Appendix II

Biological Water Quality Data Collected by DWQ

- **Benthic Macroinvertebrate Collections**
- **Lakes Assessment**

Benthic Macroinvertebrate Sampling Methodology and Bioclassification Criteria

Benthic macroinvertebrates can be collected using two sampling procedures. DWQ's standard qualitative sampling procedure includes 10 composite samples: two kick-net samples, three bank sweeps, two rock or log washes, one sand sample, one leafpack sample, and visual collections from large rocks and logs. The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1-2 specimens), Common (3-9 specimens) or Abundant (≥10 specimens).

Several data analysis summaries (metrics) can be produced from standard qualitative samples to detect water quality problems. These metrics are based on the idea that unimpaired streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a biotic index.

EPT taxa richness (EPT S) is used with DWQ criteria to assign water quality ratings (bioclassifications). "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution. Higher EPT taxa richness values usually indicate better water quality. Water quality ratings are also based on the relative tolerance of the macroinvertebrate community as summarized by the North Carolina Biotic Index (NCBI). Both tolerance values for individual species and the final biotic index values have a range of 0-10, with higher numbers indicating more tolerant species or more polluted conditions.

Water quality ratings assigned with the biotic index numbers are combined with EPT taxa richness ratings to produce a final bioclassification, using criteria for mountain/piedmont/coastal plain streams. EPT abundance (EPT N) and total taxa richness calculations also are used to help examine between-site differences in water quality. If the EPT taxa richness rating and the biotic index differ by one bioclassification, the EPT abundance value is used to determine the final site rating.

Benthic macroinvertebrates can also be collected using the DWQ's EPT sampling procedure. Four composite samples are taken at each site instead of the 10 taken for the qualitative sample: 1 kick, 1 sweep, 1 leafpack and visual collections. Only intolerant EPT groups are collected and identified, and only EPT criteria are used to assign a bioclassification.

The expected EPT taxa richness values are lower in small high quality mountain streams, <4 meters in width or with a drainage area <3.5 square miles. For these small mountain streams, an adjustment to the EPT taxa richness values is made prior to applying taxa richness criteria. Both EPT taxa richness and biotic index values also can be affected by seasonal changes. DWQ criteria for assigning bioclassification are based on summer sampling (June-September). For samples collected in other seasons, EPT taxa richness can be adjusted. The biotic index values can also be seasonally adjusted for samples collected outside the summer season.

Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample. These bioclassifications primarily reflect the influence of chemical pollutants. The major physical pollutant, sediment, is not assessed as well by a taxa richness analysis.

Flow Measurement

Changes in the benthic macroinvertebrate community are often used to help assess between-year changes in water quality. However, some between-year changes in the macroinvertebrate community may be due largely to changes in flow. High flow years magnify the potential effects of nonpoint source runoff, leading to scour, substrate instability and reduced periphyton. Low flow years may accentuate the effects of point source dischargers by providing less dilution of wastes.

For these reasons, all between-year changes in the biological communities are considered in light of flow conditions (high, low or normal) for one month prior to the sampling date. Daily flow information is obtained from the closest available USGS monitoring site and compared to the long-term mean flows. High flow is defined as a mean flow >140% of the long-term mean for that time period, usually July or August. Low flow is defined as a mean flow <60% of the long-term mean, while normal flow is 60-140% of the mean. While broad scale regional patterns are often observed, there may be large geographical variation within the state and large variation within a single summer period.

Habitat Evaluation

DWQ has developed a habitat assessment form to better evaluate the physical habitat of a stream. The habitat score has a potential range of 1-100, based on evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed for assigning ratings indicating Excellent, Good, Fair or Poor habitat.

Table A-II-1 Benthic Macroinvertebrate Data Collected in the Hiwassee River Basin, 1983 - 1999 (Current basinwide monitoring sites are bolded.)

