their reference categories, and a percentage of the highest average value (representing the worst water quality) was taken in order to account for differences in water quality between ecoregions and drainage sizes. All sites that received a score of zero (no parameters exceeded the limits) were classified as "higher" quality. Sites that had a percentage value between zero and one were classified as "middle" quality, and sites that had a percentage value greater than one were classified as "lower" quality.

Benthic macroinvertebrate samples were analyzed using seven metrics mainly derived from RBP III (Barbour and others, 1999):

(1) taxonomic richness;
(2) modified Hilsenhoff Biotic Index;
(3) percent Ephemeroptera;
(4) percent contribution of dominant taxon;
(5) number of Ephemeroptera/Plecoptera/Trichoptera (EPT) taxa;
(6) percent Chironomidae; and
(7) Shannon-Wiener Diversity Index.

Reference sites were determined for each reference category, primarily based on the results of the macroinvertebrate metrics and secondarily based on habitat and water quality scores, to represent the best combination of conditions. The metric scores were compared to the reference scores, and a biological condition category was assigned based on RBP III methods (Plafkin and others, 1989; Barbour and others, 1999).

The same reference sites were used in the analysis for the habitat scores. The ratings for each habitat condition were totaled, and a percentage of the reference site was calculated. The percentages were used to assign a habitat condition category to each site (Plafkin and others, 1989; Barbour and others, 1999).

Methods Used in the 1994 Subbasin Survey

In the 1994 survey of the West Branch Susquehanna Subbasin, SRBC selected 92 sample sites. Eighty-seven sites were sampled once between July 5 and August 17, 1994, while five sites on the mainstem of the river were sampled on September 14, 1994, due to earlier storm events. The sites where data were collected in 1994, in addition to 2002, are indicated in Appendix A with an asterisk. The methods for sampling in 1994 were very similar to the methods in 2002, with some minor changes in protocol, equipment, and monitoring forms. As in 2002, benthic macroinvertebrates and water quality were sampled, and habitat was evaluated.

Biological and habitat conditions were evaluated according to USEPA RBP III (Plafkin, 1989). A different habitat form was used in 1994 than was used in 2002. Some of the parameters were slightly different, and were rated on a different scale than in 2002. Parameters relating to substrate and instream cover were rated on a scale of 0-20; these parameters included bottom substrate, embeddedness, canopy cover, and flow. Parameters relating to channel morphology were rated on a scale of 0-15; these included channel alteration, bottom scouring and deposition, pool/riffle-run/bend ratio, and bank capacity. Parameters relating to riparian and bank structure were rated on a scale from 0 to 10 and included bank stability, bank vegetative protection, streamside cover, and riparian zone.

1994 DATA ANALYSIS

The reference categories in the 1994 analysis differed since the USEPA's ecoregion coverage was used instead of the USGS's coverage. USEPA's coverage consisted of three ecoregions in the West Branch Susquehanna Subbasin. The third ecoregion that is not included in the USGS coverage is Ecoregion 69, the Central Appalachian region (Woods, 1996), where the headwaters of the West Branch Susquehanna River are located. Small streams (drainage areas <100 sq. mi.) were grouped by Level IV Ecoregion, medium streams (drainage area 100-500 sq. mi.) were grouped by Level III Ecoregion, and large streams (drainage area >500 sq. mi.) were grouped regardless of Ecoregion. Some of the small streams in subecoregions with similar characteristics were combined into a single reference category.

A different method was used to assess the 22 water quality parameters examined in 1994 (Table 3). Each parameter from every site was assigned a ranked percentile on a scale from 0 to 100 to obtain a percentile score. Water quality indices were developed from the median and average of all the parameter percentile scores from each site to be used in the designation of water quality conditions. Every parameter was characterized as "good," "fair," or "poor" based on: comparison of its percentile ranking to the median percentile of all sites for that parameter; the percentile derived from the established water quality standard for that parameter; and the median percentile of the reference sites. Each site was then designated "good," "fair," or "poor" based on analysis of its parameters and its water quality indices.

Different metrics were chosen in 1994 for analysis of the macroinvertebrate data; however, the overall method was the same as that which was used in 2002.

