Plauditus cestus					R
	Plauditus dubius gr	A	A	A	R	A
	Procloeon spp		R			
Ephemerellidae	Drunella conestee		C			
	Drunella wayah		C			
	Serratella carolina		C			
	Teloganopsis deficiens	R			C	C
Heptageniidae	Epeorus dispar	A	A	C	A	C
	Epeorus subpallidus		R	C		
	Epeorus vitreus	A			C	C
	Heptagenia marginalis gr			R	R	
	Heptagenia spp		C			
	Leucrocuta spp				R	
	Maccaffertium ithaca	A	R	A	A	A
	Maccaffertium modestum	A	C		A	A
	Nixe spp		C			
	Rhithrogena spp		R			
	Stenacron pallidum	C			C	C
Leptophlebiidae	Habrophlebiodes spp		C			
	Paraleptophlebia spp		A		C	C
Plecoptera						
Chloroperlidae	Chloroperlidae		A		R	A
Leuctridae	Leuctra spp	C	A		C	A
Peltoperlidae	Tallaperla spp	C	A		C	C
Perlidae	Acroneuria abnormis	A	A	A	A	A
	Paragnetina immarginata	R	R		R	R
	Perlesta spp	C	C		C	C
Perlodidae	Isoperla holochlora-light form		C			
	Yugus bulbosus		A			
Pteronarcyidae	Pteronarcys dorsata	C	A			
	Pteronarcys scotti				R	C

Trichoptera						
Glossosomatidae	Glossosoma nigrior		A		R	C
Goeridae	Goera spp		R			
Hydropsychidae	Cheumatopsyche spp	A		A	A	A
	Diplectrona modesta		C			
	Hydropsyche (C.) bronta	R			R	C
	Hydropsyche (C.) macleodi		A			
	Hydropsyche (C.) morosa			C		
	Hydropsyche (C.) sparna	A	A	C	A	A
	Hydropsyche (H.) betteni/depravata	C		A	R	R
Lepidostomatidae	Lepidostoma spp	R	A		R	
Leptoceridae	Ceraclea spp					R
	Oecetis persimilis					R
	Triaenodes ignitus	C			C	R
	Triaenodes marginatus			C		
	Triaenodes perna/helo				R	
Limnephilidae	Pycnopsyche spp		A		R	R
Odontoceridae	Psilotreta spp	R	R			
Philopotamidae	Chimarra spp	A		R		R
	Dolophilodes spp	R	A		A	A
Polycentropodidae	Polycentropus sensu lato spp	C	R	R	R	R
Psychomyiidae	Lype diversa	R	R		R	
	Psychomyia spp	R				
Rhyacophilidae	Rhyacophila carolina		C			R
	Rhyacophila fuscula	R	C		R	A
Uenoidae	Neophylax consimilis	A	C		C	R
	Neophylax mitchelli	C	C			R
	Neophylax ornatus	R				
Odonata						
Aeshnidae	Boyeria vinosa	C		C	A	C
Calopterygidae	Calopteryx spp					R
Coenagrionidae	Argia spp			C		
Cordulegastridae	Cordulegaster spp				R	R
Gomphidae	Gomphus spp					C
	Hagenius brevistylus			R	C	
	Lanthus vernalis	C	R	C	C	
	Stylogomphus albistylus/sigmastylus		R		R	C
Megaloptera						
Corydalidae	Corydalus cornutus	C		C		R
	Nigronia serricornis	R	R		R	C
Coleoptera						
Dryopidae	Helichus basalis				A	A
	Helichus fastigiatus				R	R
Elmidae	Macronychus glabratus				C	
	Optioservus ovalis	R	R	C		R
	Stenelmis spp		R		C	C
Psephenidae	Ectopria nervosa		R			
	Psephenus herricki		C		R	C

Ptilodactylidae	Anchytarsus bicolor					R
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi	C	R	R	A	R
	Corynoneura spp	R			R	
	Cricotopus cf patens				R	R
	Cricotopus vierriensis gr	R				
	Cryptochironomus spp		R	R	R	R
	Demicryptochironomus sp C				R	
	Diamesa spp	R			R	
	Eukiefferiella brehmi gr		R	R		
	Eukiefferiella devonica gr	R				
	Eukiefferiella pseudomontana gr	R				R
	Lopescladius spp		A	A		
	Microtendipes pedellus gr				A	C
	Microtendipes spp	A	R	R		
	Nanocladius spp		R	R	R	C
	Nilotanypus fimbriatus				R	
	Orthocladius carlatus					R
	Orthocladius dubitatus	R	R	R		
	Parametriocnemus spp	R	C	C	R	
	Polypedilum aviceps	R	R	R		
	Polypedilum fallax/sp A		C	C	R	
	Polypedilum flavum	C				C
	Polypedilum illinoense gr				R	
	Polypedilum laetum	R			R	
	Potthastia cf gaedii					R
	Procladius spp		R	R		
	Rheocricotopus robacki				R	
	Rheosmittia spp		R	R		
	Rheotanytarsus spp	C			C	C
	Robackia demeijerei					C
	Stempellina spp		R	R		
	Stempellinella spp					R
	Synorthocladius spp	R	R	R	R	
	Tanytarsus sp M	R				
	Tanytarsus sp T					R
	Tanytarsus sp U					R
	Tanytarsus spp		R	R		R
	Thienemanniella spp		C	C		R
	Thienemannimyia gr	A	A	A	C	R
	Tribelos jucundum	R			C	
Diptera, other						
Blephariceridae	Blepharicera spp		R			
Ceratopogonidae	Bezzia/Palpomyia spp		R			
	Forcipomyia spp		R	R		
Dixidae	Dixa spp		R			R
Empididae	Empididae	R		R	R	
Simuliidae	Simulium spp		A	C	A	A

Tipulidae	Antocha spp	R			C	C
	Dicranota spp		A		R	
	Hexatoma spp		A		C	R
	Ormosia spp		R			
	Tipula spp		C	R		
	Tipulidae					R
Oligochaeta						
Lumbriculidae	Lumbriculidae	R	C			
Megadrile	Megadrile oligochaete	R	R	C		R
Naididae	Nais spp			C		R
Crustacea						
Cambaridae	Cambaridae		R			
	Cambarus spp				C	
Gastropoda						
Ancylidae	Ferrissia spp					C
Physidae	Physa spp			C		
Planorbidae	Helisoma anceps			A		
Pleuroceridae	Elimia spp	A	A	A	A	A
Other						
Hydracarina	Hydracarina	R		R	R	R
Platyhelminthes	Platyhelminthes	R				
Tetrastemmatidae	Prostoma graecense			R		

		BENT CR AB LAKE POWATAN Buncombe COUNTY 05 Aug 2014	BENT CR BE LAKE POWHATAN Buncombe COUNTY 05 Aug 2014	BENT CR AB LEDFORD BR Buncombe COUNTY 06 Aug 2014	BENT CR AB WOLF BR Buncombe COUNTY 05 Aug 2014	BENT CR BE WOLF BR Buncombe COUNTY 06 Aug 2014
Ephemeroptera						
Baetidae	Acentrella barbarae	A			C	
	Acentrella spp					R
	Baetis flavistriga			C	C	
	Baetis intercalaris	C	R	R	A	A
	Baetis pluto	A	A	A	A	A
	Baetis tricaudatus	C			R	
	Heterocloeon curiosum			R		
	Plauditus dubius gr	R		R	R	
Caenidae	Caenis spp	R				
Ephemerellidae	Drunella conestee	R				
	Eurylophella funeralis	R		R	R	R
	Serratella serrata	C	C	C	R	
	Teloganopsis deficiens	A		C	C	C
Ephemeridae	Hexagenia spp					R
Heptageniidae	Epeorus vitreus	C		R	A	C
	Heptagenia marginalis gr		C	A	A	A
	Heptagenia spp	C	R			
	Maccaffertium ithaca		R	C	R	
	Maccaffertium meririvulanum	R				
	Maccaffertium modestum	A	A	A	A	A
	Rhithrogena spp	R				
	Stenacron interpunctatum					R
	Stenacron pallidum		A	A	C	
Isonychiidae	Isonychia spp	C	C	C	R	
Leptophlebiidae	Paraleptophlebia spp	C		R	C	C
Plecoptera						
Chloroperlidae	Chloroperlidae			R		R
	Suwallia marginata				R	
Leuctridae	Leuctra spp	A	C	A	A	A
Peltoperlidae	Tallaperla spp	A	R	C	C	C
Perlidae	Acroneuria abnormis	A	A	A	A	A
	Eccoptura xanthenes	R				
	Paragnetina immarginata		R			
	Paragnetina spp					C
	Perlesta spp	C			C	R
Perlodidae	Malirekus hastatus	A				
Pteronarcyidae	Pteronarcys scotti	A			C	A
	Pteronarcys spp			R		
Trichoptera						
Brachycentridae	Micrasema spp			R		

	Micrasema wataga				R	R
Calamoceratidae	Anisocentropus pyraloides		R		R	R
Dipseudopsidae	Phylocentropus spp		R			
Glossosomatidae	Glossosoma nigrior	A		C	A	A
Goeridae	Goera spp	C			R	R
Hydropsychidae	Cheumatopsyche spp	C	R	C	A	A
	Diplectrona modesta	C			R	R
	Hydropsyche (C.) sparna	A	A	A	A	A
	Hydropsyche (H.) betteni/depravata		A			
Hydroptilidae	Hydroptila spp			R		
	Oxyethira spp		R			
Lepidostomatidae	Lepidostoma spp	A		C	R	A
Leptoceridae	Ceraclea ancylus		A	C	C	C
	Ceraclea enodis					R
	Mystacides sepulchralis	R	C	R		
	Nectopsyche exquisita			R		
	Oecetis persimilis		C	R	R	
	Triaenodes ignitus		R	C	R	
	Triaenodes marginatus			R		
Limnephilidae	Pycnopsyche spp	A	R	R	C	C
Odontoceridae	Psilotreta spp	R				
Philopotamidae	Chimarra spp		C	C		
	Dolophilodes spp	C	C	A	A	A
Polycentropodidae	Nyctiophylax spp				C	
Psychomyiidae	Lype diversa		R	R	R	R
Rhyacophilidae	Rhyacophila carolina	R	R		R	A
	Rhyacophila fuscula	C	C	C		C
Uenoidae	Neophylax consimilis	A				
	Neophylax oligius			R	R	C
	Neophylax ornatus	R				
Odonata						
Aeshnidae	Boyeria vinosa	C	C	A	A	A
Calopterygidae	Calopteryx spp	C	C	R	C	R
Cordulegastridae	Cordulegaster spp	R				
Gomphidae	Gomphus spp	C	R		C	C
	Lanthus vernalis	C			A	C
	Ophiogomphus spp	R				R
	Stylogomphus albistylus/sigmastylus		R			
Megaloptera						
Corydalidae	Nigronia serricornis	R	R	R	C	R
Sialidae	Sialis spp	R				
Coleoptera						
Dryopidae	Helichus basalis	R				
	Helichus fastigiatus	A	C	R	A	C
Elmidae	Ancyronyx variegatus				C	R
	Dubiraphia spp		R			
	Macronychus glabratus		C	C	A	A
	Optioservus ovalis	A	C	R		A

	Optioservus spp				C	
	Oulimnius spp				R	R
	Promoresia spp				A	
	Promoresia tardella	A	R			A
	Stenelmis spp	R	R	C	C	C
Hydrophilidae	Sperchopsis tessellatus	R				
Psephenidae	Ectopria nervosa	R			R	R
	Psephenus herricki	C		R	A	A
Ptilodactylidae	Anchytarsus bicolor		C			R
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi		C	R		R
	Apsectrotanypus johnsoni				R	R
	Brillia flavifrons		R	R	R	
	Cardiocladius obscurus					R
	Cricotopus annulator complex		C			R
	Cricotopus bicinctus			R		
	Cricotopus cf patens			R		R
	Cricotopus vierriensis gr	R				R
	Cryptochironomus spp				R	C
	Demicryptochironomus spp		R			
	Eukiefferiella brevicalcar gr				R	
	Eukiefferiella gracei gr			R		
	Labrundinia pilosella		R			
	Micropsectra dives/geminata				R	
	Micropsectra sp A	C				C
	Microtendipes pedellus gr		A	C	C	C
	Microtendipes rydalensis gr				R	R
	Nanocladius downesi			R	C	C
	Nanocladius sp 5	R				
	Nanocladius spp		A	C		
	Nilotanypus fimbriatus		C	R	R	C
	Nilothauma spp		R			R
	Orthocladius dubitatus			C		
	Orthocladius robacki		R			
	Orthocladius rubicundus			R		
	Parachaetocladius abnobaeus	C			R	C
	Parametriocnemus spp		C	C	R	R
	Paratendipes albimanus		R			
	Polypedilum aviceps	R			R	C
	Polypedilum flavum		R	C	R	
	Polypedilum illinoense gr			R	R	C
	Polypedilum laetum		R	C	C	
	Polypedilum scalaenum gr	R				C
	Prodiamesa olivacea				R	
	Rheocricotopus robacki		R	R		C
	Rheotanytarsus spp	C	A	C	R	R
	Saetheria tylus				R	
	Stempellinella fimbriata			R		

