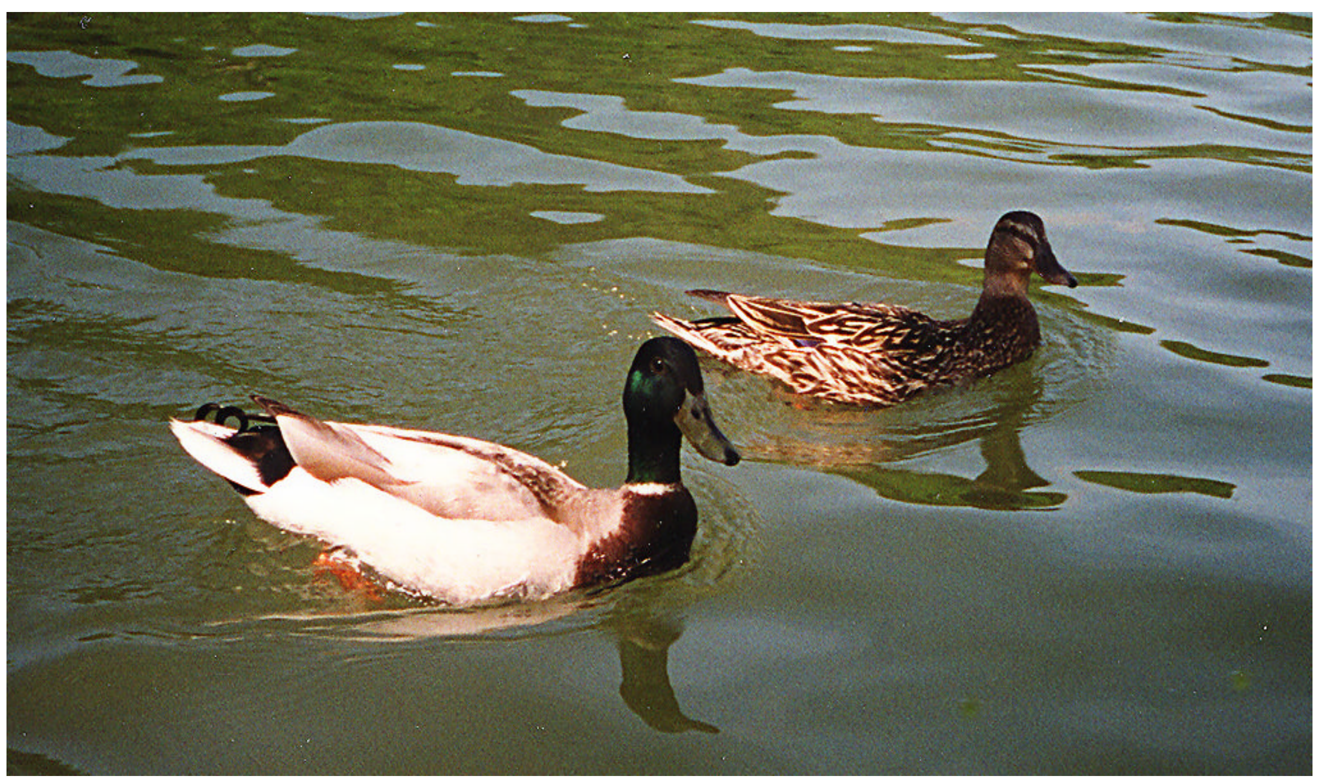
OFFICE OF WATER RESOURCES MISSION:

To enhance and preserve the physical, chemical, and biological integrity of surface and ground waters, considering nature and the health, safety, recreational and economic needs of humanity.



WEST VIRGINIA
Division of Environmental Protection

Office of Water Resources

An Ecological Assessment of the

Upper Kanawha River Watershed

AN ECOLOGICAL ASSESSMENT OF THE UPPER KANAWHA RIVER WATERSHED

Report number 05050006-1996

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Office of Water Resources

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Watershed Assessment Program

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Summary

The Upper Kanawha River watershed extends from the confluence of the Gauley River and the New River generally northwest to the confluence of the Upper Kanawha and Elk Rivers in Charleston.

Assessment teams visited 119 sites in the Upper Kanawha River Watershed during September, October and November 1996. Of the 288 named streams in this watershed, 112 were sampled. In addition 2 unnamed streams were visited. Three of the sites were on the main stem of the Kanawha River. The remaining sites were on tributaries. Since sampling extended late into the season, many leaves had begun to fall. These leaves filled the sampling nets and made it impossible to obtain proper benthological samples on some streams.

Assessments included measurements of physical attributes of the streams and riparian zones, observations of activities and disturbances in the surrounding area, water quality data, and macrobenthos collections. Historically this area has been impaired by coal mining drainage and other mining related activities. Therefore, the field teams collected information designed to reveal this type of impairment from a number of sites where mine impairment was expected.

This watershed is entirely within the Allegheny Plateau ecoregion with cyclical sequences of sandstone, shale and coal. The Kanawha River Valley is a geologic anomaly for this ecoregion. This large alluvial valley was formed by a continental ice sheet damming a pre-historic river, thus forming a giant lake. Alluvial material was deposited in the lake until the ice sheet retreated. This allowed the reservoir to drain. The Kanawha River and its tributaries began to cut their way down through the alluvial material.

As expected mining and fecal coliform bacteria were the two major impacts on these streams. At least 236 National Pollutant Discharge Elimination System (NPDES) permits were in effect in this watershed. The great majority were coal mines.

Forty-two sites were found to be negatively impacted by mine drainage. One site was noticeably impaired by dredging associated with coal mining activities. Three sites previously listed on the 303(d) list for mining reasons were not sampled during this study. Two were deemed inaccessible by the field team. The third is now a mining impoundment.

The majority of named streams (176 out of 288 or 61%) in the watershed were not sampled during this study. Approximately 36% of the sampled streams exhibited negative impacts to water quality or benthos due to mine drainage.

Forty-five sites had fecal coliform bacteria concentrations greater than the criterion established by the Environmental Quality Board. While agriculture is present in some areas, it is not believed to be a major source of fecal coliform bacteria. Some of the septic tanks in the area do not have adequate field beds. Overflow from these and sewage treatment plants contribute to the problem. In addition, a number of "straight pipes" were observed discharging into streams in the area. At one site a large quantity of waterfowl manure was observed in the stream.

The following actions have been suggested based on this study:

Some sites listed on the 1996 303(d) list for mine drainage did not exhibit concentrations of water quality constituents that indicate they should be on the list. These 19 streams should be studied to determine whether or not they should be removed from the list or if the impact is only present during a particular period, or only present in a particular reach of the stream.

Conduct a field review of all streams in the watershed to determine which are impaired from mine drainage and develop proper restoration procedures.

Identify the communities with “collect and dump downstream” sewage management and improve sewage treatment facilities in these communities.

Connect communities that do not have adequate sewage treatment facilities with those that do.

Develop a program to educate homeowners on the perils of failing sewage systems and encourage them to tie into a modern sewage treatment system or improve their septic system.

Study the effects of highway construction on water quality and quantity.

Acknowledgments

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benthos samples. summarized the data, and created the tables and figures.

Assessing Paint Creek

Watersheds and Their Assessment

In 1959, the West Virginia Legislature created the State Water Commission, predecessor of the Office of Water Resources (OWR). The OWR has since been charged with balancing the human needs of economic development and water consumption with the restoration and maintenance of water quality in the state's waters.

Water Quality Criteria – The levels of water quality parameters or stream conditions that are required to be maintained by the Code of State Regulations, Title 46, Series 1 (Requirements Governing Water Quality Standards).
Designated uses – For each water body, those uses specified in the Water Quality Standards, whether or not those uses are being attained. Unless otherwise designated by the rules, all waters of the State are designated for:

- The propagation and maintenance of fish and other aquatic life, and
- Water contact recreation.

Other types of designated uses include:

- Public water supply,
- Agriculture and wildlife uses, and
- Industrial uses.

At the federal level, the U.S. Congress enacted the Clean Water Act of 1972 (the Act) plus its subsequent amendments to restore the quality of our nation's waters. For 25 years, the Act's National Pollutant Discharge Elimination System (NPDES) has caused reductions in pollutants piped to surface waters. There is broad consensus that because NPDES permits have reduced the amount of contaminants in point sources, the water quality of our nation's streams has improved significantly.

Under the federal law, each state was given the option of managing NPDES permits within its borders or leaving the federal government in that role. When West Virginia assumed primacy over NPDES permits in 1982, the state's Water Resources Board [which combined with the Air Pollution Control Board in 1994 to become the

Environmental Quality Board (EQB)] began developing water quality criteria for each kind of use designated for the state's waters (see box). In addition the WV Division of Environmental Protection's (DEP) water protection activities are guided by the EQB's anti-degradation policy, which charges the OWR with maintaining surface waters at sufficient quality to support existing uses, whether or not the uses are specifically designated by the EQB.

Riffles on Paint Creek

Even with significant progress, by the early 1990s many streams still did not support their designated uses. Consequently, environmental managers began examining pollutants flushing off the landscape from a broad array of hard to control sources. Recognizing the negative impacts of these Non-Point Sources (NPS) of pollution, which do not originate at clearly identifiable pipes or other outlets, was a conceptual step that served as a catalyst for today's holistic watershed approach to improving water quality.

A variety of watershed projects have been implemented by several DEP units, including the Watershed Assessment Program (the Program). Located within the OWR, the Program's scientists are charged with evaluating the health of West Virginia's watersheds. The Program is partially guided by the Interagency Watershed Management Steering Committee (see sidebar).

<u>The Interagency Watershed Management Steering Committee</u> – consists of representatives from each agency that participates in the Watershed Management Framework. Its function is to coordinate the operations of the existing water quality programs and activities within West Virginia to better achieve shared water resource management goals and objectives. The Watershed Basin Coordinator serves as the day to day contact for the committee. The responsibilities of this position are to organize and facilitate the Steering Committee meetings, maintain the watershed management schedule, assist with public outreach, and to be the primary contact for watershed management related issues.

The Program uses the U.S. Geological Survey's (USGS) scheme of hydrologic units to divide the state into 32 watersheds (see map, Figure 2). Some of these watershed units are entire stream basins bounded by natural hydrologic divides (e.g., Upper Guyandotte River watershed). Two other types of watershed units were devised for manageability: 1) clusters of small tributaries that drain directly into a larger mainstem stream (e.g., Potomac River direct drains watershed) and 2) the West Virginia parts of interstate basins (e.g., Tug Fork watershed). A goal of the Program is to assess each watershed unit every 5 years, an interval coinciding with the reissuance of National Pollutant Discharge Elimination System (NPDES) permits.

GENERAL WATERSHED ASSESSMENT STRATEGY

A watershed can be envisioned as an aquatic "tree", a system of upwardly branching, successively smaller streams. An ideal watershed assessment would document changes in the quantity and quality of water flowing down every stream, at all water levels, in all seasons, from headwater reaches to the exit point of the watershed. Land uses throughout the watershed would also be quantified. Obviously this approach would require more time and resources than are available to any agency.

The Program therefore assesses the health of a watershed by evaluating as many of its streams as possible, as close to their mouths as possible. An exception to this general strategy is the strategy developed specifically for comparing watersheds to one another. This special sampling strategy is detailed in the section titled "Comparing Watersheds." The general sampling strategy can be broken into several steps:

A) The names of streams within the watershed are retrieved from the United States Environmental Protection Agency's (EPA) Water Body System database.

B) A list of streams is developed that includes several sub-lists. These sub-lists include:
   1. Severely impaired streams,
   2. Slightly or moderately impaired streams,
   3. Unimpaired streams,
   4. Unassessed streams, and
   5. Streams of particular concern to citizens or permit writers.

C) Assessment teams visit as many streams listed as possible and sample as close to the streams' mouths as allowed by road access and sample site suitability. Longer streams may also be sampled at additional sites further upstream. In general, if a stream is 15 to 30 miles (25 to 50 km) long, two sites are sampled. If a stream is 30 to 50 miles (50 to 89 km) long, three sites are sampled. If a stream is 50 to 100 miles (80 to 160 km) long, four sites are sampled. If a stream is longer than 100 miles (160 km), five sites are sampled. If inaccessible or unsuitable sites are dropped from the list, they are replaced with previously determined alternate sites.

The Program has scheduled the study of each watershed for a specific year of a 5-year cycle. Advantages of this pre-set timetable include: a) synchronizing study dates with permit cycles, b) facilitating the addition of stakeholders to the information gathering process, c) insuring assessment of all watersheds, d) improving the OWR's ability to plan and e) buffering the assessment process against domination by special interests.

In broad terms, OWR evaluates the streams and the Interagency Watershed Management Steering Committee sets priorities in each watershed in 5 phases:

Phase 1 - For an initial cursory view assessment teams measure or estimate about 50 indicator parameters in as many of each watershed's streams as possible.

Phase 2 - Combining pre-existing information, new Phase 1 data and stakeholders' reports, the Program produces a list of streams of concern.

Phase 3 - From the list of streams of concern, the Interagency Watershed Management Steering Committee (see sidebar) develops a smaller list of priority streams for more detailed study.

Phase 4 - Depending on the situation, Program teams or outside teams (e.g., USGS or consultants) intensively study the priority streams.

Phase 5 - The Office of Water Resources issues recommendations for improvement; develops total maximum daily loads, if applicable (see box); and, makes data available to any interested party such as local watershed associations, educators, consultants, and citizen monitoring teams.

This document, which reports Phase 1 findings, has been prepared for a wide variety of users, including elected officials, environmental consultants, educators and natural resources managers.

Figure 1. A Generalized Watershed

Adapted from Sarah Lauterbach's drawing of a watershed.

Watershed – In several dictionaries, the first definition of watershed is the divide between adjoining water drainage areas. This report, though, uses an alternate definition, namely "all the land surface from which water drains to a specific point". For example, the Upper Kanawha River watershed, detailed in this report, includes all of West Virginia that sheds surface water to the Kanawha River at the point where it is joined by the Elk River. Watersheds may be of any size. The Paint Creek watershed covers parts of Kanawha, Boone, and Raleigh Counties in southern West Virginia. The Mississippi River watershed, on the other hand, extends from the Appalachian Mountains west to the Rocky Mountains and from Minnesota south to Louisiana.

SPECIAL ASSESSMENT STRATEGY - COMPARING WATERSHEDS

EPA and other federal agencies have been interested in the relative conditions of the nation's waters since the Clean Water Act of 1972 mandated they prioritize water quality restoration efforts. Within West Virginia, several state agencies have an interest in prioritizing such efforts as well. The general sampling strategy is useful for comparing watersheds, but it was designed with other purposes in mind and will not pass the rigors of statistical tests that must be applied in a scientifically-sound, comparative study.

After the 1996 sampling season the Program developed a special sampling strategy for comparing watersheds and for making statistically accurate statements about the streams within each watershed. It can be highlighted in a few steps:

- 30-45 stream locations are selected randomly from an EPA database.
- Personnel from the Program, Environmental Enforcement and other groups reconnoiter the locations to determine the suitability for sampling and to secure landowner approval for entering the site.
- Sampling teams visit the sites and sample in the manner described under the general assessment strategy.
- Statistically valid statements are made about measured parameters and conditions.

Total Maximum Daily Load and the 303(d) List - The term "total maximum daily load" (TMDL) originates in the federal Clean Water Act, which requires that degraded streams be restored to their designated uses.

Every two years, a list of water quality limited streams [called the 303(d) list after the Clean Water Act section number where the list is described] is prepared. Prior to adding a stream to the list, technology-based pollution controls must have been implemented or the conclusion must have been reached that even after implementing such controls the stream would not support its designated uses. West Virginia's 303(d) lists include streams and lakes affected by a number of stressors including mine drainage, acid rain, metals and siltation.

Mathematically, a TMDL is the sum of the allocations of a particular pollutant (from point and nonpoint sources) into a particular stream, plus a margin of safety. Restoration of a 303(d) stream begins by calculating a TMDL, which involves several steps:

- define when a water quality problem is occurring, the critical condition, (e.g., at base flow, during the hottest part of the day or throughout the winter ski season),
- calculate how much of a particular contaminant must be reduced in a stream in order to meet the appropriate water quality criterion,
- calculate the total maximum daily load from flow values during the problem period and the concentration allowed by the criterion,
- divide the total load allocation between point and nonpoint sources (e.g., 70% point and 30% nonpoint) and
- recommend pollution reduction controls to meet designated uses (e.g., install best management practices, reduce permit limits or prohibit discharges during problem periods). A TMDL cannot be approved, unless the proposed controls are reasonable and implementable.

The Program was designed in part to assist in determining whether a stream belongs on the 303(d) list. In some cases, this determination can be made readily, for example, a stream degraded by acid mine drainage (AMD). However, the determination is more difficult to make for most streams because of a lack of data or data that are conflicting, of questionable quality or too old. Any stream which would not support its designated uses, even after technology based controls were applied, would be a candidate for listing.

The Program's Phase 1 screening process provides information for making decisions on listing. A broader interagency process, the West Virginia Watershed Management Approach, enables diverse stakeholders to collectively decide which streams should be studied more intensively.

ASSESSMENT METHODS

Given its charge and resources, the Program has chosen a specific combination of physical, chemical and biological indicator variables to evaluate stream health.

The stream side and instream habitats, and the benthic macroinvertebrates are the foci of the site's ecological assessment. (Benthic macroinvertebrates are bottom-dwelling animals that do not have backbones. This excludes fishes, salamanders, tadpoles, etc.) Habitat evaluations are important to the assessment because they reflect the physical conditions that support the benthic community.

The benthic community is crucial because it reflects environmental conditions for an extended period prior to the site visit. Other parameters, like dissolved oxygen concentration, are complementary, but may reflect recent fluctuations in environmental conditions. A release of a contaminant which flowed through the reach a week ago, for example, would be reflected by the impaired benthos, but might not be revealed in a water sample.

A site's fecal coliform bacteria concentration indicates the likelihood of a public health threat; higher concentrations are associated with greater concerns for public health through direct contact with the water. Fecal coliform bacteria are important indicators of contamination due to fecal material found in sewage, livestock waste and wildlife excrement.

Physico-chemical constituents are selected to help determine what types of stressors may be operating on the benthic community. They may also give clues about the sources of those stressors. A list of physico-chemical constituents typically analyzed for is found in Table 1.

TABLE 1
CONSTITUENT TABLE
All numbered references to analytical methods are from either EPA: Methods for Chemical Analysis of Water and Wastes; March 1983 unless otherwise noted.