Table 3. *Water Quality Parameters Analyzed in 1994*

PHYSICAL	NUTRIENTS	MAJOR IONS	METALS
pH	Total nitrogen	Hardness	Copper
Dissolved oxygen	Total ammonia	Sodium	Dissolved iron
Conductivity	Total nitrate	Potassium	Lead
Alkalinity	Dissolved phosphate	Chloride	Total manganese
Acidity		Sulfate	Nickel
Dissolved residue			Zinc
			Aluminum

The six metrics used in 1994 were: (1) taxonomic richness; (2) Shannon-Wiener Diversity Index; (3) Hilsenhoff Biotic Index; (4) number of EPT taxa; (5) Percent Taxonomic Similarity (measures the similarity of the taxonomic composition of the sample community against the reference community); and (6) Percent Trophic Similarity (measures the similarity of the functional feeding group composition of the sample community against the reference community). The 1994 method for analysis of the habitat data was the same as was used in 2002.

2002 Results/Discussions

Since the West Branch Susquehanna Subbasin is mostly forestland with a few small towns, there is minimal urban influence on this subbasin. However, large portions of this watershed are degraded and lacking in biological life due to AMD. Figure 3 shows that past and current mining activities occurred mostly in the headwaters region of this subbasin. Table 4 shows sites with extreme values in parameters that are characteristic of AMD or agriculture/wastewater treatment plants. This table shows that there were numerous sites that were impacted by AMD and several sites that were impacted by nitrogen; however, no stations were clearly influenced by wastewater treatment plants. Chloride and dissolved oxygen values did not exceed the limits. Table 5 lists the same parameters that are characteristic of AMD or agriculture/wastewater treatment plants; however, it contains values for sites that have been designated as Exceptional Value (EV). Tables 4 and 5 provide comparisons of the same water quality parameters at those sites that were polluted to sites that were high quality.

Figures 4 and 5 show the larger watersheds in the subbasin and their relative locations. These figures also show the ratings for water quality, biological condition, and habitat condition of the sites in each ecoregion. Figure 6 (A, B, and C) shows a summary of the ratings for water quality, biological condition, and habitat condition in each reference category. Ecoregion 67-Small had the highest number of sites severely impacted due to water quality, biological score, and habitat; however, Ecoregion 62-Large had the largest percentage of sites impaired due to water quality and biological score. The habitat condition was rated excellent for most of the sites because a majority of the subbasin is forested. This rating is misleading for many of the streams that suffered from AMD precipitate coating the streambed. This precipitate interferes with the quality of habitat used by macroinvertebrates and was scored low for the parameters of "Epifaunal Substrate" and "Embeddedness"; however, the overall high-quality habitat of the streams outweighed these ratings. Another influence that could have affected the data in this survey was the severe drought during the summer and early fall of 2002.

Headwaters of the West Branch Susquehanna River near Bakerton, Cambria County Impacted by Abandoned Mine Drainage (AMD)

S. LeFevre

The Clean Water Act Section 303(d), established in 1972, requires a Total Maximum Daily Load (TMDL) to be developed for any waterbody designated as impaired, or not meeting the state water quality standards or its designated use. Streams in Pennsylvania are being assessed as part of the State Surface Waters Assessment Program, and, if they are found to be impaired, a TMDL is calculated for the watershed. Some of the watersheds in the West Branch Susquehanna Subbasin have been rated impaired largely due to AMD, and subsequently, will require a TMDL. Figure 7 and Table 6 identify those watersheds that SRBC and Pa. DEP are working on as part of the TMDL program. More information on the TMDL program is available at http://www.dep.state.pa.us/watermanagement_apps/tmdl/default.asp.

CUSH CREEK and BEAR RUN

Cush Creek and Bear Run were the two most upstream creeks on the West Branch of the Susquehanna River that were sampled. The sampling site at the mouth of Cush Creek was found to be "middle" water quality, since it slightly exceeded the aluminum standard. The macroinvertebrate population was slightly impaired, and the habitat was partially supporting. AMD precipitate caused severe impairment at Bear Run. The precipitate covered the rocks and degraded the habitat in the stream; however, the surrounding habitat was supporting. High metal concentrations and low pH and alkalinity degraded the water quality at Bear Run. SRBC currently is sampling this stream as part of the TMDL program for AMD impairment.

CHEST CREEK WATERSHED

The water quality in Chest Creek was "middle" to "lower" quality with high nitrogen and temperature in the headwaters and elevated hardness, magnesium, and sulfate downstream. The macroinvertebrate population was moderately to slightly impaired downstream, and the habitat ranged from nonsupporting in the headwaters to excellent at the mouth. The uppermost sampling site (CHST 24.5) was located just downstream of the town of Patton in a channelized ditch with few riffles. The middle site was located in the town of Westover and also was disturbed by anthropogenic influences; the downstream site was located in a forested area.