	Stempellinella spp					C
	Stictochironomus spp		R			
	Sublettea coffmani	R	A			R
	Sympotthastia spp				R	
	Synorthocladius spp	R		C	R	R
	Tanytarsus gibbus					R
	Tanytarsus messersmithi		R		R	R
	Tanytarsus sp G gr		R			
	Tanytarsus sp M					R
	Tanytarsus sp U		C			C
	Tanytarsus spp	R				
	Thienemanniella spp		R	C	R	
	Thienemannimyia gr	C	A	A	A	C
	Tribelos jucundum		A			
	Tvetenia bavarica gr	R	A	C	R	R
	Tvetenia vitracies	R				R
	Xenochironomus xenolabis					R
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp				R	
	Dasyhelea spp			R		
	Forcipomyia spp		R			
Dixidae	Dixa spp	R			R	R
Empididae	Empididae		C	R	R	R
Simuliidae	Simulium spp	A	A	A	A	A
Tipulidae	Antocha spp			R	R	R
	Dicranota spp	A		R	R	C
	Hexatoma spp	A		R	R	R
	Limnophila spp			R		
	Limonia spp		R			
	Tipula spp	C	R	R	R	C
Oligochaeta						
Lumbriculidae	Lumbriculidae	C	C	C	R	
Megadrile	Megadrile oligochaete	R	R		R	
Naididae	Nais spp	R	C			
	Pristinella spp	R				
Tubificidae	Spirosperma nikolskyi		R			
	Tubifex tubifex		R			
	Tubificidae					R
Crustacea						
Cambaridae	Cambaridae	C		R		C
Gastropoda						
Pleuroceridae	Elimia spp	A		A	A	A
Bivalvia						
Sphaeriidae	Sphaerium spp		R		R	
Other						
Glossiphoniidae	Placobdella papillifera	R				
Hydracarina	Hydracarina		R		R	R
Platyhelminthes	Platyhelminthes			R		

		UT TOWER FK AB CAMERONS LAKE Scotland COUNTY 07 May 2014	UT TOWERS FK BE CAMERON LK DAM Scotland COUNTY 07 May 2014	UT TOWERS FK HARRISON RD Scotland COUNTY 07 May 2014	TOWERS FK SAND RD AT FORD Scotland COUNTY 10 May 2014	BIG MUDDY CR TANK BRIDGE Scotland COUNTY 10 May 2014
Ephemeroptera						
Baetidae	Baetis pluto				C	R
	Labiobaetis ephippiatus					C
	Labiobaetis frondalis				R	
	Plauditus dubius gr					A
	Plauditus spp					R
Caenidae	Caenis spp			A	C	
Ephemerellidae	Attenella attenuata					A
	Eurylophella doris					R
Heptageniidae	Maccaffertium modestum	A		R	A	A
Leptophlebiidae	Paraleptophlebia spp			R	R	A
Plecoptera						
Leuctridae	Leuctra spp	A		R	C	C
Nemouridae	Prostoia spp	R				
Perlidae	Acroneuria abnormis					R
	Perlesta spp					C
Trichoptera						
Brachycentridae	Brachycentrus spp					C
Hydropsychidae	Cheumatopsyche spp			C	C	
	Diplectrona modesta	A				
	Hydropsyche (H.) decalda			A	A	A
	Macrostemum spp					C
Hydroptilidae	Oxyethira spp					R
Lepidostomatidae	Lepidostoma spp	C				
Leptoceridae	Ceraclea enodis				R	
	Nectopsyche exquisita					R
	Oecetis georgia	R			R	C
	Oecetis inconspicua			R		
	Oecetis nocturna				R	
	Oecetis scala gr				R	C
	Triaenodes ignitus				C	C
Limnephilidae	Pycnopsyche spp	R		R		C
Molannidae	Molanna blenda	R				
Odontoceridae	Psilotreta spp				R	
Philopotamidae	Chimarra spp				C	R
Polycentropodidae	Polycentropus sensu lato spp		R			
Odonata						
Aeshnidae	Boyeria vinosa				C	R
Calopterygidae	Calopteryx spp	R			R	C
Coenagrionidae	Argia spp		R	A	A	A

	Enallagma spp		R	A	C	C
Gomphidae	Gomphus spp		C		C	
	Progomphus spp					R
Libellulidae	Celithemis spp		R			
	Libellula spp		C			
	Perithemis tenera			C	C	A
Macromiidae	Macromia spp					C
Hemiptera						
Corixidae	Sigara spp		A	R		
Naucoridae	Pelocoris spp				R	
Megaloptera						
Corydalidae	Corydalus cornutus				C	
	Nigronia serricornis	C				
Coleoptera						
Dytiscidae	Copelatus spp		R			
	Hydrovatus pustulatus		R			
Elmidae	Ancyronyx variegatus					R
	Dubiraphia spp				R	R
	Stenelmis spp	R			A	A
Gyrinidae	Dineutus spp			A	A	C
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi		C	R		
	Ablabesmyia spp		R			
	Chironomus spp		C			
	Clinotanypus spp		R			
	Cryptochironomus spp	R			R	
	Dicrotendipes thanatogratus				R	
	Diplocladius cultriger				R	
	Larsia spp		C			
	Microtendipes pedellus gr			R	R	C
	Microtendipes rydalensis gr					R
	Nilotanypus spp					R
	Orthocladius annectens			R		R
	Parachironomus spp			R		
	Paracricotopus spp		R			
	Parametriocnemus spp	C	C	R		
	Paratanytarsus spp			R		
	Polypedilum aviceps			A	A	
	Polypedilum halterale gr					R
	Polypedilum illinoense gr	R				R
	Polypedilum scalaenum gr	R				R
	Procladius spp		R			R
	Psectrocladius elatus			R		
	Rheocricotopus robacki			R		
	Rheotanytarsus spp			C	C	A
	Stenochironomus spp			R		
	Tanytarsus sepp	C		C	R	C
	Tanytarsus sp O	R				

	Tanytarsus spp			C		C
	Thienemannimyia gr	A	C	A	A	A
	Tribelos jucundum	R				R
	Tvetenia spp				R	R
	Xenochironomus xenolabis				R	
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp		C	C	R	R
Dixidae	Dixella spp				R	
Simuliidae	Simulium spp	A	A	A	A	A
Tabanidae	Chrysops spp		R			
Tipulidae	Hexatoma spp		R			R
	Pseudolimnophila spp		C			
	Tipula spp		R	R	R	
Oligochaeta						
Enchytraeidae	Enchytraeidae	R	R			
Haplotaxidae	Haplotaxis gordioides		R			
Lumbriculidae	Lumbriculidae	R	A	A		
Naididae	Nais spp				R	
	Pristinella spp				R	R
	Vejdovskyella comata				R	
Tubificidae	Spirosperma nikolskyi	R				
	Tubificidae			R		R
Crustacea						
Cambaridae	Cambaridae	R	R			R
	Procambarus spp			R		
Gammaridae	Crangonyx serratus	C	A	R	R	
Gastropoda						
Ancylidae	Ferrissia spp		R	C	R	
Other						
Hydracarina	Hydracarina		C			

		CASCADE CR AB HANGING ROCK ST PK LK Stokes COUNTY 24 Jun 2014	CASCADE CR BE DAM Stokes COUNTY 16 Jun 2014	CASCADE CR BEHIND RANGER HOUSE Stokes COUNTY 26 Jun 2014	CASCADE CR SR 2012 Stokes COUNTY 24 Jun 2014	CASCADE CR SR 1001 Stokes COUNTY 24 Jun 2014
Ephemeroptera						
Baetidae	Baetis flavistriga					C
	Baetis intercalaris					R
	Baetis pluto			C	C	
	Centroptilum spp			R	R	R
	Plauditus dubius gr					R
Ephemerellidae	Attenella attenuata			R		
	Eurylophella funeralis				R	
	Teloganopsis deficiens	R				R
Heptageniidae	Epeorus dispar	R		C	C	C
	Epeorus vitreus					C
	Leucrocuta spp			A	R	C
	Maccaffertium ithaca	C	C			C
	Maccaffertium meririvulanum			A	A	
	Maccaffertium modestum	C	A		A	A
	Stenacron carolina	C			C	
	Stenacron interpunctatum					A
Leptophlebiidae	Habrophlebia vibrans	C		C		
	Paraleptophlebia spp	A				A
Plecoptera						
Chloroperlidae	Sweltsa spp			R		
Leuctridae	Leuctra spp	A		A	A	A
Peltoperlidae	Tallaperla spp	A		A	A	C
Perlidae	Acroneuria abnormis			R		C
	Eccoptura xanthenes	A		A	A	R
	Perlesta spp	C		A	C	R
Perlodidae	Isoperla holochlora-light form					C
Trichoptera						
Calamoceratidae	Heteroplectron americanum			R		
Dipseudopsidae	Phylocentropus spp	R				
Glossosomatidae	Glossosoma nigrior	C		R	C	
Hydropsychidae	Cheumatopsyche spp		A			A
	Diplectrona modesta	A		A	C	R
	Hydropsyche (C.) sparna			A	A	A
	Hydropsyche (H.) betteni/depravata	R	A			C
Lepidostomatidae	Lepidostoma spp	A			R	
Leptoceridae	Triaenodes ignitus	C	R			
Limnephilidae	Pycnopsyche gentilis	R				
	Pycnopsyche spp	C			R	R
Molannidae	Molanna spp	R		R		
Odontoceridae	Psilotreta spp	C		R	R	R

Philopotamidae	Chimarra spp		R			R
	Dolophilodes spp	C		A	A	
Polycentropodidae	Nyctiophylax spp			C	R	
	Polycentropus sensu lato spp	R	C	R	R	R
Rhyacophilidae	Rhyacophila appalachia/nigrita	C				
	Rhyacophila carolina			R	R	
	Rhyacophila fuscula			R	C	R
Uenoidae	Neophylax mitchelli	C		A	C	
Odonata						
Aeshnidae	Boyeria vinosa	R				R
Calopterygidae	Calopteryx spp	R				R
Cordulegastridae	Cordulegaster spp	C				
Gomphidae	Gomphus spp	R				R
	Lanthus vernalis	R		R	R	
Megaloptera						
Corydalidae	Corydalus cornutus		R			
	Nigronia fasciatus				C	R
	Nigronia serricornis		R		C	C
Sialidae	Sialis spp					R
Coleoptera						
Dryopidae	Helichus fastigiatus		R			A
	Helichus spp	A				C
Elmidae	Dubiraphia spp					R
	Macronychus glabratus			R		
	Optioservus spp	R				
	Promoresia spp					C
	Stenelmis spp	C	C			C
Gyrinidae	Dineutus spp			C	R	
Hydrophilidae	Helocombus spp					R
Psephenidae	Psephenus herricki			C	R	A
Ptilodactylidae	Anchytarsus bicolor	R	C		R	C
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi					R
	Brillia flavifrons				R	
	Corynoneura spp			R		
	Cryptochironomus spp		R			
	Micropsectra spp					R
	Microtendipes pedellus gr	C		R		
	Nanocladius sp 5					R
	Nilothauma spp	R				
	Orthocladiinae				R	
	Parametriocnemus spp	C				
	Polypedilum aviceps	C		R	C	
	Polypedilum flavum		C			
	Polypedilum scalaenum gr					R
	Pseudorthocladius spp			R		
	Rheocricotopus robacki		R			
	Rheotanytarsus spp	R		R		R

	Tanytarsus sp D				R	
	Tanytarsus sp M			R		
	Thienemanniella spp			R		
	Thienemannimyia gr	C	C	C	C	C
	Tvetenia bavarica gr			R		
Diptera, other						
Dixidae	Dixa spp	R	R			
Empididae	Empididae				R	
Simuliidae	Simulium spp	C	R	C	A	
Tipulidae	Dicranota spp	R		C	C	
	Hexatoma spp	R	R	R		
	Limnophila spp			R		
	Tipula spp	C	C	R	C	C
Oligochaeta						
Lumbriculidae	Lumbriculidae	R	C	C		
Naididae	Naididae		R			
	Nais spp	R				
Crustacea						
Cambaridae	Cambaridae	R	R	C	R	
Other						
Hydracarina	Hydracarina				R	