Parameter	Minimum Detection Limit or Instrument Accuracy	Analytical Method	Maximum Holding Time
Acidity	5 mg/l	305.1	14 days
Alkalinity	5 mg/l	310.1	14 days
Sulfate	5 mg/l	375.4	28 days
Iron	200 g/l	200.7	6 months
Aluminum	100 g/l	200.7	6 months
Manganese	10 g/l	200.7	6 months
Fecal Coliform Bacteria	Not Applicable	9222 D[1]	24 hours[2]
Conductance	1% of range[3]	Hydrolab™	Instant
PH	± 0.2 units[3]	Hydrolab™	Instant
Temperature	± 0.15 C[3]	Hydrolab™	Instant
Dissolved Oxygen	± 0.2 mg/l[3]	Hydrolab™	Instant
Total Phosphorus	0.02 mg/l	4500-PE[1]	28 days
Nitrite+Nitrate-N	0.05 mg/l	353.3	28 days
Ammonia-N	0.5 mg/l	350.2	28 days
Unionized Amm-N	0.5 mg/l	350.2	28 days
Suspended Solids	5 mg/l	160.2	28 days
Chloride	1 mg/l	325.2	28 days

[1] Standard Methods For The Examination Of Water And Wastewater, 18th Edition, 1992.
[2] U. S. EPA guidelines limit the holding time for these samples to 6 hours. Due to laboratory location, personnel limitations and time constraints, 24 hours was the limit utilized during this sampling effort.
[3] Explanations of and variations in these accuracy's are noted in Hydrolab Corporation's Reporter ™ Water Quality Multiprobe Operating Manual, May 1995, Application Note #109.

ASSESSMENT PROTOCOLS

The assessment protocols described below are detailed to a greater degree in the Program's Standard Operating Procedures (DEP, undated working document) manual. This manual is available to interested persons.

Physico-chemical sampling:

Water quality sample collection, handling and analysis methods generally follow procedures approved by the U.S. EPA and detailed in the documents noted in Table 1. The only frequent exception is the holding time for Fecal Coliform Bacteria, which is explained in note 2 of Table 1. Field blanks for metals and nutrients are prepared weekly by each sampling team if metals and nutrients are being analyzed from the sampling sites visited during the week. The primary purpose of this procedure is to check for contamination of preservatives, containers and sample water during sampling and transporting. A secondary purpose is to check the precision of analytical procedures.

Field analyses for pH, temperature, dissolved oxygen and conductivity are performed utilizing a Hydrolab™ Scout™ and Multiprobe™ assembly. The manufacturer's calibration guidelines are followed with minimal variation except that the instruments are generally not calibrated at the end of each sampling run.

In some instances, stream flow is measured. Usually this is done only in streams negatively impacted by mine drainage. A current meter is used across a stream transect and the discharge is calculated with the sum-of-partial-discharges method.

Physico-chemical data analyses:

Since the sites are sampled only once, potential uses of statistical analyses per site are quite limited. Generally, only simple statistics (e.g., mean, median and percentage) are generated from each watershed's data set. Although limited in application, these simple statistics may give insight into potential causes and sources of impairment.

Assessing Paint Creek

Evaluation of habitat and the sampling site environment:

Following a specific protocol, summarized in the Program's Stream Assessment Form, assessment teams, usually composed of 2 people each, visit sites within the watershed and assess conditions at the sites. Each assessment consists of a 100-meter reach of stream and its stream side environment. The latitude and longitude of each site is recorded by either a Global Positioning System (GPS) instrument or obtained from a topographic map should the GPS unit fail. The total habitat score from the two-page Rapid Habitat Assessment portion of the form is utilized in the data analysis step described under "Integration of biological and habitat data."

Benthic macroinvertebrate sampling:

Macroinvertebrate samples are collected via several techniques, depending upon the stream type and the water level. In streams having plenty of sampleable riffle/run habitat, a modified version of Rapid Bioassessment Protocol II (Plafkin, et. al. 1989) is used for sampling the benthos. In such streams of appropriate size, a modified kick-net (Surber-on-a-stick) is used to catch organisms dislodged through kicking the substrate and rubbing of the larger rocks by the sampler. In very small riffle/run streams that will not accommodate the Surber-on-a-stick, a D-frame net is used to collect dislodged organisms. In streams that are too small to accommodate a D-frame net, rocks are picked clean of organisms by hand. This last technique provides only qualitative data that cannot be compared to the data generated from the other, net-assisted sampling procedures.

In streams dominated by glide/pool habitats, where few if any riffles are available, a D-frame net is used in a slightly modified version of a procedure developed for Mid-Atlantic Coastal Streams (Maxted 1993). Referred to as the MACS technique, this procedure consists mostly of sampling a variety of habitats (aquatic plants, wood debris, under stream banks, etc) through sweeping motions of the net.

After collection, the organisms are preserved and the sample is sent to the Marshall University Biology Department for subsampling. The 100-organism subsample technique was used in 1996 and 1997. (Plafkin, et. al. 1989). The 200-organism subsample technique has been used since 1998. The subsampled organisms are returned to Program biologists who identify them to the family taxon and count them. The completed samples are kept preserved for future reference and for identification to lower taxa if necessary. In 1996, the initial year of the Program, Safe-fix™ and formalin were used as preservatives. During the 1997 sampling season, the switch was made from formalin to ethanol. Safe-fix™ is no longer used. Since 1997, ethanol has been the standard fixative.

Appropriate biological collection permits are obtained before each sampling season from the WV Division of Natural Resources (DNR). Fishes inadvertently collected are preserved and donated to the DNR fish laboratory. Salamanders collected are preserved and donated to the Marshall University Biological Museum.

Biological data analyses:

Widely accepted biological metrics and indices are calculated to aid in interpreting the benthological data. These tools are described in detail in Plafkin, et. al. 1989 and briefly described below:

Taxa richness - Total number of families. Generally decreases with decreasing water quality, habitat diversity and habitat suitability.

Modified family biotic index - Based on organic pollution tolerance of families. Tolerance values range from 0 to 10, increasing with decreasing water quality.

Developed by William L. Hilsenhoff for benthic arthropods in Wisconsin (Hilsenhoff 1988).

Ratio of scraper and filtering collectors - Reflects the riffle/run community food base. Based on Functional Feeding Group designations for insect families (Merritt and Cummins 1984). Decreasing ratios generally indicate increasing organic enrichment (decreasing water quality).

Ratio of Ephemeroptera, Plecoptera, Trichoptera (EPT) and Chironomidae abundance - Measures community balance. Decreasing ratios indicate increasing organic enrichment or heavy metals concentration (decreasing water quality).

Percent contribution of dominant family - Number of individuals belonging to the dominant family divided by the total number of organisms found. Measures community balance. Increasing percentages indicate increasing environmental stressors (decreasing water quality).

EPT index - Summarizes taxa richness within the insect orders generally considered pollution sensitive. Decreases with decreasing water quality.

Community loss index - Measures the loss of taxa between a reference station and the station of comparison. Range is from 0 to infinity. Increasing values indicate increasing dissimilarity between the two stations.

Integration of biological, habitat and water quality data:

Each site's biological metrics and indices, and rapid habitat assessment score (see "Evaluation of habitat and the sampling site environment") are compared with those of a reference site. The reference site has optimal habitat and no obvious impairments in water quality. The biological condition and habitat condition are expressed as percentages of the reference site, which is assigned values of 100%. These percentages are graphically plotted to indicate the degree of impairment relative to the reference site.

The physico-chemical data and field notes are referred to when interpreting the results of the plot. These data and observations are useful in determining causes and sources of impairment.

Biological metrics and indices have been selected to ensure usefulness in discriminating between reference sites and sites with human-induced stressors. The metric and index tools used include those listed under the section titled "Biological data analyses," except for Community Loss Index.

The biometrics and indices are computed from the data for each of the reference sites and descriptive statistics are performed for each of the metrics/indices. From these descriptive statistics (e.g., central tendency, distribution and range), a range of reference index values (i.e., 1, 3, 5) is developed for each metric/index. For metrics/indices that have a positive correlation between benthic community condition and metric/index value, the 25th percentile marks the upper limit of the range of the middle reference index value, 3. Any value above the 25th percentile receives a reference index value of 5. Any value between zero and halfway below the 25th percentile receives a reference index value of 1.

For metrics with a negative correlation between benthic condition and metric value (i.e., Modified Family Biotic Index and Percent Contribution of Dominant Family), the 75th percentile marks the upper limit of the highest reference index value range, 5.

Above the 75th percentile, the reference index value ranges of 1 and 3 are equidistant to the upper limit of the total range.

The range of possible sums of all the reference index values is determined. Non-reference sites that score below the 50th percentile of this range are considered candidates for the 303(d) list.

Duplicate sampling:

Replicate sampling for all sampling procedures is performed at 2.5% of all sites, this is usually 3 sites per watershed. At preselected sites team members switch tasks to determine whether or not sampler variations are significant enough to warrant further training and/or corrective action.

The Upper Kanawha River Watershed

The watershed area draining into Great Kanawha River, and lying between the confluence of Gauley and New Rivers on the upstream end and the confluence of Elk and Kanawha Rivers on the downstream end, is identified as the Upper Kanawha River watershed (HUC # 05050006) (see sidebar). The named tributaries of the Kanawha River included in this study are found listed in Table 8 in Appendix A.

This watershed area lies within the Allegheny Plateau physiographic province. Its geological structure is characterized by cyclical sequences of sandstone, shale and coal. Rock formations generally dip gently westward although there are a few regional and local exceptions to this tendency. The topography consists of steep-sided hills incised by very narrow valleys. An unusual topographic feature is the broad Kanawha Valley. This alluvial valley is much larger than would result from flooding of a river the size of the present day Kanawha River. In fact, much of the depth of the alluvium can be attributed to periods of glaciation, when a continental ice sheet near Chillicothe,

Hydrologic Unit Code -The U.S. Geological Survey has developed a Hydrologic Unit Code (HUC) used to identify watersheds throughout the United States. These numbers have replaced the older "map code" system of identifying watersheds.

HUC numbers consist of eight digits. The first two indicate the region the watershed is located in. West Virginia watersheds are located in one of two regions: 02 (Mid-Atlantic) is used to designate those watersheds which drain to the Atlantic Ocean. 05 is used to designate those streams which flow to the Gulf of Mexico via the Ohio River.

The next two digits indicate the subregion. All streams which flow into the Ohio at its beginnings in Pittsburgh are in sub-region 02. Those watersheds which flow into the Ohio between Pittsburgh and the mouth of the Kanawha at Point Pleasant are in sub-region 03. The Kanawha River watershed is sub-region 05. The Mud River and Big Sandy/Tug Fork watersheds are sub-region 07. Twelvepole Creek and the creeks between Point Pleasant and the mouth of Mud River are sub-region 09.

For the Mid-Atlantic Region the Potomac River drainage is sub-region 07. The James River watershed (in Pendleton and Monroe Counties) is sub-region 08. The remaining four digits indicate the accounting and catalog units for the individual watersheds.

Ohio dammed an ancient river. This damming created a huge reservoir (called "Teays Lake" today) that resulted in alluvial material being deposited over thousands of years on the lake bed during flood events. When the ice shelf eventually retreated and the massive reservoir drained, Kanawha River and its tributaries began to meander through the thick alluvium of the ancient lake bed. (Cardwell)

Climate within the watershed is considered mild. Generally summers are warm and winters are moderately cold. Summer temperatures may average as high as the upper eighties while winter lows are just below freezing. Precipitation occurs on an average of 152 days each year. A total of 105.2 inches of snow fell during the winter preceding this sampling season. During March 1996, Charleston, at the downstream end of this watershed, experienced a record 20.4 inches (4 times the normal) of snowfall. 1996 also set the record as the wettest year for West Virginia in more than a century of keeping records. (Friedlander, Jr., Blaine P.)

The few wetlands found in the watershed, which are not open water type wetlands, are very limited in size. Perhaps the largest is one located on South Sand Branch (K-65-HH-2) alongside Interstate Highways 77/64 just north of the North Beckley interchange. This forested-shrub wetland has no special protective status even though it acts as a lone storm-runoff buffer between the frequently flooded downstream community of Pax and the sub-watershed's urbanized, headwater area.

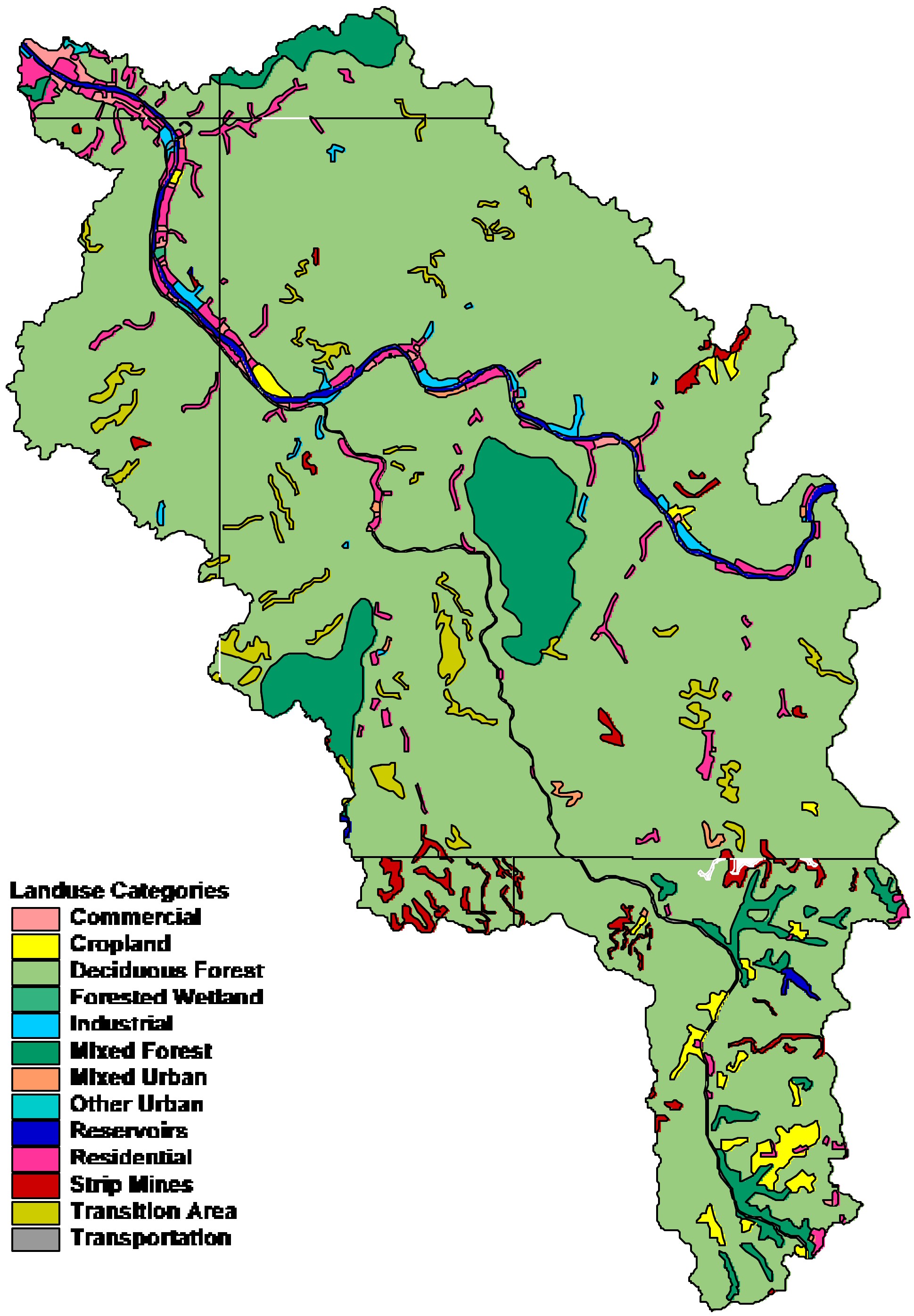
Salt was king in the Kanawha Valley long while the coal industry was just beginning. By 1817 Henry Ruffner, a local industrialist, stated “all the country for twenty miles, was stripped of its fine forests”. (Rice) Much of this forest was cleared to meet the demand for charcoal to fuel salt furnaces and for pasture to feed livestock.

Agriculture utilized not only bottomlands, but also hillside benches, and in many parts of the watershed, cattle even grazed on steep slopes. Hogs were turned loose in the forests to allow them to fatten on acorns and chestnuts before being driven to market. Later, in the late 1800s and early 1900s, timber was cut from the tributary watersheds to provide construction materials for local mines and for a rapidly growing America. Probably, sediment impaired the streams during this great logging and agricultural era. Once the farms were abandoned and the forest grew back, sediment from such activities became less.

Prior to the War Between the States, coal began to be extracted from seams located in the Upper Kanawha River watershed. Initially this black mineral was used to replace the depleted forests as a fuel in local salt works. Later it made its way to industrial markets all over the world, driving steam engines and making steel. The Chesapeake & Ohio Railroad, which roughly paralleled the Kanawha River, made this worldwide distribution possible. (Harris)

Stories from pre-mining days tell of high biological productivity in Kanawha River and its larger tributary streams. A few people living today can remember when Campbells Creek, Kellys Creek and Paint Creek produced enough fish to feed many families during the Great Depression. Archaeological sites scattered along such tributaries have produced relics of freshwater mussel shells in association with hearths and bones of wildlife, evidence that the streams once supported assemblages of such bivalves that, in turn, supported hunting/gathering parties of Indians. These tributaries support no native freshwater mussels today and recovering fisheries in some of the better streams are merely shadows of their former selves. From World War I until now, coal mine drainage has played an increasingly larger role in keeping fisheries and other aquatic resources from recovering.