Subbasin/ Stream	Location	County	Map No. [1]	Index No.	Date	S/ EPT S	NCBI EPT BI	Bio Class [1]
04-05-01								
Shooting Cr (above chicken farm)	SR 1349	Clay	B-1	1-5	08/94	68/37	2.97/2.22	G
Shooting Cr (below confluence of UT)	SR 1168	Clay	B-2	1-5	08/94	59/28	3.24/2.73	G
Shooting Cr	**SR 1340**	**Clay**	**B-3**	**1-5**	**08/99**	**-/30**	**-/2.57**	**G**
					07/94	-/32	-/2.36	G
Tusquitee Cr (above trout farm)	Off SR 1307	Clay	B-4	1-21-(0.5)	03/89	-/35	-/2.14	G
Tusquitee Cr (above Big Tuni Cr)	SR 1307	Clay	B-5	1-21-(0.5)	03/89	-/49	-/2.49	E
Tusquitee Cr	SR 1330	Clay	B-6	1-21-(4.5)	07/94	69/33	3.79/2.82	G
					03/89	-/45	-/2.25	E
					04/87	95/53	3.24/2.47	E
					05/87	101/51	3.23/2.33	E
Big Tuni Cr (headwaters)	USFS Rd 440	Clay	B-7	1-21-5	03/89	-/46	-/1.46	E[2]
					06/88	-/41	-/1.24	E
					04/88	-/39	-/1.37	E
					05/87	90/46	2.19/1.34	E
					04/87	77/38	2.06/1.44	E
Big Tuni Cr	**SR 1311**	**Clay**	**B-8**	**1-21-5**	**08/99**	**-/45**	**-/1.63**	**E**
					07/94	63/37	2.11/1.57	E
					03/89	83/45	2.89/2.10	E
Johnson Mill Cr	SR 1307	Clay	B-9	1-21-13	03/89	-/42	-/1.71	E
Tusquitee Cr	**SR 1300**	**Clay**	**B-10**	**1-21-(16.5)**	**08/99**	**82/39**	**3.56/2.81**	**E**
					03/89	90/47	3.12/2.37	E
Greasy Cr	SR 1318	Clay	B-11	1-21-20-(2)	03/89	-/38	-/2.38	G[3]
Albone Cr	SR 1300	Clay	B-12	1-24	05/87	79/37	2.96/1.80	E[3]
					04/87	77/38	3.15/2.10	E[3]
Fires Cr (headwaters)	USFS Rd C	Clay	B-13	1-27-(0.5)	06/88	-/35	-/1.15	E[3]
					04/88	-/39	-/1.19	E[3]
Coldspring Br	USFS Rd	Clay	B14	1-27-4-3	06/88	-/39	-/1.90	E
					04/88	-/37	-/1.33	E
Fires Cr (at Bristol Camp)	Off SR 1344	Clay	B-15	1-27-(5.5)	07/94	80/43	2.73/1.77	E
					06/88	102/47	3.06/1.75	E
					04/88	103/54	2.70/1.72	E
					05/87	95/52	2.95/1.97	E
Fires Cr (at picnic area)		**Clay**	**B-16**	**1-27-(5.5)**	**08/99**	**77/44**	**2.98/2.48**	**E**
					08/94	81/36	3.58/2.39	G
					07/94	-/35	-/1.78	G
					08/88	107/54	3.54/2.61	E
					04/88	-/48	-/1.47	E
					05/87	113/58	2.89/2.03	E
					04/87	101/54	2.68/1.97	E
					08/85	111/50	4.03/2.37	E
Fires Cr	SR 1300	Clay	B-17	1-27-(5.5)	05/87	-/41	-/2.14	E
					04/87	-/43	-/2.27	E
L Fires Cr (near mouth)	USFS Rd	Clay	B-18	1-27-7	12/91	-/34	-/1.75	E
					06/88	-/38	-/1.46	E
					04/88	-/37	-/1.43	E
Leatherwood Br	USFS Rd	Clay	B-19	1-27-12	06/88	-/30	-/2.25	E[2]
					04/88	-/34	-/1.78	E[2]
					05/87	60/30	2.81/1.80	E[2]
					04/87	58/34	2.12/1.44	E[2]
Brasstown Cr	**SR 1104**	**Clay**	**B-20**	**1-42**	**08/99**	**77/44**	**4.63/3.88**	**G**
					07/94	-/18	-/4.41	F