		CLEAR CR AB POND McDowell COUNTY 29 May 2014	CLEAR CR BE POND McDowell COUNTY 29 May 2014	CLEAR CR US 64 McDowell COUNTY 29 May 2014	CLEAR CR AB POWERLINE McDowell COUNTY 28 May 2014	CLEAR CR JEETER RD McDowell COUNTY 28 May 2014
Ephemeroptera						
Ameletidae	Ameletus lineatus	R				
Baetidae	Acentrella turbida gr				R	
	Baetis flavistriga	C	C			C
	Baetis intercalaris		R		A	C
	Baetis pluto	C			A	A
	Baetis spp			R		
	Labiobaetis propinquus			C	C	C
	Plauditus dubius gr	A		R	A	C
Caenidae	Caenis spp				R	C
Ephemerellidae	Ephemerella dorothea	C				
	Eurylophella aestiva				R	
	Eurylophella funeralis	R		R		R
	Eurylophella verisimilis					R
	Teloganopsis deficiens	C		R	A	A
Ephemeridae	Ephemera spp	R				
	Hexagenia spp	C				
Heptageniidae	Epeorus dispar	A				
	Maccaffertium modestum	A	A	C	C	A
	Stenacron pallidum			R		C
Isonychiidae	Isonychia spp	R		R	A	A
Leptophlebiidae	Habrophlebia vibrans	R				
	Paraleptophlebia spp	C				
Plecoptera						
Leuctridae	Leuctra spp	C				
Nemouridae	Amphinemura spp	R				R
Peltoperlidae	Tallaperla spp	A				
Perlidae	Acroneuria abnormis	C		R		
	Acroneuria spp		R			
	Eccoptura xanthenes	C				
	Perlesta spp	C	R	A	A	A
Perlodidae	Isoperla holochlora-light form	C				R
	Remenus spp	C				
Pteronarcyidae	Pteronarcys biloba			R	A	A
	Pteronarcys dorsata	R				
Trichoptera						
Glossosomatidae	Glossosoma nigrior	C		R		
Hydropsychidae	Cheumatopsyche spp		A	A	A	A
	Diplectrona modesta	A				
	Hydropsyche (C.) sparna			A	A	C
	Hydropsyche (H.) betteni/depravata		A	C	C	R

	Hydropsyche (H.) venularis		C			
Lepidostomatidae	Lepidostoma spp	A				
Leptoceridae	Nectopsyche exquisita				R	R
	Oecetis persimilis				R	R
	Triaenodes ignitus				A	C
Limnephilidae	Pycnopsyche gentilis	R				
	Pycnopsyche lepida gr					R
	Pycnopsyche spp	C		R	R	
Molannidae	Molanna blenda	R				
Philopotamidae	Chimarra spp		A	R		
	Dolophilodes spp	A				
Polycentropodidae	Polycentropus sensu lato spp	R				
Rhyacophilidae	Rhyacophila carolina	C				
	Rhyacophila fuscula	C				
Uenoidae	Neophylax mitchelli	A				
	Neophylax oligius			C		
Odonata						
Aeshnidae	Boyeria vinosa		C	C	R	C
Calopterygidae	Calopteryx spp	R	R	C	C	R
Coenagrionidae	Argia spp					R
Gomphidae	Lanthus vernalis	C				
	Ophiogomphus spp			R		R
Megaloptera						
Corydalidae	Corydalus cornutus		C	R	R	C
	Nigronia fasciatus	R				
Coleoptera						
Dryopidae	Helichus spp	C		R		R
Elmidae	Ancyronyx variegatus				R	R
	Macronychus glabratus			C	C	A
	Optioservus spp					R
	Stenelmis spp	R				
Gyrinidae	Dineutus spp			R	C	R
Hydrophilidae	Sperchopsis tessellatus					C
Psephenidae	Psephenus herricki	A			R	
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi	R				
	Brillia spp	R				R
	Cardiocladius obscurus		R			
	Cricotopus bicinctus			R		
	Cryptochironomus spp	R		R		
	Demicryptochironomus spp	R			R	
	Diamesa spp			R		
	Microtendipes pedellus gr	C			R	
	Nanocladius spp					R
	Orthocladius nigritus				R	
	Paralauterborniella nigrohalteralis	R				
	Parametriocnemus spp		R	R		
	Paratendipes albimanus			R		

	Polypedilum aviceps		R	R	C	C
	Polypedilum illinoense gr			C		A
	Polypedilum scalaenum gr	R				
	Rheocricotopus robacki					R
	Rheotanytarsus spp				R	C
	Stempellinella spp	R				
	Stictochironomus spp			R		
	Thienemanniella spp	R				R
	Thienemannimyia gr	R	C		R	R
	Tribelos jucundum			R		
	Tribelos spp	R				
	Tvetenia bavarica gr	R		R	C	C
	Xylotopus par			R		
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp	R	R			
Dixidae	Dixa spp	R		R	R	
Empididae	Empididae			R		
Simuliidae	Simulium spp	R	A		C	R
Tipulidae	Antocha spp			C	R	R
	Dicranota spp	C				
	Hexatoma spp	C			R	R
	Tipula spp	C	R	A	R	C
Oligochaeta						
Lumbriculidae	Lumbriculidae		C	C	C	
Megadrile	Megadrile oligochaete		R			
Naididae	Nais spp			R	R	R
Crustacea						
Cambaridae	Cambaridae		C	C		
	Cambarus spp	C				
Gastropoda						
Ancylidae	Ferrissia spp			C		
Physidae	Physa spp		R			
Planorbidae	Menetus dilatatus		C			
Pleuroceridae	Elimia spp	A	A	R	R	R
Bivalvia						
Corbiculidae	Corbicula fluminea			R		
Sphaeriidae	Pisidium spp	R		R		
Other						
Glossiphoniidae	Desserobdella phalera					R
Hydracarina	Hydracarina			R	R	R
Lepidoptera	Lepidoptera		R			
Platyhelminthes	Platyhelminthes			R		

		CROOKED RUN FK SR 1107 Stokes COUNTY 11 Jun 2014	CROOKED RUN FK AB US 52 Stokes COUNTY 11 Jun 2014	CROOKED RUN FK SR 1105 Stokes COUNTY 11 Jun 2014	CROOKED RUN FK SR 1607 Forsyth COUNTY 11 Jun 2014	CROOKED RUN FK SR 1103 Stokes COUNTY 11 Jun 2014
Ephemeroptera						
Baetidae	Acentrella turbida gr				R	R
	Baetis flavistriga	C	R	C	C	R
	Baetis intercalaris			A	C	C
	Baetis pluto	C		R	R	R
	Labiobaetis propinquus			R		R
	Plauditus dubius gr				R	R
Ephemerellidae	Teloganopsis deficiens	R			C	C
Heptageniidae	Epeorus dispar					C
	Epeorus vitreus				R	A
	Heptagenia marginalis gr					A
	Maccaffertium modestum	A	C	A	A	A
	Stenacron interpunctatum				R	C
	Stenacron pallidum				A	C
Isonychiidae	Isonychia spp				A	A
Leptophlebiidae	Paraleptophlebia spp	R				R
Plecoptera						
Leuctridae	Leuctra spp	R				R
Perlidae	Acroneuria abnormis					C
	Eccoptura xanthenes	R				
	Perlesta spp			R	A	A
Trichoptera						
Glossosomatidae	Glossosoma nigrior					A
Hydropsychidae	Cheumatopsyche spp	C	A	A	A	A
	Diplectrona modesta	C				
	Hydropsyche (C.) sparna			C	A	A
	Hydropsyche (H.) betteni/depravata	A	A	C	A	A
Lepidostomatidae	Lepidostoma spp	R				
Leptoceridae	Ceraclea enodis		R			
	Oecetis persimilis			R	R	
	Triaenodes ignitus	R		R	R	
Limnephilidae	Pycnopsyche spp				R	C
Philopotamidae	Chimarra spp	C				A
	Dolophilodes spp	C				
Rhyacophilidae	Rhyacophila fuscula					C
Uenoidae	Neophylax oligius	R			A	C
Odonata						
Aeshnidae	Boyeria vinosa	C	C	A	C	
Calopterygidae	Calopteryx spp	C	R			R
Coenagrionidae	Argia spp		A	R	C	R
Gomphidae	Gomphus spp			C		

	Lanthus vernalis			R		
	Stylogomphus albistylus/sigmastylus	R				R
Macromiidae	Macromia spp			R		
Hemiptera						
Nepidae	Ranatra spp		R			
Megaloptera						
Corydalidae	Corydalus cornutus		C		R	C
	Nigronia fasciatus				R	
Coleoptera						
Dryopidae	Helichus basalis				R	
	Helichus spp			R		C
Elmidae	Macronychus glabratus			A	C	C
	Stenelmis spp	C	R			R
Psephenidae	Psephenus herricki					A
Ptilodactylidae	Anchytarsus bicolor	C				
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi			R		
	Brillia flavifrons					R
	Chironomus spp	R		R		
	Coelotanypus spp			R		
	Cricotopus bicinctus				R	
	Cryptochironomus spp		R	R		
	Diamesa spp					R
	Eukiefferiella brevicalcar gr	R				
	Glyptotendipes spp		R			
	Microtendipes pedellus gr		R			
	Nanocladius spp				R	
	Nilotanypus fimbriatus				R	
	Paratanytarsus spp				R	
	Paratendipes albimanus			R		
	Phaenopsectra obediens gr			C		
	Polypedilum aviceps	C				R
	Polypedilum fallax/sp A	R				
	Polypedilum flavum		C	R	C	C
	Polypedilum illinoense gr	C		R	R	
	Procladius spp		R			
	Psectrocladius spp					R
	Rheotanytarsus spp	C	C	R	C	R
	Thienemanniella spp					R
	Thienemannimyia gr	C		C		
	Tribelos jucundum			R		
	Tvetenia bavarica gr	R				
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp			R		
Dixidae	Dixa spp	R				
	Dixella spp			R		R
Simuliidae	Prosimulium spp		R			
	Simulium spp	A	A	A		R

Tipulidae	Antocha spp	C	R	R	R	C
	Dicranota spp	C				
	Tipula spp	A	R	R		R
Oligochaeta						
Lumbriculidae	Lumbriculidae	C	C	C		C
Naididae	Nais spp			R	R	R
	Pristina spp		R			
Tubificidae	Tubificidae			C	R	
Crustacea						
Asellidae	Caecidotea spp					R
Cambaridae	Cambaridae			C	C	C
	Cambarus spp	A				
Talitridae	Hyalella spp		C			
Gastropoda						
Ancylidae	Ferrissia spp		A	R	R	R
Physidae	Physa spp		C	R		
Pleuroceridae	Elimia spp			A	A	C
Bivalvia						
Corbiculidae	Corbicula fluminea		A			R
Other						
Glossiphoniidae	Helobdella stagnalis		C			
	Placobdella parasitica		R			
Hydracarina	Hydracarina				C	C
Platyhelminthes	Platyhelminthes					R

		E PR ENO R COMPTON RD Orange COUNTY 07 Jul 2014	E PR ENO R BE DAM Orange COUNTY 09 Jul 2014	E PR ENO R BE SR 1323 Orange COUNTY 10 Jul 2014	E PR ENO R SR 1332 Orange COUNTY 10 Jul 2014	ENO R SR 1336 Orange COUNTY 07 Jul 2014
Ephemeroptera						
Baetidae	Baetis flavistriga	C				R
	Baetis intercalaris				R	R
	Baetis pluto					R
	Centroptilum spp	C			R	
	Labiobaetis propinquus	C				R
Caenidae	Caenis spp	A		R		
Heptageniidae	Leucrocuta spp			R	C	R
	Maccaffertium modestum	A	R	A	A	A
	Stenacron interpunctatum			C	C	C
	Stenacron pallidum	A		R	A	A
Isonychiidae	Isonychia spp	C				
Trichoptera						
Hydropsychidae	Cheumatopsyche spp	A	A	A	C	A
	Diplectrona modesta		R			
	Hydropsyche (H.) betteni/depravata	A	C	A	C	A
Hydroptilidae	Hydroptila spp				R	
Leptoceridae	Nectopsyche exquisita	C				
	Oecetis nocturna	R				
	Oecetis persimilis	A		A	C	R
	Oecetis spp			R		
	Triaenodes ignitus	C		R	C	C
	Triaenodes perna/helo				C	R
Limnephilidae	Pycnopsyche spp	A		C	R	R
Philopotamidae	Chimarra spp	C			R	R
Polycentropodidae	Nyctiophylax spp				R	
	Polycentropus sensu lato spp	A			A	A
Psychomyiidae	Lype diversa				R	R
Uenoidae	Neophylax oligius	R				
Odonata						
Aeshnidae	Boyeria vinosa	A		C	C	C
Calopterygidae	Calopteryx spp	A				
Coenagrionidae	Argia spp	A				C
	Enallagma spp	C				R
Cordulegastridae	Cordulegaster maculata	R				
Corduliidae	Epitheca princeps			C	R	A
	Helocordulia selysi					R
	Somatochlora spp	R				
Gomphidae	Gomphus spp	C		C	C	
	Hagenius brevistylus	C				R
	Progomphus spp	A				R