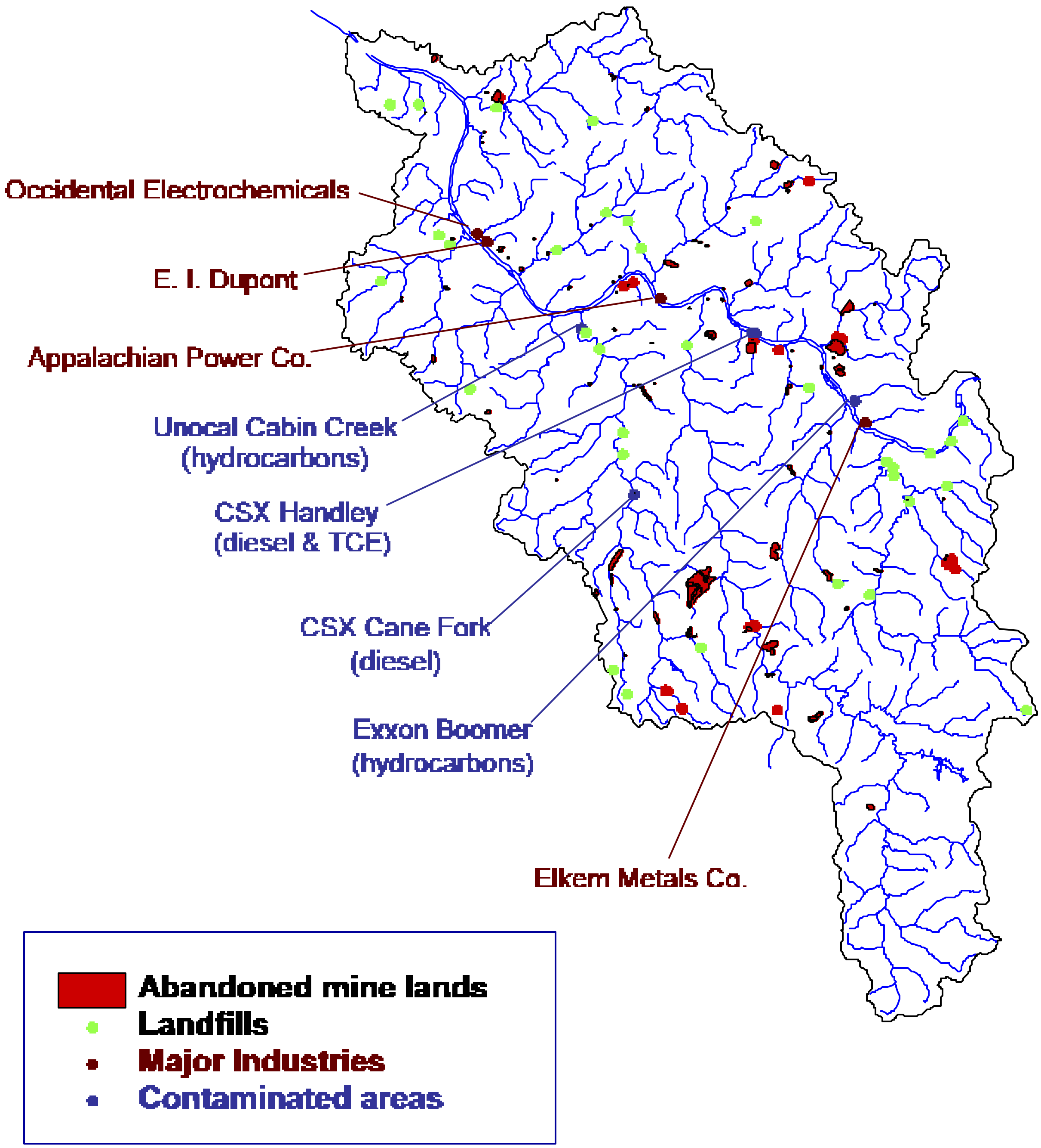
Figure 3 – Landuses of the Upper Kanawha River Watershed



As of January 1998, there were at least 236 NPDES discharge permits in effect within the upper Kanawha River watershed. Of the 236 known permitted dischargers, the great majority were coal companies.

Although the West Virginia Division of Natural Resources (WV DNR) lists Paint Creek and Loop Creek as high quality streams (WV DNR, 1986), the West Virginia Division of Environmental Protection (WV DEP) had placed these two streams on the 303(d) list of water quality limited streams due to mine drainage. This discrepancy may be due to the fragmented nature of mine drainage impacts on these large tributaries to Kanawha River. One segment may suffer from mine drainage impacts, while another may be either upstream of the impact or far enough downstream to have recovered from the effects of mine drainage.

Figure 4. Major Industries, Contaminated Sites set for Remediation, Landfills, and Abandoned Mine Lands



Assessment Procedures for the Upper Kanawha River Watershed

In September, October and November of 1996, staff of the Division of Environmental Protection's Watershed Assessment Program, visited 119 sites throughout the watershed. Three of these sites were located on the river mainstem. The remaining sites were located on tributaries of Kanawha River upstream of Elk River. Details of the sampling sites can be found in Table 2.

Since sampling extended late into the autumn, many leaves had begun to fall. These leaves filled the sampling nets and made it impossible to obtain proper benthological samples at 35 sites. If the field team did not collect benthological samples, they did not obtain habitat data either. In these cases only water quality data was obtained. These streams are listed in the tables under “Stream Width Classification Not Determined”.

Table 2
Upper Kanawha River Sampling Site Summary

Names Streams	288
Tributaries on 1996 303(d) list	50
Mainstem Sites Visited	3
Tributary Sites Visited	116
Streams Visited	114
Names Streams Visited	112
Named Streams Not Visited	176
Unnamed Streams Visited	2
Habitat Assessed	89

Samples were obtained from at least one location on 112 (approximately 39%) of the 288 named tributaries within this watershed. Some of the longer streams were sampled at more than one site. Only 2 unnamed tributaries were sampled. All but 3 of the 50 streams found on the 1996 303(d) list were sampled. The 3 not sampled are New West Hollow (K-58-B.8-1), Right Fork of Armstrong Creek (K-73-F), and Left Fork of Armstrong Creek (K-73-G). A coal refuse impoundment has been constructed in New West Hollow and the forks of Armstrong Creek were considered inaccessible.

Field teams (usually two persons) collected benthic macroinvertebrate samples at each site following Rapid Bioassessment Protocol II (RBP II) (Plafkin, et. al. 1989). Many sites listed on the 1996 303(d) list were sampled for mine drainage constituents but were not fully sampled for benthic macroinvertebrates, so that no biological comparisons can be made with the reference sites. Some of these sites were cursorily sampled to determine whether or not any organisms were likely present. Very few organisms were found at these partially sampled sites. These sites are noted in Table 2, Level Of Assessment. Samples were collected through the use of a half-meter wide rectangular frame net or a “D” frame net. Sampling technique is described in greater detail in the chapter “Watersheds and Their Assessment”.

The benthic samples were delivered to Marshall University where students of Dr. Donald Tarter, Professor of Aquatic Biology, prepared them for identification by Office of Water Resources personnel. The 100-count subsample preparation technique (Plafkin, et. al. 1989) was used. Evaluation of the benthological data consisted of summarizing the results of six community metrics [taxa richness, EPT taxa, Modified HBI (FBI), % dominant taxa, the ratio of EPT taxa to chironomidae, and the ratio of scrapers to filtering collectors].

In order to determine the biological health of a stream, it is necessary to have a reference condition to compare it to. In previous assessments, the Program has used the least impaired single site in the watershed as the reference condition. This assumes that there is at least one non-impaired stream in an assessment area to compare other sites to, and that this one stream will fairly represent the entire study area. As the watershed assessment movement has progressed, it has become clear that it is difficult to identify a single reference site that has both minimal impairment and the biological community that would provide defensible conclusions about the impairment of assessed streams based on comparisons to that stream. As a result, the Program has started using a collection of streams which meet a predetermined minimum impairment criterion as the reference condition.

The benthic community metric values for the reference set are calculated and the distribution of these values determines the scoring criterion for each metric. The lower quartile (25th percentile) of the reference set is the lower cutoff for the optimal score for metrics whose values decrease with increasing perturbation. The upper quartile is used for metrics whose values increase with increasing perturbation (HBI, percent dominant taxa).

For each metric there are three possible scores: optimal receives a 2; mid-range receives a 1; and the lowest values receive a zero. The division between the middle and the lowest score is the point halfway between the quartile used to determine the optimal score and the lowest possible score (or highest -for those which use the 75th quartile). The sum of the scores of the 6 metrics used by the Program provide a single index value for each site. This value is adjusted to a scale of 100 (a score of 12, which is the highest possible, is 100) and this value referred to as the "biological condition" and is the value used in the biological and habitat data summary figures.

Also collected from each site was a fecal coliform bacteria sample. US EPA sampling guidelines limit the field holding time for such samples to 6 hours. However, due to the distance to laboratories, personnel limitations and time constraints, 24 hours was the limit utilized during this sampling effort. All bacteria samples were packed in wet ice until delivered to the laboratory.

The physico-chemical parameters of temperature, pH, dissolved oxygen, and conductivity were determined on site. Assessment teams were instructed to collect water samples for the analysis of nitrite + nitrate, total phosphorus and ammonia if they suspected the stream to have elevated levels of nutrients. No nutrient samples were collected from any of the tributary sites visited. Only the 3 mainstem sites were sampled for nutrients.

An eight page Stream Assessment Form was filled out at each site. A 100 meter section of stream and the land in its immediate vicinity were qualitatively evaluated for instream and stream side habitat conditions. The assessment team recorded the location of each site, utilizing GPS when possible, and provided detailed directions so that future researchers can return to the same spot. A map was also sketched to aid in locating these sites. The team recorded stream measurements, erosion potential, possible non-point source pollution, and any anthropogenic activities and disturbances. They also recorded observational data about the substrate, water, and riparian zone. Part of the eight page form is a two page Rapid Habitat Assessment (from EPA's EMAP-SW Klemm and Lazorchak, 1994) which provides a numerical score of the habitat conditions most likely to affect aquatic life.

A few locations were sampled in some fashion even though they were not on the list of streams to sample. The teams sampling such sites suspected pollution and wished to document it.

Paint Creek Watershed Association Data

The West Virginia Save Our Streams Citizen Stream Monitoring Program (SOS) is a WV DEP-sponsored program with the goal of promoting water quality awareness through citizen participation and education. Volunteers record stream conditions, land uses and macroinvertebrate diversity at each of their stream monitoring sites. These data become part of the DEP's statewide database that records the water quality of the state's streams.

The West Virginia Stream Partners Program (SP) is a cooperative effort of the WV DEP, the Division of Forestry, the WV DNR and the State Soil Conservation Agency. The Program's goal is to help organizations form partnerships for the completion of watershed improvement projects that have long-term effects on the communities and the waterhseds in which these partnerships operate.

Sometimes, the SOS and the SP Programs operate in tandem in a particular watershed, resulting in great progress toward water quality improvement and watershed appreciation. In the Upper Kanawha River watershed, one organization, The Lower Paint Creek Watershed Association (LPCWA), has taken advantage of the resources available under the two Programs and has begun a watershed awareness movement nearly unparalleled in West Virginia.

Members of the LPCWA have collected and properly disposed of over 4,139 bags of trash, 630 tons of solid waste and more than 1,400 illegally discarded tires. They have installed fish habitat improvement structures, stocked over 6,000 brown trout fingerlings, hand-cleaned over 9 miles of stream, erected signs with tributary names to enhance watershed awareness, and monitored Paint Creek and several tributaries through water quality and benthological sampling. During the course of their labors they have become leaders and teachers, sharing their experiences with school groups and other watershed organizations, and sharing their data with agencies involved in water quality conservation. For more information on the West Virginia Citizen Stream Monitoring Program contact the Office of Water Resources at (304) 558-2108.

Handicapped Fishing Pier Constructed by The Lower Paint Creek Watershed Association

During 1996 the Program monitored some of the same streams sampled by the LPCWA. Therefore, a comparison between the volunteer collected data and the data collected by the Program is possible.

Ten sites on tributaries of Paint Creek and two sites on Paint Creek itself were compared. Due to differences in collection equipment, technique, and scoring it was difficult to compare the two sets of data. The Program uses nets with a finer mesh than the LPCWA. Therefore, the LPCWA collects fewer small organisms than the Program. The Program identifies the insects to the family level and uses six different metrics to score a sample by comparing it to a reference station. SOS identifies most insects to the Order level, except for Magaloptera and Diptera. SOS scoring is standardized without regard for a reference station.

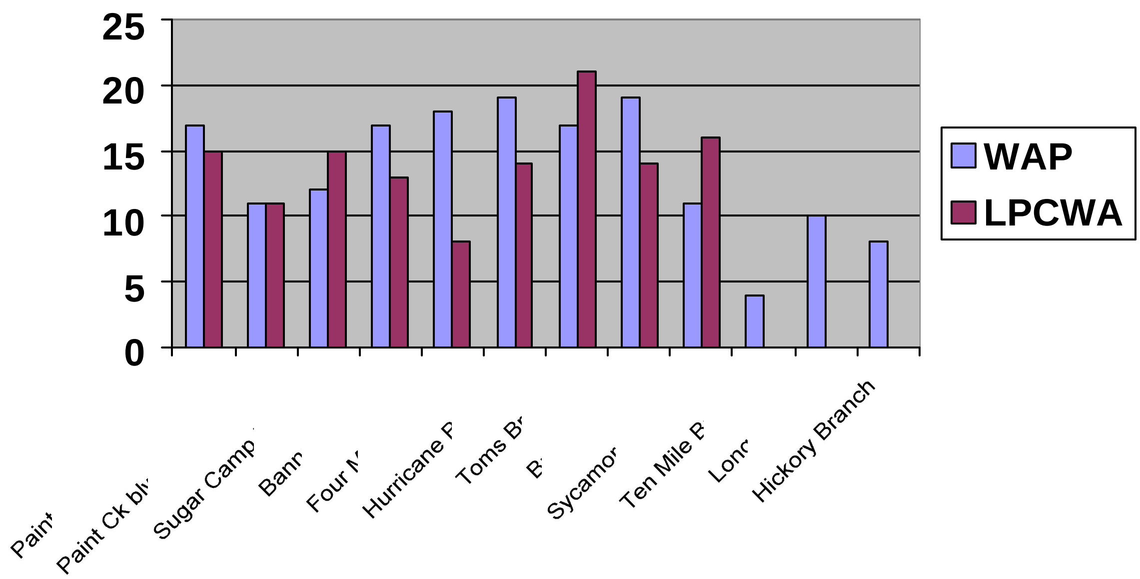
Falls of Paint Creek

To compare the data the Program scores were converted to SOS scores. There are some problems with this conversion. In SOS scoring, hellgrammites and fish flies (Corydalidae) are scored differently but the Program classifies them as one. For this comparison all Corydalidae from the Program samples are considered hellgrammites This may tend to raise the Program scores.

SOS considers adult riffle beetles (Elmidae) as good water quality indicators and the larva as fair water quality indicators. For this comparison all Elmidae in the Program's samples are considered as adult riffle beetles. This too, may tend to raise the Program scores.

A more detailed comparison of the sampling conducted by the Program and the Paint Creek Watershed Association is available from the West Virginia Citizen Stream Monitoring Program at the Office of Water Resources.

WAP VERSUS LPCWA
1996 Comparisons



Findings

Benthological Sampling and Habitat Assessment

Benthic collection data is difficult, if not impossible, to interpret without comparing it to a reference site (i.e. one from a similar region and time that has a minimum of human or other impacts) or, preferably, a collection of reference sites. All 119 sites visited in the Upper Kanawha River Watershed are within the Allegheny Plateau physiographic province and were sampled during a relatively short time period. Therefore, analysis of the benthic data for this watershed could eliminate these two variables from consideration.

In addition, data from numerous studies have shown that aquatic communities at stream sites of vastly different sizes are not comparable to one another. The reasons for this fact are myriad, but collectively they can be identified as differences in number and character of ecological niches among various sizes of streams. Therefore, in order to make comparisons among stream sites, it is necessary to classify them in some fashion. The underlying premise in all such classification schemes is that fewer uncontrolled variables are operating upon the studied communities within each class than between each class. Biologists have more confidence in conclusions drawn from intraclass comparisons than from interclass comparisons.

However, recent studies (Stribling, et. al.) (PA DEP 1997) indicate that as long as similar riffle habitats are sampled, stream width may not significantly influence benthic communities. In other words, a riffle in a small stream is likely to harbor the same type of community as a large stream's riffle as long as all other factors, including water quality, are similar. Numbers of individuals may be greater per unit area in larger streams, but the 100-individual subsampling technique used in this study equalizes this parameter. Debate about the influence of stream size on the benthic community continues. In order to remain consistent, this report utilizes the same stream size classification scheme used in other 1996 watershed assessment reports.

Sites were classified according to average widths of the 100 meter assessed stream reaches. Stream Width Class I (SWC I) sites have average widths up to 3 meters. Stream Width Class II (SWC II) sites are greater than 3 meters, but equal to or less than 10 meters. Stream Width Class III (SWC III) are greater than 10 meters wide.

The results of benthic sample statistical analyses (biological community metrics or biometrics) are found in Table 9 in Appendix A. The results of Biological & Habitat Data Summary exercises for SWC I and SWC II are shown in Figures 4 and 5. For SWC III sites, Figures 6, 7 and 8 graphically portray these results. Since biometric values tended to be low, even for the reference sites, the intermediate zones shown on the Data Summary graphs are considered extensions of the lower zones to which they are attached. For example, if a site's biological condition score fell within the intermediate zone between moderately impaired and nonimpaired, then the site was considered moderately impaired biologically.

In the following discussions, percentages of the total number of sites are exclusive of the reference sites since reference sites are the standards by which all other sites were compared. For example, in SWC II, 20 sites were sampled for benthos, but one of these, Loop Creek (K-76), is the reference site. Since the other sites were compared to Loop Creek and since Loop Creek cannot be compared to itself, percentages were figured from a total of 19 sites instead of 20.

In SWC I, the largest percentage of sites (approximately 62%) fell within the moderately impaired category compared to the reference site, Beards Fork (K-76-D).

Approximately 11% of the sites were within the severely impaired category while approximately 26% were considered nonimpaired compared to the reference site. Approximately 36% (19 of 53) of the sites scored less than 51% of the reference site's biological condition.

Although there was no distinct correlation between biological condition and habitat condition in SWC I, approximately 62% of sites in the optimal habitat category fell within the nonimpaired biological condition category as well. However, only approximately 36% of sites in the nonimpaired biological category also fell within the optimal habitat category.

No clear correlation between biological and habitat conditions among SWC II sites was observed. A majority proportion of sites, approximately 68%, fell within the moderately impaired biological condition category. Twenty six percent were severely impaired compared to the reference site, Loop Creek (K-76). Approximately 53% (10 of 19) of the sites scored less than 51% of the reference site's biological condition.

It was decided that the limited number of sites (only 4) in the SWC III group was insufficient to reliably utilize the Biological and Habitat Data Summary to compare the sites. Selected (biometrics) for the 4 sites are illustrated graphically in Figure 8.