Subbasin/ Stream	Location	County	Map No.[1]	Index No.	Date	S/ EPT S	NCBI EPT BI	Bio Class[1]
04-05-02								
Hiwassee R (near Murphy)	**US 64**	**Cherokee**	**B-1**	**1-(43.7)**	**08/99**	**73/36**	**4.42/3.53**	**G**
					08/90	79/38	4.43/3.40	G
					08/87	78/35	4.77/3.47	G
					07/86	65/32	4.97/3.98	G-F
					08/85	56/25	4.49/3.77	G
					08/84	67/29	4.60/3.56	G
					08/83	62/23	4.77/3.62	G-F
Peachtree Cr	**SR 1537**	**Cherokee**	**B-2**	**1-44**	**08/99**	**-/38**	**-/2.91**	**E**
					07/94	-/37	-/2.42	E
Valley R (near Rhodo)	Off US 19	Cherokee	B-3	1-52	08/94	-/23	-/2.84	G-F
Valley R (above Andrews)	SR 1389	Cherokee	B-4	1-52	08/94	-/15	-/3.30	F
Valley R (above WWTP)	Bus. US 19	Cherokee	B-5	1-52	08/99	-/24	-/4.75	G-F
					08/94	40/6	5.97/2.47	F
Valley R (above Andrews WWTP)		Cherokee	B-6	1-52	08/85	76/33	5.34/3.97	G-F
Valley R (below Andrews WWTP)		Cherokee	B-7	1-52	08/85	75/30	5.72/3.86	G-F
Valley R (above landfill)	Off US 19	Cherokee	B-8	1-52	08/94	57/13	5.51/4.00	F
Valley R (below landfill)	Off SR 1315	Cherokee	B-9	1-52	08/99	63/28	5.26/4.49	G-F
Valley R (near Tomotla)	**SR 1554**	**Cherokee**	**B-10**	**1-52**	**08/99**	**80/33**	**5.15/4.27**	**G-F**
					07/94	77/29	5.05/4.37	G-F
					08/90	87/33	4.75/3.88	G
					08/88	91/33	5.02/4.29	G-F
					07/86	71/28	5.60/4.04	G-F
					08/84	70/26	5.05/4.16	G-F
Junaluska Cr	**SR 1505**	**Cherokee**	**B-11**	**1-52-25**	**08/99**	**-/31**	**-/3.22**	**G**
					07/94	-/25	-/2.11	G-F
					08/94	-/22	-/2.50	G-F
Britton Cr (near SR 1339)	Off USFS Rd	Cherokee	B-12	1-52-29-(1)	12/91	-/35	-/1.54	E
Webb Cr	SR 1428,	Cherokee	B-13	1-52-32	08/99	58/37	3.21/2.80	G
Hanging Dog Cr	**SR 1331**	**Cherokee**	**B-14**	**1-57**	**08/99**	**-/40**	**-/2.62**	**E**
					07/94	-/46	-/2.49	E
Nottely R	**SR 1596**	**Cherokee**	**B-15**	**1-58**	**08/99**	**-/33**	**-/3.54**	**G**
					07/94	-/36	-/2.83	E
Persimmon Cr	**SR 1127**	**Cherokee**	**B-16**	**1-63**	**08/99**	**-/40**	**-/3.65**	**E**
					07/94	-/42	-/2.97	E
Beaverdam Cr	**SR 1326**	**Cherokee**	**B-17**	**1-72**	**08/99**	**-/38**	**-/2.76**	**E**
					08/94	-/39	-/2.45	E
South Shoal Cr	**SR 1314**	**Cherokee**	**B-18**	**1-77**	**0/899**	**-/33**	**-/2.55**	**G**
					08/94	-/30	-/2.40	G
Shuler Cr	**SR 1323**	**Cherokee**	**B-19**	**1-86**	**08/99**	**-/40**	**-/2.78**	**E**
					08/94	-/35	-/2.42	G

[1] E = Excellent, G = Good, G-F = Good-Fair, and F = Fair.

[2] Small stream criteria.

Lakes Assessment

Numerical indices are often used to evaluate the trophic state of lakes. An index was developed specifically for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NCDNRCD, 1982). The North Carolina Trophic State Index (NCTSI) is based on total phosphorus (TP in mg/l), total organic nitrogen (TON in mg/l), Secchi depth (SD in inches), and chlorophyll *a* (CHL in µg/L). Lakewide means for these parameters are used to produce a NCTSI score for each lake, using the equations:

TON_{Score} = ((Log (TON) + 0.45)/0.24)*0.90

TP_{Score} = ((Log (TP) + 1.55)/0.35)*0.92

SD_{Score} = ((Log (SD) – 1.73)/0.35)*-0.82

CHL_{Score} = ((Log (CHL) – 1.00)/0.48)*0.83

NCTSI = $TON_{Score} + TP_{Score} + SD_{Score} + CHL_{Score}$

In general, NCTSI scores relate to trophic classifications (Table L1). When scores border between classes, best professional judgment is used to assign an appropriate classification. NCTSI scores may be skewed by highly colored water typical of dystrophic lakes. Some variation in the trophic state of a lake between years is not unusual because of the potential variability of data collections which usually involve sampling a limited number of times during the growing season.

Table L1 Lakes Classification Criteria

NCTSI Score	Trophic Classification
< -2.0	Oligotrophic
-2.0 – 0.0	Mesotrophic
0.0 – 5.0	Eutrophic
> 5.0	Hypereutrophic

Lakes are classified for their "best usage" and are subject to the state's water quality standards. Primary classifications are C (suited for aquatic life propagation /protection and secondary recreation such as wading), B (primary recreation, such as swimming, and all Class C uses), and WS-I through WS-V (water supply source ranging from highest watershed protection level I to lowest watershed protection V, and all Class C uses).

Lakes with a CA designation represent water supplies with watersheds that are considered Critical Areas (i.e., an area within 0.5 mile and draining to water supplies from the normal pool elevation of reservoirs, or within 0.5 mile and draining to a river intake).

Supplemental classifications may include HQW (High Quality Waters which are rated excellent based on biological and physical/chemical characteristics) and ORW (Outstanding Resource Waters which are unique and special waters of exceptional state or national recreational or ecological value). A complete listing of these water classifications and standards can be found in Title 15 North Carolina Administrative Code, Chapter 2B, Section .0100 and .0200.