Macromiidae	Macromia spp			C	C	C
Hemiptera						
Nepidae	Ranatra spp					R
Megaloptera						
Corydalidae	Corydalus cornutus			C	C	C
	Nigronia serricornis	A		A	A	A
Sialidae	Sialis spp	C		C	C	C
Coleoptera						
Dryopidae	Helichus fastigiatus	A			C	
Dytiscidae	Neoporus spp	C	R	A	C	
Elmidae	Ancyronyx variegatus	A				R
	Dubiraphia spp	C		A		R
	Macronychus glabratus	A		R	A	R
	Stenelmis spp	C		R	A	R
Gyrinidae	Dineutus spp		A	A	C	C
Hydrophilidae	Cymbiodyta spp		A			
	Laccobius minutoides	C				
	Paracymus spp	R				
	Sperchopsis tessellatus	C			R	
	Tropisternus natator	R				
Ptilodactylidae	Anchytarsus bicolor				R	
Scirtidae	Scirtes spp		R			R
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi	C		A	A	C
	Ablabesmyia rhamphe gr			C	R	R
	Brillia flavifrons	R	C			
	Chironomus spp		C		R	
	Cladotanytarsus sp A	C				
	Cladotanytarsus sp F				R	
	Clinotanypus spp			C		
	Corynoneura spp		R			
	Cricotopus bicinctus	R				
	Cricotopus cf cylindraceus	R			C	
	Cricotopus cf patens			C	A	A
	Cricotopus vierriensis gr				C	
	Cryptochironomus spp	C	R		R	
	Demicryptochironomus spp			C		
	Dicrotendipes neomodestus	C				
	Eukiefferiella gracei gr					R
	Glyptotendipes spp			R		
	Labrundinia pilosella					R
	Micropsectra dives/geminata		A			
	Micropsectra polita		A			R
	Microtendipes pedellus gr	C	R	C	C	A
	Nanocladius distinctus			R		
	Nanocladius downesi			R		
	Nanocladius spp		A		R	C
	Natarsia spp		R	R		

	Nilotanypus fimbriatus			R		C
	Orthocladius carlatus				R	
	Orthocladius robacki			C		R
	Paracladopelma spp	C				
	Parametriocnemus spp	R	A			
	Paratendipes albimanus	R	R			
	Phaenopsectra obediens gr					R
	Polypedilum aviceps		C			
	Polypedilum fallax/sp A	R				
	Polypedilum flavum	A	C	A	C	A
	Polypedilum halterale gr			R		
	Polypedilum illinoense gr		C	R		A
	Polypedilum scalaenum gr	C		A	6	C
	Procladius spp			R		
	Pseudochironomus spp	C				R
	Rheocricotopus robacki	C				C
	Rheotanytarsus spp	C	C	C	C	A
	Saetheria tylus				R	
	Stenochironomus spp	R		R	C	C
	Synorthocladius spp				R	
	Tanytarsus allicis/buckleyi	C				C
	Tanytarsus messersmithi	C		R	A	A
	Tanytarsus sepp	C		C	C	
	Tanytarsus sp L gr			R	C	
	Tanytarsus sp U	C			C	
	Tanytarsus spp			R		
	Thienemanniella spp		R		R	R
	Thienemannimyia gr	A	A	A	A	A
	Tribelos jucundum	C		R	C	R
	Tribelos spp		A			
	Xenochironomus xenolabis	R				
	Xylotopus par	C	R		R	
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp	R				
	Forcipomyia spp					R
Chaoboridae	Chaoborus spp		A			
Culicidae	Anopheles spp	R		R	C	C
Dolichopodidae	Dolichopodidae		R			
Empididae	Empididae	R	C			R
Ptychopteridae	Bittacomorpha clavipes		C			
Simuliidae	Simulium spp	C	A	C		A
Tabanidae	Chrysops spp	C		R		
Tipulidae	Antocha spp				R	
	Epiphragma spp		C			
	Hexatoma spp	C		A	A	C
	Limonia spp			R		
	Pedicia spp		R			
	Pseudolimnophila spp		C	R	R	

	Tipula spp	R	A	R		R
Oligochaeta						
Enchytraeidae	Enchytraeidae		R			
Haplotaxidae	Haplotaxis gordioides		R			
Lumbriculidae	Lumbriculidae		A	C	R	C
Megadrile	Megadrile oligochaete	R	R	R		C
Naididae	Pristina spp	R				
Tubificidae	Branchiura sowerbyi			C		
	Limnodrilus hoffmeisteri	R		R	R	C
	Spirosperma nikolskyi					R
	Tubifex tubifex	R		C		
Crustacea						
Cambaridae	Cambaridae		A	C	C	
	Cambarus spp	C				C
	Procambarus spp	C				
Gammaridae	Crangonyx spp		A	R		
Talitridae	Hyalella spp	C		A	A	A
Gastropoda						
Ancylidae	Ferrissia spp	R		R	R	
Lymnaeidae	Pseudosuccinea columella			R		
Physidae	Physa spp	C	C		R	
Planorbidae	Helisoma anceps	R				
	Menetus dilatatus	R		R	R	C
Pleuroceridae	Elimia spp			C		
Bivalvia						
Corbiculidae	Corbicula fluminea	A		C		C
Sphaeriidae	Musculium spp		C			
	Pisidium spp					R
Unionidae	Elliptio spp	R				
Other						
Glossiphoniidae	Desserobdella phalera			R		
	Helobdella triserialis		R			
Hydracarina	Hydracarina	A		C	A	A
Platyhelminthes	Platyhelminthes		R	A	R	

		FLANNERY FK AB TROUT LAKE Watauga COUNTY 24 Jun 2014	FLANNERY FK OF SR 1541 BE DAM Watauga COUNTY 24 Jun 2014	FLANNERY FK SR 1541 AB 1ST BRIDGE Watauga COUNTY 24 Jun 2014	FLANNERY FK OFF SR 1541 @ PK BOUNDARY Watauga COUNTY 24 Jun 2014	FLANNERY FK BLOCK RD Watauga COUNTY 25 Jun 2014
Ephemeroptera						
Baetidae	Baetis flavistriga			R	C	A
	Baetis pluto	R				A
	Plauditus dubius gr				C	A
Ephemerellidae	Drunella conestee					R
	Drunella cornutella				R	
	Drunella longicornis					R
	Ephemerella dorothea					R
	Ephemerella invaria gr	R				
	Teloganopsis deficiens			C	C	A
Heptageniidae	Epeorus dispar	A			C	A
	Epeorus vitreus				R	A
	Heptagenia spp					A
	Leucrocuta spp				C	
	Maccaffertium meririvulanum	A			C	
	Maccaffertium modestum			A	A	C
	Maccaffertium pudicum				R	
	Nixe spp	A				A
	Stenacron pallidum	R		C	A	R
Isonychiidae	Isonychia spp					A
Leptophlebiidae	Habrophlebia vibrans			A	C	
	Paraleptophlebia spp	A		C	C	C
Plecoptera						
Chloroperlidae	Haploperla spp	C				
	Sweltsa spp	R				
Leuctridae	Leuctra spp	C	C	A	A	A
Nemouridae	Amphinemura spp			R	R	R
Peltoperlidae	Tallaperla spp	A		A	A	A
Perlidae	Acroneuria abnormis			A	A	A
	Acroneuria carolinensis					C
	Eccoptura xanthenes	R		R		
	Paragnetina immarginata					A
	Perlesta spp					R
Perlodidae	Isoperla holochlora-light form					C
	Isoperla nr holochlora	R				
	Yugus bulbosus	R		R	C	
Pteronarcyidae	Pteronarcys proteus					C
Trichoptera						
Calamoceratidae	Heteroplectron americanum			R		
Glossosomatidae	Glossosoma nigrior	R			R	C
Hydropsychidae	Cheumatopsyche spp		A	R	R	R

	Diplectrona modesta	A		A	A	C
	Hydropsyche (C.) slossonae					C
	Hydropsyche (C.) sparna		C	C	C	
	Hydropsyche (H.) betteni/depravata		A	C	R	
Lepidostomatidae	Lepidostoma spp	C	R	A	C	C
Limnephilidae	Pycnopsyche gentilis	R				R
	Pycnopsyche spp	C	R	A	C	
Odontoceridae	Psilotreta spp	R		R		
Philopotamidae	Dolophilodes spp	R		A	A	A
Polycentropodidae	Nyctiophylax spp				R	R
Rhyacophilidae	Rhyacophila appalachia/nigrita			R		
	Rhyacophila carolina	R		R		C
	Rhyacophila fuscula	R		R	R	A
	Rhyacophila glaberrima/montana	R				
Sericostomatidae	Fattigia pele	R				
Uenoidae	Neophylax atlanta				C	
	Neophylax consimilis			R		
	Neophylax mitchelli	A		R	C	C
	Neophylax oligius			C	C	
Odonata						
Aeshnidae	Boyeria vinosa			R		
Coenagrionidae	Argia spp		C			
Cordulegastridae	Cordulegaster spp					R
Gomphidae	Gomphus spp		R			
	Stylogomphus albistylus/sigmastylus	A	C	C	C	R
Megaloptera						
Corydalidae	Nigronia serricornis					C
Coleoptera						
Elmidae	Optioservus spp					R
	Promoresia spp					R
	Stenelmis spp			A	C	C
Helophoridae	Helophorus spp		R	R	R	R
Hydrophilidae	Enochrus spp		R			
Psephenidae	Ectopria nervosa			R	R	R
	Psephenus herricki			C	R	A
Ptilodactylidae	Anchytarsus bicolor		R	R		
Diptera, chironomids						
Chironomidae	Cryptochironomus spp	R				
	Demicryptochironomus spp					R
	Hydrobaenus spp			R		
	Microtendipes pedellus gr	R		R		R
	Nilotanypus fimbriatus			R	R	
	Pagastia orthogonia					R
	Parametriocnemus spp	R	C	R	R	R
	Paraphaenocladius spp	C				
	Polypedilum aviceps			R	C	C
	Polypedilum flavum		A			
	Rheotanytarsus spp		C			

	Stempellinella spp			R		
	Synorthocladius spp				R	
	Tanytarsus sp L gr				R	
	Tanytarsus sp M	R				
	Thienemanniella spp			R		
	Thienemannimyia gr		A	C		C
	Tvetenia bavarica gr	R			R	
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp	R				
Dixidae	Dixa spp	R	R	R		C
Simuliidae	Simulium spp		R	R		A
Tipulidae	Dicranota spp	C	R	A	A	C
	Hexatoma spp	C			R	A
	Limnophila spp				R	
	Ormosia spp	R				
	Tipula spp				R	R
Oligochaeta						
Enchytraeidae	Enchytraeidae	R	R			
Lumbriculidae	Lumbriculidae			R	C	
Naididae	Nais spp			R	R	
Crustacea						
Cambaridae	Cambaridae	A	R	C	C	C
Talitridae	Hyalella spp		C			
Gastropoda						
Ancylidae	Ferrissia spp					R
Physidae	Physa spp		R			
Pleuroceridae	Elimia spp	A	A	A	A	C
Bivalvia						
Sphaeriidae	Pisidium spp					R
Other						
Hydracarina	Hydracarina		R	R		
Platyhelminthes	Platyhelminthes			R	R	
Tetrastemmatidae	Prostoma graecense		R			