Recent research indicates that wadable streams of SWC orders I through III (Stribling, et. al. 1993) and streams of less than 1300 square kilometers (500 square miles) (PA DEP 1997) with similar habitats may be grouped for analysis. As a general rule, stream size does not influence taxa richness. In other words, the number of taxa found in a riffle of a small stream is generally the same as that found in a larger stream's riffle habitat if water quality is similar between the streams. Of the 4 SWC III sites, Cabin and Kellys Creeks (respectively K-61 and K-64) produced the highest number of taxa with 11 each. The SWC I reference site, Beards Fork, produced 13 taxa and the SWC II reference site, Loop Creek, produced 15 taxa. If Cabin, Kellys and Paint Creeks were undisturbed, 13 taxa or greater could be expected from them. Therefore, it is reasonable to conclude that the SWC III sites were negatively impacted by something, perhaps degraded habitat or poor water quality.

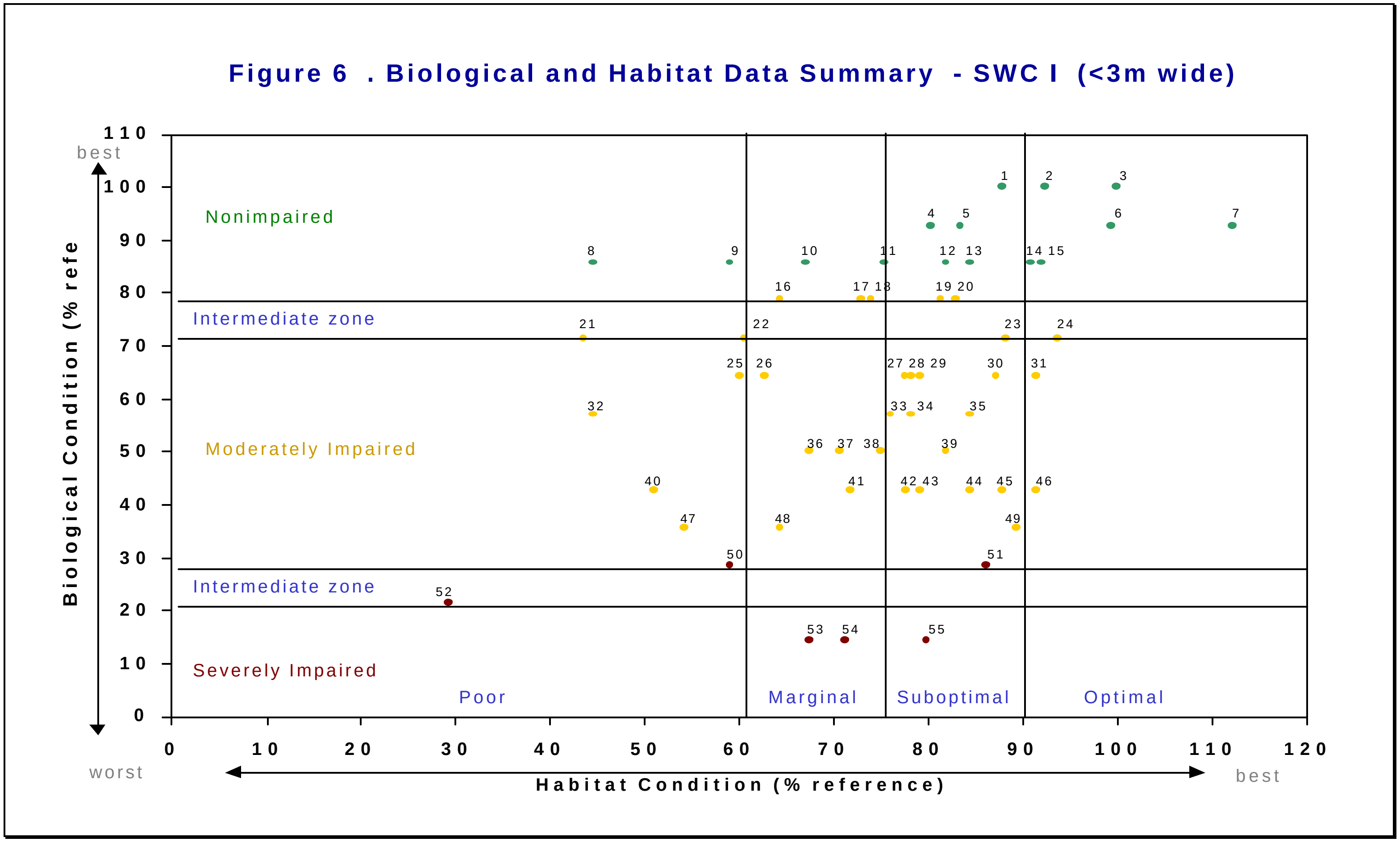
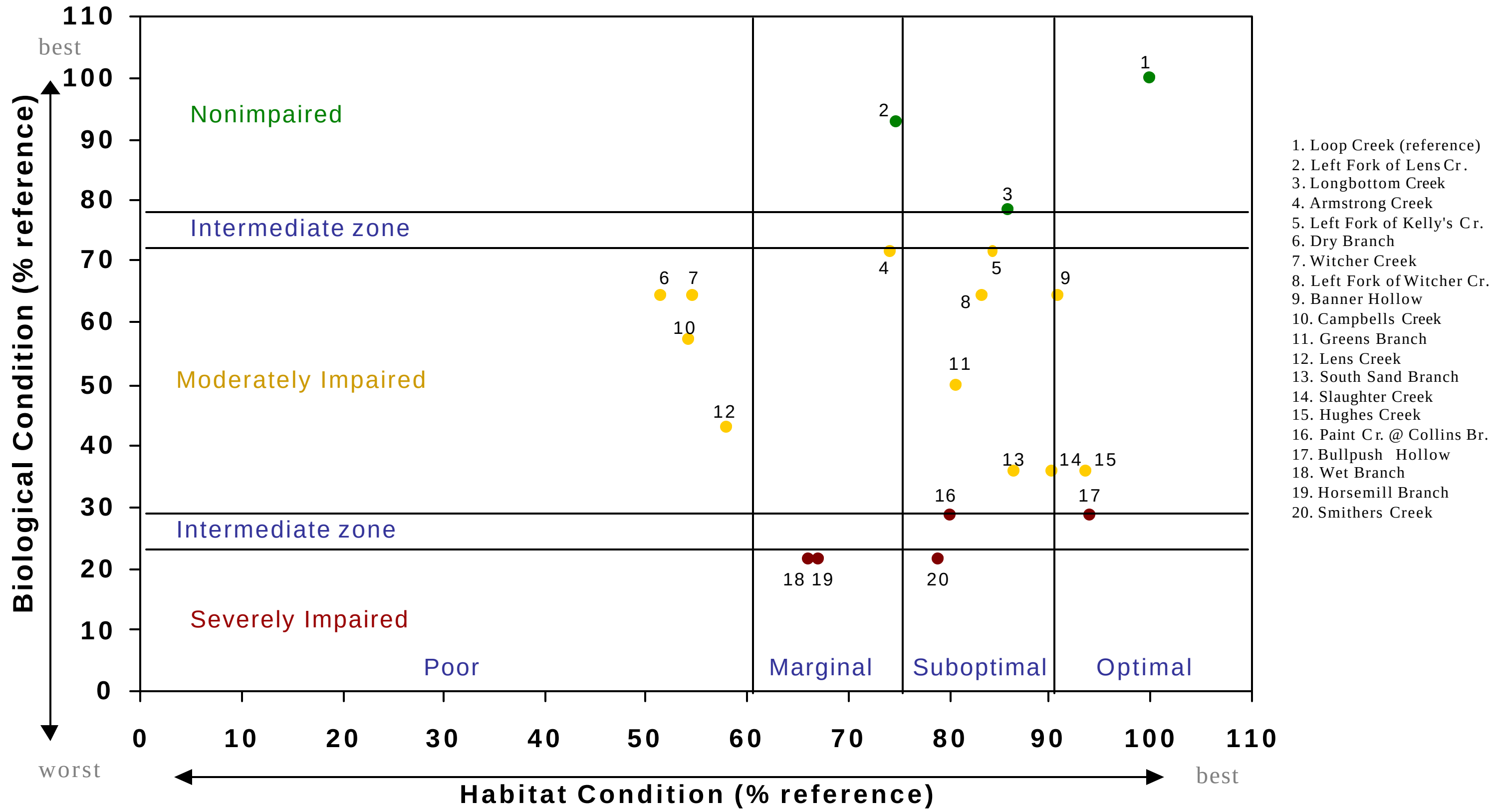


Figure 6 . Biological and Habitat Data Summary - SWC I (<3m wide)
Nonimpaired
Intermediate zone
Moderately Impaired
Intermediate zone
Severely Impaired
Poor
Marginal
Suboptimal
Optimal
Biological Condition (% refe
best
worst
Habitat Condition (% reference)
best
0
10
20
30
40
50
60
70
80
90
100
110
120

Figure 6 (continued). Stream Names for SWC I Riffle / Run Sites		
1. BIG RIGHT HAND FORK	20. HURRICANE BRANCH/ PAINT CK.	39. FIELDS CREEK
2. PACKS BRANCH	21. GEORGES CREEK	40. DRY BRANCH/ WITCHERS CREEK
3. BEARDS FORK (reference)	22. SCHUYLER FORK	41. LAUREL FORK/ COAL FORK
4. PLUM ORCHARD CREEK	23. DRY BRANCH/ CABIN CREEK	42. HURRICANE FORK
5. SPRUCE FORK	24. FALLS CREEK	43. INGRAM BRANCH
6. FIVEMILE CREEK	25. FOURMILE FORK/ PAINT CREEK	44. JARRETT BRANCH
7. COAL FORK/ CABIN CREEK	26. FOURMILE CREEK/ LENS CREEK	45. SYCAMORE BRANCH
8. KELLY BRANCH/ SIMMONS CREEK	27. DEMPSEY BRANCH	46. LONG BRANCH/ TENMILE FORK
9. RUSH CREEK	28. TOMS BRANCH	47. BEAR HOLLOW
10. PAINT BRANCH/ CABIN CREEK	29. MILBURN CREEK	48. TENMILE FORK/ CABIN CREEK
11. BRUSHY CREEK	30. MAPLE FORK	49. HICKORY CAMP BRANCH
12. RIGHT FORK/ RUSH CREEK	31. BISHOP BRANCH	50. COAL FORK/ CAMPBELLS CREEK
13. FIVEMILE HOLLOW	32. LICK BRANCH/ KANAWHA RIVER	51. TENMILE FORK/ PAINT CREEK
14. BURNING SPRING BRANCH	33. LITTLE CREEK	52. MISSION HOLLOW
15. UPPER CREEK	34. SKITTER CREEK	53. BOOMER BRANCH
16. CLOVER HOLLOW	35. SUGAR CAMP BRANCH	54. MORRIS CREEK
17. RING HOLLOW	36. RATTLESNAKE HOLLOW	55. NORTH SAND BRANCH
18. MULBERRY FORK	37. LOWER CREEK	
19. SIMMONS CREEK	38. POINT LICK FORK	

Figure 7. Biological and Habitat Data Summary - SWC II Streams (3-10m wide)



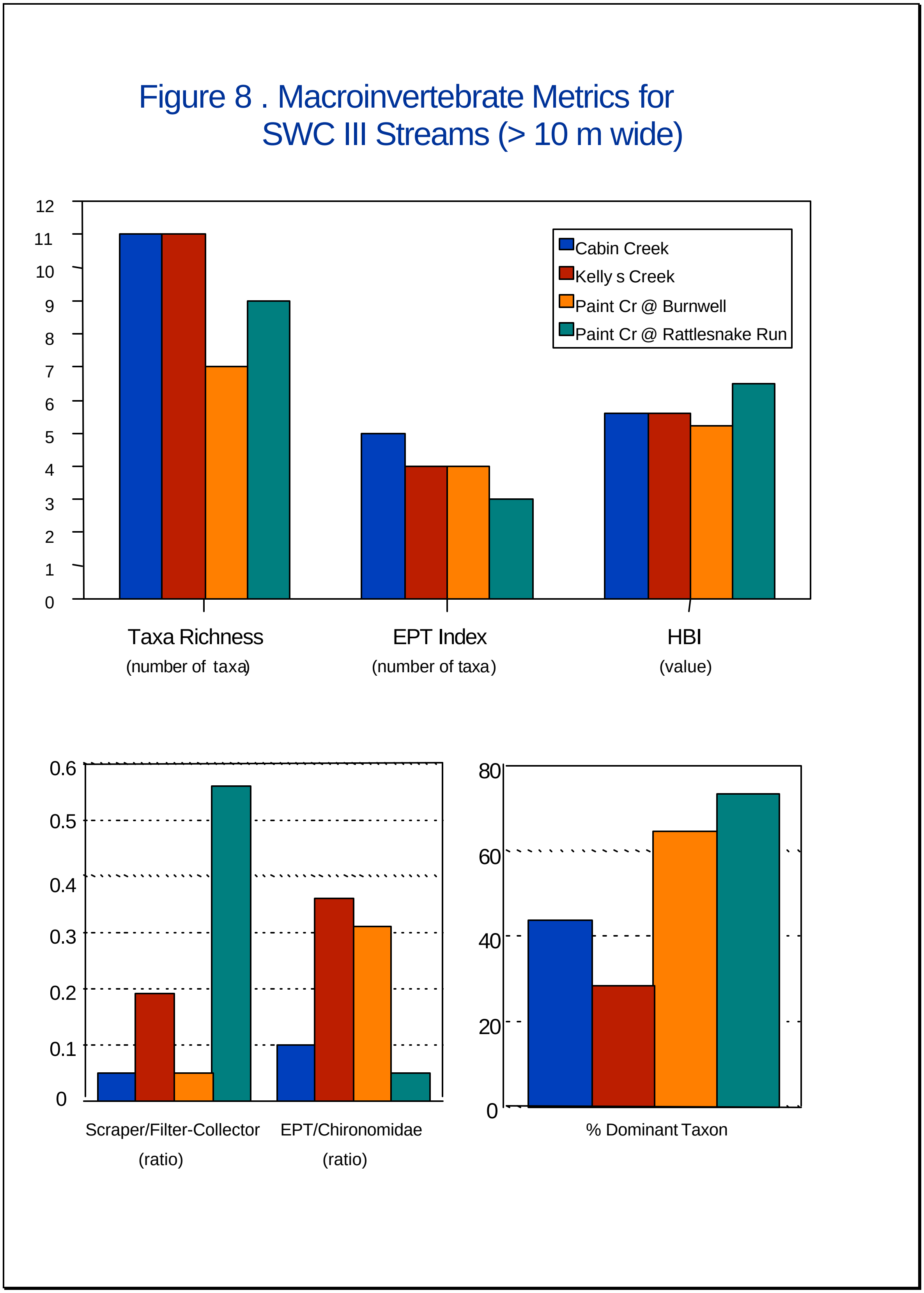


Figure 8 . Macroinvertebrate Metrics for
SWC III Streams (> 10 m wide)
Cabin Creek
Kelly s Creek
Paint Cr @ Burnwell
Paint Cr @ Rattlesnake Run
12
11
10
9
8
7
6
5
4
3
2
1
0
Taxa Richness
(number of taxa)
EPT Index
(number of taxa)
HBI
(value)
0.6
0.5
0.4
0.3
0.2
0.1
0
Scraper/Filter-Collector
(ratio)
EPT/Chironomidae
(ratio)
80
60
40
20
0
% Dominant Taxon

Findings from Bacterial and Physico-Chemical Sampling

Overall, 42% of samples analyzed for fecal coliform bacteria had concentrations exceeding the appropriate water quality criterion of no more than 400 colonies per 100ml in more than 10% of all samples collected within a month. In SWC I, approximately 45% of the 62 sites sampled for bacteria exceeded the criterion, approximately 39% had greater than 1,000 and 11 produced concentrations greater than 6,000. The highest concentration (52,000) of certainty (9 samples were reported rather uncertainly by the lab as >6,000), was found in North Sand Branch (K-65-HH-1), which has 5 NPDES sewage treatment facility permit holders operating upstream of the sampling point. The second highest concentration of certainty (12,000), was reported from Lick Branch (K-45), which drains the Charleston landfill as well as an unsewered residential area.

In SWC II, 55% were in violation of the criterion and 35% had greater than 1,000. Of the 5 sites in SWC III, 3 (60%) exceeded the criterion. Of the 27 sites sampled for bacteria, but not sampled for benthos or placed in one of the stream width classes, only 22% exceeded the criterion and only 3 had concentrations greater than 1,000.

Bacterial results compared with subjective turbidity ratings (Table 8) show no clear correlation between the two. Indeed some of the highest bacteria counts were found in streams determined visually to be clear. Overall, there was also no clear correlation between bacteria concentration and biological condition score.

It should be noted that the laboratory analyzing fecal coliform bacteria samples reported the results after rounding to two significant figures. In other words, a value reported as 400 (not a violation) may actually be 404 (a violation). The lab followed EPA guidelines for such estimation, but in the future, it would be beneficial to report actual results. The rounded figures were not corrected. Therefore, this discussion has been based upon the rounded values reported by the laboratory.

Explanation of Findings

Of the 6 SWC I sites classed as having severely impaired benthos, 3 (50%) exhibited water quality constituents indicative of negative impacts from mine drainage. Of these three sites (Morris Creek K-70, Boomer Branch K-74 and Tenmile Fork of Paint Creek K-65-M), only Morris Creek showed evidence of severe fecal contamination (3,400/100ml) as well as mine drainage pollution.

The other 3 severely impaired sites showed no evidence of mine drainage pollution. Of these, North Sand Branch (K-65-HH-1) was negatively impacted by at least one sewage treatment facility discharge. Mission Hollow (K-46-A) had the poorest habitat score, and Coal Fork of Campbells Creek (K-49-D) was noted as having numerous potential habitat and water quality impacts, including channelization, silt and sand deposits, household refuse, nearby road impacts, and pipes, lawns, and residences in close proximity. Coal Fork also had a very degraded riparian zone, recorded as only 1 meter wide on each bank.

Mission Hollow showed signs of fecal contamination as well, producing a bacteria sample of 1,000. A portion of the Charleston landfill may lie within the Mission Hollow drainage area although the bulk of it is within the Lick Branch (K-45) drainage area. Like Coal Fork of Campbells Creek, Mission Hollow was severely impaired by urban/suburban development.

The North Sand Branch site was reported as having abundant organic material and algae on its rocks as well as smelling of sewage. It was bordered by a quarry on each side and had abundant silt and sand deposits. Further evidence of organic pollution at this site was in the benthic sample. Except for sewage tolerant aquatic segmented worms and fly larvae, no other organisms were collected in the laboratory subsample. The high numbers of most of these pollution tolerant taxa (1,068 worms, 1,223 blackfly larvae, 103 midge larvae and 1 horsefly larva) are sure signs of severe, chronic organic pollution.