		IRISH BUFFALO CR BE SAW RD Rowan COUNTY 02 Jun 2016	IRISH BUFFALO CR PUMP STATION RD Rowan COUNTY 02 Jun 2016	IRISH BUFFALO CR C ST Rowan COUNTY 02 Jun 2016	IRISH BUFFALO CR SR 1609 Cabarrus COUNTY 03 Jun 2016	IRISH BUFFALO CR SR 1625 Cabarrus COUNTY 03 Jun 2016
Ephemeroptera						
Baetidae	Acentrella alachua					R
	Baetis flavistriga	C		R	C	C
	Baetis intercalaris	C			A	A
	Baetis pluto	A			C	C
	Labiobaetis frondalis	R				
	Labiobaetis propinquus				R	R
	Paracloeodes minutus					R
	Plauditus cestus	A				
Caenidae	Caenis spp		R			
Heptageniidae	Maccaffertium modestum	C			A	A
	Maccaffertium terminatum	R				
Isonychiidae	Isonychia spp	R				
Plecoptera						
Chloroperlidae	Haploperla spp					R
Nemouridae	Amphinemura spp	R				
Peltoperlidae	Tallaperla spp	A				
Perlidae	Eccoptura xanthenes	A				
	Perlesta spp	A			C	A
Perlodidae	Isoperla holochlora-light form	R				R
Trichoptera						
Hydropsychidae	Cheumatopsyche spp	A	R	A	A	A
	Diplectrona modesta	A		R	R	
	Hydropsyche (H.) betteni/depravata	A	R	C	A	A
Leptoceridae	Oecetis scala gr		R			
	Oecetis sp A		R			
	Triaenodes ignitus			R	R	R
Limnephilidae	Ironoquia punctatissima					R
	Pycnopsyche gentilis	R				
	Pycnopsyche spp	C				R
Philopotamidae	Chimarra spp				R	
Psychomyiidae	Lype diversa	R		A	R	C
Odonata						
Aeshnidae	Boyeria vinosa	C		A	A	A
Calopterygidae	Calopteryx spp	A		C	C	
Coenagrionidae	Argia spp	R		R	C	A
	Enallagma spp		A			
	Ischnura spp		C			
Cordulegastridae	Cordulegaster spp	R		R		
Corduliidae	Corduliidae		C			
	Somatochlora spp		R	R	R	

Gomphidae	Gomphidae	R				
	Gomphus spp	A	R	C	C	C
	Hagenius brevistylus	R	R			
	Ophiogomphus spp	A		R	R	C
	Progomphus spp				C	R
	Stylogomphus albistylus/sigmastylus				R	C
	Stylurus spp				R	
Libellulidae	Pachydiplax longipennis		C			
Hemiptera						
Corixidae	Sigara spp		R			
Hydrometridae	Hydrometra spp		R			
Megaloptera						
Corydalidae	Chauliodes rastricornis			R		
	Nigronia serricornis					R
Sialidae	Sialis spp	R	C	R		
Coleoptera						
Curculionidae	Bagous spp		R			
Dryopidae	Helichus fastigiatus	C		R	R	R
Dytiscidae	Hydrovatus pustulatus		A			
	Ilybius spp	R				
	Neoporus spp	R	A	R	R	
Elmidae	Ancyronyx variegatus					R
	Macronychus glabratus				R	C
	Microcylloepus pusillus					R
	Stenelmis spp			C	C	A
Gyrinidae	Dineutus spp			R	C	R
	Gyrinus spp		C			
Hydrochidae	Hydrochus spp		R			
Hydrophilidae	Helochares maculicollis		R			
	Laccobius reflexipenis	R				
	Sperchopsis tessellatus				C	R
Ptilodactylidae	Anchytarsus bicolor	R				
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi		A	R	C	R
	Brillia flavifrons	A				R
	Cardiocladius obscurus		R			R
	Chironomus spp			C	R	
	Clinotanypus spp		C			
	Corynoneura spp					R
	Cricotopus annulator complex	C				
	Cricotopus bicinctus	C	R	C		
	Cricotopus cf patens	C				
	Cricotopus luciae/tremulus		C			
	Cricotopus spp			R		R
	Cricotopus sylvestris gr			C		
	Cricotopus vierriensis gr			C		
	Cryptochironomus spp		C			
	Dicrotendipes nervosus		R			

	Endochironomus nigricans		A	C		
	Eukiefferiella brevicalcar gr			R		
	Eukiefferiella claripennis gr	R				
	Glyptotendipes spp		A			
	Kiefferulus dux		C			
	Larsia spp		C			
	Microtendipes pedellus gr					R
	Natarsia sp A	R				C
	Natarsia spp			A		
	Nilotanypus fimbriatus	R				
	Odontomesa fulva	R				
	Orthocladius dubitatus			R		
	Orthocladius rubicundus	R				
	Orthocladius spp			C		
	Parachironomus tenuicaudatus complex		C			
	Paracladopelma spp			R		
	Parametriocnemus spp	A	R	R	R	C
	Paratanytarsus spp			R		R
	Paratendipes albimanus	R		C	C	R
	Phaenopsectra obediens gr				C	R
	Phaenopsectra punctipes gr			R		
	Polypedilum aviceps	A		R	R	C
	Polypedilum flavum	R				
	Polypedilum illinoense gr	R	A	C		
	Polypedilum laetum			R		
	Polypedilum tritum	R				
	Procladius spp		C			
	Rheocricotopus robacki			C		R
	Rheotanytarsus spp	C		R		C
	Robackia demeijerei			C	R	C
	Saetheria tylus			R		
	Stenochironomus spp				R	C
	Stictochironomus spp	C				
	Tanytarsus sp G gr		R			
	Tanytarsus sp L gr				C	
	Tanytarsus sp U	R				
	Tanytarsus spp	R				
	Thienemanniella spp	C			R	C
	Thienemannimyia gr	A	R	C	C	A
	Tribelos jucundum			R		R
	Tvetenia bavarica gr	A		R		C
	Xylotopus par			R		
	Zavreliella marmorata		R			
	Zavrelimyia spp				R	
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp			R		
	Sphaeromias spp		R			
Dixidae	Dixa spp	A			C	

Empididae	Empididae					R
Ephydridae	Ephydridae	R				
Simuliidae	Simulium spp	A	A	A	A	A
Tabanidae	Chrysops spp		R			
Tipulidae	Hexatoma spp				C	
	Limnophila spp	R				
	Tipula spp	R	R	C	C	C
Oligochaeta						
Enchytraeidae	Enchytraeidae	R				
Lumbriculidae	Lumbriculidae	C	C	R	R	R
Megadrile	Megadrile oligochaete	C		A	C	C
Megascolecidae	Perichaetine oligochaete	R				
Naididae	Nais spp					R
	Stylaria lacustris		R			
Tubificidae	Branchiura sowerbyi		R			
	Isochaetides curvisetosus			C		
	Limnodrilus hoffmeisteri		C	C		
	Tubifex tubifex		R	R		
	Tubificidae					R
Crustacea						
Asellidae	Caecidotea spp	R	A		R	C
Cambaridae	Cambaridae				C	C
	Cambarus spp	R				
Talitridae	Hyalella spp		A		C	
Gastropoda						
Lymnaeidae	Pseudosuccinea columella		R			
Physidae	Physa spp	R	A			
Planorbidae	Helisoma anceps				R	
	Menetus dilatatus		A	R		R
Bivalvia						
Corbiculidae	Corbicula fluminea				A	C
Sphaeriidae	Sphaerium spp		R			
Other						
Erpobdellidae	Erpobdella/Mooreobdella spp		R			
Glossiphoniidae	Desserobdella phalera		R			
	Gloiobdella elongata		C	R		
	Helobdella stagnalis		R	R		
Hydracarina	Hydracarina		C			
Platyhelminthes	Platyhelminthes		A			R

		LOWER CR UGUGU RD Transylvania COUNTY 17 Jun 2014	LOWER CR BE DAM Transylvania COUNTY 17 Jun 2014	LOWER CR WALNUT GROVE RD AB HOUSE Transylvania COUNTY 17 Jun 2014	LOWER CR WALNUT GROVE RD BE HOUSE Transylvania COUNTY 18 Jun 2014	LOWER CR CARSON CR RD Transylvania COUNTY 18 Jun 2014
Ephemeroptera						
Baetidae	Baetis flavistriga		A	C	R	
	Baetis intercalaris		R			
	Baetis pluto		R	C	C	R
	Labiobaetis frondalis				R	
	Plauditus dubius gr					R
Ephemerellidae	Drunella conestee				C	R
	Ephemerella invaria gr	R				
	Teloganopsis deficiens	R			C	A
Heptageniidae	Epeorus dispar					R
	Heptagenia spp					C
	Maccaffertium meririvulanum	A		R	C	
	Maccaffertium modestum				C	C
	Maccaffertium terminatum				R	
Isonychiidae	Isonychia spp	A			A	C
Leptophlebiidae	Paraleptophlebia spp	A			R	C
Plecoptera						
Chloroperlidae	Suwallia marginata	R				
Leuctridae	Leuctra spp	A			C	A
Nemouridae	Amphinemura spp	C			R	R
Peltoperlidae	Tallaperla spp	A			A	A
Perlidae	Acroneuria abnormis				A	A
	Beloneuria spp	C				
	Eccoptura xanthenes	R			R	
	Perlesta spp				A	C
Perlodidae	Isoperla holochlora-light form	R			A	A
	Remenus spp	C			R	
	Yugus bulbosus				C	
Pteronarcyidae	Pteronarcys dorsata	C			R	R
Trichoptera						
Brachycentridae	Brachycentrus spinae					C
	Micrasema rusticum					R
Glossosomatidae	Agapetus spp					R
	Glossosoma nigrior				C	A
Hydropsychidae	Cheumatopsyche spp		A	A	C	
	Diplectrona modesta	A				C
	Hydropsyche (C.) sparna		R	C	A	A
	Hydropsyche (H.) betteni/depravata	R	A	A	C	R
	Parapsyche cardis	C				
Lepidostomatidae	Lepidostoma spp	A			A	C
Leptoceridae	Oecetis persimilis					R

	Triaenodes ignitus				R	R
Limnephilidae	Pycnopsyche gentilis	A			R	
	Pycnopsyche spp	R			R	A
Odontoceridae	Psilotreta spp	R				C
Philopotamidae	Chimarra spp	R		A	A	C
	Dolophilodes spp	C			C	A
Rhyacophilidae	Rhyacophila carolina				R	
	Rhyacophila fuscula			A	A	A
	Rhyacophila glaberrima/montana					R
	Rhyacophila torva			C		
Uenoidae	Neophylax consimilis					R
	Neophylax mitchelli	A		R	C	C
	Neophylax ornatus				C	C
Odonata						
Aeshnidae	Boyeria vinosa				C	R
Calopterygidae	Calopteryx spp				R	
Coenagrionidae	Argia spp			C		
Cordulegastridae	Cordulegaster erronea	C				
	Cordulegaster spp				R	
Gomphidae	Gomphus spp				R	
	Lanthus vernalis			R		R
	Stylogomphus albistylus/sigmastylus	C	R	C	R	C
Megaloptera						
Corydalidae	Corydalus cornutus			C		
	Nigronia serricornis				R	C
Coleoptera						
Elmidae	Ancyronyx variegatus					R
	Macronychus glabratus			C	C	R
	Optioservus spp			R	R	
	Stenelmis spp				C	C
Helophoridae	Helophorus spp				R	
Hydrophilidae	Sperchopsis tessellatus				R	C
Psephenidae	Psephenus herricki					R
Ptilodactylidae	Anchytarsus bicolor					R
Diptera, chironomids						
Chironomidae	Brillia flavifrons	R				
	Corynoneura spp	R			R	
	Cricotopus sylvestris gr			R		
	Eukiefferiella gracei gr			R		
	Eukiefferiella spp		R			
	Metriocnemus spp				R	
	Microtendipes pedellus gr	R				C
	Nanocladius sp 5				R	
	Nanocladius spp					R
	Nilotanypus fimbriatus				R	R
	Parachaetocladius abnobaeus					R
	Parametriocnemus spp	R		R	C	
	Polypedilum aviceps			C		R

	Polypedilum fallax/sp A				R	
	Polypedilum flavum		C	R	C	R
	Polypedilum laetum					R
	Polypedilum scalaenum gr				R	
	Rheocricotopus robacki				R	
	Rheosmittia spp	R				
	Rheotanytarsus spp				C	R
	Stilocladius clinopecten	R				
	Tanytarsus spp					R
	Thienemannimyia gr		R	R	R	C
	Tribelos spp			R		R
	Tvetenia bavarica gr				C	
	Xylotopus par					R
Diptera, other						
Dixidae	Dixa spp	R	R		A	C
Empididae	Empididae		R			R
Rhagionidae	Atherix lantha					R
Simuliidae	Prosimulium spp		A	C		
	Simulium spp		A	A	A	C
Tabanidae	Chrysops spp					R
Tipulidae	Dicranota spp	C			C	A
	Hexatoma spp	R			R	C
	Tipula spp	C	C	C	C	
Oligochaeta						
Lumbriculidae	Lumbriculidae	C	R	C	C	C
Naididae	Nais spp		R	R	C	
	Pristina spp	R		R		
Crustacea						
Cambaridae	Cambarus spp					R
Gastropoda						
Physidae	Physa spp		C	A		
Planorbidae	Helisoma anceps		R	R		
Pleuroceridae	Elimia spp	C	A	C	A	A
Bivalvia						
Sphaeriidae	Pisidium spp		C			
Other						
Hydracarina	Hydracarina				R	
Platyhelminthes	Platyhelminthes	R				

		MILL CR ABOVE DAM Surry COUNTY 24 Jul 2014	MILL CR BELOW DAM Surry COUNTY 24 Jul 2014	MILL CR NR CONF MITCHELL R Surry COUNTY 24 Jul 2014	MITCHELL R HAYSTACK RD Surry COUNTY 23 Jul 2014	MITCHELL R NR HAYSTACK RD Surry COUNTY 23 Jul 2014
Ephemeroptera						
Baetidae	Acentrella nadineae				C	
	Acentrella turbida gr				C	
	Baetis flavistriga	A		C	C	R
	Baetis intercalaris	R		C	A	C
	Baetis pluto	R		R	C	R
	Baetis tricaudatus	A				
	Centroptilum spp			C		
	Labiobaetis propinquus				R	
	Plauditus dubius gr	A		C	A	C
	Procloeon spp				R	
Ephemerellidae	Drunella conestee	C				
	Drunella cornutella	C				
	Eurylophella funeralis				R	
	Eurylophella spp	C				
	Eurylophella verisimilis					R
	Serratella carolina	R				
	Serratella spiculosa	C				
	Teloganopsis deficiens	R		R	A	C
Ephemeridae	Ephemera spp				R	
	Hexagenia spp					R
Heptageniidae	Epeorus dispar	A		C	A	A
	Epeorus subpallidus	A				
	Epeorus vitreus	A		R	A	A
	Heptagenia marginalis gr	R			R	R
	Heptagenia spp	R				
	Leucrocuta spp	R			C	
	Maccaffertium ithaca			R	A	A
	Maccaffertium meririvulanum	R				
	Maccaffertium modestum	A	A	A	A	A
	Maccaffertium pudicum	R				
	Nixe spp				R	A
	Rhithrogena spp					R
	Stenacron pallidum			A		C
Isonychiidae	Isonychia spp	R				C
Leptophlebiidae	Habrophlebiodes spp	R				
	Paraleptophlebia spp	R		R	A	A
Potamanthidae	Anthopotamus distinctus					R
Plecoptera						
Chloroperlidae	Chloroperlidae				R	
	Sweltsa spp	R			R	

Leuctridae	Leuctra spp	A		A	A	A
Peltoperlidae	Tallaperla spp	A			A	A
Perlidae	Acroneuria abnormis	A	R	C	C	C
	Eccoptura xanthenes	R				R
	Paragnetina immarginata	C			A	A
	Perlesta spp	C			A	A
Perlodidae	Isoperla holochlora-light form	R				
	Malirekus hastatus	A				
	Perlodidae				R	R
	Yugus bulbosus			R	R	
Pteronarcyidae	Pteronarcys proteus	A			C	R
	Pteronarcys scotti				C	R
Trichoptera						
Brachycentridae	Micrasema spp	R				
Glossosomatidae	Glossosoma nigrior	R			R	
Goeridae	Goera spp			R	R	
Hydropsychidae	Arctopsyche irrorata	R				
	Cheumatopsyche spp	A	A	C	A	A
	Diplectrona modesta	A				
	Hydropsyche (C.) bronta				R	R
	Hydropsyche (C.) morosa		R		R	
	Hydropsyche (C.) sparna	A	R	A	A	A
	Hydropsyche (H.) betteni/depravata		A	A		
Lepidostomatidae	Lepidostoma spp	A		R		C
Leptoceridae	Mystacides sepulchralis				R	
	Oecetis persimilis			R	R	
	Triaenodes ignitus			A		A
Limnephilidae	Pycnopsyche gentilis			R		
	Pycnopsyche spp	A	C	A	C	C
Philopotamidae	Chimarra spp		C	A		
	Dolophilodes spp	A			R	C
	Wormaldia spp			R		
Polycentropodidae	Nyctiophylax spp					R
	Polycentropus sensu lato spp	R		C		R
Psychomyiidae	Lype diversa	R				
	Psychomyia spp					C
Rhyacophilidae	Rhyacophila appalachia/nigrita	C				
	Rhyacophila fuscula	C			A	C
Uenoidae	Neophylax consimilis				R	
	Neophylax mitchelli	C				
	Neophylax oligius	C		A	R	A
	Neophylax ornatus	R				
Odonata						
Aeshnidae	Boyeria vinosa		R	A	C	A
Calopterygidae	Calopteryx spp			C	R	R
Coenagrionidae	Argia spp			R		
Cordulegastridae	Cordulegaster erronea			C		
Gomphidae	Gomphus spp			R		R

	Stylogomphus albistylus/sigmastylus	C	R	R	C	R
Macromiidae	Macromia spp			R		
Hemiptera						
Nepidae	Ranatra spp			R		
Megaloptera						
Corydalidae	Corydalus cornutus		C	C	A	C
	Nigronia fasciatus					R
	Nigronia serricornis			A	A	C
Sialidae	Sialis spp			R		R
Coleoptera						
Dryopidae	Helichus basalis				A	A
	Helichus fastigiatus	C		R	A	A
	Helichus lithophilus					R
Dytiscidae	Hydroporus spp			R		
	Neoporus spp		C	C		
Elmidae	Macronychus glabratus					C
	Optioservus ovalis			R	A	A
	Optioservus spp	R				
	Oulimnius latiusculus	C				
	Oulimnius nitidulus	C				
	Oulimnius spp				R	
	Promoresia elegans				R	
	Promoresia tardella	C				R
	Stenelmis spp	C	R		C	C
Gyrinidae	Dineutus spp		R			
	Gyrinus spp			A		
Haliplidae	Peltodytes spp			R		
Hydrophilidae	Cymbiodyta spp		R			
Psephenidae	Psephenus herricki	A		C	A	A
Ptilodactylidae	Anchytarsus bicolor	R	R	R	R	C
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi		R			R
	Apsectrotanypus johnsoni					R
	Brillia flavifrons		R	R	R	R
	Cardiocladius obscurus					R
	Cricotopus annulator complex			C	A	R
	Cricotopus bicinctus			C		
	Cricotopus cf patens			A	C	R
	Cricotopus infuscatus gr			R	C	
	Cryptochironomus spp			C	A	C
	Diamesa spp			R	C	A
	Eukiefferiella brevicalcar gr				C	
	Eukiefferiella gracei gr				C	
	Labrundinia pilosella				R	
	Limnophyes spp	R				
	Lopescladius spp				A	R
	Microtendipes pedellus gr			R	C	C
	Microtendipes rydalensis gr					C

	Nanocladius branchicolus	R	R			
	Nanocladius spp				C	C
	Nilotanypus fimbriatus			C	R	
	Orthocladius carlatus			C		
	Orthocladius dorenus			C	C	
	Orthocladius dubitatus			A	C	
	Orthocladius lignicola				R	
	Pagastia orthogonia					R
	Paralauterborniella nigrohalteralis	C				
	Parametriocnemus spp	C		C	A	R
	Paratendipes albimanus		R			
	Phaenopsectra obediens gr			C		
	Polypedilum aviceps				A	
	Polypedilum fallax/sp A	R		R	C	C
	Polypedilum flavum	C	C	A	A	
	Polypedilum illinoense gr			R	R	C
	Polypedilum laetum			R		C
	Polypedilum scalaenum gr	R		R	R	A
	Potthastia cf gaedii			R	C	
	Procladius spp				R	
	Prodiamesa olivacea	R				
	Rheocricotopus robacki			R		
	Rheotanytarsus spp	R	C	C	C	C
	Stempellinella fimbriata				C	
	Stempellinella spp					R
	Stenochironomus spp				R	
	Sublettea coffmani			R	C	R
	Synorthocladius spp			C	C	
	Tanypodinae	R				
	Tanytarsus messersmithi			R		
	Tanytarsus sp L gr	R		C	R	
	Tanytarsus sp T			R		
	Tanytarsus sp U			C	A	R
	Tanytarsus spp				C	
	Thienemanniella spp			A	A	R
	Thienemannimyia gr	C	C	A	A	C
	Tribelos jucundum			R	R	
	Tvetenia bavarica gr				A	R
	Xylotopus par	R				
	Zavrelimyia spp	R				
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp		C	R		
	Dasyhelea spp				R	
	Forcipomyia spp			C	A	
Culicidae	Culicidae			C		
Dixidae	Dixa spp	R				
	Dixella spp		R	C		
Empididae	Empididae	R		C	R	R

Rhagionidae	Atherix lantha				C	C
Simuliidae	Simulium spp	C		A	A	A
Tabanidae	Chrysops spp				R	
Tipulidae	Antocha spp	R		R	A	C
	Dicranota spp	A	R		A	A
	Hexatoma spp	C			C	C
	Pseudolimnophila spp			R		R
	Tipula spp	R	C	C	R	
Oligochaeta						
Branchiobdellidae	Branchiobdellidae	R				
Lumbriculidae	Lumbriculidae	C	C	A	A	C
Megadrile	Megadrile oligochaete			C	C	
Naididae	Nais spp	R		A	R	
Tubificidae	Limnodrilus hoffmeisteri					R
Crustacea						
Cambaridae	Cambaridae				A	
	Cambarus spp	A		A		A
Gastropoda						
Ancylidae	Ferrissia spp		R	R	A	C
Physidae	Physa spp			C	R	
Planorbidae	Helisoma anceps			R		
Pleuroceridae	Elimia spp	A		A	A	A
Bivalvia						
Sphaeriidae	Pisidium spp		R			
	Sphaerium spp					R
Other						
Hydracarina	Hydracarina			C	C	C
Platyhelminthes	Platyhelminthes	R		C	R	R

		S CROWDERS CR AB POND Gaston COUNTY 27 May 2014	S CROWDERS CR BE DAM Gaston COUNTY 27 May 2014	S CROWDERS CR BE SR 1125 Gaston COUNTY 27 May 2014	S CROWDERS CR SR 1126 Gaston COUNTY 28 May 2014	S CROWDERS CR SR 1103 Gaston COUNTY 28 May 2014
Ephemeroptera						
Baetidae	Acentrella parvula					C
	Baetidae				R	
	Baetis flavistriga			R	A	A
	Baetis intercalaris				R	C
	Labiobaetis propinquus				R	C
	Plauditus dubius gr				C	R
Caenidae	Caenis spp		R			
Ephemerellidae	Eurylophella funeralis				C	R
Heptageniidae	Maccaffertium modestum	C	R	A	A	A
	Stenacron interpunctatum				C	R
	Stenacron pallidum			R		R
Isonychiidae	Isonychia spp	R			C	A
Leptophlebiidae	Paraleptophlebia spp	C			R	
Plecoptera						
Leuctridae	Leuctra spp	R				
Nemouridae	Amphinemura spp	C			R	R
Peltoperlidae	Tallaperla spp	R				
Perlidae	Eccoptura xanthenes	A				
	Perlesta spp	R		C	A	A
Perlodidae	Remenus spp	R			C	
Trichoptera						
Hydropsychidae	Cheumatopsyche spp		A	A	A	A
	Diplectrona modesta	C	R			
	Hydropsyche (H.) betteni/depravata		R		R	R
Lepidostomatidae	Lepidostoma spp	C				
Leptoceridae	Triaenodes ignitus				R	
Limnephilidae	Pycnopsyche gentilis			R		
	Pycnopsyche spp	R		C	C	C
Philopotamidae	Chimarra spp			C	C	
Rhyacophilidae	Rhyacophila carolina	R			R	
Uenoidae	Neophylax atlanta			R		
	Neophylax oligius			C		C
Odonata						
Aeshnidae	Boyeria vinosa			R	C	C
Calopterygidae	Calopteryx spp				R	R
Coenagrionidae	Argia spp				R	
	Enallagma spp				C	
Cordulegastridae	Cordulegaster spp					R
Corduliidae	Somatochlora spp	R				
Gomphidae	Gomphus spp				R	

	Lanthus spp			C		
	Lanthus vernalis				R	
	Ophiogomphus spp					R
Megaloptera						
Corydalidae	Nigronia serricornis	R	R	R	R	R
Sialidae	Sialis spp				R	
Coleoptera						
Dryopidae	Helichus spp			R	C	R
Dytiscidae	Hydroporus spp				R	
Elmidae	Dubiraphia spp				R	
	Macronychus glabratus				R	
	Optioservus spp					R
	Stenelmis spp	A	R		R	
Gyrinidae	Dineutus spp				C	C
Helophoridae	Helophorus spp					R
Psephenidae	Psephenus herricki			R		
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi				R	R
	Brillia spp					C
	Corynoneura spp			R		
	Cricotopus bicinctus				R	
	Cricotopus cf patens					C
	Cryptochironomus spp				R	R
	Microtendipes pedellus gr				R	C
	Nanocladius alternantherae				R	
	Parametriocnemus spp	C		R	R	R
	Paratanytarsus spp					C
	Polypedilum aviceps	R			R	R
	Polypedilum fallax/sp A				R	
	Polypedilum flavum		R		C	A
	Polypedilum illinoense gr				R	C
	Polypedilum scalaenum gr				R	
	Rheocricotopus robacki					R
	Rheotanytarsus spp	R		R	C	R
	Smittia spp					R
	Stenochironomus spp		R			
	Tanytarsus sp M			R		
	Tanytarsus spp				R	R
	Thienemannimyia gr	C	R		C	C
	Tvetenia bavarica gr					R
	Xylotopus par				R	
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp	C			R	
Culicidae	Anopheles spp				C	
Dixidae	Dixa spp	C			R	C
	Dixella spp			R		
Empididae	Empididae	R			R	
Simuliidae	Simulium spp	R	R		C	C