None of the biologically nonimpaired SWC I sites, including the reference site, exhibited water quality indicative of negative impacts from mine drainage.

In the group of moderately impaired SWC I sites, there is a clear delineation between those that exhibited mine drainage parameters and those that did not. Of the 9 sites with mine drainage constituents, 8 (89%) had a biological condition score less than 50% of the reference site's score. One had a score of exactly 50%, while none had a score above that percentage. The 50% biological condition level seems to be a de facto boundary, above which no SWC I sites exhibiting water quality indicative of mine drainage were found. Although other factors probably impacted the sites identified as moderately impaired, none are so clearly implicated as mine drainage.

After a thorough study of potential correlations between biological condition scores, and each of the many variables and observations collected during the sampling effort, only two observations stand out as potential corollaries; Stream Management and Channel Alteration. Stream Management includes stream modification practices such as rip-rapping, dredging and channelization. Channel Alteration is similar to Stream Management, but it transforms the notes about these activities into numbers that are useful in developing habitat condition scores.

Of the 24 moderately impaired SWC I sites that did not have mine drainage evidence, 13 (approximately 54%) were noted as having evidence of stream management activities. Twenty percent, (3 of 15, including the reference site) of the nonimpaired sites, on the other hand, were noted as having stream management activities. A majority (approximately 67%) of both moderately impaired and nonimpaired SWC I sites were rated in the sub-optimal range of the Channel Alteration category. However, approximately 29% of the moderately impaired sites received either a marginal or poor category score, while the nonimpaired sites had a better showing of approximately 7% total in these categories. The moderately impaired/non-mine drainage SWC I sites fared poorly in the optimal range with approximately 4% scoring therein, while the nonimpaired sites did a little better with approximately 27% scoring in the optimal range.

Whether or not stream management activities had a significant influence on the benthic communities at the SWC I sites, is not testable with the data generated from this sampling effort. However, the exercise highlighted above does point out the distinct possibility that stream modification does exert a negative influence on such communities even after 20 years (many of the assessment forms indicated that stream modification appeared to have taken place more than 20 years ago).

Four of the five (80%) SWC II sites considered to be severely impaired biologically, appeared to be negatively impacted by mine drainage. The other severely impaired site, Wet Branch (K-61-C), had been dredged recently by P.G. & H. Coal Company and was little more than a drainage ditch for the company's mine and coal processing plant. Although water quality was not found to be poor in Wet Branch, the habitat was marginal due to mining activity and proximity to loose rock fill at the mine site. These sources of habitat degradation likely caused the biological impairment. Neither the reference site (Loop Creek, K-76)) nor the biologically nonimpaired site (Left Fork of Lens Creek, K-53-A) exhibited water quality indicative of negative mine drainage impacts.

Somewhat similar to the SWC I sites, none of those in SWC II with biological condition scores above 50% of the reference site's score exhibited water quality constituents indicative of mine drainage. Below the 50% level, 2 of 4 (50%) exhibited mine drainage constituents. No variables or observations stand out as potentially correlated with biological condition at the SWC II sites.

The lack of correlation between habitat score and biological condition score among SWC I and SWC II sites indicates that habitat did not play a significant role in causing differences between benthic macroinvertebrate communities. The data hint at a minor role for habitat in supporting the healthiest communities in SWC I, but among the moderately impaired and severely impaired sites, habitat appeared to play a less significant role than mine drainage. However, for a few sites, very poor habitat was the only obvious factor contributing to their poor benthic communities.

In both SWC I and SWC II, all of the sites that exhibited mine drainage impacted water quality also had biological condition scores less than 50% of the respective reference site's score. It is obvious that mine drainage with elevated levels of acid, metals, sulfate, conductivity or combinations of these constituents was associated with poor benthological community condition. In other words, such mine drainage caused damage to the aquatic ecosystems at these sites.

A greater variety of taxa would be expected from an undisturbed stream in SWC III than those obtained from Cabin (K-61), Kellys (K-64) and Paint Creeks (K-65). The low taxa richness at these sites probably reflects poor water quality. The Family Biotic Index values (5.6) from the Cabin and Kellys Creeks samples (the best of the 4 SWC III sites sampled for benthos) indicate only fair water quality, making fairly substantial organic pollution likely (Hilsenhoff 1988). Habitat Condition scores of the SWC III sites compare favorably with nonimpaired sites in both SWC I and SWC II, so habitat cannot be considered the primary contributor to poor benthic community condition at the four sites.

The fact that bacteria concentrations were not positively correlated with subjective turbidity ratings may indicate that the major contributor to high bacteria counts within the watershed was poor sewage treatment. In areas where livestock is common, bacteria is often positively correlated with turbidity. In areas where failing or nonexistent sewage treatment is common, there is no such correlation with turbidity. Indeed, often there is a negative correlation.

The history of many of the communities located in the narrow valleys and hollows of the upper Kanawha River watershed lends support to this hypothesis. Most of these communities were established or expanded during coal mining boom times in the earlier part of our present century. During this period, a "modern, improved" sewage processing system consisted of collection lines that carried each household's sewage to the lower end of town where it was "safely" discharged into the local stream.

Yet some of these communities did not and still do not have even this level of sewage processing. Straight piping from house to creek is still common. Where individual septic systems exist, they are often not tied into a leach field, or the leach lines are failing. Several of the staff members noted raw or only partially treated sewage discharging into streams in the vicinity of some of their sample sites.

It should not be assumed, however, that in all instances of bacteria criterion violation, the source is untreated human sewage. Upstream of the Greens Branch sample site (K-61-G), no houses existed, yet the bacteria sample had a concentration of 700 colonies/100ml. There were several domestic ducks in the immediate vicinity and their curled, whitewashed fecal pellets were scattered everywhere in the stream, and on rocks surrounding the stream. It is very likely that the source of bacteria contamination on the day of sampling was the flock of ducks.

Implications

The streams listed below (Table 3) were on the 1996 303(d) list. Based on a single sample, the analysis did not support their remaining on the 303(d) list. These streams should be investigated further to determine if a) negative impacts occur only during certain periods (e.g., snow melt runoff), b) only certain reaches are negatively impacted, c) other parameters should be sampled (e.g., metals from Long Branch) or d) some combinations of a, b and/or c.

Of the streams with low concentrations of the mining related water quality constituents, 9 produced fecal coliform bacteria concentrations that exceeded the state's water quality criterion of no more than 400 colonies/100 ml in more than 10% of the samples collected over a one month period. Six sites with high concentrations of the mining related water quality constituents present also had high fecal coliform concentrations. These 15 sites should be investigated to determine if they are water quality limited by sewage or animal waste or mine drainage or both.

Thirty sites on the 1996 303(d) list for mining related activities were found to be negatively impacted by mine drainage to the extent that they should be retained on the 303(d) list due to mine drainage. These 30 sites (29 streams) represent 58% of the 50 streams in this watershed listed on the 1996 303(d) list.

Three streams, Right Fork of Armstrong Creek (K-73-F), Left Fork of Armstrong Creek (K-73-G), and New West Hollow (K-58-B.8-1) were listed on the 1996 303(d) list and were not sampled during this study. Two of the streams were inaccessible to the field team. The third stream, New West Hollow, no longer performs its ecological and hydrological functions as a headwater stream due to the construction of a mining refuse impoundment. The cumulative impacts of the loss of headwater streams is currently being discussed.

Table 3 Mine Drainage and Fecal Coliform Bacteria Status From a Single Sample for Streams on 1996 - 303(d) list		
Stream Name and AN Code	Mine Drainage Constituents	Fecal Coliform
Stream Width Category I		
Fields Creek (K-58)	Low	Above Criterion
Wolfpen Hollow (K-58-B.1)	High	Below Criterion
Bear Hollow (K-61-I)	High	Below Criterion
Tenmile Fork/Cabin Creek (K-61-L)	High	Above Criterion
Hicks Hollow (K-61.5)	High	Below Criterion
Fourmile Fork of Paint Creek (K-65-E)	Low	Below Criterion
Tenmile Fork/Paint Creek (K-65-M)	High	
Long Branch/Tenmile Fork (K-65-M-1)	High	
Hickory Camp Branch (K-65-P)	High	
Packs Branch (K-65-DD) - not sampled for metals	Low	Above Criterion
Morris Creek (K-70-{00.4})-not sampled for metals	High	Above Criterion
Boomer Branch (K-74)	High	Below Criterion
Jarrett Branch (K-75) – not sampled for metals	High	Above Criterion
Beards Fork (K-76-D) – not sampled for metals	Low	Below Criterion
Ingram Branch (K-76-K)	High	Below Criterion
Stream Width Category II		
Left Fork/Lens Creek (K-53-A)-not sampled for metals	Low	Below Criterion
Slaughter Creek (K-60)	High	Below Criterion
Greens Branch (K-61-G)	Low	Above Criterion
Paint Creek at Collins Branch (K-65-{06.9}) – not sampled for metals	High	Below Criterion
Smithers Creek (K-72) – not sampled for metals	High	Above Criterion
Armstrong Creek (K-73) - not sampled for metals	Low	Above Criterion
Loop Creek (K-76-{00.3})	Low	Above Criterion
Stream Width Category III		
Cabin Creek (K-61-{00.8})	High	Above Criterion
Paint Creek at mouth (K-65-{00.5}) – not sampled for metals	Low	Above Criterion
Paint Creek at Burnwell (K-65-{12.8}) - no metals sampled	High	Below Criterion
Paint Creek below Rattlesnake Run (K-65-{20.1}) - no metals sampled	Low	Above Criterion

Table 3
Mine Drainage and Fecal Coliform Bacteria Status
From a Single Sample for Streams on 1996 - 303(d) list

Stream Name and AN Code	Mine Drainage Constituents	Fecal Coliform
Stream Width Category Not Determined		
Counterfeit Branch (K-57-D)	Low	Above Criterion
Mill Branch (K-58-A)	Low	Below Criterion
Carroll Branch (K-59)	High	Below Criterion
Cane Fork (K-61-J)	High	Below Criterion
Fifteenmile Fork/Cabin Creek (K-61-O)	High	Below Criterion
Abbott Creek (K-61-O-1)	High	Below Criterion
Long Branch/Fifteenmile Fork (K-61-O-2)	High	Below Criterion
Watson Branch (K-62)	High	Below Criterion
Mile Branch (K-63)	High	Below Criterion
Jones Branch (K-65-C)	Low	Below Criterion
Fifteenmile Creek/Paint Creek (K-65-R)	High	Below Criterion
Lykins Creek (K-65-W)	Low	Below Criterion
Long Branch (K-65-Y-2) –not sampled for metals	Low	Below Criterion
Big Fork (K-65-DD-2)	Low	Below Criterion
West Hollow (K-68.5)	High	Below Criterion
Staten Run (K-71)	High	Below Criterion
Fishhook Fork (K-72-A-1)	High	Below Criterion
Jenkins Fork (K-73-D)	High	Above Criterion
Powellton Fork (K-73-E)	Low	Above Criterion
Laurel Fork (K-73-E-1)	Low	Below Criterion
Right Fork/Beards Fork (K-76-D-1)	Low	Below Criterion
Robinson Branch (K-76-E)	High	Below Criterion
Molly Kincaid Branch (K-76-G)	High	Below Criterion
Camp Branch (K-76-J)	Low	Below Criterion

Separate efforts are underway to understand the complex ecological relationships between headwater streams and their downstream reaches. New West Hollow should be included if these studies, or any similar study, call for listing of streams impacted by construction fill. In addition, Wet Branch (K-61-C) has been noticeably degraded by dredging associated with coal mining activities.

Several sites not on the 1996 303(d) list showed evidence of negative impact from mine drainage, acidic or otherwise. In some cases, where limited water quality constituents were analyzed for, high conductivities indicated that further scrutiny of the data was required. Low biological condition scores and pertinent field notes supported the suspicion that these sites were damaged by mining. These sites should be investigated to determine if they belong on a future 303(d) list. These streams are: Rattlesnake Hollow/Campbells Creek (K-49-I), Old West Hollow (K-58-B.8-2), Laurel Fork (K-61-H-1), Sycamore Branch (K-65-L), Cedar Creek (K-65-Q), Unnamed tributary of Paint Creek (K-65-Q.3), Unnamed tributary of Paint Creek (K-65-Q.5), Spring Branch (K-65-S), Horsemill Branch (K-64-A), Hughes Creek (K-66-{00.3}), Bullpush Hollow (K-72-B), and Tucker Hollow (K-73-A).

A few of the streams on the current 303(d) list due to metals were not sampled for metals. Seven sites were impacted by other constituents (i.e., pH and conductivity) and appear to be free from negative impact due to mine drainage. These streams should be further investigated to determine whether or not metals are problematical at any time and along any reach. These seven sites are: Packs Branch (K-65-DD), Beards Fork (K-76-D), Left Fork/Lens Creek (K-53-A), Armstrong Creek (K-73-{00.4}), Paint Creek below Rattlesnake Run (K-65-{20.1}), Paint Creek at mouth (K-65-{00.5}), and Long Branch (K-65-Y-2).

The majority of named streams (176 or 61%) and all but two unnamed streams in the Upper Kanawha River watershed were not sampled. Approximately 36% of the sampled streams exhibited negative impacts to water quality and/or benthos due to mine drainage. In addition 42%of the streams sampled exhibited an excess of Fecal Coliform Bacteria. From these observations, it is reasonable to conclude that several unsampled streams in this watershed may be negatively impacted by mine drainage or Fecal Coliform Bacteria. Further investigation is required to determine the actual extent of impact from mine drainage and Fecal Coliform Bacteria to streams within the Upper Kanawha River watershed.

Cabin Creek (K-61)

Negative impacts to water quality from mine drainage were obvious in Cabin Creek and approximately 54% of its sampled tributaries. Mine drainage impacts were observed near the creek's mouth, in tributaries along its middle reaches and in headwater tributaries. These data indicate that the mainstem of Cabin Creek from its mouth to near its headwaters at the confluence with Fifteenmile Fork (K-61-O) was negatively impacted by mine drainage. Abandoned underground mines are located on the mainstem upstream from this confluence to the community of Republic. Probably, the mainstem upstream of this confluence, was impacted as well.

Weighing Fish during a Survey of Paint Creek
In Cooperation with the LPCWA

The bacteria data show that criterion violations occurred at sites scattered throughout the Cabin Creek subwatershed including the mainstem site near the mouth. The Cabin Creek mainstem has the potential to be in violation of the bacteria criterion from its mouth upstream to the confluence with Tenmile Fork (K-61-l). Funding for a sewer extension serving the Cabin Creek area was approved

Paint Creek (K-65)

The mainstem of Paint Creek was likely negatively impacted by mine drainage from the vicinity of Spring Branch (K-65-S), at the old Milburn Colliery refuse area, downstream to its mouth. Several mine drainage impacted tributaries along this reach were acidic, while others were only affected by metals normally associated with mine drainage.

Upstream of the Milburn Colliery refuse area, a few streams have active mines. Close attention to environmental maintenance is necessary to prevent discharges of alkaline black water from haul roads and/or inadequate sediment sumps. Typically, these impacts would be less significant biologically than the continuous acidic and metal-laden discharges further downstream.

A few inactive mines and abandoned refuse areas located on tributaries of Paint Creek upstream of the Milburn Colliery site have caused these tributaries to be placed on the 303(d) list. However, the data in this study do not implicate Lykins Creek (K-65-W), Long Branch of Mossy Creek (K-65-Y-2), Packs Branch (K-65-DD) and Big Fork of Packs Branch (K-65-DD-2) as having degraded water quality due to mine drainage. Therefore, it seems reasonable to identify the reach of Paint Creek degraded most by mine drainage as that from the mouth upstream to Skitter Creek (K-65-T). A shorter reach, degraded to a lesser degree by mine drainage, extends from Skitter Creek upstream to the mouth of Milburn Creek (K-65-V).

Further study will be required to determine the reach negatively impacted by highway runoff. Widening and expansion of the West Virginia Turnpike into Interstate Highways 77 and 64 negatively impacted habitat in many reaches of Paint Creek and the changes wrought by that construction continue to contribute to streambank erosion in the vicinity of straightened meanders. To date, no study has been designed to determine the impact of highway runoff on water quantity and quality. Salt application in winter is of concern as are occasional tanker truck spills and other runoff polluting events. There are no runoff-holding or runoff-treating structures (e.g., sediment catch basins, vortex concentrators) located along I-77/64 within the Paint Creek subwatershed.

Bacteria criterion violations along the Paint Creek mainstem and from some of its tributaries, especially those in the headwater area, indicate that the Paint Creek mainstem likely experiences chronic violations of the bacteria criterion from its mouth upstream to its confluence with Sand Branch (K-65-HH). Further study is required to confirm the extent of violations within the subwatershed.

Paint Creek is on the 1996 303(d) sublist due to mine drainage and highway runoff, yet 66% of its named tributaries were not sampled during this study. Only two unnamed tributaries (K-65-Q.3 and K-65-Q.5) were sampled and they were found to be severely impacted by mine drainage. Especially neglected in this study were the headwater tributaries. If the list of 66 named tributaries (both direct and indirect tributaries) is halved at the ascending order midpoint, it becomes evident that approximately 82% of the upper tributaries were not sampled. Of the lower named tributaries, only 39% were not sampled. Future studies of Paint Creek should include more sampling in the upper drainage area.

Although outside the scope of this document, flooding should be mentioned due to its relative importance to stakeholders within the Paint Creek subwatershed. Six categories of human-induced activities likely exacerbated problems of flooding in this area:

1) Construction of I-77/64 resulted in less permeable surface area and altered streambank erosion patterns,
2) Formation of unvegetated areas (e.g., refuse piles and coal processing plants) through mineral resource extraction activities increased peak runoff,
3) Development of urban areas in the headwaters decreased land permeability to water, thus increasing peak runoff,
4) Development and continued expansion of communities in flood-prone areas of the lower watershed, such as Pax,
5) Increased peak runoff due to timbering, and
6) Extensive, frequent wildfires burned ground-protecting vegetation and leaf litter resulting in increased runoff.

All of these activities are also sources of pollutants in streams of the subwatershed and should be considered in depth by authorities planning to deal with flooding there. "Remedies" popular in the past (e.g., stream channelization, streambank vegetation removal and rip-rapping) will only magnify the problems downstream of the applied "remedies." Unless the above mentioned activities are seriously curbed or mitigated for, flooding and pollution are likely to increase.