Tipulidae	Antocha spp	R				R
	Hexatoma spp					R
	Tipula spp	C	C	C	C	C
Oligochaeta						
Lumbriculidae	Lumbriculidae		C		C	C
Naididae	Nais spp		R			R
	Pristina spp				R	
Tubificidae	Tubificidae				R	
Crustacea						
Asellidae	Caecidotea spp	R				
Cambaridae	Cambaridae			C		R
	Cambarus spp	A				
Talitridae	Hyalella spp				C	
Gastropoda						
Ancylidae	Ferrissia spp	R		R	R	
Physidae	Physa spp		R		R	
Pleuroceridae	Elimia spp		R	A		A
Bivalvia						
Corbiculidae	Corbicula fluminea			C		
Other						
Hydracarina	Hydracarina				C	C
Platyhelminthes	Platyhelminthes			R		

		SMITH CR SR 1942 Wake COUNTY 01 Jul 2014	SMITH CR NC 98 Wake COUNTY 01 Jul 2014	SMITH CR SR 2063 Wake COUNTY 01 Jul 2014	SMITH CR SR 2049 Wake COUNTY 02 Jul 2014	SMITH CR SR 2052 Wake COUNTY 02 Jul 2014
Ephemeroptera						
Baetidae	Acentrella alachua					R
	Baetis flavistriga	C				A
	Baetis intercalaris		R	R		R
	Baetis pluto	A	R	C		A
	Centroptilum spp		R			
	Labiobaetis propinquus	A		C	C	R
	Plauditus cestus					C
Caenidae	Caenis spp		C			
Heptageniidae	Maccaffertium modestum	A	R	A	A	A
	Stenacron interpunctatum	C				
Isonychiidae	Isonychia spp	A				
Leptohyphidae	Tricorythodes spp	C		R	C	C
Plecoptera						
Leuctridae	Leuctra spp	R				R
Perlidae	Eccoptura xanthenes	A				
	Perlesta spp	A			C	R
	Perlidae				R	R
Trichoptera						
Hydropsychidae	Cheumatopsyche spp	A	C	A	A	A
	Diplectrona modesta	C				
	Hydropsyche (H.) betteni/depravata	A	A	A	A	A
Leptoceridae	Oecetis persimilis		R	R	C	
	Triaenodes ignitus			A	A	A
Limnephilidae	Pycnopsyche spp	A				
Philopotamidae	Chimarra spp					C
	Wormaldia spp		R			
Psychomyiidae	Lype diversa	R			A	
Rhyacophilidae	Rhyacophila carolina			R		
Uenoidae	Neophylax oligius					R
Odonata						
Aeshnidae	Boyeria vinosa	A	R	A	A	C
Calopterygidae	Calopteryx spp	C	R		C	R
Coenagrionidae	Argia spp		A	C	R	A
	Enallagma spp		C			R
	Ischnura spp		R			
Cordulegastridae	Cordulegaster spp	C				
Gomphidae	Gomphus spp	C		C	R	R
	Hagenius brevistylus				R	R
	Ophiogomphus spp	C				R
	Progomphus spp	C		C	C	

	Stylogomphus albistylus/sigmastylus	R				
Libellulidae	Plathemis lydia			R		
Macromiidae	Macromia spp			R	R	
Hemiptera						
Nepidae	Ranatra spp		R			
Megaloptera						
Corydalidae	Nigronia fasciatus	R				
	Nigronia serricornis	C			R	
Sialidae	Sialis spp	R				
Coleoptera						
Dryopidae	Helichus fastigiatus	A			R	C
Dytiscidae	Neoporus spp	C		C		
Elmidae	Ancyronyx variegatus				A	C
	Dubiraphia spp	C				
	Macronychus glabratus	C		R	A	A
	Stenelmis spp	R			R	R
Haliplidae	Peltodytes spp		R			
Hydrophilidae	Cymbiodyta spp	R				
	Helocombus spp			R		
	Sperchopsis tessellatus	R				
Ptilodactylidae	Anchytarsus bicolor	R				
Diptera, chironomids						
Chironomidae	Ablabesmyia mallochi	R		R		A
	Ablabesmyia rhamphe gr		R	R		R
	Brillia flavifrons					R
	Chironomus spp	A	C	C		C
	Cladotanytarsus spp		C			
	Clinotanypus spp			R		
	Corynoneura spp			C	C	
	Cricotopus bicinctus		R			
	Cricotopus cf patens	R				
	Cryptochironomus spp		R	A		
	Cryptotendipes spp			R		
	Dicrotendipes neomodestus		R			
	Endochironomus subtendens		A	R		
	Eukiefferiella gracei gr					C
	Eukiefferiella spp		R			
	Glyptotendipes spp		A	C		
	Microtendipes pedellus gr	A		R		
	Nanocladius crassicornus/cf rectinervis		R	C		
	Nanocladius spp				R	
	Natarsia spp			R		
	Nilotanypus fimbriatus	R		R	C	R
	Orthocladius carlatus	C				
	Paracricotopus spp	R				
	Paramerina spp				R	
	Parametriocnemus spp	R				
	Paratendipes albimanus	C			R	C

	Phaenopsectra obediens gr				R	
	Polypedilum aviceps	R		A	A	
	Polypedilum fallax/sp A	R				
	Polypedilum flavum	C	A	A	C	A
	Polypedilum halterale gr		R			
	Polypedilum illinoense gr	C	A	A	R	A
	Polypedilum laetum	R			R	
	Polypedilum scalaenum gr		C			R
	Rheocricotopus robacki	R			C	
	Rheotanytarsus spp	R		A	C	C
	Robackia demeijerei	C			C	C
	Saetheria tylus	R		A	R	C
	Stenochironomus spp	C		R		
	Stictochironomus spp	A				
	Sublettea coffmani	R				
	Tanytarsus allicis/buckleyi			R	R	
	Tanytarsus messersmithi			R	C	A
	Tanytarsus sp G gr		R			
	Tanytarsus sp L gr			R		A
	Tanytarsus sp U			R		C
	Tanytarsus spp				R	
	Thienemanniella spp	C		R	C	R
	Thienemannimyia gr	A	C	A	A	A
	Tribelos jucundum			R		A
	Tvetenia bavarica gr	R			C	
	Tvetenia vitracies			R		
	Xestochironomus spp				A	
	Xylotopus par	C			C	R
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp			R		
	Dasyhelea spp	R				
Culicidae	Anopheles spp					R
Dixidae	Dixa spp	A				
	Dixella spp	R				R
Empididae	Empididae		C	C		
Psychodidae	Pericoma spp	R				
Simuliidae	Prosimulium spp			R		
	Simulium spp	A				C
Syrphidae	Syrphidae	C				
Tipulidae	Antocha spp	R				C
	Dolichopeza spp				R	
	Epiphragma spp				R	
	Hexatoma spp	R				
	Limnophila spp				R	
	Pseudolimnophila spp					R
	Tipula spp	A	R	C	A	C
Oligochaeta						
Lumbriculidae	Lumbriculidae		R		R	

Megadrile	Megadrile oligochaete	R		C		C
Naididae	Nais spp	C	A			
	Stylaria lacustris			R		
Tubificidae	Limnodrilus hoffmeisteri	R	A	C	R	C
	Tubifex tubifex		C	R		
Crustacea						
Cambaridae	Cambaridae				C	
	Cambarus spp	A				R
Palaemonidae	Palaemonetes paludosus		C	R	R	C
Gastropoda						
Ancylidae	Ferrissia spp					R
Lymnaeidae	Pseudosuccinea columella		R			
Physidae	Physa spp		C	R	R	R
Planorbidae	Menetus dilatatus		R	R		
Bivalvia						
Corbiculidae	Corbicula fluminea				C	R
Other						
Glossiphoniidae	Placobdella papillifera					R
Hydracarina	Hydracarina					R
Lepidoptera	Lepidoptera				R	
Platyhelminthes	Platyhelminthes		R		R	R
Tetrastemmatidae	Prostoma graecense		R			

		SMITH CR SR 1942 Wake COUNTY 31 May 2016	SMITH CR NC 98 Wake COUNTY 31 May 2016	SMITH CR SR 2063 Wake COUNTY 31 May 2016	SMITH CR SR 2049 Wake COUNTY 01 Jun 2016	SMITH CR SR 2052 Wake COUNTY 01 Jun 2016
Ephemeroptera						
Baetidae	Acentrella alachua			R	C	R
	Baetis flavistriga		R		R	A
	Baetis intercalaris				C	
	Baetis pluto	R		C	R	
	Labiobaetis propinquus	R		R	C	R
Caenidae	Caenis spp		A	C		
Heptageniidae	Maccaffertium modestum	A	A	A	A	A
Isonychiidae	Isonychia spp	C				
Leptohyphidae	Tricorythodes spp				R	R
Plecoptera						
Leuctridae	Leuctra spp	C				
Nemouridae	Amphinemura spp	R				
Perlidae	Eccoptura xanthenes	A				
	Perlesta spp	A		R	A	A
Trichoptera						
Hydropsychidae	Cheumatopsyche spp	A	A	A	A	A
	Diplectrona modesta	A		R	R	
	Hydropsyche (H.) betteni/depravata	A	A	A	A	A
Leptoceridae	Oecetis cinerascens		C	C		
	Oecetis sp A		R			
	Triaenodes ignitus				R	
	Triaenodes injustus	R	A	C	R	R
	Triaenodes perna/helo		R			
Limnephilidae	Pycnopsyche gentilis	R				
	Pycnopsyche spp	A			R	
Philopotamidae	Chimarra spp					R
Psychomyiidae	Lype diversa	C			C	
Rhyacophilidae	Rhyacophila carolina	R				
Odonata						
Aeshnidae	Boyeria vinosa	A		A	A	A
Calopterygidae	Calopteryx spp	A			A	A
Coenagrionidae	Argia spp		R	A	C	A
	Enallagma spp		A	C		C
	Ischnura spp		R			
Corduliidae	Somatochlora spp				R	R
Gomphidae	Gomphus spp	R	C	C	C	R
	Hagenius brevistylus				R	
	Ophiogomphus spp				C	C
	Progomphus spp	R			A	A
	Stylogomphus albistylus/sigmastylus	C				

Libellulidae	Erythemis simplicicollis		R			
	Pachydiplax longipennis			R		
Macromiidae	Macromia spp		R		C	R
Hemiptera						
Hydrometridae	Hydrometra spp		R			
Nepidae	Ranatra spp		C			
Megaloptera						
Corydalidae	Nigronia fasciatus	R				
	Nigronia serricornis	A	R			
	Nigronia spp				R	
Sialidae	Sialis spp	C		C		
Coleoptera						
Dryopidae	Helichus fastigiatus	A		R	R	R
	Helichus lithophilus	C				
Dytiscidae	Neoporus spp	C		R		C
Elmidae	Ancyronyx variegatus				C	
	Dubiraphia spp	R				
	Macronychus glabratus	C		R	A	A
	Stenelmis spp			R	R	C
Haliplidae	Peltodytes spp					R
Ptilodactylidae	Anchytarsus bicolor	C				
Diptera, chironomids						
Chironomidae	Ablabesmyia hauberi		R			
	Ablabesmyia mallochi		C	R	C	C
	Ablabesmyia rhamphe gr		C			
	Brillia flavifrons	C			R	C
	Cardiocladius obscurus		R			C
	Chironomus spp	R	A	A	C	C
	Cladotanytarsus sp F		R	A		
	Corynoneura spp	R		R		R
	Cricotopus annulator complex	R		R	C	C
	Cricotopus bicinctus	A	A	A	A	A
	Cricotopus fugax		A	A		
	Cryptochironomus spp		R	A	R	R
	Dicrotendipes modestus		C			
	Dicrotendipes neomodestus		C	R		
	Endochironomus subtendens		A			
	Eukiefferiella claripennis gr				R	R
	Glyptotendipes spp		A	R	R	
	Labrundinia pilosella			R		
	Microtendipes pedellus gr	C		R	A	
	Nanocladius crassicornus/cf rectinervis		R	C	R	
	Nanocladius spp					R
	Natarsia spp			R		R
	Nilotanypus americanus					R
	Orthocladiinae					C
	Orthocladius annectens					R
	Orthocladius dubitatus				R	

	Orthocladius lignicola	R				
	Paracladopelma spp	C				
	Parametriocnemus spp	A	C	A	C	A
	Paratanytarsus spp	C	R			C
	Paratendipes albimanus				R	R
	Phaenopsectra obediens gr			C		R
	Phaenopsectra punctipes gr				R	
	Polypedilum aviceps	A			A	A
	Polypedilum fallax/sp A	C		R		
	Polypedilum flavum		A	A	A	
	Polypedilum halterale gr	R	C	R		
	Polypedilum illinoense gr	C	A	C	A	R
	Polypedilum scalaenum gr		A	R		R
	Procladius spp		R	R		R
	Prodiamesa olivacea					R
	Rheocricotopus robacki	C		C	A	A
	Rheotanytarsus spp	A	A	A	A	A
	Robackia demeijerei	R			C	A
	Saetheria tylus					R
	Stenochironomus spp			R		
	Stictochironomus spp	R				
	Tanytarsus allicis/buckleyi			A		
	Tanytarsus gibbus			R		
	Tanytarsus messersmithi				R	
	Tanytarsus sepp			C		
	Tanytarsus sp G gr	R	A	C	R	
	Tanytarsus sp T					R
	Tanytarsus sp U		R	R	R	
	Tanytarsus spp	R	R	R		
	Thienemanniella spp	A		C	C	C
	Thienemannimyia gr	A	A	A	A	C
	Tribelos fuscicorne	R				
	Tribelos jucundum	R				
	Tvetenia bavarica gr	A			C	A
	Tvetenia vitracies				R	
	Xylotopus par	C				
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp	R	R			
Dixidae	Dixa spp	A				
Empididae	Empididae	R				
Ptychopteridae	Bittacomorpha clavipes		R			
Simuliidae	Simulium spp	A	C	C		R
Tabanidae	Chrysops spp	R				
Tipulidae	Antocha spp					A
	Epiphragma spp			R		
	Limonia spp		R			
	Tipula spp	C	C	C	A	C
Oligochaeta						

Branchiobdellidae	Branchiobdellidae		R	R		
Enchytraeidae	Enchytraeidae			R		R
Lumbriculidae	Lumbriculidae	R	R	C	R	
Megadrile	Megadrile oligochaete	R	C			
Naididae	Naididae				R	R
	Nais spp				R	
	Stephensoniana spp			R		
	Stylaria lacustris			R		
Tubificidae	Isochaetides curvisetosus					R
	Limnodrilus hoffmeisteri		A			
	Spirosperma nikolskyi	R	R			
	Tubifex tubifex	R				
	Tubificidae					R
Crustacea						
Asellidae	Caecidotea spp			C		
Cambaridae	Cambaridae				A	C
	Cambarus spp	C	A	R		
Palaemonidae	Palaemonetes paludosus		R	R		
Talitridae	Hyalella spp		A			
Gastropoda						
Ancylidae	Ferrissia spp	R				
Lymnaeidae	Pseudosuccinea columella			R		
Physidae	Physa spp		C			R
Bivalvia						
Corbiculidae	Corbicula fluminea				R	
Other						
Glossiphoniidae	Desserobdella phalera		R			
	Gloiobdella elongata		R			
	Placobdella ornata					R
Hydracarina	Hydracarina		R	R		

		WILLIAMS CR SR 1308 Wake COUNTY 01 May 2014	WILLIAMS CR BE PINE LAKE DAM Wake COUNTY 01 May 2014	WILLIAMS CR BE LAKE PINE DR Wake COUNTY 01 May 2014	WILLIAMS CR US 64 Wake COUNTY 06 May 2014	SWIFT CR OFF GREGSON RD Wake COUNTY 06 May 2014	SWIFT CR COVERED BRIDGE Wake COUNTY 06 May 2014
Ephemeroptera							
Baetidae	Baetis flavistriga				R	A	C
Caenidae	Caenis spp		C	A			
Trichoptera							
Hydropsychidae	Cheumatopsyche spp			C	A	A	A
	Hydropsyche (H.) betteni/depravata						C
	Hydropsychidae	R					
Odonata							
Calopterygidae	Calopteryx spp	R					R
Coenagrionidae	Argia spp			C		C	
	Enallagma spp	R		R		A	
Libellulidae	Libellula spp	R	R				
	Plathemis lydia		R				
Hemiptera							
Corixidae	Sigara spp		C				
Coleoptera							
Dryopidae	Helichus fastigiatus	R					
Elmidae	Stenelmis spp	R	C	C	C	C	A
Haliplidae	Peltodytes spp		C			R	
Noteridae	Hydrocanthus spp		R			R	
Diptera, chironomids							
Chironomidae	Chironomus spp		R	C	R	C	C
	Cricotopus annulator complex	R					
	Cricotopus bicinctus		R	R	A	A	C
	Cricotopus cf patens				R		
	Cricotopus sylvestris gr		R			C	R
	Dicrotendipes modestus		R	R	R	R	
	Diplocladius cultriger	R					
	Endochironomus nigricans		R				
	Eukiefferiella claripennis gr	C				R	
	Eukiefferiella gracei gr						C
	Glyptotendipes spp		R	A	R	A	C
	Hydrobaenus spp	R					
	Microtendipes pedellus gr					R	
	Orthocladius dentifer	C					
	Orthocladius robacki	C				R	R
	Paracricotopus spp	C					
	Parametriocnemus spp	R		R			
	Paratanytarsus quadratus gr			R			
	Paratanytarsus spp	C					

	Polypedilum fallax/sp A					R	
	Polypedilum flavum				A	A	A
	Polypedilum halterale gr					C	
	Polypedilum illinoense gr		R	C	A	A	R
	Polypedilum scalaenum gr	R					
	Procladius spp					C	
	Rheocricotopus glabricollis				R	R	
	Rheotanytarsus spp	R				R	
	Tanytarsus spp			R	R		R
	Thienemanniella spp					R	
	Thienemannimyia gr			A	A	A	C
	Tribelos fuscicorne					C	
	Tribelos jucundum					R	R
Diptera, other							
Psychodidae	Pericoma spp			R			
Simuliidae	Prosimulium spp			A		R	
	Simulium spp	A			C	C	A
Tipulidae	Tipula spp	C	C	R		C	C
Oligochaeta							
Enchytraeidae	Enchytraeidae						R
Haplotaxidae	Haplotaxis gordioides				R		
Lumbriculidae	Lumbriculidae	C	A	A	A	A	A
Megadrile	Megadrile oligochaete	C			A	C	
Naididae	Nais spp	C	R	A	A	A	A
	Pristina spp			C			
	Slavina appendiculata	R	R	C	C	C	
Tubificidae	Limnodrilus hoffmeisteri		C	R		A	C
	Tubificidae	R		R		R	R
Crustacea							
Cambaridae	Cambaridae				R	R	C
	Cambarus spp	C					
Talitridae	Hyalella spp		R				
Gastropoda							
Ancylidae	Ferrissia spp					R	
Lymnaeidae	Fossaria spp		R				
	Pseudosuccinea columella		R				
Physidae	Physa spp		A	C	A	A	C
Planorbidae	Menetus dilatatus		R	R	R	A	
Bivalvia							
Corbiculidae	Corbicula fluminea	C					R
Sphaeriidae	Sphaerium spp		R			C	R
Other							
Erpobdellidae	Erpobdella/Mooreobdella spp		A	R		C	R
Glossiphoniidae	Helobdella stagnalis					R	R
	Helobdella triserialis					R	
Hydracarina	Hydracarina		R			C	
Platyhelminthes	Platyhelminthes			R	R	R	C
Sisyridae	Climacia spp						R

		UT RYAN CR FRIENDLY RD Guilford COUNTY 06 May 2016	UT RYAN CR RIVERSIDE DR Guilford COUNTY 04 May 2016	UT RYAN CR LYNNHAVEN RD Guilford COUNTY 04 May 2016	UT RYAN CR RANDLEMAN RD Guilford COUNTY 04 May 2016	UT RYAN CR ELM ST Guilford COUNTY 05 Apr 2016
Ephemeroptera						
Baetidae	Baetis flavistriga	A		A	A	A
	Baetis intercalaris			R		
	Plauditus dubius gr	R			C	
Ephemerellidae	Eurylophella verisimilis					R
Heptageniidae	Maccaffertium modestum	C	R		A	A
	Stenacron interpunctatum				C	C
Plecoptera						
Perlidae	Perlesta spp					R
Trichoptera						
Hydropsychidae	Cheumatopsyche spp	C	C	A	A	A
	Hydropsyche (H.) betteni/depravata		C	R	R	
Philopotamidae	Chimarra spp				R	
Odonata						
Aeshnidae	Boyeria vinosa					R
Calopterygidae	Calopteryx spp	C			R	A
Coenagrionidae	Argia spp		R	A	C	A
	Enallagma spp			C		C
	Ischnura spp			R		
Gomphidae	Gomphus spp					R
	Progomphus spp	R			R	A
Libellulidae	Pachydiplax longipennis					R
Coleoptera						
Dryopidae	Helichus fastigiatus					R
Dytiscidae	Neoporus spp				R	
	Uvarus spp		R			
Elmidae	Dubiraphia spp					R
	Stenelmis spp	R	A	A	A	C
Hydrophilidae	Berosus spp					R
Psephenidae	Psephenus herricki			C	R	
Diptera, chironomids						
Chironomidae	Brillia flavifrons			R		
	Chironomus spp	A	A	C	A	R
	Cricotopus annulator complex	A	A		C	
	Cricotopus bicinctus	A	A	A	A	A
	Cricotopus infuscatus gr	R		A	R	A
	Cricotopus spp		R			
	Cricotopus sylvestris gr		A	C	R	
	Cryptochironomus spp				C	
	Dicrotendipes neomodestus	R				

	Eukiefferiella claripennis gr	A	A	A	C	C
	Hudsonimyia karelena	R				
	Hydrobaenus spp		R			
	Micropsectra dives/geminata	R				
	Nanocladius alternantherae			R		
	Orthocladius dentifer	R				
	Orthocladius dorenus	C			A	
	Orthocladius dubitatus		C	R		
	Orthocladius rubicundus		R			
	Parachironomus carinatus		R			
	Parametriocnemus spp	R	C	C		R
	Paratanytarsus spp		R	C	R	R
	Paratendipes albimanus			R	C	R
	Polypedilum flavum	A	R	C	A	A
	Polypedilum halterale gr	R	R	R		C
	Polypedilum illinoense gr	R	C	R		
	Polypedilum scalaenum gr			C	A	C
	Polypedilum tritum		R	R		
	Potthastia longimana	R				R
	Procladius spp		R	R		
	Rheocricotopus robacki				R	R
	Rheotanytarsus spp	R	C	C	C	R
	Stenochironomus spp					R
	Tanytarsus allicis/buckleyi			R	R	
	Tanytarsus sp G gr				R	
	Thienemannimyia gr	A	R	A	A	A
	Tribelos jucundum				R	R
	Tvetenia bavarica gr	A		A	A	A
	Xenochironomus xenolabis				R	
Diptera, other						
Ceratopogonidae	Bezzia/Palpomyia spp		R			
Simuliidae	Simulium spp	A	A	A	A	A
Tabanidae	Chrysops spp	R		R		
Tipulidae	Tipula spp			R	R	R
Oligochaeta						
Enchytraeidae	Enchytraeidae	R				
Lumbriculidae	Lumbriculidae	C	A	C	R	C
Naididae	Nais spp	A	C	A	C	A
Tubificidae	Branchiura sowerbyi		C	R		
	Limnodrilus hoffmeisteri	R	A	C		C
	Spirosperma nikolskyi			C		
	Tubifex tubifex				R	
Crustacea						
Asellidae	Caecidotea spp	C	R	C		
Cambaridae	Cambaridae		R	R	C	C
Gammaridae	Crangonyx spp			R		
Gastropoda						
Ancylidae	Ferrissia spp	C		R		R

Physidae	Physa spp	A	C	C		
Planorbidae	Menetus dilatatus		R			
Bivalvia						
Corbiculidae	Corbicula fluminea			A		C
Sphaeriidae	Pisidium spp		R			
	Sphaerium spp		C	C		
Other						
Erpobdellidae	Erpobdella/Mooreobdella spp		C	R		
Hydracarina	Hydracarina			R		
Platyhelminthes	Platyhelminthes			R		
Sisyridae	Climacia spp				C	