Loop Creek (K-76)

Loop Creek is listed on the 1996 303(d) sublist for mine drainage impacted waters, yet at the sampled site, neither water quality nor benthological indicators clearly identified negative mine drainage impacts. As in the Paint Creek subwatershed, sampling effort was biased heavily toward the lower subwatershed tributaries. Seven of the 12 (approximately 58%) lowermost tributaries were sampled, while only 3 of the 11 (approximately 28%) uppermost tributaries were sampled.

One sampler said that four tributaries of Loop Creek which were sampled for water quality only had red dog (burned coal waste, usually carbonaceous shale) and other coal refuse particles on their substrates. Yet the samples did not indicate acid mine drainage impacts at these sites. These sites are on Right Fork of Beard Fork (K-76-D-1), Robinson Branch (K-76-E), Molly Kincaid Branch (K-76-G) and Camp Branch (K-76-J). In samples from Right Fork of Beards Fork and Camp Branch, metals concentrations did not reflect mine drainage.

Coal has been mined in the subwatershed for a century, so it seems reasonable to assume that some negative impacts have taken place. Another study must be carried out to determine whether or not any portion of the Loop Creek mainstem or its unsampled tributaries are negatively impacted by mine drainage before they can be recommended for removal from the 303(d) sublist.

Table 4:
Suggested Action List

1. Study the streams listed on the current 303(d) list which do not appear to belong on it to determine if they should be removed from the list or if the impact is only present during a particular period or in a particular reach of the stream.
2. Conduct a field review study of all streams in the watershed to determine which are impaired from mine drainage and develop proper restoration procedures.
3. Identify the communities with “collect-and-dump” sewage management and improve sewage treatment facilities in these communities.
4. Connect communities that do not have adequate sewage treatment with those that do.
5. Develop a program to educate homeowners on the perils of failing sewage systems and encourage them to tie into a modern sewage treatment system or improve their septic system.
6. Study the effects of highway construction on water quality and quantity.
7. Continue the cooperative efforts to support the Lower Paint Creek Watershed Association and similar organizations around the state.

Additional Resources

The watershed movement in West Virginia includes a wide variety of federal, state, and non-governmental organizations that are available to help improve the health of the streams in a Watershed. Several agencies are participants in the West Virginia Watershed Management Framework and/or the West Virginia Watershed Network.

The Watershed Basin Coordinator has been employed to coordinate the activities of the agencies which participate in the West Virginia Watershed Management Framework. An important part of this process is public participation. The Basin Coordinator may be contacted at (304) 558-2108.

In addition the DEP’s Stream Partners Program coordinator, available at 1-800-556-8181, serves as a resource for emerging watershed associations. The Stream Partners program helps groups organize, form partnerships, decide on projects, and find the technical and financial resources they need.

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Appendix A -- Stream Lists, Statistics and Tables

TABLE 5. LEVEL OF ASSESSMENT

STREAM NAME	Ancode	field chemistry	Fecal coliform	mine drain	habitat	nutrient	benthos	comments
S.W.C. I (0-3 meters)								
LICK BRANCH/KANAWHA RIVER	WVK-45	√	√		√		√	
MISSION HOLLOW	WVK-46-A	√	√		√		√	
LOWER DONNALLY BRANCH	WVK-48	√	√		√		√	
COAL FORK/CAMPBELLS CREEK	WVK-49-D	√	√		√		√	
CLOVER HOLLOW	WVK-49-E	√	√		√		√	
POINT LICK FORK	WVK-49-F	√	√		√		√	
FIVEMILE HOLLOW	WVK-49-H	√	√		√		√	
RATTLESNAKE HOLLOW	WVK-49-I	√	√		√		√	
GEORGES CREEK	WVK-50	√	√		√		√	
RUSH CREEK	WVK-51	√	√		√		√	
RIGHT FORK/RUSH CREEK	WVK-51-A	√	√		√		√	
BURNING SPRING BRANCH	WVK-52	√	√		√		√	
RING HOLLOW	WVK-53-B	√	√		√		√	
FOURMILE CREEK/LENS CK	WVK-53-C	√	√		√		√	
SPRUCE FORK	WVK-53-C-1	√	√		√		√	
SIMMONS CREEK	WVK-54	√	√		√		√	
KELLY BRANCH/SIMMONS CK	WVK-54-A	√	√		√		√	
DRY BRANCH/WITCHERS CK	WVK-57-A	√	√		√		√	
FIELDS CREEK	WVK-58	√	√	√	√		√	
WOLFPEN HOLLOW	WVK-58-B.1	√	√	√	√			
OLD WEST HOLLOW	WVK-58-B.8-2	√	√	√	√			
LITTLE CREEK	WVK-60-A	√	√		√		√	
DRY BRANCH/CABIN CREEK	WVK-61-B	√	√		√		√	
PAINT BRANCH/CABIN CREEK	WVK-61-E	√	√		√		√	
COAL FORK/CABIN CREEK	WVK-61-H	√	√		√		√	
LAUREL FORK/COAL FORK	WVK-61-H-1	√	√	√	√		√	
BEAR HOLLOW	WVK-61-I	√	√	√	√		√	
TENMILE FORK/CABIN CREEK	WVK-61-L	√	√	√			√	
HICKS HOLLOW	WVK-61.5	√		√			partial	only 4 kicks
FIVEMILE FORK	WVK-64-I	√	√		√		√	
HURRICANE FORK/KELLYS CK	WVK-64-J	√	√		√		√	
MILBURN BRANCH	WVK-65-A	√	√		√		√	
SUGARCAMP BRANCH	WVK-65-B	√	√		√		√	
FOURMILE FORK/PAINT CREEK	WVK-65-E	√	√	√	√		√	
HURRICANE BRANCH/PAINT CK	WVK-65-I	√	√		√		√	
TOMS BRANCH	WVK-65-J	√	√		√		√	
BRUSHY CREEK	WVK-65-K	√	√		√		√	
SYCAMORE BRANCH	WVK-65-L	√	√	√	√		√	
TENMILE FORK/PAINT CREEK	WVK-65-M	√	√	√	√		√	
LONG BRANCH/TENMILE FORK	WVK-65-M-1	√	√	√	√		√	
HICKORY CAMP BRANCH	WVK-65-P	√	√	√	√		√	
CEDAR CREEK	WVK-65-Q	√	√	√	√		√	
1st UNT ABOVE CEDAR CREEK	WVK-65-Q.3	√	√	√	√		√	pre-sampled
2nd UNT ABOVE CEDAR CREEK	WVK-65-Q.5	√	√	√	√		√	no bugs

TABLE 5. LEVEL OF ASSESSMENT

STREAM NAME	Ancode	field chemistry	Fecal coliform	mine drain	habitat	nutrient	benthos	comments
LICK BRANCH/PAINT CREEK	WVK-65-S	√	√	√	√		√	
SKITTER CREEK	WVK-65-T	√	√		√		√	
MILBURN CREEK	WVK-65-V	√	√	√	√		√	
BISHOP BRANCH	WVK-65-X	√	√		√		√	
PLUM ORCHARD CREEK	WVK-65-Z	√	√		√		√	
PACKS BRANCH	WVK-65-DD	√	√		√		√	
NORTH SAND BRANCH	WVK-65-HH-1	√	√		√		√	
MAPLE FORK	WVK-65-HH-1-A	√	√		√		√	
LOWER CREEK	WVK-67	√	√		√		√	
UPPER CREEK	WVK-68	√	√		√		√	
MORRIS CREEK	WVK-70-{00.4}	√	√	√	√		√	
SCHUYLER FORK	WVK-70-A	√	√	√	√		√	
BOOMER BRANCH	WVK-74	√	√	√	√		√	
JARRETT BRANCH	WVK-75	√	√		√		√	
BIG RIGHT HAND FORK	WVK-76-B	√	lost		√		√	
MULBERRY FORK	WVK-76-C	√	√		√		√	
DEMPSEY BRANCH	WVK-76-C-1	√	√		√		√	
BEARDS FORK	WVK-76-D	√	√		√		√	
INGRAM BRANCH	WVK-76-K	√	√	√	√		√	
FALLS CREEK	WVK-80	√	√		√		√	
S.W.C. II (3-10 meters)								
CAMPBELLS CREEK	WVK-49-{00.3}	√	√		√		√	
DRY BRANCH/CAMPBELLS CREEK	WVK-49-A	√	√		√		√	
LEFT FORK/LENS CREEK	WVK-53-A	√	√		√		√	
LENS CREEK	WVK-53-{00.3}	√	√		√		√	
WITCHER CREEK	WVK-57	√	√		√		√	
LEFT FORK/WITCHERS CREEK	WVK-57-C	√	√		√		√	
SLAUGHTER CREEK	WVK-60	√	√	√	√		√	
WET BRANCH	WVK-61-C	√	√		√		√	
LONGBOTTOM CREEK	WVK-61-F	√	√		√		√	
GREENS BRANCH	WVK-61-G	√	√	√	√		√	
HORSEMILL BRANCH	WVK-64-A			√	√		√	
LEFT FORK/KELLYS CREEK	WVK-64-K	√	√		√		√	
PAINT CREEK AT COLLINS	WVK-65-{06.9}	√	√		√		√	
BANNER HOLLOW	WVK-65-D	√	√		√		√	
SOUTH SAND BRANCH	WVK-65-HH-2	√	√		√		√	
HUGHES CREEK	WVK-66-{00.3}	√	√		√		√	
BULLPUSH RUN	WVK-72-B	√	√	√	√		√	
SMITHERS CREEK	WVK-72-{00.5}	√	√		√		√	
ARMSTRONG CREEK	WVK-73-{00.4}	√	√		√		√	
LOOP CREEK	WVK-76-{00.3}	√	√	√	√		√	
S.W.C. III (>10 meters)								
CABIN CREEK NEAR MOUTH	WVK-61-{00.8}	√	√	√	√		√	
KELLYS CREEK	WVK-64-{00.4}	√	√		√		√	
PAINT CREEK @ MOUTH	WVK-65-{00.5}	√	√		√		√	
PAINT CREEK @ BURNWELL	WVK-65-{12.8}	√	√		√		√	Safe-Fix used no bugs intact

TABLE 5. LEVEL OF ASSESSMENT								
STREAM NAME	Ancode	field chemistry	Fecal coliform	mine drain	habitat	nutrient	benthos	comments
PAINT CREEK @ RATTLESNAKE RUN	WVK-65-{20.1}	√	√		√		√	
Water Quality Only Streams								
SIXMILE BRANCH/LENS CREEK	WVK-53-D		√					
COUNTERFEIT BRANCH	WVK-57-D	√	√	√				
MILL BRANCH	WVK-58-A	√	√	√				
NEW WEST HOLLOW	WVK-58-B.8-1							
CARROLL BRANCH	WVK-59		√	√				
CANE FORK	WVK-61-J	√		√				
FIFTEENMILE FORK/CABIN CR	WVK-61-O	√	√	√				
ABBOTT CREEK	WVK-61-O-1	√	√	√				
LONG BRANCH/FIFTEENMILE	WVK-61-O-2	√	√	√				
WATSON BRANCH	WVK-62	√		√				
MILE BRANCH	WVK-63	√	√	√				
JONES BRANCH	WVK-65-C	√	√	√				
FIFTEENMILE CREEK/PAINT CR	WVK-65-R	√	√	√				
LYKINS CREEK	WVK-65-W	√	√	√				
LONG BRANCH	WVK-65-Y-2	√	√					
BIG FORK/PACKS BRANCH	WVK-65-DD-2	√	√	√				
WEST HOLLOW	WVK-68.5	√	√	√				
STATEN RUN	WVK-71	√	√	√				
FISHHOOK FORK	WVK-72-A-1	√	√	√				
TUCKER HOLLOW	WVK-73-A	√	√	√				
JENKINS FORK	WVK-73-D	√	√	√				
POWELLTON FORK/ARMSTRONG	WVK-73-E	√	√	√				
LAUREL FORK/POWELLTON FK	WVK-73-E-1	√	√	√				
RIGHT FORK/BEARDS FORK	WVK-76-D-1	√	√	√				
ROBINSON BRANCH	WVK-76-E	√	√	√				
MOLLY KINCAID BRANCH	WVK-76-G	√	√	√				
CAMP BRANCH	WVK-76-J	√	√	√				
KANAWHA RIVER @ SOUTHSIDE BRANCH	WVO-20-{58.5}	√	√	√				
KANAWHA RIVER @ CHELYAN	WVO-20-{73.6}	√	√	√		√		
KANAWHA RIVER @ FALLS CR	WVO-20-{94.4}	√	√	√		√		

Key : AN code = A stream identification system using an alpha numeric code devised by WV DNR to assign a unique code to every stream in the state.
field chemistry = chemical parameters measured in the field (pH, DO, conductivity, and temperature)
Fecal Coliform = fecal coliform bacteria sample taken to contract laboratory
mine drain = acid mine drainage parameters - includes: hot acidity, alkalinity, sulfates, Aluminum, Iron, Manganese, and flow
habitat = habitat assessed on site
nutrient = enrichment parameters - includes: phosphorous, nitrate-nitrite, and ammonia
benthos = macroinvertebrate sample collected

TABLE 6. WATER QUALITY – PHYSICOCHEMICAL CHARACTERISTICS						
Stream name	Ancode	temp C	Ph	oxygen mg/l	conduct mhos/cm	flow cfs
S.W.C. I (0 - 3 meters)						
LICK BRANCH/KANAWHA RIVER	WVK-45	9.90	7.70	9.50	287	
MISSION HOLLOW	WVK-46-A	15.00	7.80	8.50	272	
LOWER DONNALLY BRANCH	WVK-48	13.00	7.60	8.90	193	
COAL FORK/CAMPBELLS CREEK	WVK-49-D	16.80	7.50	8.40	118	
CLOVER HOLLOW	WVK-49-E	14.40	7.60	8.40	155	
POINT LICK FORK	WVK-49-F	13.60	8.00	9.74	500	
FIVEMILE HOLLOW	WVK-49-H	14.81	7.20	6.30	280	
RATTLESNAKE HOLLOW	WVK-49-I	13.90	9.50	9.20	647	
GEORGES CREEK	WVK-50	15.40	7.60	8.20	181	
RUSH CREEK	WVK-51	13.90	7.50	9.30	203	
RIGHT FORK/RUSH CREEK	WVK-51-A	13.80	7.70	8.70	213	
BURNING SPRING BRANCH	WVK-52	15.50	7.40	8.30	152	
RING HOLLOW	WVK-53-B	13.32	7.66	9.54	118	
FOURMILE CREEK/LENS CREEK	WVK-53-C	16.08	8.45	10.72	262	
SPRUCE FORK	WVK-53-C-1	16.48	7.90	7.73	302	
SIMMONS CREEK	WVK-54	16.90	7.30	8.20	137	
KELLY BRANCH/SIMMONS CREEK	WVK-54-A	16.92	7.42	8.30	150	
DRY BRANCH/WITCHERS CREEK	WVK-57-A	14.40	7.60	9.00	141	
FIELDS CREEK	WVK-58	15.80	8.00	10.10	429	
WOLFPEN HOLLOW	WVK-58-B.1	13.10	4.40	9.50	656	
OLD WEST HOLLOW	WVK-58-B.8-2	14.10	7.20	6.10	331	
LITTLE CREEK	WVK-60-A	14.50	7.40	9.40	515	
DRY BRANCH/CABIN CREEK	WVK-61-B	12.47	7.60	9.30	285	
PAINT BRANCH/CABIN CREEK	WVK-61-E	14.10	7.40	8.80	258	
COAL FORK/CABIN CREEK	WVK-61-H	10.99	7.81	10.11	687	
LAUREL FORK/COAL FORK	WVK-61-H-1	14.60	5.40	8.80	712	1.7908
BEAR HOLLOW	WVK-61-I	14.40	5.90	8.80	276	0.6901
TENMILE FORK/CABIN CREEK	WVK-61-L	17.10	8.10	8.60	954	6.7472
HICKS HOLLOW	WVK-61.5	15.24	3.93	7.68	955	0.2449
FIVEMILE FORK	WVK-64-I	14.28	7.57	8.56	500	
HURRICANE FORK/KELLYS CREEK	WVK-64-J	14.30	7.40	8.60	395	
MILBURN BRANCH	WVK-65-A	15.10	7.20	8.80	213	
SUGARCAMP BRANCH	WVK-65-B	13.80	7.30	9.70	497	
FOURMILE FORK/PAINT CREEK	WVK-65-E	15.30	7.20	8.80	311	3.1318
HURRICANE BRANCH/PAINT CR	WVK-65-I	14.90	7.00	8.90	281	
TOMS BRANCH	WVK-65-J	15.90	7.60	8.70	427	
BRUSHY CREEK	WVK-65-K	15.30	7.20	8.30	612	
SYCAMORE BRANCH	WVK-65-L	15.40	8.20	8.90	1373	
TENMILE FORK/PAINT CREEK	WVK-65-M	13.60	4.70	9.10	922	2.143
LONG BRANCH/TENMILE FORK	WVK-65-M-1	13.60	4.60	9.00	619	1.869
HICKORY CAMP BRANCH	WVK-65-P	11.60	4.70	9.10	823	0.1538
CEDAR CREEK	WVK-65-Q	10.80	4.50	8.90	665	0.2204
1st UNT ABOVE CEDAR CREEK	WVK-65-Q.3	11.20	3.60	9.30	859	0.0853
2nd UNT ABOVE CEDAR CREEK	WVK-65-Q.5	11.40	2.70	9.00	1600	
LICK BRANCH/PAINT CREEK	WVK-65-S	12.30	4.00	8.70	710	0.3571
SKITTER CREEK	WVK-65-T	12.00	8.00	10.20	755	
MILBURN CREEK	WVK-65-V	12.30	7.00	8.80	786	
BISHOP BRANCH	WVK-65-X	12.11	7.72	9.53	701	
PLUM ORCHARD CREEK	WVK-65-Z	12.00	6.70	9.20	58	

TABLE 6. WATER QUALITY – PHYSICOCHEMICAL CHARACTERISTICS						
Stream name	Ancode	temp C	Ph	oxygen mg/l	conduct mhos/cm	flow cfs
PACKS BRANCH	WVK-65-DD	13.50	7.66	9.50	234	
NORTH SAND BRANCH	WVK-65-HH-1	13.90	7.45	8.90	200	
MAPLE FORK	WVK-65-HH-1-A	13.20	7.30	9.30	135	
LOWER CREEK	WVK-67	15.40	7.90	9.10	431	
UPPER CREEK	WVK-68	13.61	7.96	8.99	383	
MORRIS CREEK	WVK-70-{00.4}	15.00	7.00	9.30	492	
SCHUYLER FORK	WVK-70-A	14.40	6.63	7.60	375	
BOOMER BRANCH	WVK-74	16.99	8.08	8.54	1610	
JARRETT BRANCH	WVK-75	14.37	9.31	9.47	597	
BIG RIGHT HAND FORK	WVK-76-B	11.97	7.63	9.50	247	
MULBERRY FORK	WVK-76-C	15.30	7.80	9.20	418	
DEMPSEY BRANCH	WVK-76-C-1	14.90	8.00	9.30	257	
BEARDS FORK	WVK-76-D	14.80	7.90	9.30	480	
INGRAM BRANCH	WVK-76-K	14.40	5.90	9.20	544	
FALLS CREEK	WVK-80	12.61	7.90	10.07	363	
S.W.C. II (3-10 meters)						
CAMPBELLS CREEK	WVK-49-{00.3}	15.00	7.50	8.60	345	
DRY BRANCH/CAMPBELLS CREEK	WVK-49-A	16.00	7.40	8.00	143	
LEFT FORK/LENS CREEK	WVK-53-A	12.46	7.46	8.78	361	
LENS CREEK	WVK-53-{00.3}	11.70	7.81	10.61	328	
WITCHER CREEK	WVK-57	14.40	7.40	8.90	220	
LEFT FORK/WITCHERS CREEK	WVK-57-C	14.40	7.30	8.60	299	
SLAUGHTER CREEK	WVK-60	14.32	7.16	8.40	603	
WET BRANCH	WVK-61-C	13.40	7.80	9.30	444	
LONGBOTTOM CREEK	WVK-61-F	13.01	6.97	9.14	124	
GREENS BRANCH	WVK-61-G	14.20	7.50	8.90	470	0.4816
HORSEMILL BRANCH	WVK-64-A	14.00	6.33	8.81	517	
LEFT FORK/KELLYS CREEK	WVK-64-K	13.60	7.90	8.80	586	
PAINT CREEK AT COLLINS	WVK-65-{06.9}	13.30	8.10	10.00	652	
BANNER HOLLOW	WVK-65-D	15.20	7.60	8.90	274	
SOUTH SAND BRANCH	WVK-65-HH-2	14.80	7.80	9.50	283	
HUGHES CREEK	WVK-66-{00.3}	12.39	8.03	9.35	848	
BULLPUSH RUN	WVK-72-B	14.30	7.70	8.86	1200	
SMITHERS CREEK	WVK-72-{00.5}	14.61	8.00	9.54	1100	
ARMSTRONG CREEK	WVK-73-{00.4}	16.00	7.70	9.20	372	
LOOP CREEK	WVK-76-{00.3}	9.80	7.90	9.80	442	
S.W.C. III (>10 meters)						
CABIN CREEK NEAR MOUTH	WVK-61-{00.8}	12.40	7.50	9.20	710	
KELLYS CREEK	WVK-64-{00.4}	14.44	7.41	8.43	519	
PAINT CREEK AT MOUTH	WVK-65-{00.5}	16.40	7.60	9.90	372	
PAINT CREEK AT BURNWELL	WVK-65-{12.8}	14.06	8.30	10.23	618	
PAINT CREEK AT RATTLESNAKE RUN	WVK-65-{20.1}	12.09	8.50	9.36	496	
Water Quality Only Streams						
SIXMILE BRANCH/LENS CREEK	WVK-53-D					
COUNTERFEIT BRANCH	WVK-57-D	12.27	7.34	10.49	86	
MILL BRANCH	WVK-58-A	11.07	7.31	11.00	100	
NEW WEST HOLLOW	WVK-58-B.8-1					
CARROLL BRANCH	WVK-59					0.3114
CANE FORK	WVK-61-J	12.79	3.51	9.87	925	1.1608
FIFTEENMILE FORK/CABIN CR	WVK-61-O	12.84	5.65	9.65	1011	5.2147

TABLE 6. WATER QUALITY – PHYSICOCHEMICAL CHARACTERISTICS						
Stream name	Ancode	temp C	Ph	oxygen mg/l	conduct mhos/cm	flow cfs
ABBOTT CREEK	WVK-61-O-1	12.31	6.59	9.42	1056	
LONG BRANCH/FIFTEENMILE	WVK-61-O-2	12.02	6.92	10.66	746	
WATSON BRANCH	WVK-62	11.33	3.31	9.87	595	
MILE BRANCH	WVK-63	14.06	7.85	7.65	802	0.1373
JONES BRANCH	WVK-65-C	9.32	7.90	11.40	393	
FIFTEENMILE CREEK/PAINT CR	WVK-65-R	14.00	7.50	9.50	899	
LYKINS CREEK	WVK-65-W	15.20	6.30	8.30	225	
LONG BRANCH	WVK-65-Y-2	11.40	6.50	6.70	191	
BIG FORK/PACKS BRANCH	WVK-65-DD-2	11.30	6.60	9.70	425	
WEST HOLLOW	WVK-68.5	12.60	7.50	8.00	828	
STATEN RUN	WVK-71	15.30	7.60	8.00	1164	
FISHHOOK FORK	WVK-72-A-1	10.90	8.90	9.20	1550	
TUCKER HOLLOW	WVK-73-A	15.90	5.00	8.70	500	0.138
JENKINS FORK	WVK-73-D	15.50	7.20	7.90	320	
POWELLTON FORK/ARMSTRONG	WVK-73-E	16.50	7.50	9.10	467	
LAUREL FORK/POWELLTON FORK	WVK-73-E-1	14.00	6.90	8.38	325	
RIGHT FORK/BEARDS FORK	WVK-76-D-1	12.60	6.90	8.80	386	
ROBINSON BRANCH	WVK-76-E	12.70	7.30	8.70	577	
MOLLY KINCAID BRANCH	WVK-76-G	12.50	7.60	8.80	344	
CAMP BRANCH	WVK-76-J	11.60	6.80	8.50	462	
KANAWHA RIVER @ SOUTHSIDE BR.	WVO-20-{58.5}	17.40	7.70	8.80	181	
KANAWHA RIVER @ CHELYAN	WVO-20-{73.6}	17.80	7.70	8.70	152	
KANAWHA RIVER @ FALLS CR	WVO-20-{94.4}	16.40	7.80	8.90	153	

TABLE 7: WATER QUALITY - PHYSICOCHEMICAL CHARACTERISTICS OF SITES SAMPLED FOR ACID MINE DRAINAGE

name	Ancode	pH S.U.	acid-hot mg/l	alkalinity mg/l	sulfate mg/l	Fe mg/l	Al mg/l	Mn mg/l	flow
S.W.C. I (0-3 meters)									
FIELDS CREEK	WVK-58	8.0	ND	72	93	0.12	0.11	0.31	
WOLFPEN HOLLOW	WVK-58-B.1	4.4	77	1	330	0.21	11	11	
OLD WEST HOLLOW	WVK-58-B.8-2	7.2	ND	120	19	1.5	ND	0.49	
LAUREL FORK/COAL FK	WVK-61-H-1	5.4	4	4	120	0.16	0.83	0.42	1.79
BEAR HOLLOW	WVK-61-I	5.9	5	5	350	0.09	0.48	3	0.69
TENMILE FORK/CABIN CR	WVK-61-L	8.1	ND	115	370	1.1	1.2	0.25	6.74
HICKS HOLLOW	WVK-61.5	3.9	130	ND	560	10	19	2.7	0.24
FOURMILE FORK	WVK-65-E	7.2	ND	21	110	0.3	0.44	0.23	3.13
SYCAMORE BRANCH	WVK-65-L	8.2			530	0.3	0.4		
TENMILE FORK	WVK-65-M	4.7	22	3	470	2.7	4.4	1.4	2.14
LONG BRANCH/TENMILE	WVK-65-M-1	4.6	35	2	330	0.12	5	0.83	1.86
HICKORY CAMP BRANCH	WVK-65-P	4.7	31	3	450	0.15	6.7	1.8	0.15
CEDAR CREEK	WVK-65-Q	4.5	63	1	360	0.33	11	1.5	0.22
1st UNT ABOVE CEDAR CR	WVK-65-Q.3	3.6	70	ND	430	1.8	7.8	6.3	0.1
2nd UNT ABOVE CEDAR CR	WVK-65-Q.5	2.7	320	ND	310	15	23	4.8	
LICK BRANCH	WVK-65-S	4.0	49	ND	370	0.26	6.7	2.2	0.35
MILBURN CREEK	WVK-65-V	7.0	ND	65	390	0.42		0.32	
MORRIS CREEK	WVK-70-{00.4}	7.0	ND	12	200	2.1	1.1	0.74	
SCHUYLER FORK	WVK-70-A	6.6	ND	26	150		0.96	0.44	
BOOMER BRANCH	WVK-74	8.1	ND	180	890	2.2	1.1	0.26	
INGRAM BRANCH	WVK-76-K	5.9	4		240	0.2	1	0.28	
S.W.C. II (3-10 meters)									
SLAUGHTER CREEK	WVK-60	7.2	ND	24	230	0.19	0.89	3.2	
GREENS BRANCH	WVK-61-G	7.5	ND	37	120	0.27	0.71	0.32	0.48
HORSEMILL BRANCH	WVK-64-A	6.3	4	6	240	0.48	3.2	3.2	
BULLPUSH RUN	WVK-72-B	7.7	ND	190	470	0.43	ND	0.13	
LOOP CREEK	WVK-76-{00.3}	7.9	ND	68	150	0.12	0.26	ND	
S.W.C. III (>10 meters)									
CABIN CREEK NEAR MOUTH	WVK-61-{00.8}	7.5	ND	46	310	0.17	ND	0.25	
Water Quality Only Streams									
COUNTERFEIT BRANCH	WVK-57-D	7.3	ND	15	25	ND	0.22	ND	
MILL BRANCH	WVK-58-A	7.3	ND	14	25	0.13	0.16	ND	
CARROLL BRANCH	WVK-59	N/A	36	4	310	0.15	5	2.9	0.31
CANE FORK	WVK-61-J	3.5	64	ND	500	2.4	6.6	2.2	1.16
FIFTEENMILE FORK	WVK-61-O	5.7	56	7	550	26	6.9	2.4	5.21
ABBOTT CREEK	WVK-61-O-1	6.6	ND	37	600	14	1.8	1.2	
LONG BRANCH	WVK-61-O-2	6.9	ND	11	380	0.35	3	0.55	
WATSON BRANCH	WVK-62	3.3	95	ND	240	0.88	11	4.1	
MILE BRANCH	WVK-63	7.9	ND	220	240	1.6	0.37	0.07	0.13
JONES BRANCH	WVK-65-C	7.9	ND	80	140	ND	0.12	ND	
FIFTEENMILE CREEK	WVK-65-R	7.5	ND	69	470	0.81	0.18	0.15	
LYKINS CREEK	WVK-65-W	6.3	1	5	94	ND	ND	0.12	
BIG FORK/PACKS BR	WVK-65-DD-2	6.6	ND	56	170	0.09	ND	0.024	
WEST HOLLOW	WVK-68.5	7.5	ND	130	310	0.13	0.2	ND	
STATEN RUN	WVK-71	7.6	ND	280	350	3.3	0.26	0.49	
FISHHOOK FORK	WVK-72-A-1	8.9	ND	76	850	0.09	0.18	ND	
TUCKER HOLLOW	WVK-73-A	5.0	14	3	220	0.13	1.5	0.81	0.13

JENKINS FORK	WVK-73-D	7.2	ND	9	150	0.44	1.2	0.2	
POWELLTON FORK	WVK-73-E	7.5	ND	35	220	ND	0.4	0.049	
LAUREL FORK	WVK-73-E-1	6.9	ND	39	120	0.57	0.32	0.036	
RIGHT FORK	WVK-76-D-1	6.9	ND	20	180	0.12	0.24	ND	
ROBINSON BRANCH	WVK-76-E	7.3	ND	33	270	0.84	0.47	0.42	
MOLLY KINCAID BRANCH	WVK-76-G	7.6	ND	67	110	3.3	0.23	0.49	
CAMP BRANCH	WVK-76-J	6.8	ND	32	210	ND	0.16	ND	
KANAWHA RIVER @ SOUTH SIDE BRIDGE.	WVO-20-{58.5}	7.7	ND	56	25	0.27	0.23	0.034	
KANAWHA RIVER @ CHELYAN	WVO-20-{73.6}	7.7	ND	46	24	0.19	0.23	0.03	
KANAWHA RIVER @ FALLS CR	WVO-20-{94.4}	7.8	ND	54	33	0.15	0.24	ND	

TABLE 8. WATER QUALITY - FECAL COLIFORM BACTERIA AND TURBIDITY

Name	Ancode	fecal coliform colonies/ 100 ml	turbidity				
			clear	slightly	moderately	turbid	opaque
S.W.C. I (0-3 meters)							
LICK BRANCH/KANAWHA RIVER	WVK-45	12000		√			
MISSION HOLLOW	WVK-46-A	1000	√				
LOWER DONNALLY BRANCH	WVK-48	4300	√				
COAL FORK/CAMPBELLS CREEK	WVK-49-D	300			√		
CLOVER HOLLOW	WVK-49-E	300			√		
POINT LICK FORK	WVK-49-F	1000	√				
FIVEMILE HOLLOW	WVK-49-H	220	√				
RATTLESNAKE HOLLOW	WVK-49-I	200	√				
GEORGES CREEK	WVK-50	400				√	
RUSH CREEK	WVK-51	130	√				
RIGHT FORK/RUSH CREEK	WVK-51-A	180	√				
BURNING SPRING BRANCH	WVK-52	900		√			
RING HOLLOW	WVK-53-B	>6000	√				
FOURMILE CREEK/LENS CREEK	WVK-53-C	1600	√				
SPRUCE FORK	WVK-53-C-1	>6000	√				
SIMMONS CREEK	WVK-54	2600		√			
KELLY BRANCH/SIMMONS CREEK	WVK-54-A	6000+	√				
DRY BRANCH/WITCHERS CREEK	WVK-57-A	6000+			√		
FIELDS CREEK	WVK-58	3200	√				
WOLFPEN HOLLOW	WVK-58-B.1	390	√				
OLD WEST HOLLOW	WVK-58-B.8-2	26	√				
LITTLE CREEK	WVK-60-A	50	√				
DRY BRANCH/CABIN CREEK	WVK-61-B	4200	√				
PAINT BRANCH/CABIN CREEK	WVK-61-E	1500	√				
COAL FORK/CABIN CREEK	WVK-61-H	110	√				
LAUREL FORK/COAL FORK	WVK-61-H-1	<2	√				
BEAR HOLLOW	WVK-61-I	150	√				
TENMILE FORK/CABIN CREEK	WVK-61-L	6000+		√			
HICKS HOLLOW	WVK-61.5			√			
FIVEMILE FORK	WVK-64-I	40	√				
HURRICANE FORK/KELLYS CREEK	WVK-64-J	6000 +	√				
MILBURN BRANCH	WVK-65-A	200	√				
SUGARCAMP BRANCH	WVK-65-B	110	√				
FOURMILE FORK/PAINT CREEK	WVK-65-E	320		√			
HURRICANE BRANCH/PAINT CR	WVK-65-I	140	√				
TOMS BRANCH	WVK-65-J	120			√		
BRUSHY CREEK	WVK-65-K	6000+	√				
SYCAMORE BRANCH	WVK-65-L	230		√			
TENMILE FORK/PAINT CREEK	WVK-65-M	10		√			
LONG BRANCH/TENMILE FORK	WVK-65-M-1	32	√				
HICKORY CAMP BRANCH	WVK-65-P	10	√				

TABLE 8. WATER QUALITY - FECAL COLIFORM BACTERIA AND TURBIDITY

Name	Ancode	fecal coliform colonies/ 100 ml	turbidity				
			clear	slightly	moderately	turbid	opaque
CEDAR CREEK	WVK-65-Q	48	√				
1st UNT ABOVE CEDAR CREEK	WVK-65-Q.3	6	√				
2nd UNT ABOVE CEDAR CREEK	WVK-65-Q.5	<2	√				
LICK BRANCH/PAINT CREEK	WVK-65-S	18	√				
SKITTER CREEK	WVK-65-	24	√				
MILBURN CREEK	WVK-65-V	1900	√				
BISHOP BRANCH	WVK-65-X	>6000	√				
PLUM ORCHARD CREEK	WVK-65-Z	90	√				
PACKS BRANCH	WVK-65-DD	1200		√			
NORTH SAND BRANCH	WVK-65-HH-1	52000			√		
MAPLE FORK	WVK-65-HH-1-A	2000			√		
LOWER CREEK	WVK-67	600		√			
UPPER CREEK	WVK-68	84			√		
MORRIS CREEK	WVK-70-{00.4}	3400		√			
SCHUYLER FORK	WVK-70-A	200	√				
BOOMER BRANCH	WVK-74	250	√				
JARRETT BRANCH	WVK-75	420			√		
BIG RIGHT HAND FORK	WVK-76-B	SAMPLE LOST	√				
MULBERRY FORK	WVK-76-C	700	√				
DEMPSEY BRANCH	WVK-76-C-1	6000+	√				
BEARDS FORK	WVK-76-D	380	√				
INGRAM BRANCH	WVK-76-K	170	√				
FALLS CREEK	WVK-80	2200		√			
S.W.C. II (3-10 meters)							
CAMPBELLS CREEK	WVK-49-{00.3}	1000		√			
DRY BRANCH/CAMPBELLS CREEK	WVK-49-A	400		√			
LEFT FORK/LENS CREEK	WVK-53-A	250	√				
LENS CREEK	WVK-53-{00.3}	6000+	√				
WITCHER CREEK	WVK-57	500		√			
LEFT FORK/WITCHERS CREEK	WVK-57-C	3600	√				
SLAUGHTER CREEK	WVK-60	30	√				
WET BRANCH	WVK-61-C	120	√				
LONGBOTTOM CREEK	WVK-61-F	3200	√				
GREENS BRANCH	WVK-61-G	700	√				
HORSEMILL BRANCH	WVK-64-A	2	√				
LEFT FORK/KELLYS CREEK	WVK-64-K	300	√				
PAINT CREEK AT COLLINS	WVK-65-{06.9}	140	√				
BANNER HOLLOW	WVK-65-D	2200	√				
SOUTH SAND BRANCH	WVK-65-HH-2	340		√			
HUGHES CREEK	WVK-66-{00.3}	160	√				
BULLPUSH RUN	WVK-72-B	3000	√				
SMITHERS CREEK	WVK-72-{00.5}	1500	√				

TABLE 8. WATER QUALITY - FECAL COLIFORM BACTERIA AND TURBIDITY

Name	Ancode	fecal coliform colonies/ 100 ml	turbidity				
			clear	slightly	moderately	turbid	opaque
ARMSTRONG CREEK	WVK-73-{00.4}	1600	√				
LOOP CREEK	WVK-76-{00.3}	800	√				
S.W.C. III (>10 meters)							
CABIN CREEK NEAR MOUTH	WVK-61-{00.8}	2700	√				
KELLYS CREEK	WVK-64-{00.4}	300	√				
PAINT CREEK AT MOUTH	WVK-65-{00.5}	2200		√	√		
PAINT CREEK AT BURNWELL	WVK-65-{12.8}	64	√				
PAINT CREEK AT RATTLESNAKE RUN	WVK-65-{20.1}	2800	√				
Water Quality Only Streams (turbidity estimates not recorded)							
SIXMILE BRANCH/LENS CREEK	WVK-53-D	450					
COUNTERFEIT BRANCH	WVK-57-D	800					
MILL BRANCH	WVK-58-A	360					
NEW WEST HOLLOW	WVK-58-B.8-1						
CARROLL BRANCH	WVK-59	<2					
CANE FORK	WVK-61-J						
FIFTEENMILE FORK/CABIN CR	WVK-61-O	360					
ABBOTT CREEK	WVK-61-O-1	28					
LONG BRANCH/FIFTEENMILE	WVK-61-O-2	6					
WATSON BRANCH	WVK-62						
MILE BRANCH	WVK-63	2800					
JONES BRANCH	WVK-65-C	340					
FIFTEENMILE CREEK/PAINT CR	WVK-65-R	420					
LYKINS CREEK	WVK-65-W	50					
LONG BRANCH	WVK-65-Y-2	190					
BIG FORK/PACKS BRANCH	WVK-65-DD-2	12					
WEST HOLLOW	WVK-68.5	120					
STATEN RUN	WVK-71	22					
FISHHOOK FORK	WVK-72-A-1	20					
TUCKER HOLLOW	WVK-73-A	2					
JENKINS FORK	WVK-73-D	1100					
POWELLTON FORK/ARMSTRONG	WVK-73-E	6000					
LAUREL FORK/POWELLTON FORK	WVK-73-E-1	32					
RIGHT FORK/BEARDS FORK	WVK-76-D-1	30					
ROBINSON BRANCH	WVK-76-E	20					
MOLLY KINCAID BRANCH	WVK-76-G	56					
CAMP BRANCH	WVK-76-J	12					
KANAWHA RIVER @ SOUTHSIDE BR.	WVO-20-{58.5}	180					
KANAWHA RIVER @ CHELYAN	WVO-20-{73.6}	80					
KANAWHA RIVER @ FALLS CR	WVO-20-{94.4}	44					

TABLE 9. BENTHIC COMMUNITY METRICS							
Stream AN Code	Taxa Richness	EPT	HBI	% Dom. Taxon	CLI	EPT/ Chir.	Scrapers/ Fil-Coll
S.W.C. I (0-3 meters)							
WVK-45	10	3	5.4	75.5	0.9	1.00	0.27
WVK-46-A	5	1	9.1	79.7	2	0.20	0.00
WVK-48	9	2	6.5	23.8	0.78	0.25	0.33
WVK-49-D	5	0	7.9	66.1	2	0.00	1.00
WVK-49-E	12	5	5.1	37.8	0.42	0.15	0.30
WVK-49-F	13	5	5.8	43.4	0.46	0.13	0.04
WVK-49-H	13	7	5	45.7	0.46	0.16	0.38
WVK-49-I	7	0	5	36	1.14	0.00	1.00
WVK-50	11	4	5.1	30.2	0.55	0.80	0.51
WVK-51	12	6	4.8	34.5	0.42	0.40	0.55
WVK-51-A	12	5	4.9	25	0.5	0.50	0.71
WVK-52	17	6	5.7	20.4	0.29	0.25	0.37
WVK-53-B	12	6	5.3	34	0.5	0.16	0.83
WVK-53-C	12	5	6	46.4	0.33	0.05	0.71
WVK-53-C-1	17	10	4.7	21.2	0.18	0.32	0.58
WVK-54	11	5	5.4	24	0.27	0.13	0.54
WVK-54-A	17	11	4.9	49.1	0.24	0.16	0.62
WVK-57-A	11	2	6.8	72.6	0.73	0.04	0.67
WVK-58	8	4	6.9	38.2	0.88	0.24	0.46
WVK-60-A	6	1	4.7	50	1.5	1.00	0.14
WVK-61-B	11	4	6	22.6	0.36	0.18	0.57
WVK-61-E	13	6	4.8	34.6	0.38	0.24	0.50
WVK-61-H	11	5	4	18.8	0.45	0.42	0.25
WVK-61-H-1	7	4	4	56.5	1.43	0.80	0.00
WVK-61-I	6	2	3.2	65.1	1.67	0.40	0.00
WVK-61-L	5	2	5.3	40.7	1.8	0.11	0.11
WVK-61.5	2	0	6	75	6	0.00	0.00
WVK-64-I	14	6	4.7	41.3	0.36	0.55	0.39
WVK-64-J	8	3	7.1	33.3	0.88	0.10	0.19
WVK-65-A	SAMPLE NOT PRESERVED						
WVK-65-B	10	8	4.6	67	0.8	0.62	0.01
WVK-65-DD	19	12	4.3	27.5	0.16	0.67	0.21
WVK-65-E	11	5	5.2	44.9	0.64	0.50	0.07
WVK-65-HH-1	4	0	7.8	51.1	2.5	0.00	0.00
WVK-65-HH-1-A	12	5	5.5	40.7	0.42	0.22	0.09
WVK-65-I	15	9	4	33.6	0.33	0.39	0.08
WVK-65-J	11	6	4.4	73	0.64	0.67	0.05
WVK-65-K	13	7	4.5	48.1	0.31	0.78	0.08
WVK-65-L	9	4	5.4	26.9	0.89	0.12	0.00
WVK-65-M	2	1	5.1	95	5.5	0.50	0.00
WVK-65-M-1	8	2	4.9	68.9	1.13	0.20	0.09
WVK-65-P	4	1	5.1	88.9	2.5	0.50	0.00
WVK-65-Q	3	1	4.9	87.5	3.33	0.50	0.00

WVK-65-Q.3		PARTIAL KICK - UNCOMPARABLE						
WVK-65-Q.5		PARTIAL KICK - UNCOMPARABLE						
WVK-65-S		PARTIAL KICK - UNCOMPARABLE						
WVK-65-T		9	6	4.5	51.2	0.89	0.86	0.00
WVK-65-V		11	5	3.6	35	0.45	0.33	0.00
WVK-65-X		14	5	5.1	51.6	0.36	0.28	0.10
WVK-65-Z		15	6	5.2	28.4	0.4	0.26	0.19
WVK-67		10	5	5.4	41	0.6	0.22	0.00
WVK-68		13	7	5.8	30.8	0.31	0.47	0.58
WVK-70-A		13	5	3.9	41.8	0.46	0.45	0.03
WVK-70-{00.4}		1	0	5	100	13	0.00	0.00
WVK-74		4	2	7.3	54.3	2.25	0.04	0.00
WVK-75		7	3	4.8	69.6	1.14	0.75	0.04
WVK-76-B		16	10	3.8	20.4	0.31	0.83	0.60
WVK-76-C		15	5	5.2	34.7	0.27	0.29	0.40
WVK-76-C-1		13	5	5.5	36.3	0.54	0.14	0.84
WVK-76-D		13	6	4.7	24.3	N/A	0.55	0.30
WVK-76-K		5	1	5.2	50	2	1.00	0.00
WVK-80		13	6	4.4	63.7	0.46	0.86	0.06
S.W.C. I n=58	average	10.17	4.45	5.26	47.03	1.24	0.37	0.27
	minimum	1	0	3.20	18.8	0.2	0.0	0.0
	maximum	19	12	9.10	100.0	13.0	1.0	1.0
S.W.C. II (3-10 meters)								
WVK-49-A		14	7	6.7	60.7	0.5	0.78	0.71
WVK-49-{00.3}		11	3	6.1	27.9	0.64	0.27	0.60
WVK-53-A		16	8	4.9	25.3	0.31	0.40	0.50
WVK-53-{00.3}		8	1	6.2	50	1.13	0.02	0.51
WVK-57		11	5	5.6	30.8	0.45	0.42	0.86
WVK-57-C		11	6	4.8	35.3	0.45	0.26	0.60
WVK-60		4	2	5.6	40	3	1.00	0.00
WVK-61-C		5	2	5	92.9	2.2	0.29	0.00
WVK-61-F		14	6	5.5	24.1	0.29	0.19	0.38
WVK-61-G		10	4	4.7	77.9	0.9	1.00	0.46
WVK-64-A		2	1	5.4	91.7	6.5	1.00	0.00
WVK-64-K		13	7	5.6	27.2	0.31	0.41	0.09
WVK-65-D		13	7	5.5	42.2	0.31	0.13	0.14
WVK-65-HH-2		10	5	5.3	34.6	0.7	0.33	0.00
WVK-65-{06.9}		8	3	5.7	47.9	1	0.07	0.07
WVK-66-{00.3}		7	2	6.5	56.1	1.14	0.04	0.39
WVK-72-B		9	3	6.4	41.8	1	0.07	0.03
WVK-72-{00.5}		6	2	6.2	56.7	1.5	0.04	0.05
WVK-73-{00.4}		13	6	5.6	45.3	0.38	0.40	0.10
WVK-76-{00.3}		15	8	3.8	26.7	N/A	0.50	0.38
	Average	10.00	4.40	5.56	46.76	1.20	0.38	0.29

S. W. C. II N =20	Minimum	2	1	3.80	24.10	0.29	0.02	0.00
	Maximum	16	8	6.70	93	6.50	1.00	0.86
S.W.C. III (>10 meters)								
WVK-61-{00.8}		11	5	5.6	43.6		0.10	0.05
WVK-64-{00.4}		11	4	5.6	28.3	0.27	0.36	0.19
WVK-65-{12.8}		7	4	5.2	64.6	0.57	0.31	0.05
WVK-65-{20.1}		9	3	6.5	73.3	0.44	0.05	0.56
S. W. C. III n=4	Average	9.50	4.00	5.73	52.45	0.43	0.21	0.21
	Minimum	7	3	5.20	28.3	0.3	0.05	0.05
	Maximum	11	5	6.50	73.3	0.6	0.36	0.56
ALL STREAMS	Average	10.10	4.41	5.37	47.23	1.20	0.37	0.28
	Minimum	1	0	3.20	18.8	0.2	0.00	0.00
	Maximum	19	12	9.10	100.0	13.0	1.00	1.00

Taxa Richness = total number of different macroinverebrate families collected
EPT = number of Ephemeropteran (mayfly), Plecopteran (stonefly), and Tricopteran (caddisfly) families collected
HBI = Hilsenhoff Biotic Integrity - an index indicating relative pollution tolerance of macrobenthos collected
% Dom. Fam. = percent of total number of organisms which are of the numerically dominant family
CLI = Community Loss Index - measures loss of taxa between the reference site and sample site, value increases as degree of dissimilarity with reference increases.
EPT/Chir = ratio of number of EPT taxa to number of Chironomidae
Scraper/Fil-Coll = ratio of scrapers to filtering collectors

Appendix B -- Glossary

303(d) list -a list of streams that are water quality limited and not expected to meet water quality criteria even after applying technology-based controls. Required by the Clean Water Act and named for the section of the Act in which it appears.

acidity -the capacity of water to donate protons. The abbreviation pH (see def.) refers to degree of acidity. Higher acidities are more corrosive and harmful to aquatic life.

acid mine drainage (AMD) -acidic water discharged from an active or abandoned mine.

alkalinity -measures water's buffering capacity, or resistance to acidification; often expressed as the concentration of carbonate and bicarbonate.

aluminum - Al - a potentially toxic metallic element often found in mine drainage; when oxidized forms a white precipitate called "white boy".

benthic macroinvertebrates - small animals without backbones yet still visible to the naked eye, that live on the bottom (the substrate) of a water body, that are large enough to be collected with a 595 µm mesh screen. Examples include insects, snails, and worms.

benthic organisms, or benthos - organisms that live on or near the substrate (bottom) of a water body, e.g., algae, mayfly larvae, darters.

buffer -a dissolved substance that maintains a solution's original pH by neutralizing added acid.

canopy -The layer of vegetation that is more than 5 meters from the ground; see understory and ground cover.

citizens monitoring team -a group of people that periodically check the ecological health of their local streams.

conductivity (conductance) -the capacity of water to conduct an electrical current, higher conductivities indicate higher concentrations of ions.

designated uses -the uses specified in the state water quality standards for each water body or segment (e.g., "fish propagation" or "industrial water supply").

discharge -liquid flowing from a point source; or the volume of water flowing down a stream per unit of time, typically recorded as cfs (cubic feet / second).

discharge permit -a legal document issued by a government regulatory agency specifying the kinds and amounts of pollutants a person or group may discharge into a water body; often called NPDES permit.

dissolved oxygen - DO - the amount of molecular oxygen dissolved in water.

Division of Environmental Protection (DEP) -a unit in the executive branch of West Virginia's state government charged with enforcing environmental laws and monitoring environmental quality.

ecoregion -a land area with relative homogeneity in ecosystems that, under nonimpaired conditions, contain habitats which should support similar communities of animals (specifically macrobenthos).

ecosystem -the complex of a community and its environment functioning as an ecological unit in nature. A not easily defined aggregation of biotic and abiotic components that are interconnected through various trophic pathways, and that interact systematically in the transfer of nutrients and energy.

effluent -liquid flowing from a point source (e.g., pipe or collection pond).

Environmental Quality Board (EQB) -a standing group, whose members are appointed by the governor, that promulgates water quality criteria and judges appeals for relief from water quality regulations.

Environmental Protection Agency (EPA) -a unit in the executive branch of the federal government charged with enforcing environmental laws.

ephemeral -a stream that carries surface water during only part of the year; a stream that occasionally dries up.

eutrophic -a condition of a lake or stream which has higher than normal levels of nutrients, contributing to excessive plant growth. Usually eutrophic waters are seasonally deficient in oxygen. Consequently more food and cover is provided to some macrobenthos than would be provided otherwise.

fecal coliform bacteria -a group of single-celled organisms common in the alimentary tracts of some birds and all mammals, including man; indicates fecal pollution and the *potential* presence of human pathogens.

ground cover -vegetation that forms the lowest layer in a plant community defined as less than 0.5 meters high for this assessment) .

impaired -(1) according to the water quality standards, a stream that does not fully support 1 or more of its designated uses; (2) as used in this assessment report, a benthic macroinvertebrate community with metric scores substantially worse than those of an appropriate reference site.

iron - Fe - a metallic element, often found in mine drainage, that is potentially harmful to aquatic life. When oxidized, it forms an orange precipitate called "yellow boy" that can clog fish and macroinvertebrate gills.

lacustrine - of or having to do with a lake or lakes.

MACS -Mid-Atlantic Coastal Streams -macrobenthic sampling methodology used in streams with very low gradient that lack riffle habitat suitable for The Program's preferred procedure (see Appendix B).

manganese - a metallic element, often found in mine drainage, that is potentially harmful to aquatic life.

metrics -statistical tools used by ecologists to evaluate biological communities (see Appendix B).

National Pollutant Discharge Elimination System (NPDES) -a government permitting activity created by section 402 of the federal Clean Water Act of 1972 to control all discharges of pollutants from point sources. In West Virginia this activity is conducted by the Office of Water Resources.

nonimpaired -(1) according to the water quality standard, a stream that fully supports all of its designated uses: (2) as used in this assessment report, a benthic community with metric scores comparable to those of an appropriate reference site.

nonpoint source (NPS) pollution -contaminants that run off a broad landscape area (e.g., plowed field, parking lot, dirt road) and enter a receiving water body.

Office of Water Resources (OWR) -a unit within the DEP that manages a variety of regulatory and voluntary activities to enhance and protect West Virginia's surface and ground waters.

Oligotrophic - a stream, lake or pond which is poor in nutrients.

Palustrine - of or having to do with a marsh, swamp or bog.

pH -indicates the concentration of hydrogen ions; a measure of the intensity of acidity of a liquid. Represented on a scale of 0-14, a pH of 1 describes the strongest acid, 14 represents the strongest base, and 7 is neutral. Aquatic life cannot tolerate either extreme.

point source -a specific, discernible site (e.g., pipe, ditch, container) locatable on a map as a point, from which pollution discharges into a water body.

reference site -a stream reach that represents an area's (watershed or ecoregion) least impacted condition; used for comparison with other sites within that area. Site must meet the agency's minimum degradation criteria.

SCA -Soil Conservation Agency

stakeholder -a person or group with a vested interest in a watershed, e.g., landowner, businessperson, angler.

STORET -STOrage and RETrieval of U.S. waterways parametric data -a system maintained by EPA and used by OWR to store and analyze water quality data.

SWC I, SWC II and SWC III, - Stream Width Category - a system of classifying streams by width. SWC I includes streams less than three meters wide. SWC II includes streams between three and ten meters wide. SWC III includes all streams over ten meters wide.

total maximum daily load (TMDL) -the total amount of a particular pollutant that can enter a water body and not cause a water quality standards violation.

turbidity - the extent to which light passes through water, indicating its clarity; indirect measure of suspended sediment.

understory - the layer of vegetation that form a forest's middle layer (defined as 0.5 to 5 meters high for this assessment).

USGS - United States Geological Survey.

water-contact recreation -the type of designated use in which a person (e.g., angler, swimmer, boater) comes in contact with the stream's water.

watershed -a geographic area from which water drains to a particular point.

Watershed Approach Steering Committee -a task force of federal (e.g., U.S. EPA, USGS) and state (e.g., DEP, SCA) officers that recommends streams for intense, detailed study.

Watershed Assessment Program (the Program) -a group of scientists within the OWR charged with evaluating and reporting on the ecological health of West Virginia's watersheds.

watershed association -a group of diverse stakeholders working via a consensus process to improve water quality in their local streams.

Watershed Network -an informal coalition of federal, state, multi-state, and non-govern mental groups cooperating to support local watershed associations.